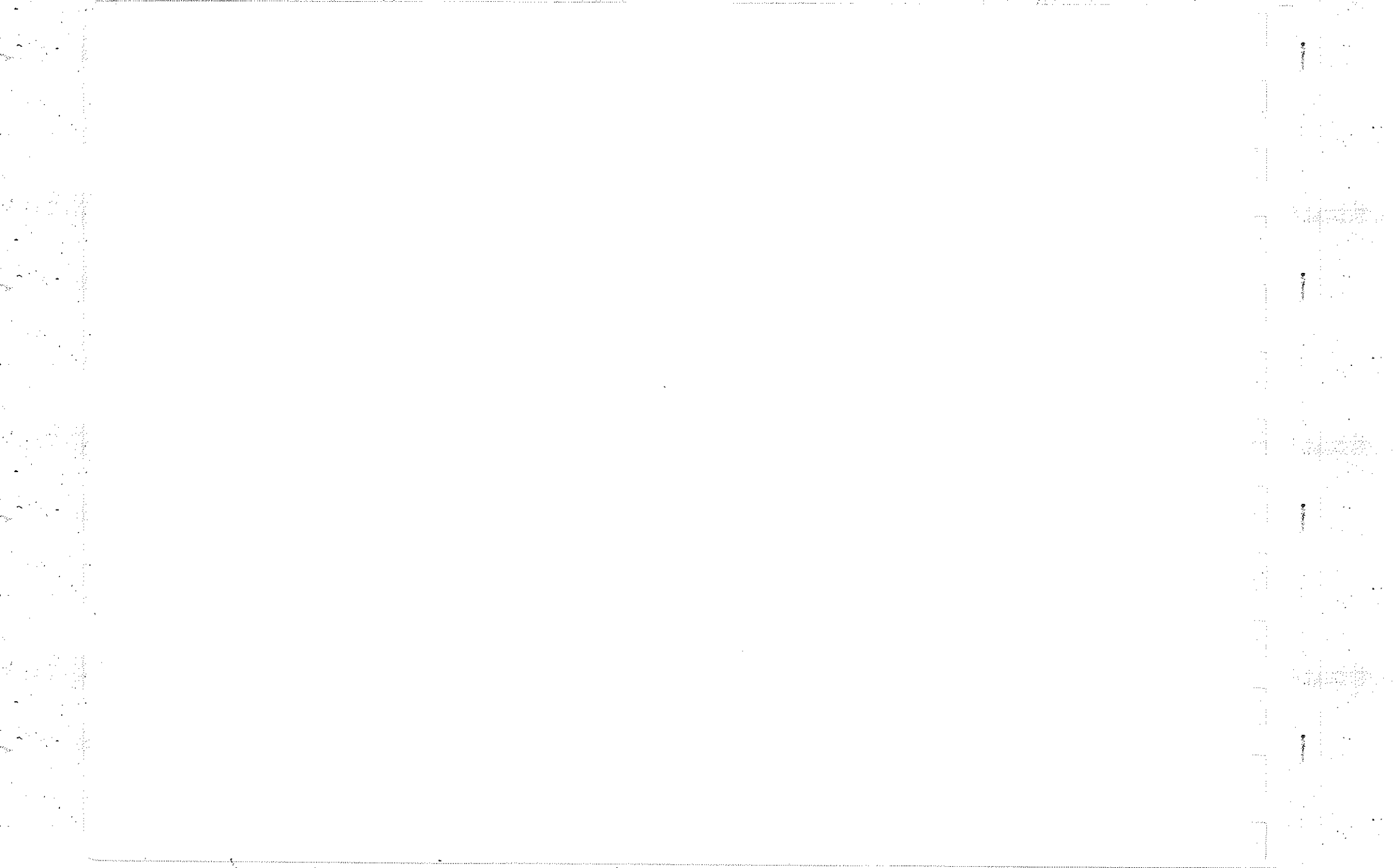


Basic English for Science

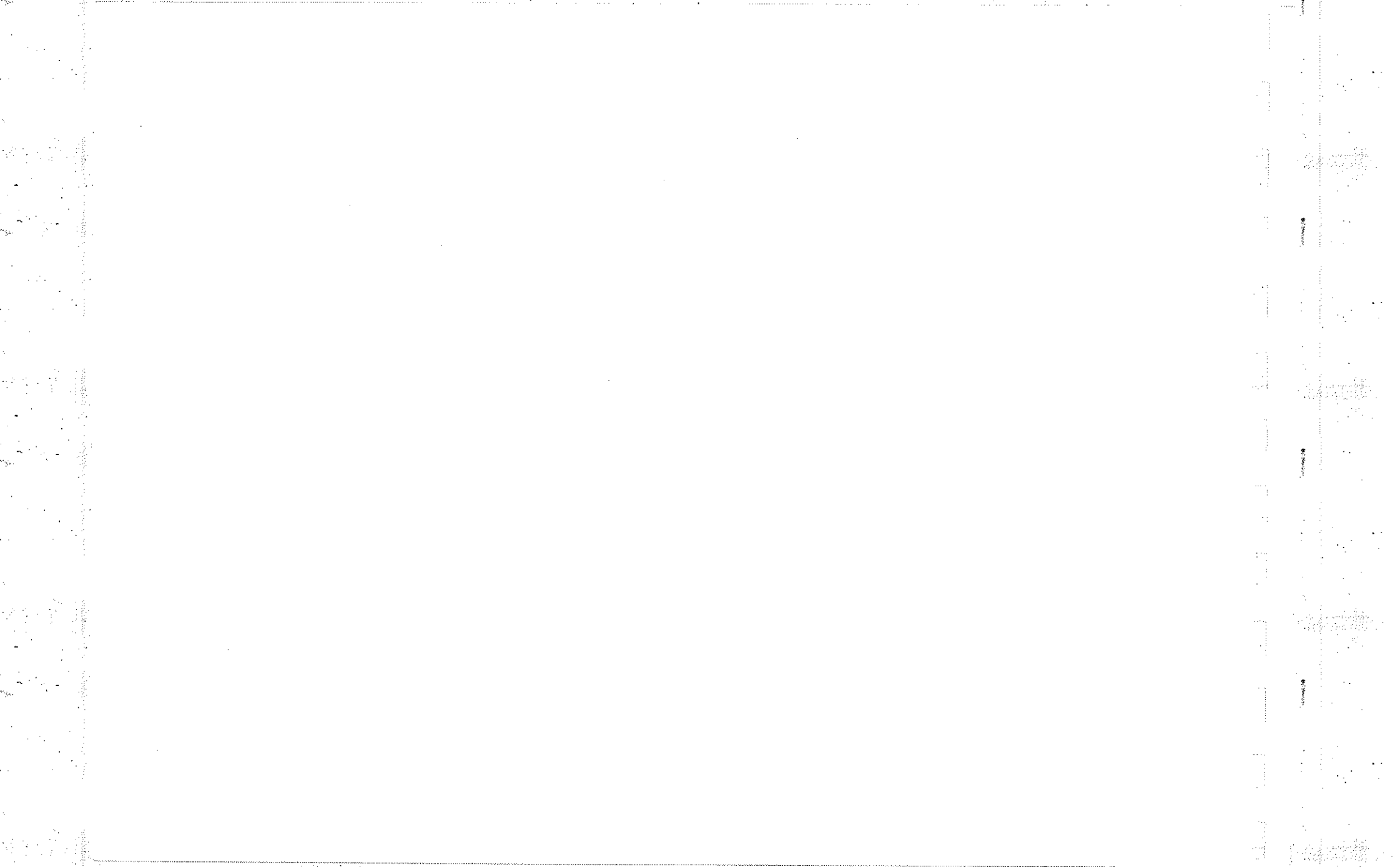


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L
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L

classwork

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SECTION 1 numbers and dimensions

A Read out these numbers.

1	3	8	1,053	15	153.87
2	14	9	2,279	16	73.5
3	40	10	10,874	17	90,005
4	93	11	12.00	18	19.31
5	102	12	100,302	19	44.829
6	231	13	1,000,000	20	80.75
7	995	14	82.985		

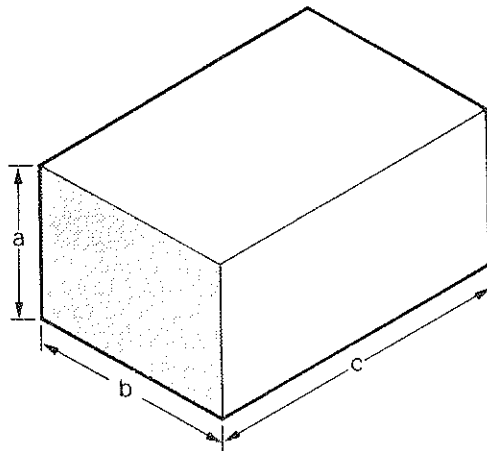
B Put in the decimal point, eg 12.00, or the comma, eg 1,000, when you hear these numbers.

8593	27149	385293	00100
10301	91349	72835	3005
281	7219		

C Write down the names of these units: *mm*, *m*, *cm*, *km*.

D Write down the twelve values you hear.

E What are these dimensions called?



F Use these patterns to ask and answer questions about objects in your classroom, eg window, door, table, etc.

How	high wide long	is ... ?
-----	----------------------	----------

high. ... is ... wide. long.

What is the	height width length	of ... ?
-------------	---------------------------	----------

The	height width length	of ... is ...
-----	---------------------------	---------------

... is ... in		height. width. length.
... has a	height width length	of ...

Height, width and length are all **nouns**
High, wide and long are all **adjectives**

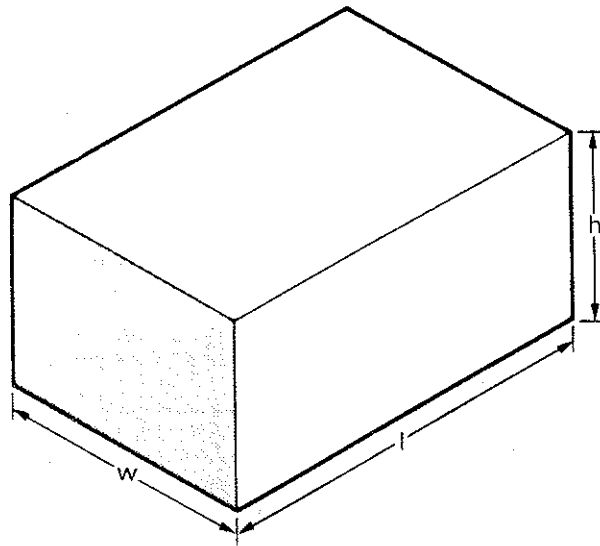
Height, width, length are 1 _____ dimensions.

G Make a table of adjectives and the corresponding nouns like the one below. When you meet new pairs of adjectives and nouns, add them to the list.

Adjective	Noun
high	height

H Describe this block, using the dimensions given:

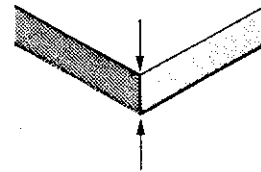
- 1 $w=0.95\text{ m}$ 2 $w=34.24\text{ cm}$ 3 $w=0.23\text{ m}$
 $h=1.02\text{ m}$ $h=18.75\text{ cm}$ $h=0.09\text{ m}$
 $l=2.75\text{ m}$ $l=72.31\text{ cm}$ $l=0.85\text{ m}$



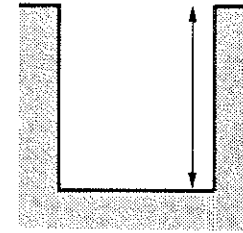
SECTION 2 describing objects

A Write down the names for these dimensions.

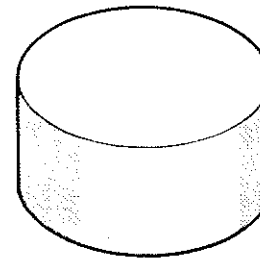
1



2

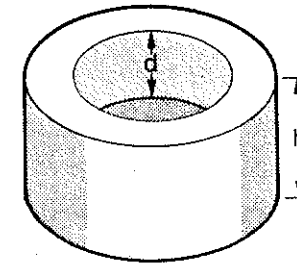


3 This object is ...



4 This object is ...

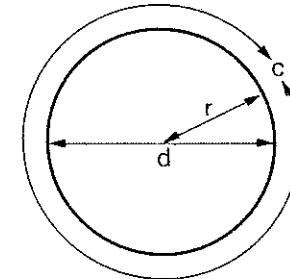
h is an _____ dimension.
 d is an _____ dimension.



5 The adjective to describe a circle is c _____ or r _____.

A circle has dimensions of:

d _____,
 r _____
 and
 c _____.

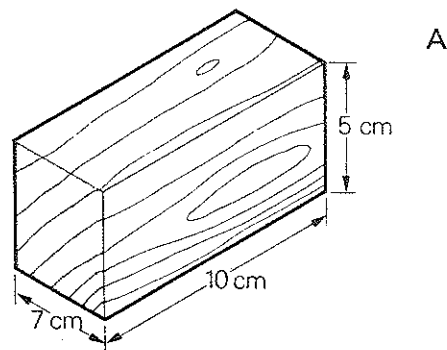


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B Study the descriptions below.

A is a solid wooden block 5 cm high, 10 cm long and 4 cm wide.

A is a solid wooden block. It has a height of 5 cm, a length of 10 cm and a width of 4 cm.



There are three other ways of writing this description:

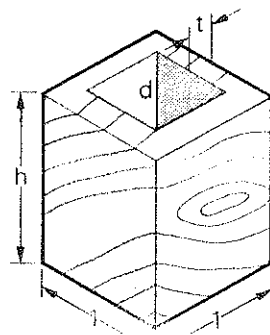
A is a solid wooden block which has a height of 5 cm, a length of 10 cm and a width of 4 cm.

A is a solid wooden block having a height of 5 cm, a length of 10 cm and a width of 4 cm.

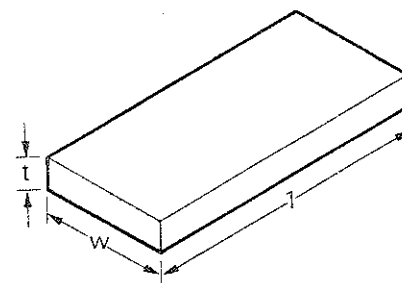
A is a solid wooden block of height 5 cm, length 10 cm and width 4 cm.

Now make similar statements about the following objects:

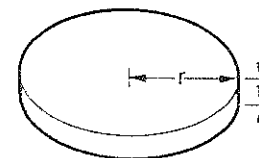
- 1 $h=10$ cm
 $l=8$ cm
 $t=1$ cm
 $d=9$ cm
wood



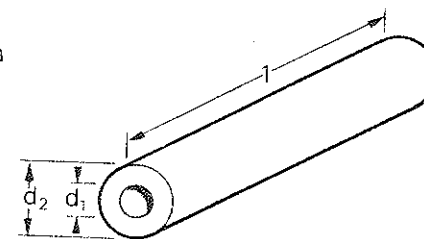
- 2 $t=0.03$ m
 $w=1.0$ m
 $l=5.0$ m
steel



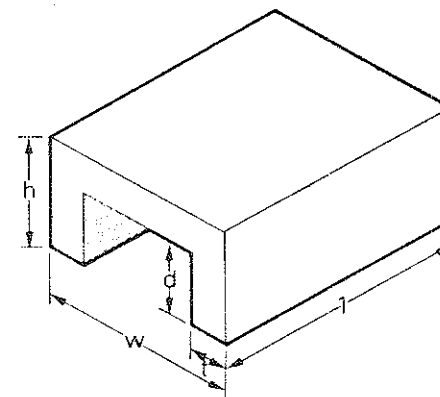
- 3 $r=20$ cm
 $t=0.25$ cm
plastic



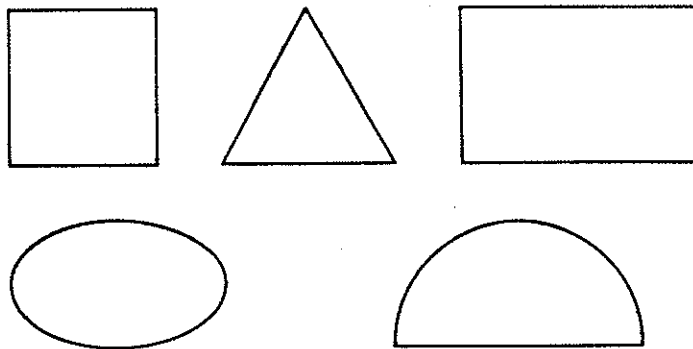
- 4 $l=0.75$ m
 $d_1=0.08$ m
 $d_2=0.002$ m
copper



- 5 $l=0.72$ m
 $h=0.20$ m
 $d=0.28$ m
 $t=0.04$ m
 $w=0.32$ m
aluminium

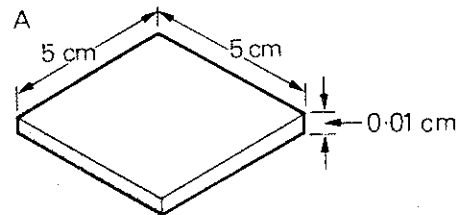


C Here are some shapes which you must learn the names of:

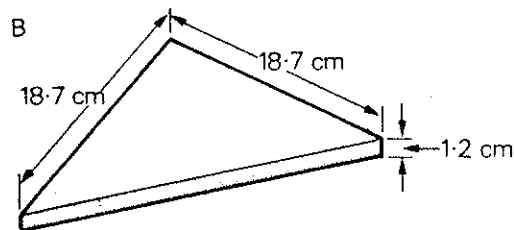


Now complete these descriptions of flat three-dimensional objects.

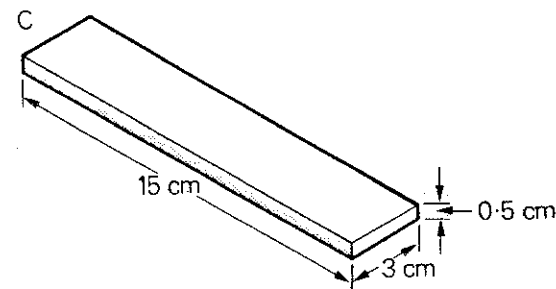
- 1 Object **A** is a _____ plate of side _____ and _____ 0.01 cm.



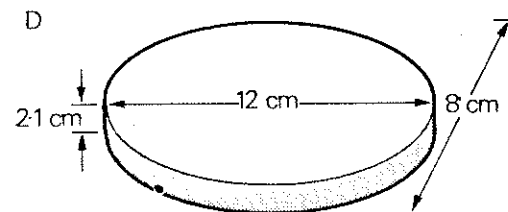
- 2 Object **B** is a _____ plate of side _____ and _____ 1.2 cm.



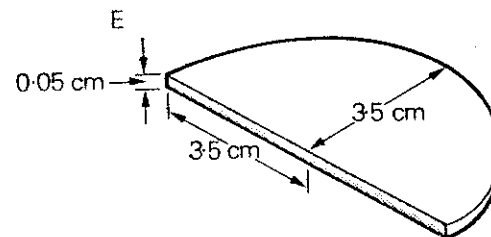
- 3 Object **C** is a _____ plate having a _____ of 15 cm, a _____ of 3 cm and a _____ of 0.5 cm.



- 4 Object **D** is an _____ plate of _____ 2.1 cm.

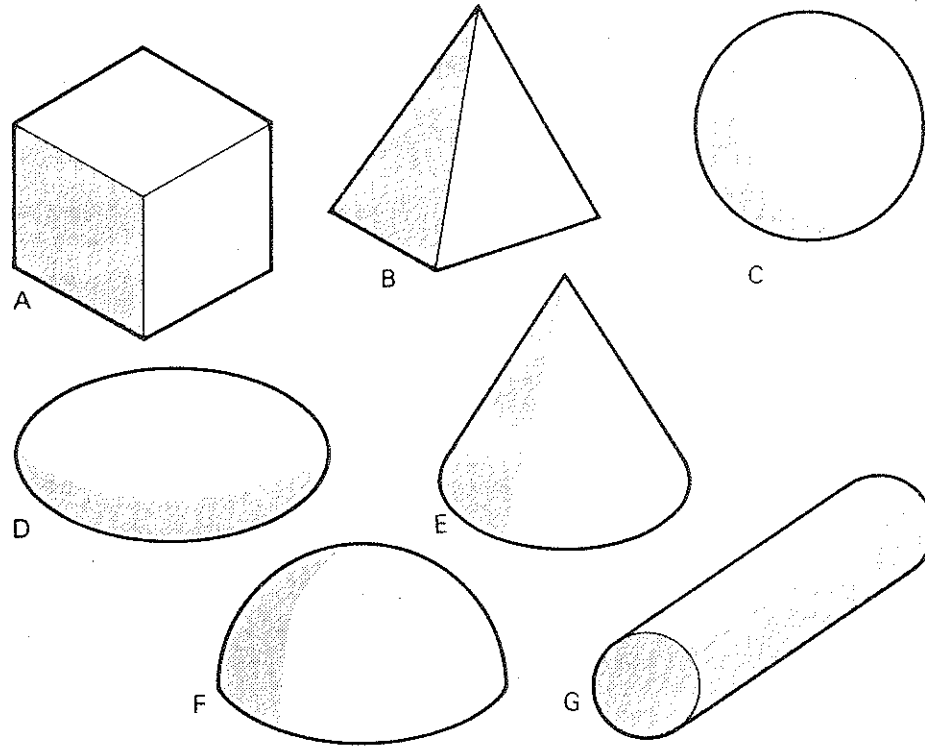


- 5 Object **E** is a _____ plate which has a _____ of 3.5 cm and a _____ of 0.05 cm.



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D Here are some important 3-dimensional shapes:



If the objects are made of the following materials, make statements about them as in this example:

A metal

A is a metal cube.

A steel

B wood

C rubber

D copper (solid)

E iron (hollow)

F plastic (hollow)

G glass (solid)

E Now describe these objects. For example,

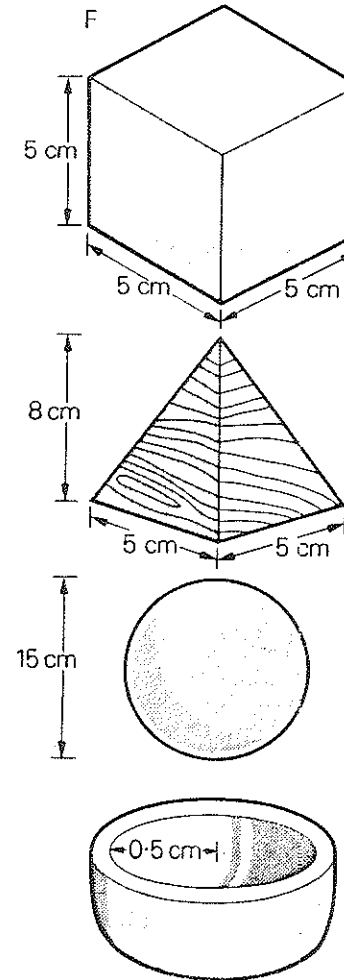
cube: solid
steel

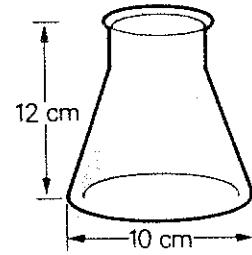
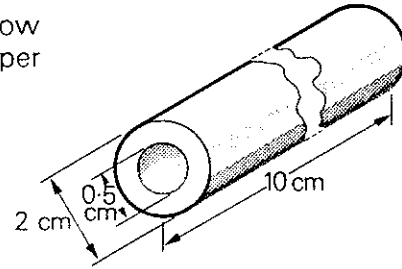
F is a solid steel cube of side 5 cm/having a side of 5 cm/which has a side of 5 cm.

G block: solid
wood

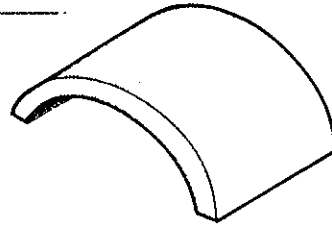
H ball: hollow
rubber

I cup: hollow
silver

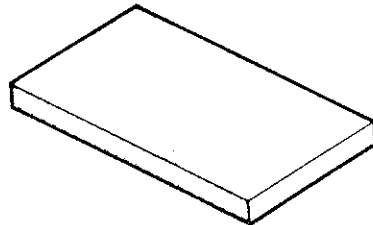


J flask: empty
glassK tube: hollow
copperF Here are some other shapes that are useful for
describing things:

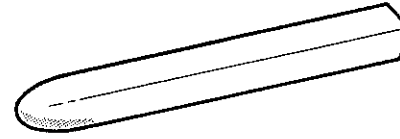
1 This plate is _____.



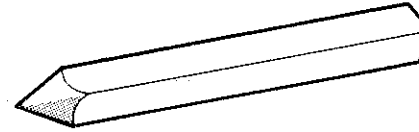
2 This plate is _____.



3 This rod is _____ at one end.



4 This rod is _____ at one end.



5 This line is _____.



6 This line is _____.



7 A _____ line.



8 A _____ line.



9 A _____ line.



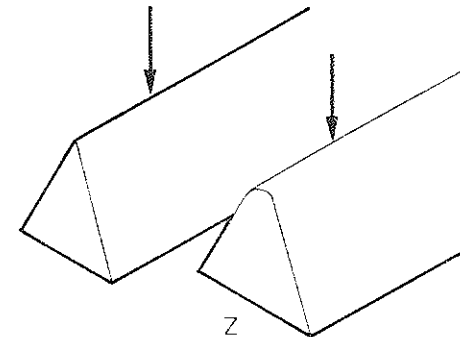
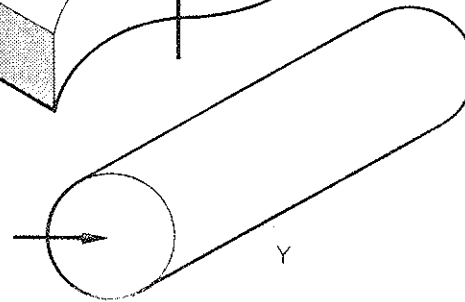
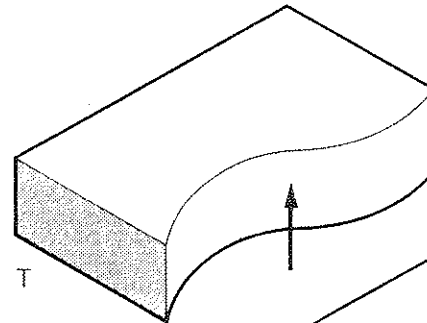
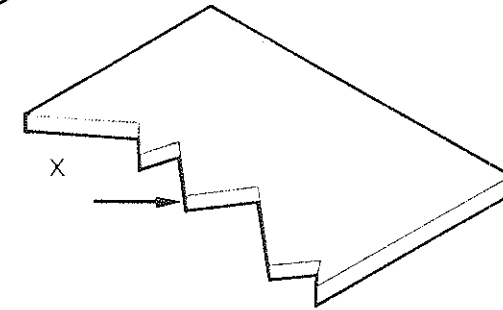
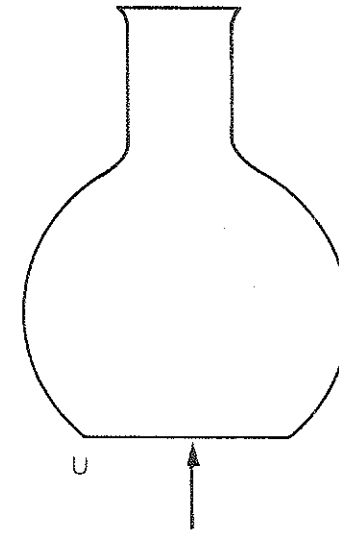
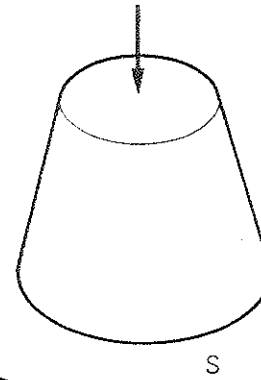
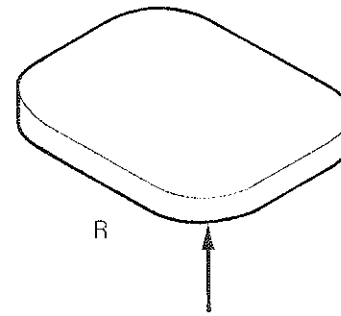
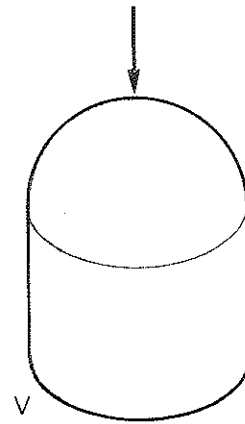
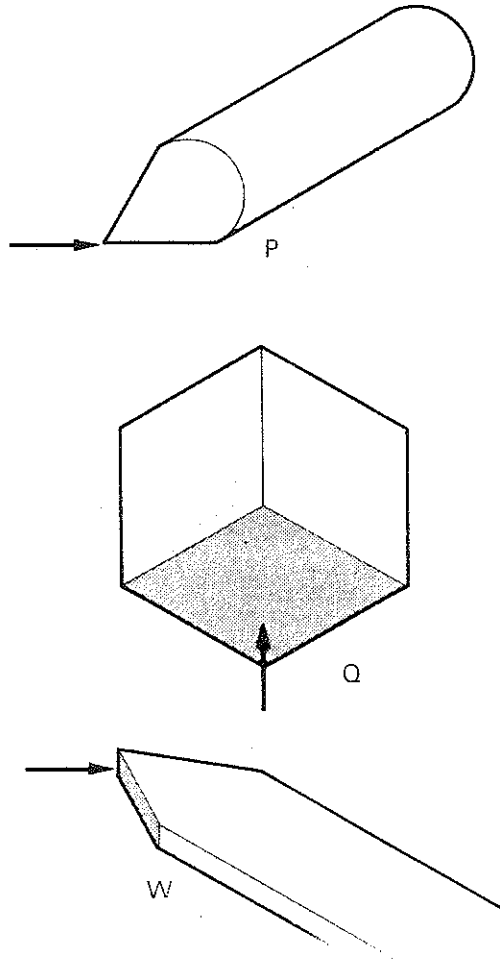
10 A _____ line.



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G Describe the shapes of the parts of the following objects which are marked with an arrow. For example,

What shape is the end of P?
It's pointed.



SECTION 3 describing shape, size, use, etc

A Here are some more expressions to use when describing things. Ask and answer questions about various objects, using the tables on this page.

What	shape size colour	is it?
------	-------------------------	--------

How	big large heavy	is it?
-----	-----------------------	--------

It's	roughly more or less	square. circular. triangular. etc
------	-------------------------	--

It's	not very fairly quite very extremely	heavy. light. large. small. big.
------	--	--

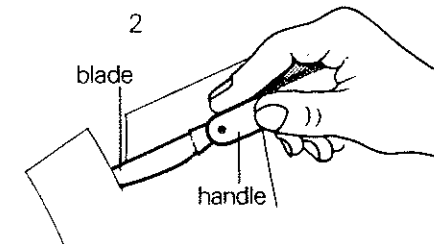
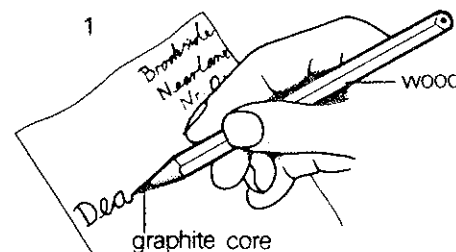
It's	light dark	red. blue. green. etc
------	---------------	--------------------------------

It's		roughly approximately about nearly almost just under just over	10 kg.
It	weighs measures		5 gm. 20 cm. 2 m.
			etc

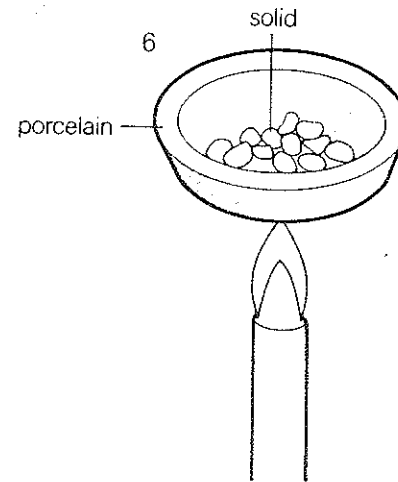
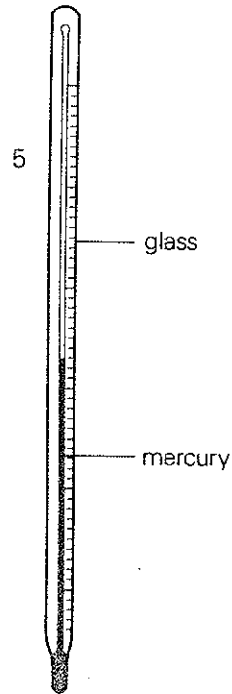
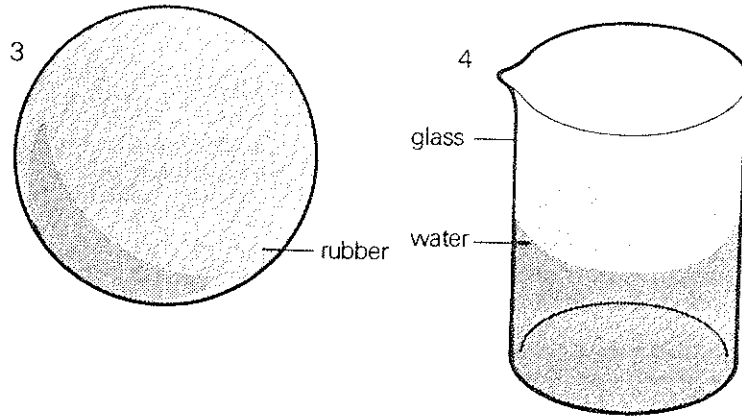
What's it	used for? made of?
What does it	consist of? contain?

It's used for _____ing _____
 It's made of _____.
 It consists of _____.
 It contains _____.

B Ask questions and make statements like those you have just practised about these things:



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section 3



C Here are some opposites:

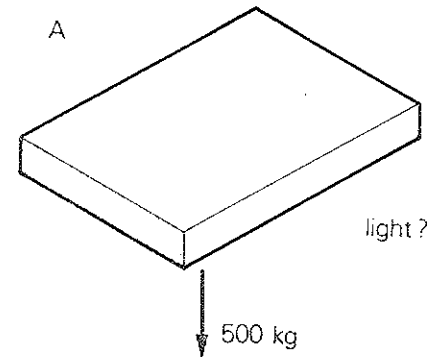
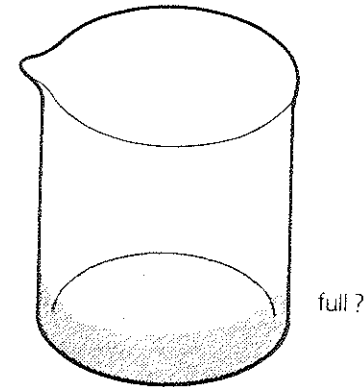
curved	flat
hollow	solid
long	short
heavy	light

Practise these and other opposites with your teacher.
Add more opposites to the list above.

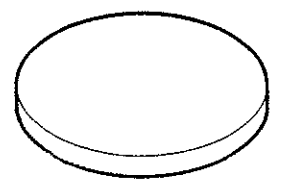
Ask questions about these things. Give an answer
using an opposite. For example,

Is this full?

No, it isn't, it's nearly empty.

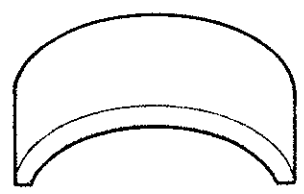


B



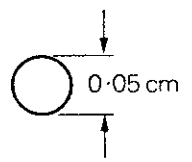
rectangular?

C



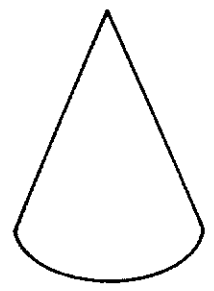
flat?

D



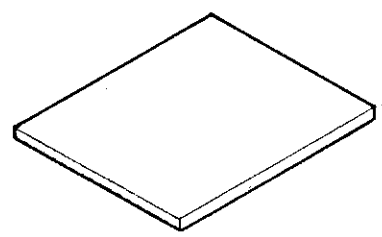
large?

E



cylindrical?

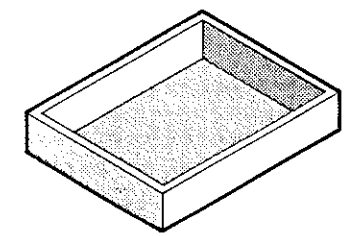
F



0.005 cm

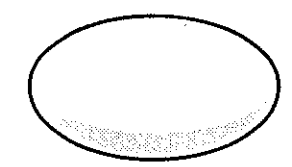
thick?

G



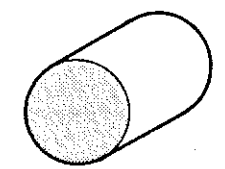
solid?

H



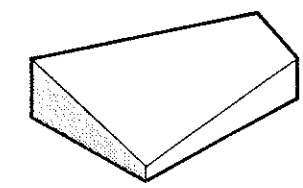
spherical?

I



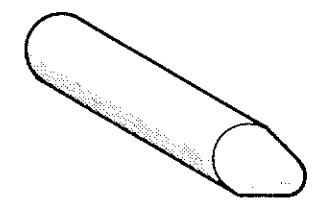
long?

J



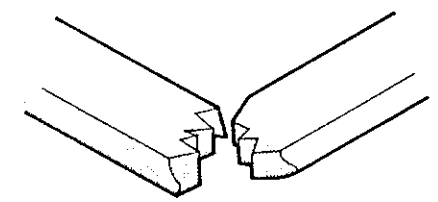
regular?

K



sharp?

L



strong?

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D We can make *general descriptions* about things in the following way:

A pencil consists of a wooden bar. This bar contains a thin cylindrical rod of graphite. It is pointed at one end.

A matchbox is a wooden or cardboard box in two parts. The two parts consist of a hollow inner tray and an outer sleeve. It is used for holding matches.

These descriptions can be changed slightly in the following way:

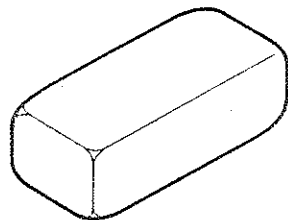
A pencil consists of a wooden bar **which contains** a thin cylindrical rod of graphite. It is pointed at one end.

A matchbox is a wooden or cardboard box in two parts **which consist** of a hollow inner tray and an outer sleeve. It is used for holding matches.

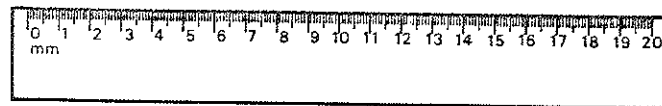
Notice the way *which* is used to connect pieces of information. Notice also that we say *a pencil* or *a matchbox* when we are making a statement about pencils and matchboxes in general.

Study the following general descriptions, and then combine two of the sentences together with *which*, as above.

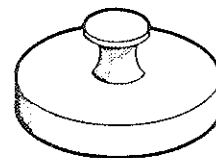
- 1 An eraser is a solid block of rubber. It is used for erasing pencil marks. It can be either rectangular or round.



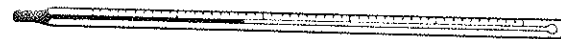
- 2 A ruler is a thin rectangular wooden or plastic strip. It is used for drawing straight lines and measuring linear dimensions.



- 3 A standard mass is a solid cylindrical brass block. It is used for comparing masses on a laboratory beam balance.

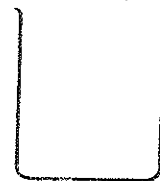


- 4 A laboratory thermometer consists of a sealed hollow glass tube with a hollow spherical bulb at one end. The bulb and the tube both contain mercury. A thermometer is used for measuring temperature.



Now write similar descriptions of your own for:

- 5 A beaker
(hollow cylindrical glass container/closed/one end/hold liquids or solids)



- 6 A measuring cylinder
(tall hollow cylindrical glass container/closed/one end/measure volumes/liquids)



- 7 A test-tube
(short hollow glass tube/rounded/one end/hold liquids/solids)



E Describe the objects your teacher shows you. Write down the details briefly under the following headings:

shape

size

colour

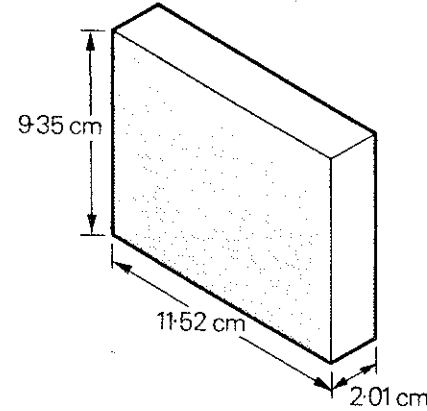
material

weight

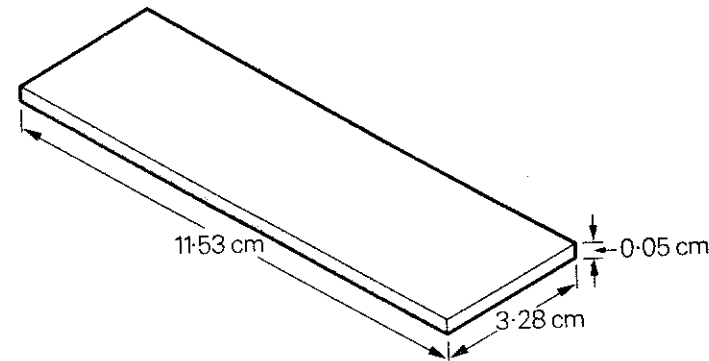
use

exercise 1 Complete these descriptions by giving the dimensions required.

- 1 The block has a h _____ of _____, a l _____ of _____ and a w _____ of _____.

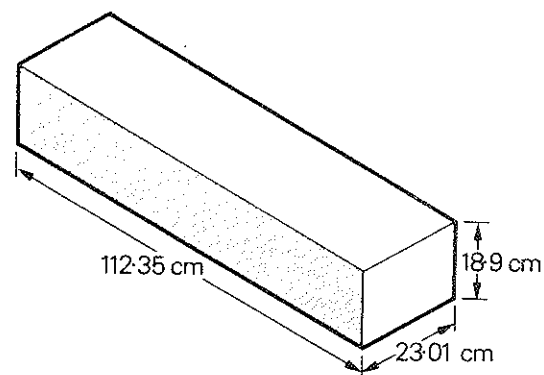


- 2 The l _____ of the block is _____, the w _____ is _____ and the h _____ is _____.

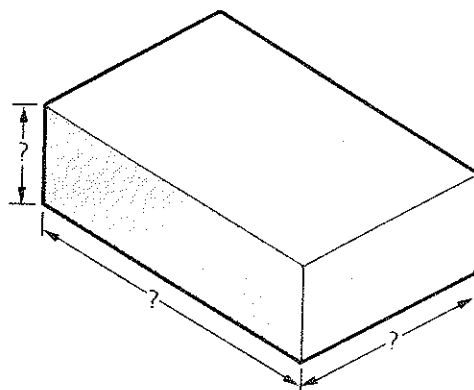


unit 1
exercises
exercise 1

- 3 The block is _____ w _____,
 l _____ and _____ h _____.

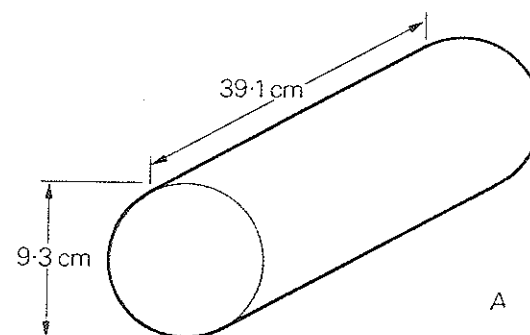


4. How w _____ is the block?
 What's the l _____ of the block?
 How h _____ is the block?
 What's the w _____ of the block?
 How l _____ is the block?

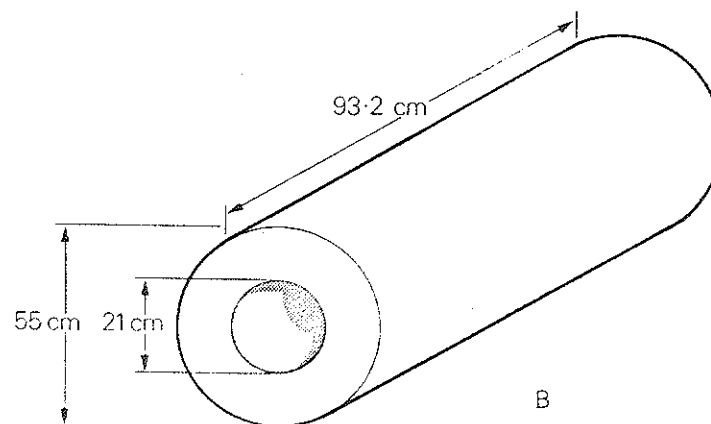


exercise 2 Complete the descriptions of these objects.

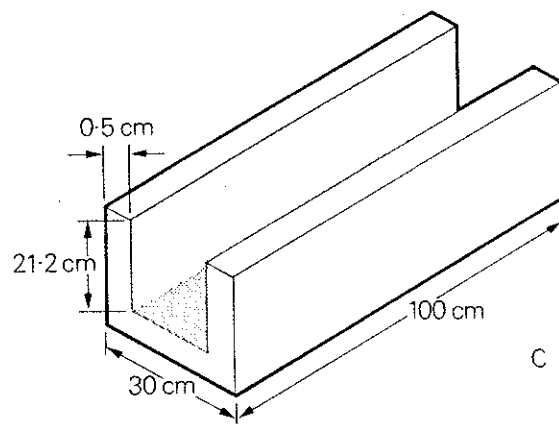
- 1 A is a _____ steel _____, of
 _____ 39.1 cm and _____ 9.3 cm.



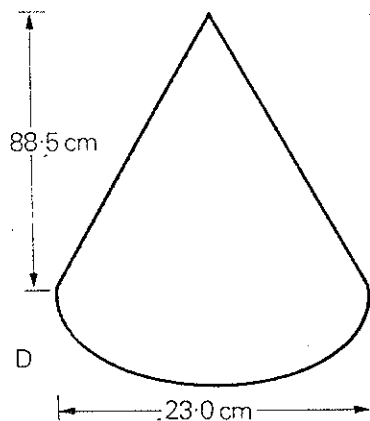
- 2 B is a _____ copper _____ having an
 _____ of 21 cm, an _____
 of 55 cm and a _____ of 93.2 cm.



C is an aluminium _____ which has a _____ of 21.2 cm, a _____ of 0.5 cm, a _____ of 30 cm and a _____ of 100 cm.

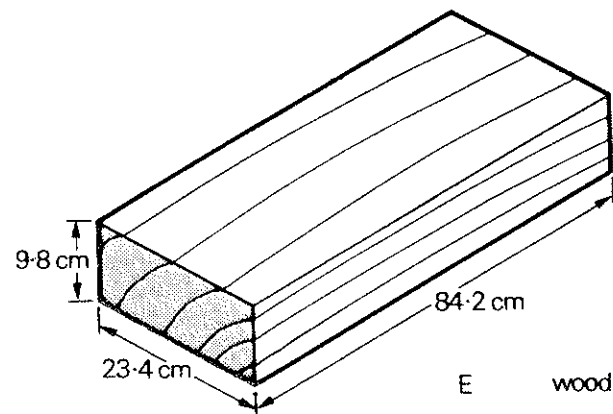


4 The cone D has a _____ of 88.5 cm, and a _____ of 23.0 cm.

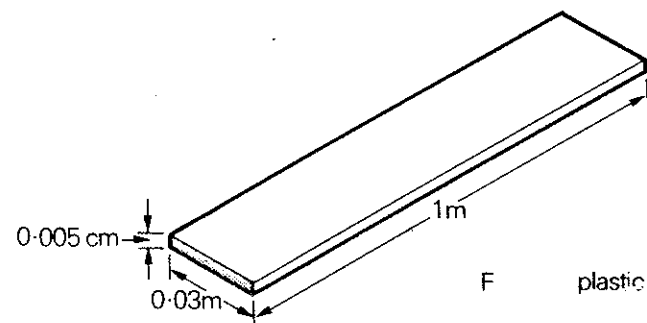


Describe these objects in the same way.

5 E is a ...

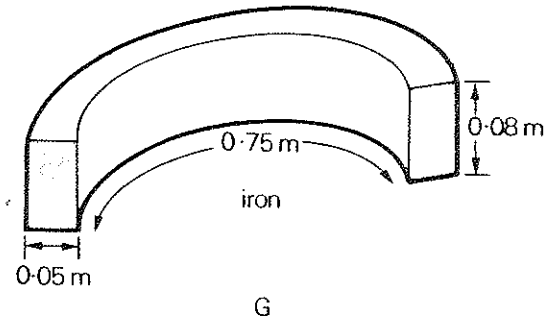


6 F is a ...

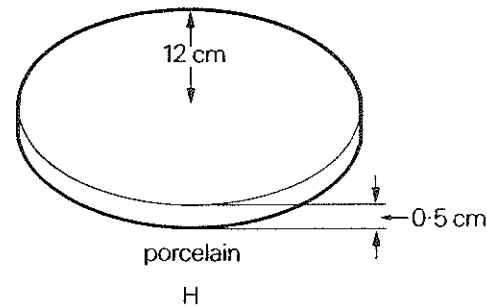


unit 1
exercises
exercise 2

7 G is a ...



8 H is a ...



exercise 3 Draw the following shapes:

- 1 A square with rounded corners.
- 2 A triangle with one rounded corner.
- 3 A semi-circle.
- 4 A cone with a flat top.
- 5 A cylinder with a point at one end.
- 6 Draw a curved line from a point A to a point B.

drills

17

drill 1

What's the first value?

Thirteen centimetres.

What's the second value?

Twenty-eight point five centimetres.

1	13 cm	7	935.201 cm
2	28.5 cm	8	0.0915 km
3	534.8 km	9	723.58 m
4	7.385 m	10	5.002 cm
5	8.720.5 km	11	30.35 cm
6	98.021 cm	12	14.14 m

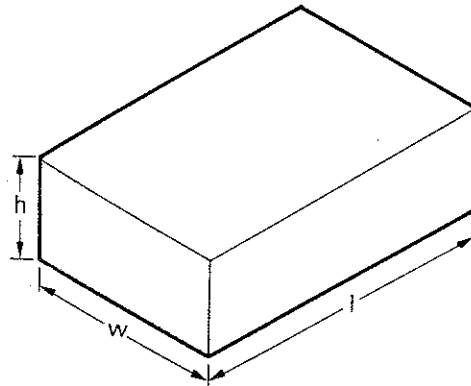
drill 2

What's the height of the block?

The height is twenty-eight point five one centimetres.

How wide is the block?

It's thirty-two point oh eight centimetres wide.



1	$h = 28.51$ cm
2	$w = 32.08$ cm
3	$l = 73.29$ cm
4	$h = 8.32$ cm
5	$w = 7.93$ cm
6	$l = 24.34$ cm
7	$h = 90.05$ cm
8	$w = 88.95$ cm
9	$l = 212.00$ cm
10	$h = 0.31$ cm
11	$w = 0.45$ cm
12	$l = 2.72$ cm

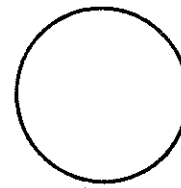
drill 3

What is A?

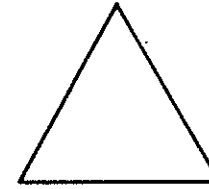
A is a circle.

Is F square?

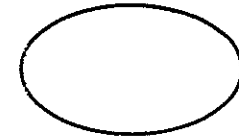
No, it isn't square, it's cubic.



A



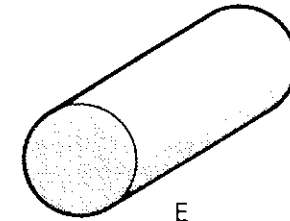
B



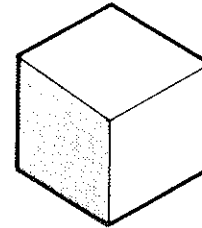
C



D



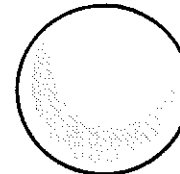
E



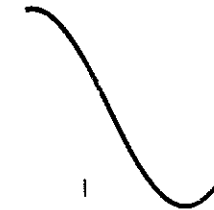
F



G



H



I

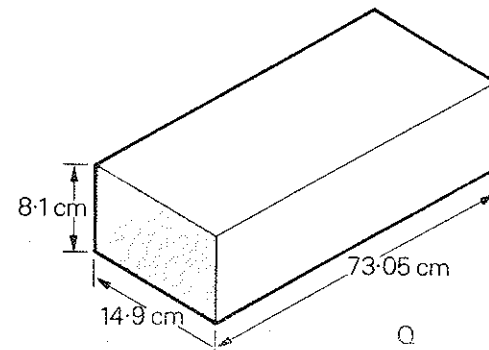
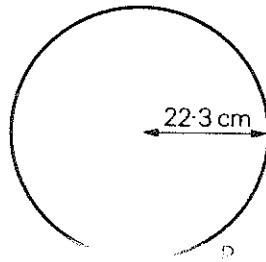
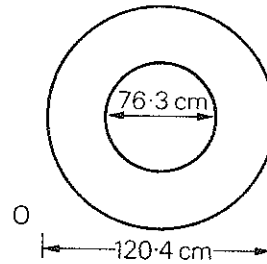
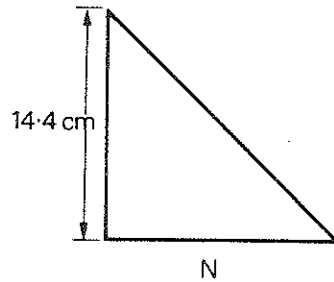
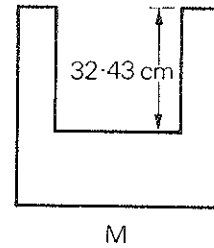
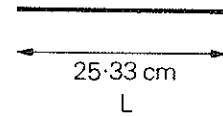
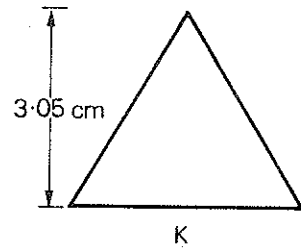
unit 1
drills
drill 3

unit 1
drills
drill 4

drill 4

What's the depth of **M**?
Thirty-two point four three centimetres.

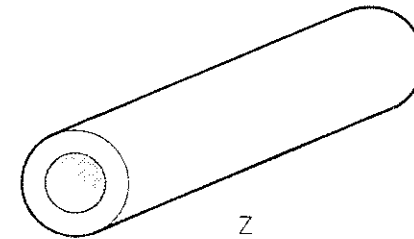
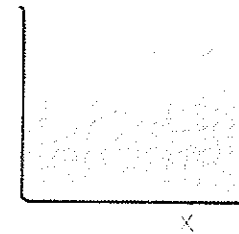
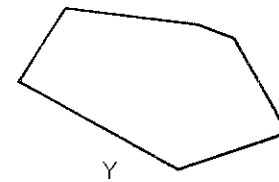
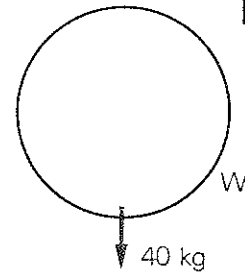
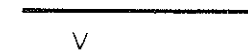
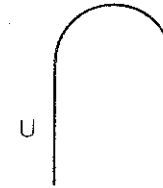
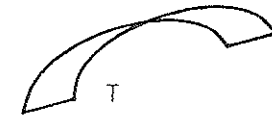
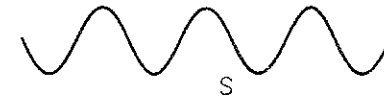
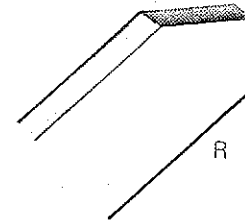
What's the radius of **P**?
Twenty-two point three centimetres.



drill 5

Is **R** pointed?
Yes, it is.

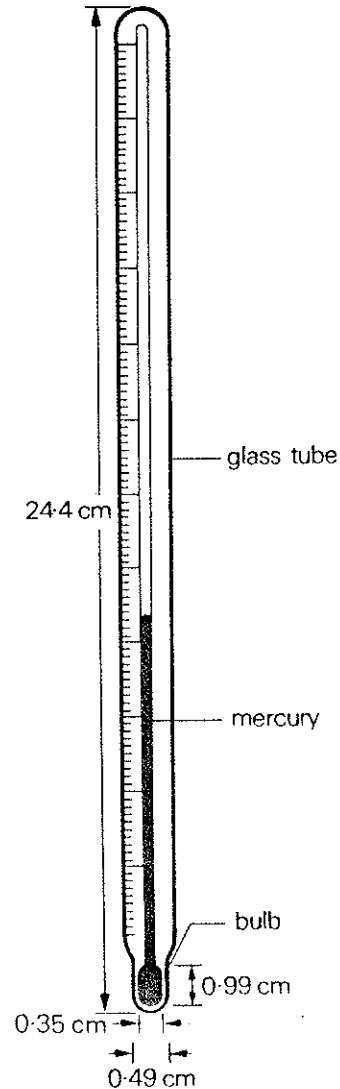
Is **T** flat?
No, it isn't; it's curved.



drill 6

What is it?

It's a thermometer.



Choose an object in the classroom and write down a description of it. Make your description of the colour, shape, size, etc. as complete as you can. Use these headings:

Shape

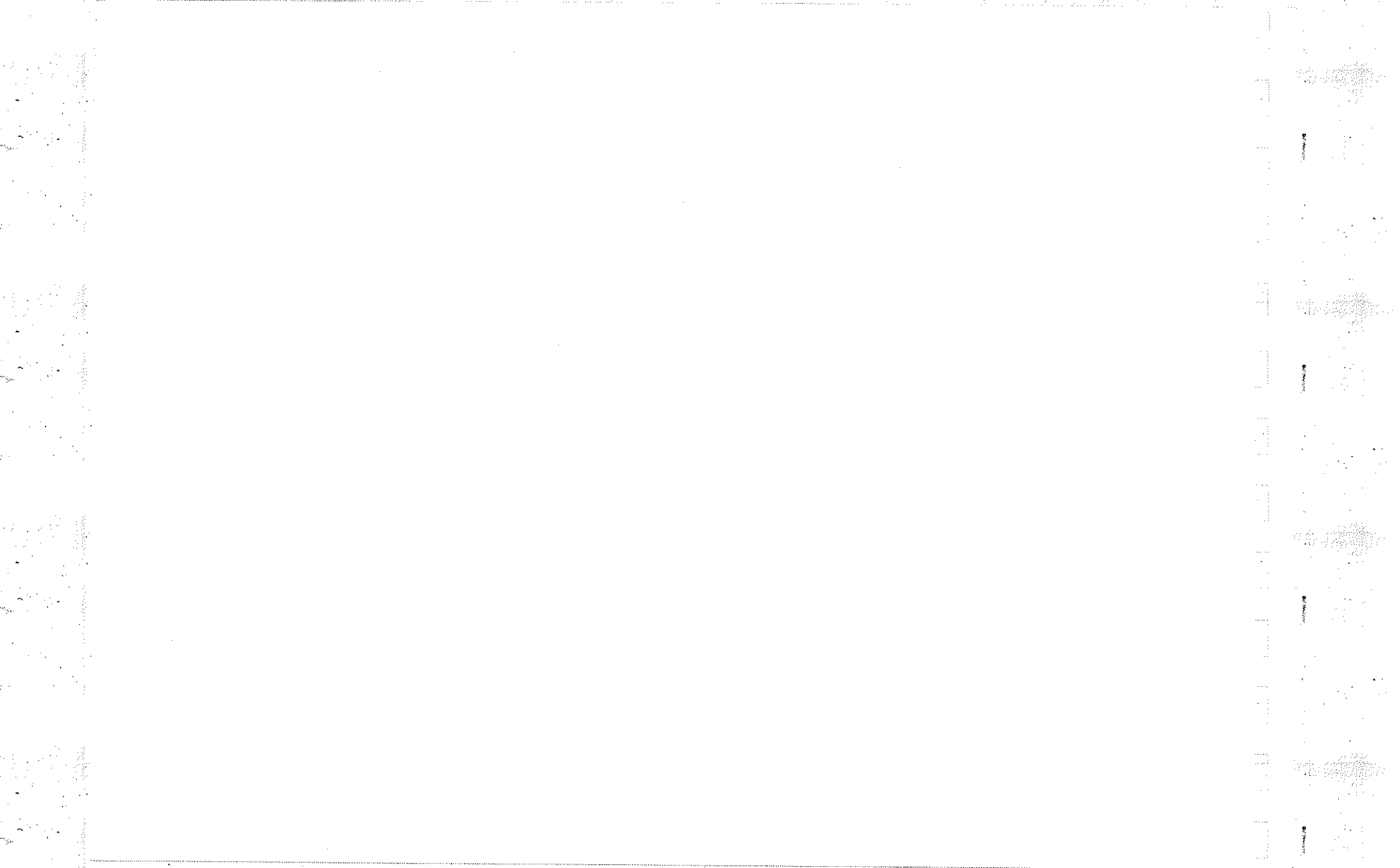
Size

Colour

Material

Weight

Use



L

L

L

L

L

L

L

L

L

L

L

L

L

classwork

unit 2 classwork section 1

SECTION 1 describing angles and lines

A Complete the descriptions of the lines and angles given below:

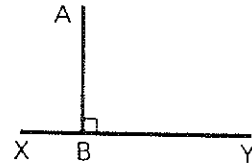
- 1 This line is _____



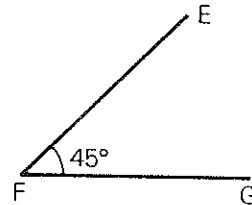
This line is _____
(A _____ line.) (A _____ line.)



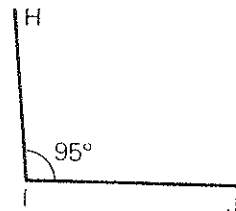
- 2 The line AB ... the line XY. \widehat{ABY} ...



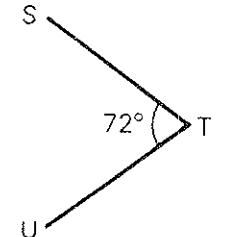
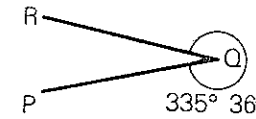
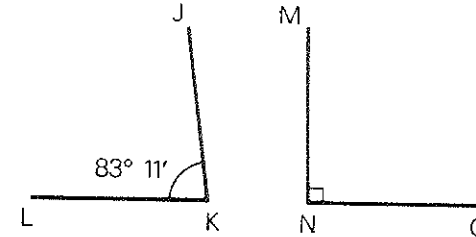
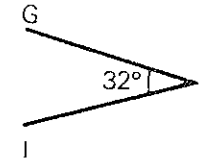
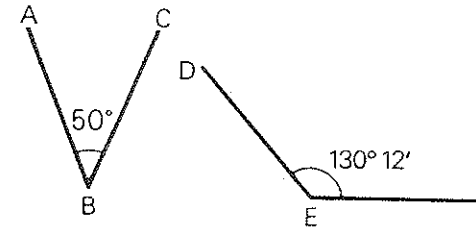
- 3 EF ... FG.



- 4 \widehat{HIJ} ... angle.
 \widehat{HIJ} ... 95° .
HI ... IJ.



B Describe these angles:

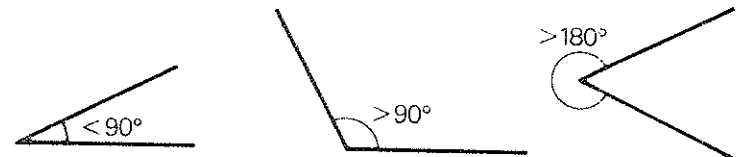


C Complete the descriptions of these angles:

An angle $< 90^\circ$ is called an _____ angle.

An angle $> 90^\circ$ is called an _____ angle.

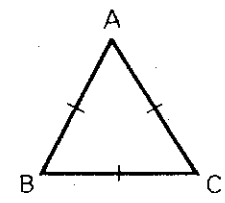
An angle $> 180^\circ$ is called a _____ angle.



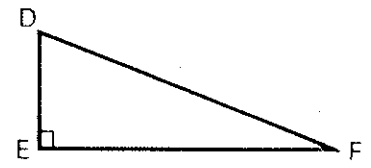
Look at **B** again. Say what sorts of angles they are.

D What sorts of triangles are these?

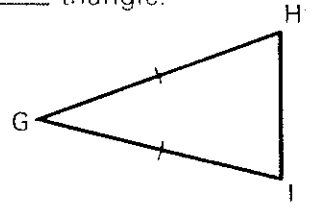
ABC is an _____ triangle.



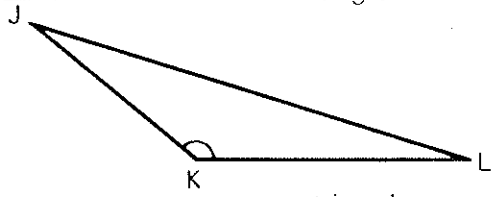
DEF is a _____ triangle.



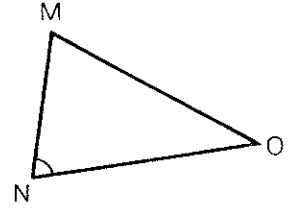
GHI is an _____ triangle.



JKL is an _____ triangle.

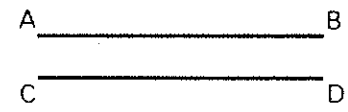


MNO is an _____ triangle.

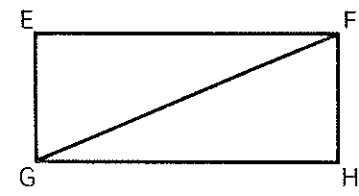


E What sorts of lines are these?

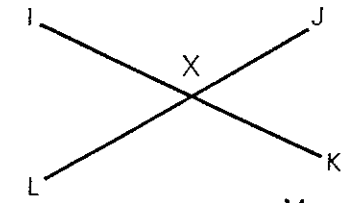
AB and CD are _____ lines



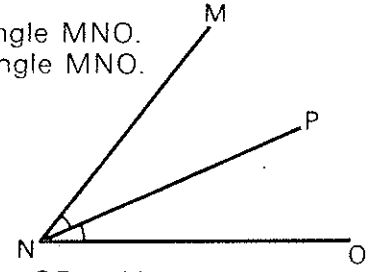
FG is a _____ line.



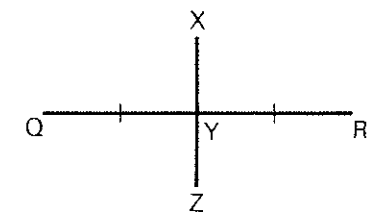
IK and JL are _____ lines.
Lines IK and JL _____ at X.



The line PN _____ the angle MNO.
PN is the _____ of the angle MNO.



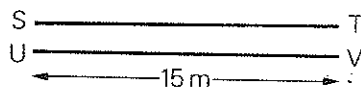
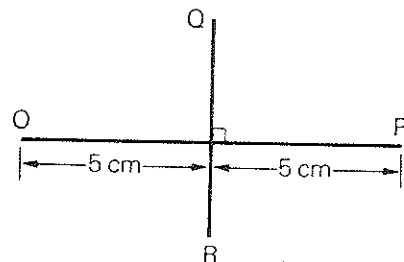
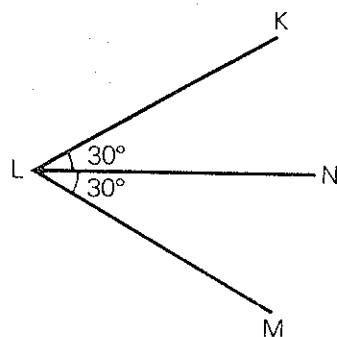
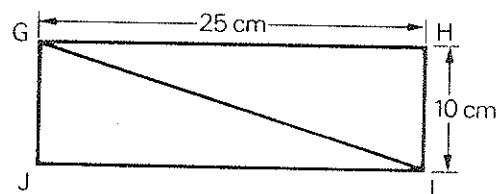
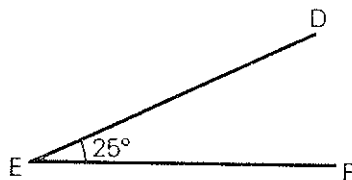
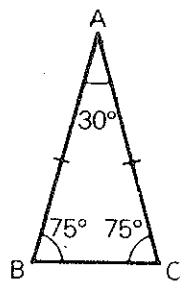
The line XZ _____ the line QR at Y.
The line XZ is the _____ of the line QR.



unit 2
classwork
section 1

F Describe these angles and figures as fully as possible. For example,

ABC is an isosceles triangle which has one angle of 30° and two angles of 75° .



G Draw the figures your teacher tells you to.

SECTION 2 reading basic formulae

A How are these formulae spoken?

$$a+b=c$$

$$a \times b = e$$

$$a-b=d$$

$$\frac{a}{b}=f$$

We can also say:

$$a \times b = e$$

$$\frac{a}{b}=f$$

These signs indicate mathematical processes. What **nouns** and **verbs** are used to talk and write about them? The first one is done as an example.

Sign	Noun	Verb
+	addition	add
-		
x		
÷		

These signs () are called _____.

These signs [] are called _____.

ABC are _____ letters; def are _____ letters.

How do we read: R_x ?

B How are these fractions spoken in English?

$$\frac{1}{2}$$

$$\frac{1}{3}$$

$$\frac{2}{3}$$

$$\frac{3}{16}$$

$$\frac{1}{4}$$

$$\frac{3}{4}$$

$$\frac{1}{8}$$

C Read out these equations:

$$x = \frac{a+b}{c}$$

$$6 \quad v = u + at$$

$$7 \quad Ft = mv - mu$$

$$x + y = \frac{A}{a-b}$$

$$8 \quad \frac{1}{R} = -\frac{M}{EI}$$

$$l = a + (n-1)d$$

$$9 \quad \frac{dQ}{dz} = -q$$

$$V = IR$$

$$10 \quad E = T + P - c + e$$

$$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$$

D How are these values spoken?

$$x^2 \quad x^{n-1} \quad \sqrt[3]{x}$$

$$x^3 \quad x^{-n} \quad \sqrt[n]{x}$$

$$x^n \quad \sqrt{x}$$

Now read out these values and equations:

$$20 \text{ cm s}^{-1} \quad x^{1/2}$$

$$98.3 \text{ km s}^{-2} \quad x^{3/4}$$

$$33 \text{ cm}^3 \quad (a+b^{1/2})^2$$

$$4.39 \text{ cm}^2 \quad \sqrt{xy}$$

$$9.1 \times 10^{-31} \text{ kg} \quad \sqrt[3]{(x-a^2)}$$

E Practise reading these expressions:

$$1 \quad x^{-p} = \frac{1}{x^p}$$

$$2 \quad x^{n/q} = \sqrt[q]{x^n}$$

$$3 \quad x^2 - a^2 = (x+a)(x-a)$$

$$4 \quad y = ae^{bx}$$

$$5 \quad x = \frac{nx_1 + mx_2}{m+n}$$

$$6 \quad y - y_1 = \left(\frac{y_2 - y_1}{x_2 - x_1} \right) (x - x_1)$$

$$7 \quad \frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{z^2}{c^2} = 1$$

$$8 \quad d = \sqrt{[(x_1 - x_2)^2 + (y_1 - y_2)^2 + (z_1 - z_2)^2]}$$

$$9 \quad b^2 = a^2(1 - e^2)$$

$$10 \quad x^2 + y^2 + 2gx + 2fy + c = 0$$

SECTION 3 reading more complex formulae

A What do these symbols mean in English? Give an example of each one.

1 \equiv	6 $>$	11 \propto
2 \neq	7 \ll	12 ∞
3 $\simeq \approx$	8 \gg	13 \pm
4 \rightarrow	9 \leq	14 \therefore
5 $<$	10 \geq	15 $/$

B Here is the Greek alphabet. Make sure you know how this is read.

α A	η H	ν N	τ T
β B	θ Θ	ξ Ξ	υ Y
γ Γ	ι I	\omicron O	ϕ Φ
δ Δ	κ K	π Π	χ X
ϵ E	λ Λ	ρ P	ψ Ψ
ζ Z	μ M	σ Σ	ω Ω

C Practise reading out these expressions:

$$1 \quad f = \frac{1}{2\pi\sqrt{LC}}$$

$$2 \quad E = \delta T^4$$

$$3 \quad W_s = \frac{2\pi f}{P}$$

$$4 \quad \gamma = \frac{W_0}{4\pi R} F$$

$$5 \quad \mu_0 = 4\pi \times 10^{-7} \text{ Hm}^{-1}$$

$$6 \quad C = \frac{L}{R^2 + \omega^2 L^2}$$

unit 2
classwork
section 2

$$7 \quad v_2 = \sqrt{\left(\frac{2e}{m} V_2\right)}$$

$$9 \quad \sigma = \frac{M_{yc}}{I} + \frac{P}{A}$$

$$8 \quad u = \frac{\frac{1}{2}\sigma_v^2}{K}$$

$$10 \quad \gamma = \frac{4Q}{3\pi R^2} (R^2 - \gamma^2)$$

D Here is the formula for calculating the volume of a cylinder:

$$V = \pi r^2 h$$

Now, read through this simple calculation with your teacher:

A is a solid metal cylinder of height 16.3 cm and diameter 6.7 cm. Calculate its volume.

$$V = \pi r^2 h$$

$$\pi = 3.142$$

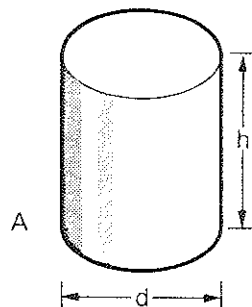
$$r = \frac{d}{2}$$

$$= \frac{6.7}{2} = 3.35 \text{ cm}$$

$$h = 16.3 \text{ cm}$$

$$\therefore V = 3.142 \times 3.35^2 \times 16.3$$

$$= 574.75 \text{ cm}^3$$



E Write down the formulae you hear.

F Read out these expressions:

$$1 \quad \theta > 90^\circ$$

$$6 \quad \theta \approx 0.5^\circ$$

$$11 \quad 7\frac{3}{4}$$

$$2 \quad x \rightarrow \infty$$

$$7 \quad E \leq \pm 0.32$$

$$12 \quad \frac{1}{2} + \frac{2}{3} + \frac{3}{4}$$

$$3 \quad e \propto T$$

$$8 \quad \mu = 5.3$$

$$13 \quad \frac{1}{2}(24+9) = x$$

$$4 \quad \alpha \equiv \beta$$

$$9 \quad \therefore E \equiv 1 + \Delta$$

$$14 \quad \frac{1}{16}$$

$$5 \quad a_1 \neq b_1$$

$$10 \quad \lambda > 1$$

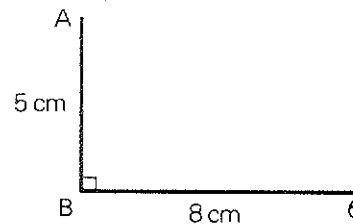
$$15 \quad \frac{4}{3}\pi r^3$$

exercises

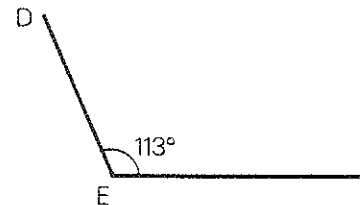
When you do these exercises, do not look back in your book.

exercise 1 Write out these statements, filling in the missing words.

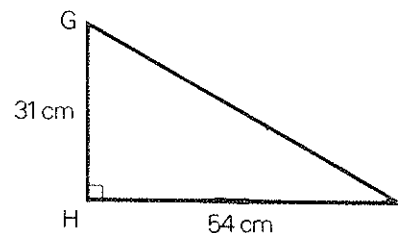
- 1 AB is a v_____ s_____ line of l_____ 5 cm. AB is at r_____ a_____ to BC, a h_____ s_____ line of l_____ 8 cm.



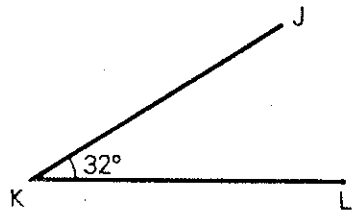
- 2 \hat{DEF} is an o_____ a_____ of 113°



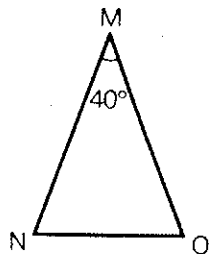
- 3 GHI is a r_____ a_____ triangle having a h_____ of 31 cm and a l_____ of 54 cm.



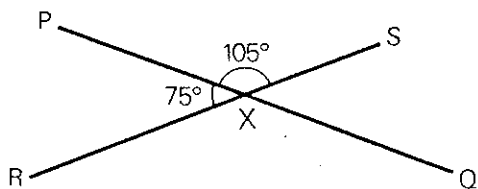
- 4 \hat{JKL} is an a _____ a _____ of 32° .



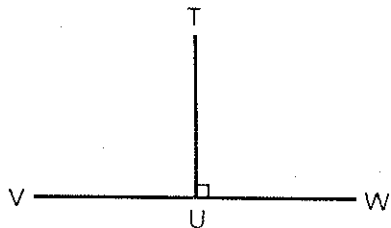
- 5 MNO is an i _____ triangle, having an angle NMO of 40°



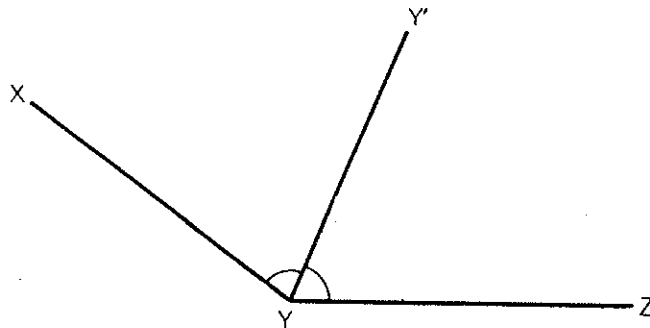
- 6 The lines PQ and RS i _____ at X. The value of the o _____ angle is 105° .



- 7 The v _____ line TU is p _____ to the h _____ line VW.



- 8 The s _____ line YY b _____ the o _____ angle XYZ.



exercise 2 What are the processes shown here?

Example: $\frac{x}{y}$

division

- 1 ab
- 2 32×10^{-1}
- 3 $a^2 + b^2 + c$
- 4 $y - x^2$
- 5 $73.2a - 9.27a - a$

Put the correct words in these expressions. For example,

$\frac{x}{y}$ Divide x by y

- | | | | | | |
|----|---------------|-------|--------|-------|-------|
| 6 | 34×7 | _____ | 34 | _____ | 7 |
| 7 | $x^2 - x$ | _____ | x | _____ | x^2 |
| | a^2b | _____ | | _____ | |
| 8 | c | _____ | a^2b | _____ | c |
| 9 | $3b + 2c$ | _____ | $3b$ | _____ | $2c$ |
| 10 | ab | _____ | a | _____ | b |

unit 2
exercises
exercise 3

exercise 3 Write down the symbols for these expressions:

- 1 Example: Approximately equal \approx
- 2 Not equal
- 3 Less than
- 4 Tends to
- 5 Infinity
- 6 Plus or minus
- 7 Therefore
- 8 Greater than
- 9 Proportional to
- 10 Equivalent to
- 11 Less than or equal
- 12 Factorial
- 13 Per
- 14 Much less than

Write down these Greek letters (in small letters):

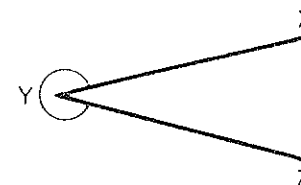
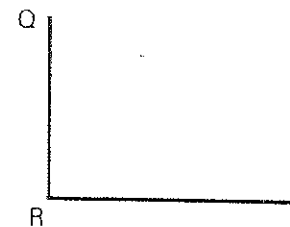
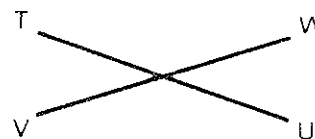
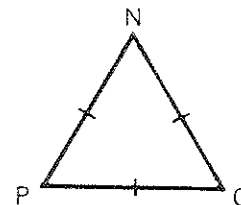
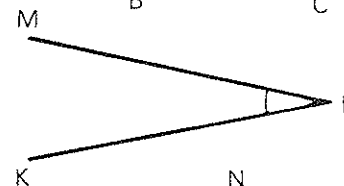
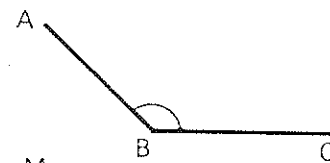
- | | |
|---------------------------|----------|
| 1 Example: Alpha α | 6 Lambda |
| 2 Beta | 7 Mu |
| 3 Gamma | 8 Pi |
| 4 Delta | 9 Sigma |
| 5 Theta | 10 Omega |

drills

drill 1

What sort of angle is \hat{ABC} ?
It's an obtuse angle.

What sort of lines are GH and IJ?
They are parallel lines.



drill 2 Now you ask the questions about the lines in drill 1.

\hat{ABC}
What sort of angle is \hat{ABC} ?

GH and IJ
What sort of lines are GH and IJ?

x
a
y

drill 3

Number one

a squared plus b squared equals c.

Number two

x to the power of a half over d equals thirty.

1 $a^2 + b^2 = c$

2 $\frac{x^{1/2}}{d} = 30$

3 $a_2 = \frac{(b-c)^2}{a_1}$

4 $7.6 \times 10^{-3} \text{ m s}^{-1}$

5 $\frac{x^{-1/2}}{a^2 + b^2} = 1$

6 $\left(\frac{y}{a} - \frac{x}{b}\right)^2$

7 $\frac{\sqrt[3]{(x^2 + y^2)}}{x}$

8 $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$

drill 4

What's the square root of x?

12.

What's y to the power of 4?

3.78.

$\sqrt{x} = 12 \quad \frac{a}{b} = 9 \quad d^{1/4} = 2.5 \quad \sqrt[3]{z} = 7.29$

$y^4 = 3.78 \quad x^{-1} = 40 \quad a^{-n} = 0.721$

$y^{3/2} = 721.5 \quad y^{n-1} = z \quad x^{-7} = 91$

drill 5

Is x equal to y?

*No, x is greater than y.*Is a proportional to b^2 ?*No, a is equal to b^2 .*

$x > y$

$y \geq 45$

$a = b^2$

$d \rightarrow \infty$

$z \approx 50$

$\alpha \neq \beta$

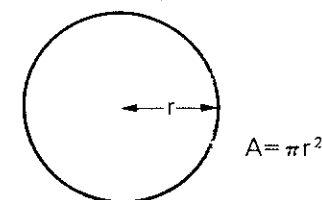
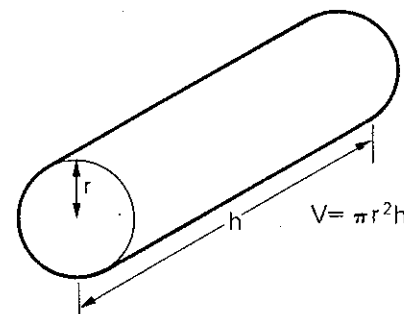
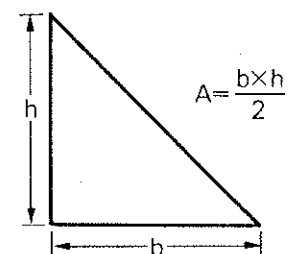
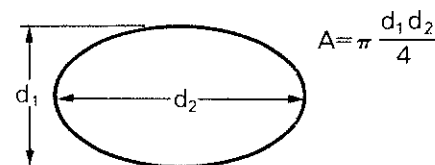
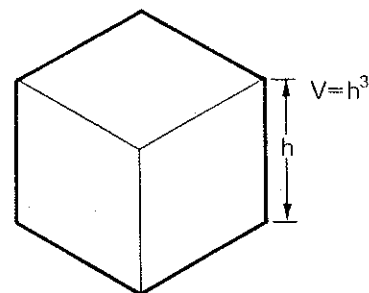
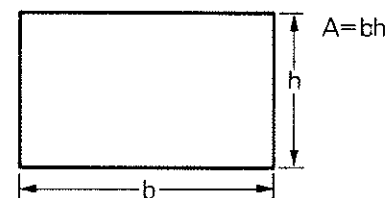
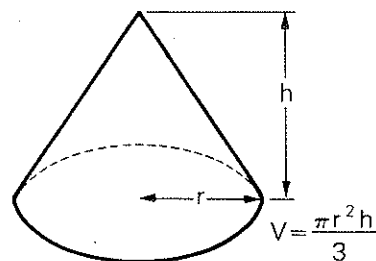
$y = \pm 30$

$0 \leq 90^\circ$

$f \propto d^2$

$a^2 \equiv b^2$

drill 6

What's πr^2 ? *πr^2 is the area of a circle.*What's $\pi r^2 h$? *$\pi r^2 h$ is the volume of a cylinder.*

activity**unit 2**
activity

Follow the instructions your teacher gives you for drawing a figure. When you have finished, compare your work with other people's.

L

L

L

L

L

L

L

L

L

L

L

L

L

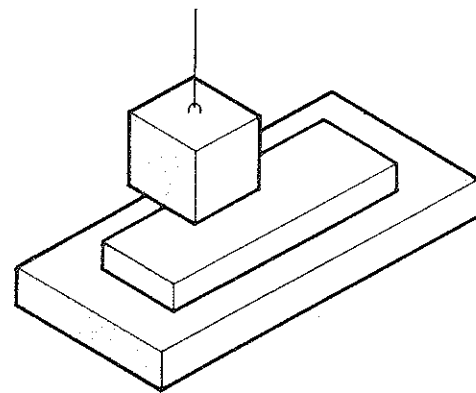
classwork

unit 3
classwork
section 1

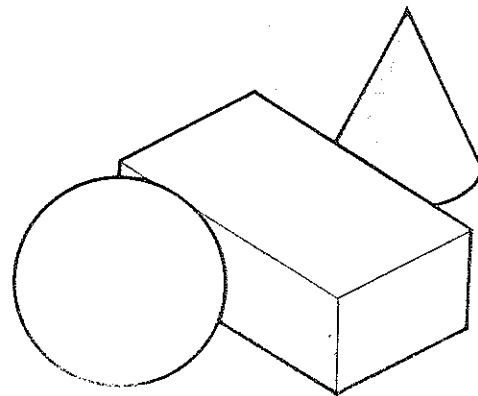
SECTION 1 describing position

A Complete these descriptions of position.

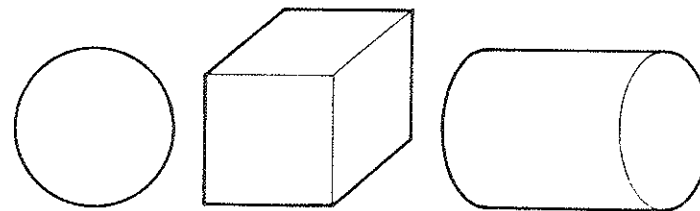
- 1 The cube is suspended _____ the small rectangular block.
The small rectangular block rests _____ the large rectangular block. _____ the cube.



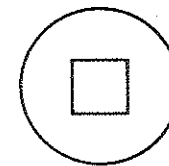
- 2 The cone is _____ the rectangular block.
The sphere is _____ the rectangular block.



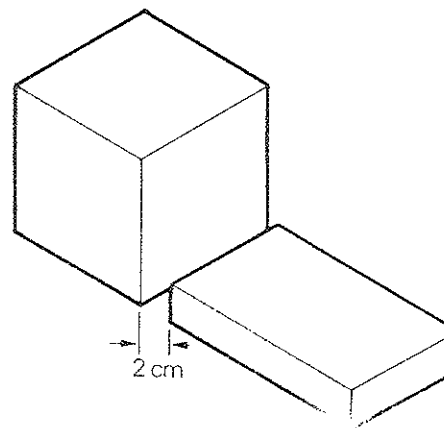
- 3 The cube is _____ the sphere and the cylinder.



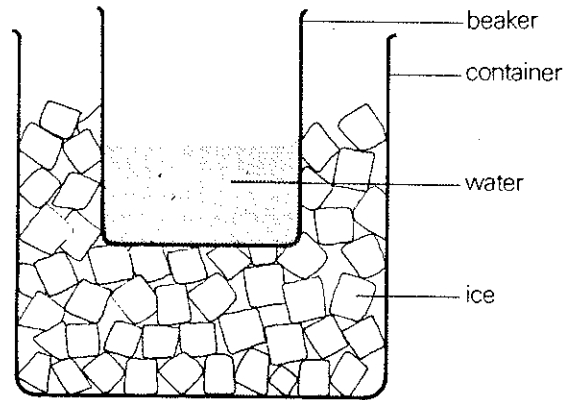
- 4 The square is _____ the circle.



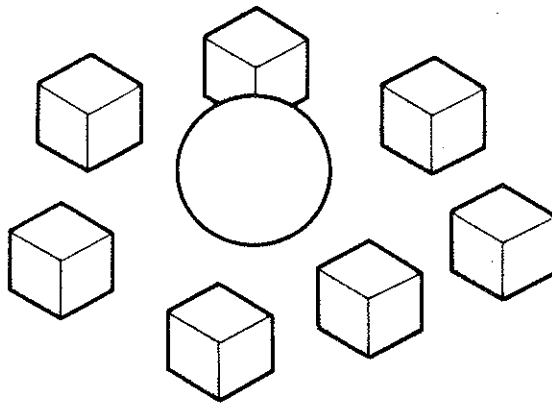
- 5 The rectangular block is _____ the cube.
The cube is _____ the rectangular block.



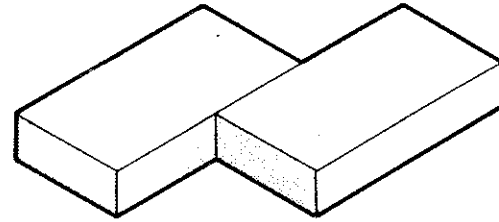
- 6 There is water _____ the beaker. The beaker stands _____ a container of ice. There is ice _____ the beaker.



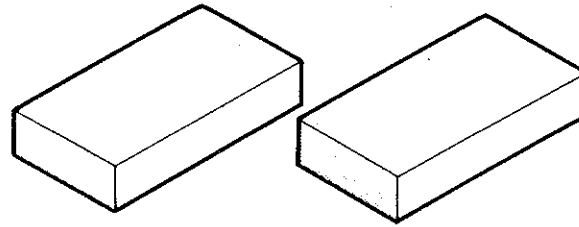
- 7 There is a sphere _____ the cubes.



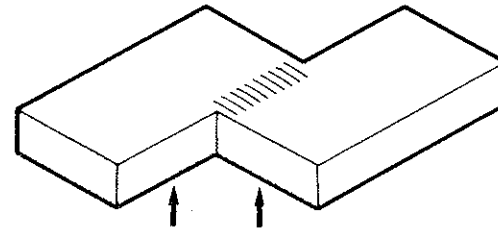
- 8 These blocks are _____ (each other).



- 9 These blocks are _____



- 10 These blocks are _____



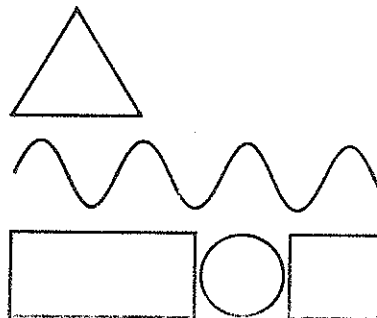
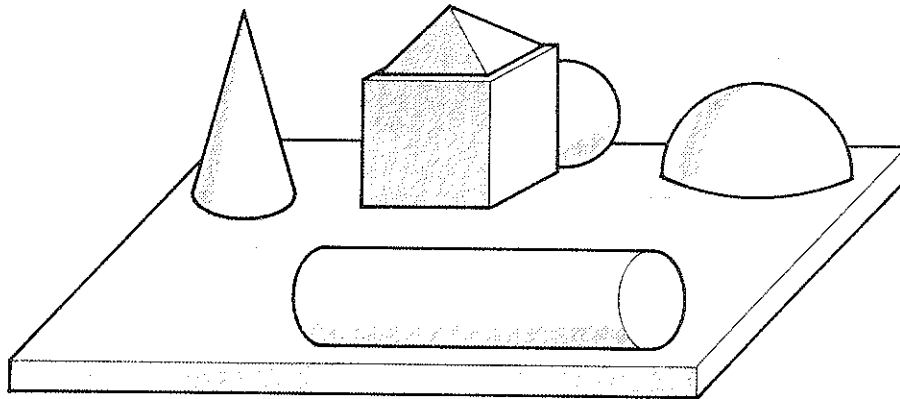
This side and this end are _____ (to each other).

unit 3
classwork
section 1

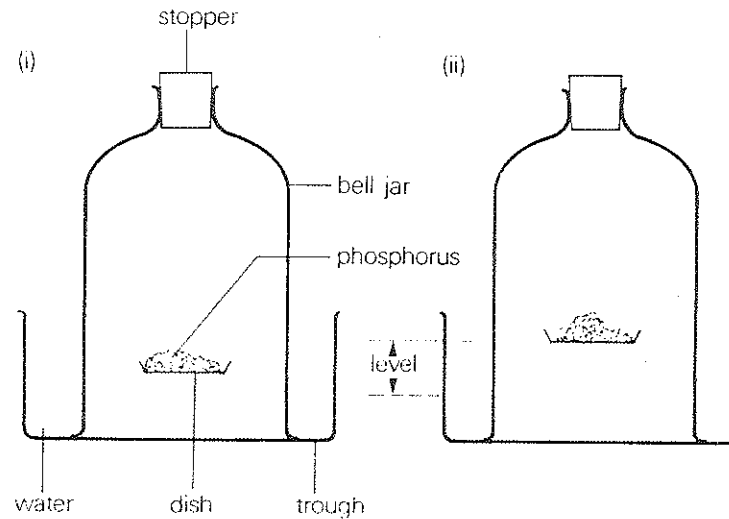
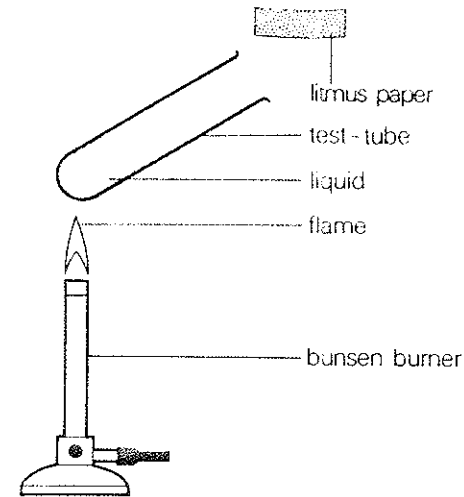
B We can ask questions about the positions of objects like this:

Where	is the	sphere	?
Which side		cone	on?
What position		cylinder	in?
		cube	

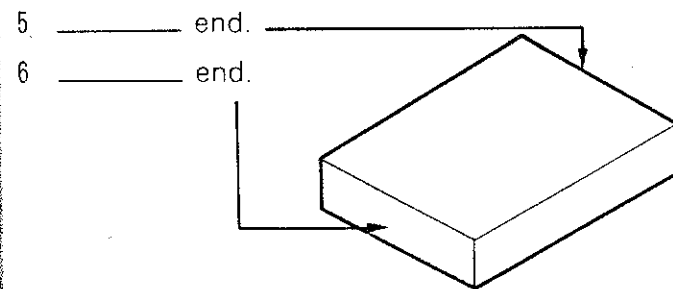
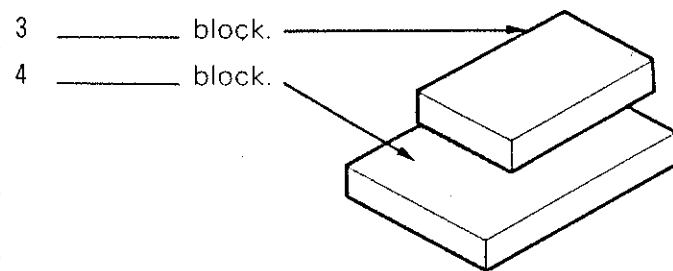
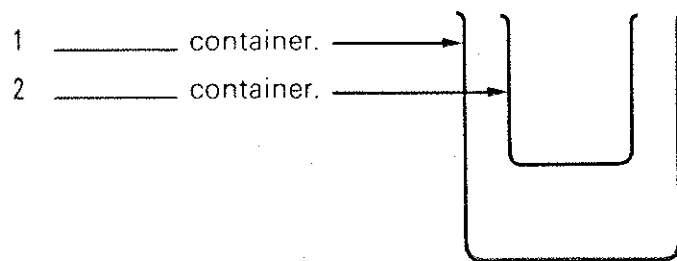
Use questions like this to ask about the positions of the objects in the following pictures.



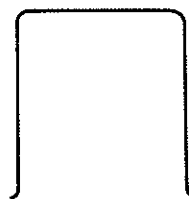
C Describe the apparatus in these drawings as fully as possible, using the words of position you have practised so far.



D Some more useful words of position are:

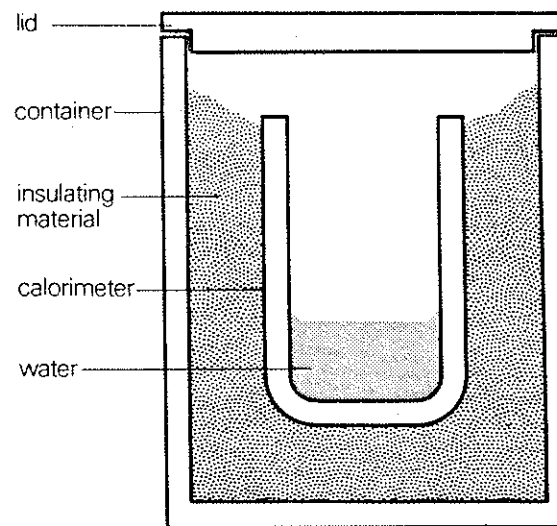


7 An _____ or _____ beaker.



E Read the following description of the apparatus in the diagram carefully.

The apparatus below is used for measuring quantities of heat energy. The apparatus consists of a calorimeter, which is made of aluminium or copper, inside a container. The calorimeter holds a quantity of water. There is a space between the inner calorimeter and the outer container, which is filled with insulating material. The top of the apparatus is covered by a lid. The inner calorimeter is therefore completely enclosed by the outer container, and is surrounded by insulating material.



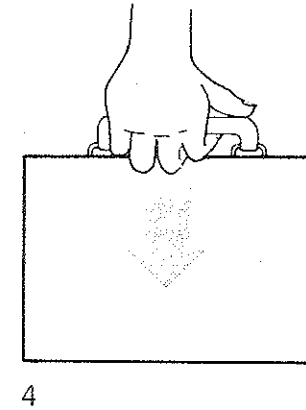
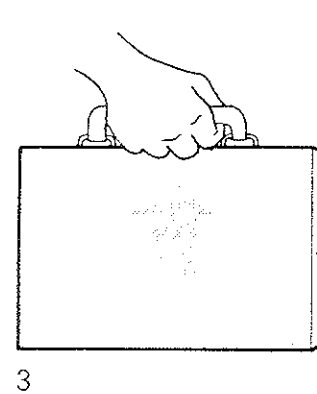
Ask questions and make statements about the position of these parts of the apparatus:

- | | |
|-----------------------|-------------|
| 1 lid | 4 container |
| 2 calorimeter | 5 space |
| 3 insulating material | 6 water |

unit 3
classwork
section 2

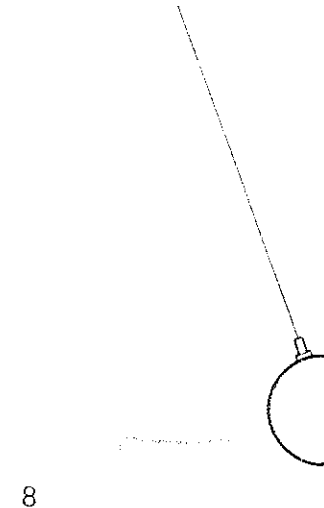
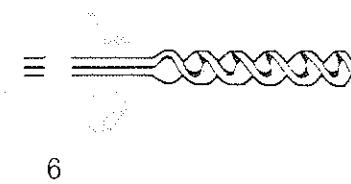
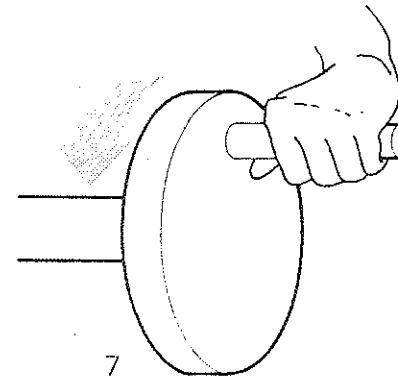
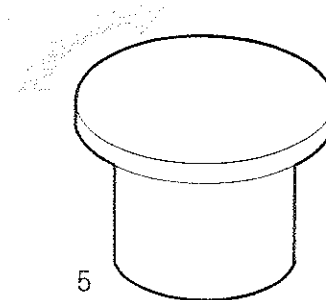
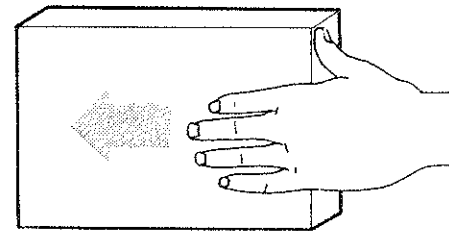
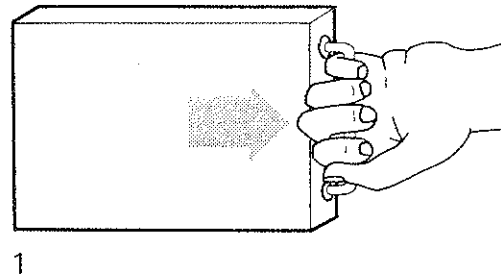
F Study the following description of some apparatus and then draw a diagram of the apparatus.

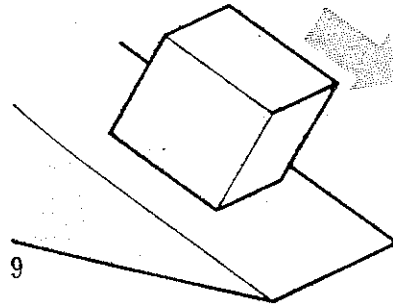
A beaker holds a small quantity of a liquid. It stands on a tripod, over a bunsen burner. An inverted funnel is suspended over the top of the beaker. The top of the funnel is connected to a tube, which passes into a test-tube beside the apparatus. The test-tube, which also contains a small quantity of liquid, is at an angle of 45° to the horizontal. The end of the tube is below the surface of the liquid in the test-tube.



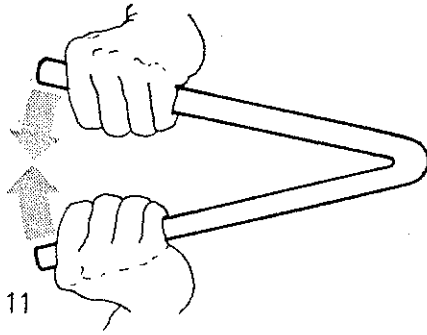
SECTION 2 describing movement and action

A What words are used to describe these actions?

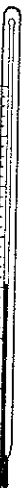




9

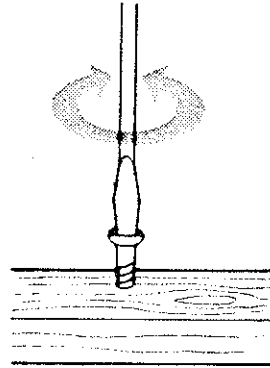


11

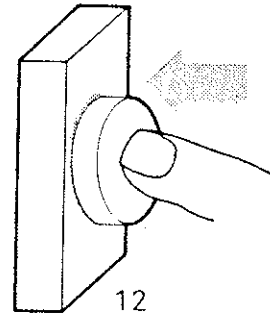


13

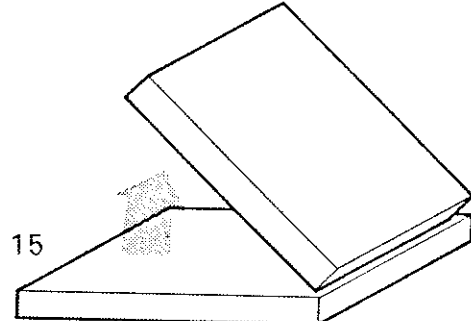
14



10

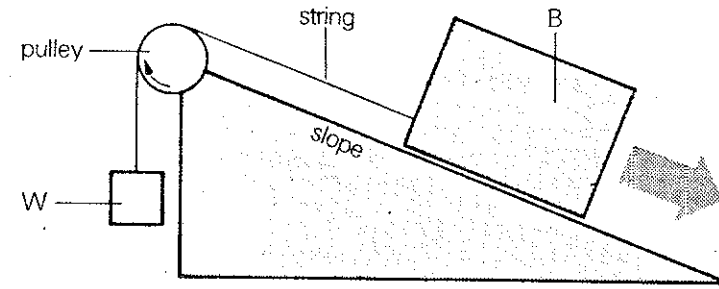


12



15

B Look at this diagram and description:



The block B rests on a slope. A string is attached to one end of the block and passes over a pulley at the top of the slope. A weight W is suspended from the end of the string.

Write out these descriptions, filling in the missing words.

When the block _____ down the slope, it _____ the string and _____ the weight. At the same time, the pulley _____ in a clockwise direction.

We can say:

- 1 The block _____ the string.
- 2 The string _____ the pulley.
- 3 The string _____ the weight.

Or we can say:

- 4 The string _____ by the block.
- 5 The pulley _____ by the string.
- 6 The weight _____ by the string.

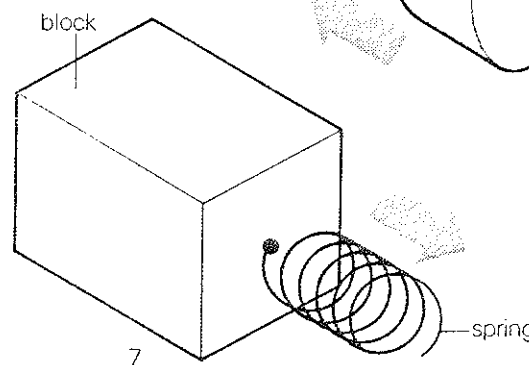
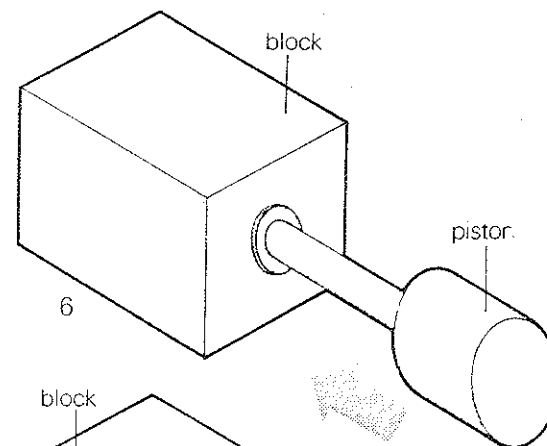
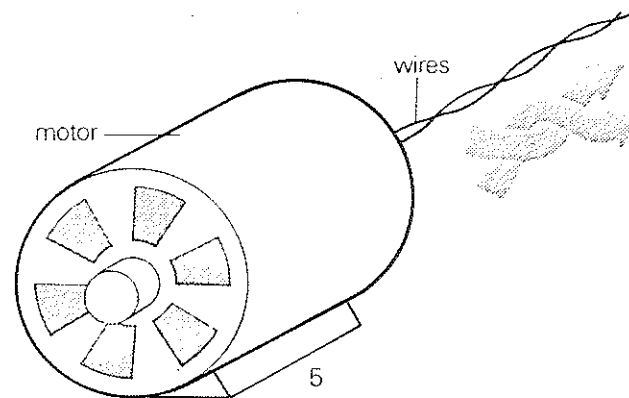
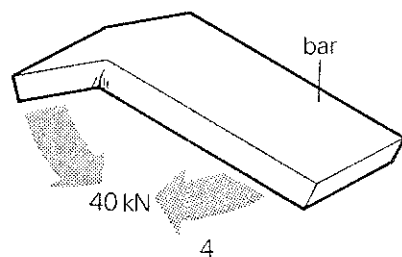
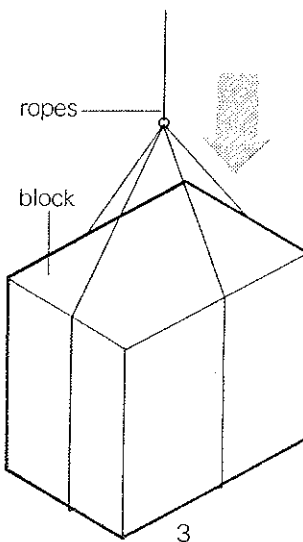
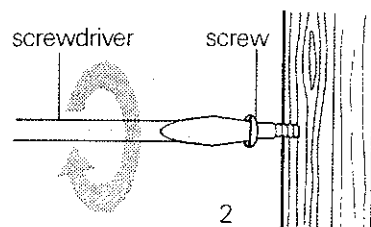
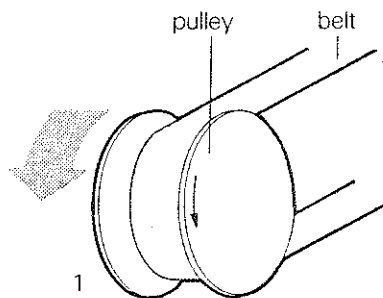
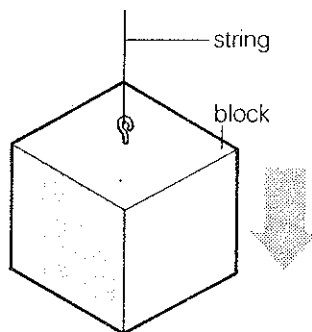
Sentences 1, 2 and 3 are in the **active** voice.
Sentences 4, 5 and 6 are in the **passive** voice.
The passive voice is used a great deal in scientific description.

unit 3
classwork
section 2

C Look at these motions and make similar statements to those in **B**, using both the active and the passive voice. For example:

The string **raises/lifts** the block.

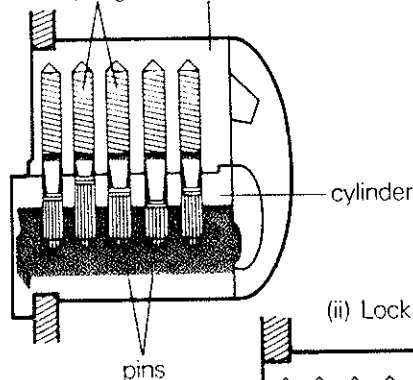
The block is **raised/lifted** by (means of) the string.



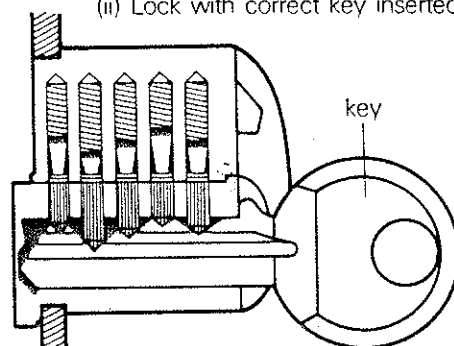
D Use these notes and diagrams to help you describe the action of a cylinder lock.

- 1 correct key/push/lock
- 2 all pins/raise/therefore/cylinder/can/rotate
- 3 when/cylinder/turn/by/key/lock/open
- 4 when/lock/open/key and cylinder/rotate/back/original position
- 5 key/pull/lock
- 6 when incorrect key/use/pins/not raise/correct height
- 7 cylinder/therefore/cannot/rotate

(i) Lock without key

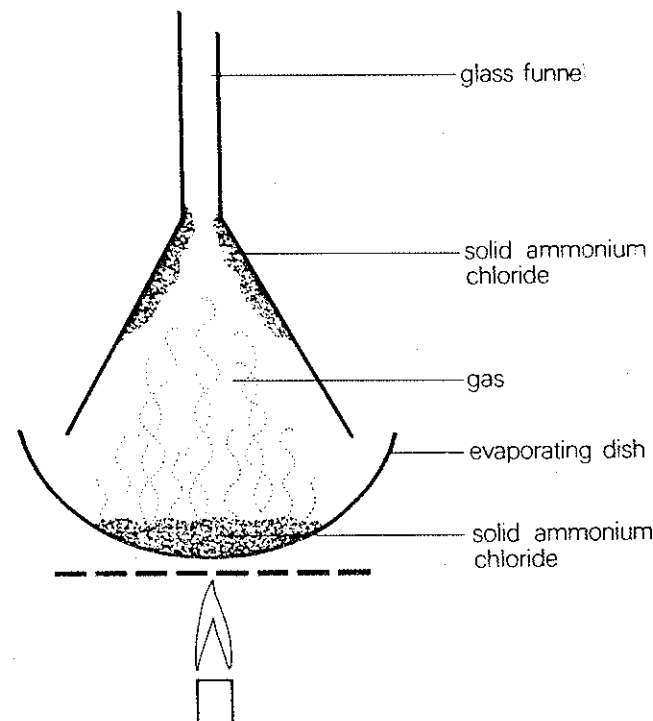


(ii) Lock with correct key inserted



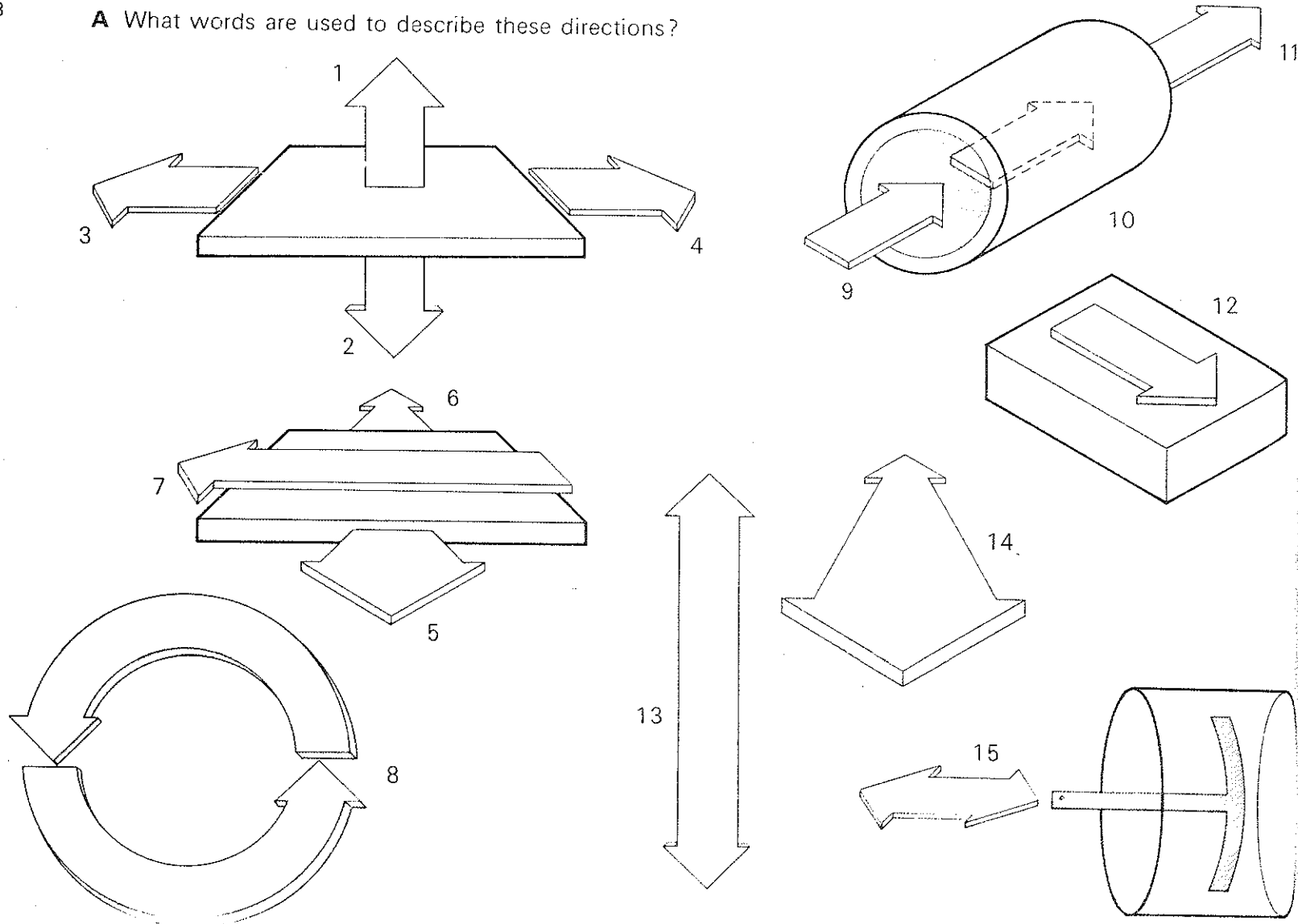
E Complete the following description of an experiment by putting the verbs given in brackets into the appropriate form, either active or passive.

A small amount of white solid ammonium chloride (place in an evaporating dish). A funnel (invert) over it. The dish (heat) gently. A white vapour (observe). The white vapour (rise). White crystals of ammonium chloride (form) on the inner surface of the funnel. No liquid stage (observe). It (conclude) that ammonium chloride (change) from a solid to a gas and from a gas to a solid directly, with no liquid stage.

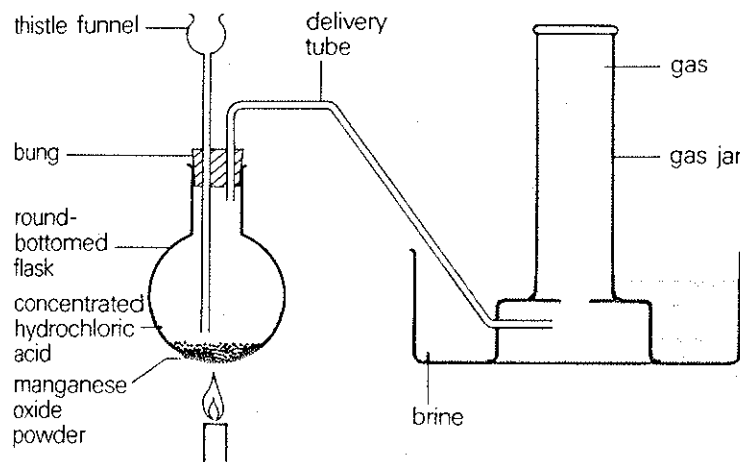


SECTION 3 describing direction

A What words are used to describe these directions?



B Study the diagram and then complete the text below with suitable words of direction and position.



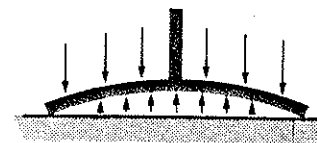
A thistle funnel and a delivery tube are held i_____ the t_____ of a flask by means of a bung. Manganese oxide powder is in the b_____ of the flask. Concentrated hydrochloric acid is poured t_____ the thistle funnel until the end of the thistle funnel is just b_____ the surface of the liquid.

The delivery tube passes i_____ a trough of brine (salt and water). A gas-jar full of brine is i_____ on t_____ of a shelf, immediately a_____ the end of the delivery tube.

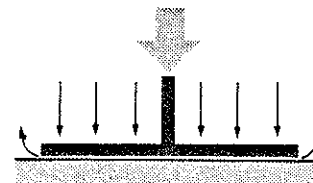
The flask is held o_____ a Bunsen burner flame and the contents are heated. A reaction takes place in the flask, and a gas is produced. The gas passes a_____ the delivery tube, i_____ the jar of brine. Bubbles of gas rise u_____ t_____ the brine and the level of brine in the gas-jar goes d_____. The level of the brine f_____ until the jar is completely full of the gas.

C Study this description of the action of a suction pad and complete the statements.

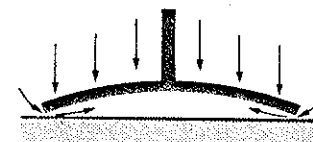
The air pressure which acts d_____ on the top of the pad is equal to the air pressure which acts u_____ b_____ the underneath of the pad and the lower surface.



When a force pushes the pad d_____ (t_____ the surface), the air is expelled from underneath the pad. There is therefore a vacuum b_____ the pad and the flat surface, and the air pressure pressing d_____ on the pad is greater than the air pressure u_____ the pad. The pad therefore 'sticks' to the surface.



When air enters b_____ the pad and the flat surface, the air pressure u_____ the pad rapidly becomes equal to the air pressure a_____ the pad. When this happens, the pad no longer 'sticks' to the surface, and it returns to its original curved shape.



unit 3
classwork
section 3

D Study this description of the pendulum action of a clock.

The weight W acts d_____, and this force is transmitted to the circumference of the spindle. This force t_____ the spindle and the toothed wheel in a c_____ direction. However, the wheel cannot t_____ continuously because of the anchor. The ends of the anchor are alternately r_____ and l_____ by the pendulum, as it s_____ from side to side. When the pendulum is vertical, the anchor allows the wheel to t_____. When the pendulum is at the end of its swing, one end of the anchor is l_____ and the wheel cannot t_____. The time the pendulum takes to make one swing can be adjusted by moving the bob u_____ or d_____.

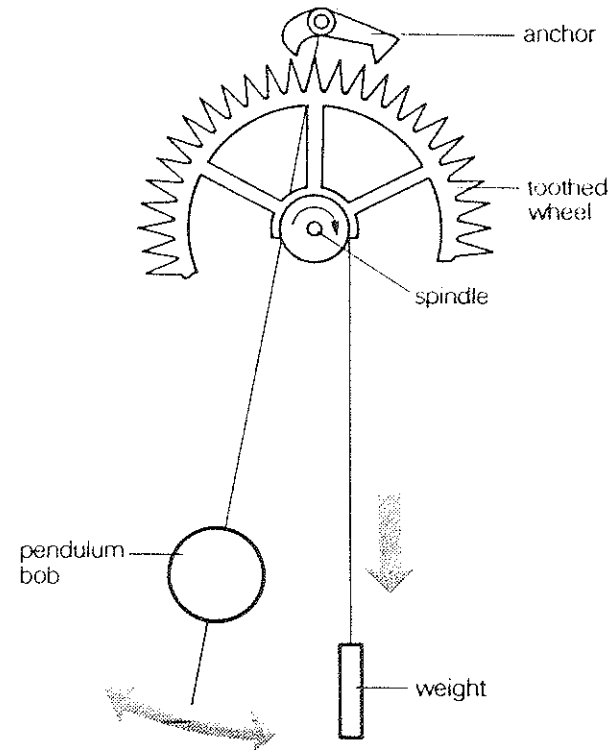
Say which way these parts move:

- 1 The weight.
- 2 The spindle.
- 3 The pendulum.
- 4 The ends of the anchor.
- 5 The toothed wheel.

E Now describe the pendulum action yourself. Use these notes but do not look at the previous exercise.

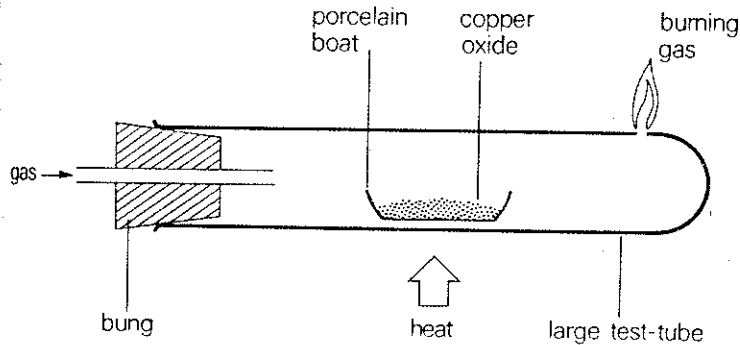
- 1 weight W /act/downwards
- 2 force/transmit/to/circumference/of/spindle
- 3 this force/turn/spindle/and/toothed wheel/in/clockwise direction
- 4 however,/wheel/not turn/continuously/because of/anchor
- 5 this/raise/and/lower/by/pendulum/which/swing/from/side to side
- 6 when/pendulum/is/vertical,/anchor/lift/and/wheel/turn

- 7 when/pendulum/is/at/end of its swing/anchor/lower/and/wheel/cannot/turn
- 8 time/pendulum/take/to make one swing/can/adjust/by/move/bob/up or down

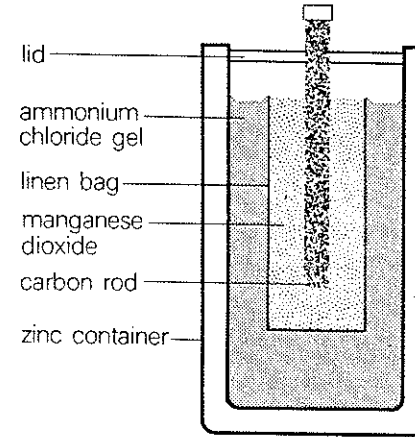


F Here is a description of an experiment. Use suitable words of **position** and **direction** to complete the description.

Copper oxide is placed _____ a porcelain boat, which is then placed _____ a large test-tube. Coal gas or hydrogen passes _____ the test-tube _____ the tube _____ the diagram. The gas passes _____ the copper oxide. At the same time, the copper oxide is heated by a bunsen burner _____ the apparatus. The excess gas escapes _____ a small hole on the _____ side of the test-tube, where it burns.



exercise 1 Study this diagram of a cell and then make sentences from the notes.



- 1 diagram/show/simple cell
- 2 cell/consist of/zinc container/carbon rod/
manganese dioxide/inside/linen bag/and/gel/
ammonium chloride
- 3 carbon rod/suspend/in/centre/container
- 4 carbon rod/surround/by/manganese dioxide/
inside/linen bag
- 5 there/space/between/zinc container/and/
manganese dioxide
- 6 space/fill/with/ammonium chloride gel
- 7 carbon rod/suspend/from/lid
- 8 lid/cover/apparatus

Now you have eight sentences describing the diagram. Use the word *which* to combine sentence 1 with sentence 2, sentence 3 with sentence 4, and so on, until you have just four sentences. For example,

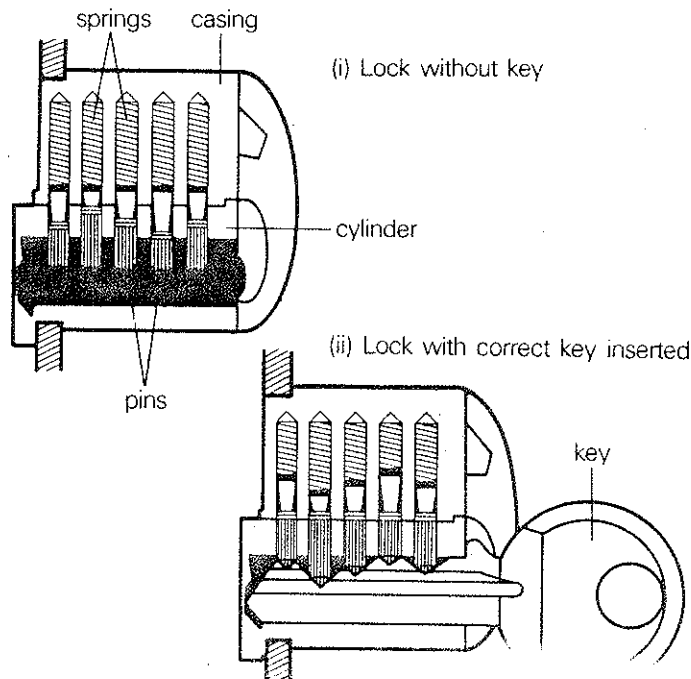
The diagram is at the beginning of this exercise.
The diagram shows the construction of a cell.

The diagram which is at the beginning of this exercise shows the construction of a cell.

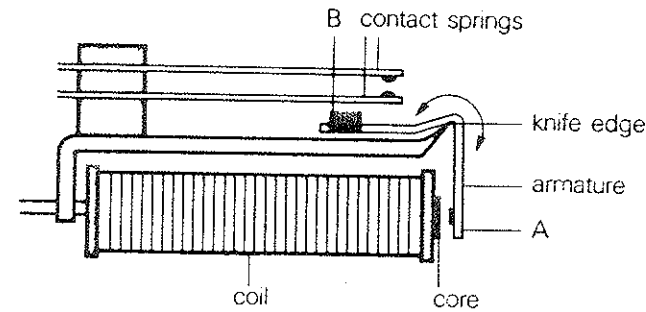
unit 3
exercises
exercise 2

exercise 2 Describe the action of a cylinder lock. Use the verbs *pull*, *push*, *raise*, *turn*, *rotate* in either the **active** or **passive** forms. Do not look back in your book.

- 1 The correct key _____ into the lock. This _____ the pins, and the cylinder can _____.
- 2 When the cylinder _____ by the key, the lock opens.
- 3 The key and the cylinder then _____ back to their original position.
- 4 The key _____ out of the lock.
- 5 When an incorrect key is used, the pins _____ (not) to the correct height, and the cylinder cannot _____.



exercise 3 Study this diagram of an electrical relay and then complete the passage below with words of **direction** or **action**.



The armature of the relay pivots around the knife-edge. When an electric current passes through the coil, the end of the armature A moves towards the core. The end of the armature B is therefore raised, and it pushes the lower contact spring, which moves upwards and touches the upper contact.

When the electric current stops passing through the coil, the end of the armature A moves away from the core. The end B is lowered, and the contact spring moves back to its original position.

drills

drill 1

Where is the cone?

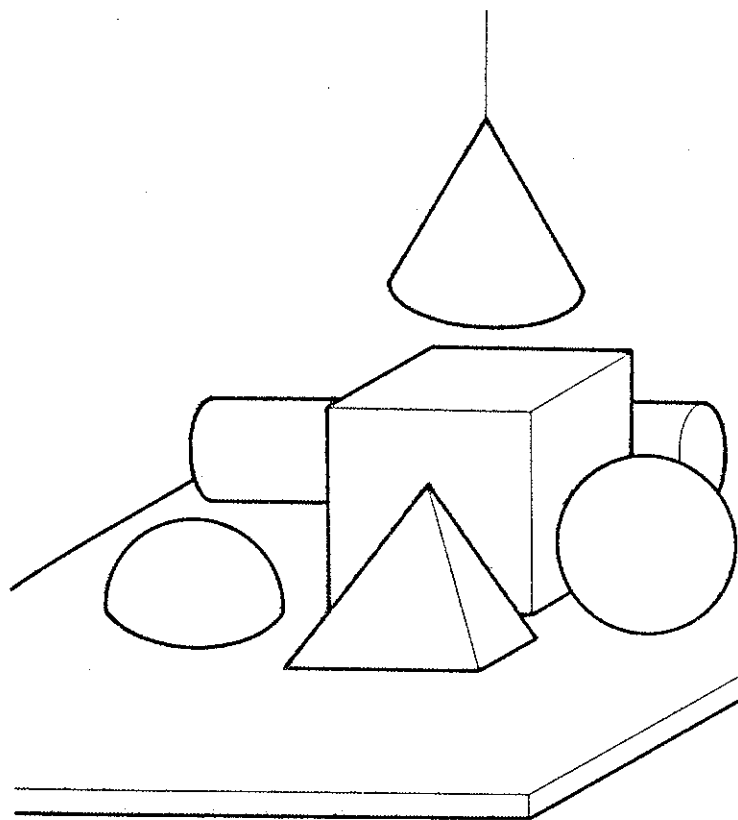
It's above the cube.

Which side of the cube is the sphere on?

It's on the right-hand side.

Is the hemisphere on the left-hand side of the cube?

Yes, it is.



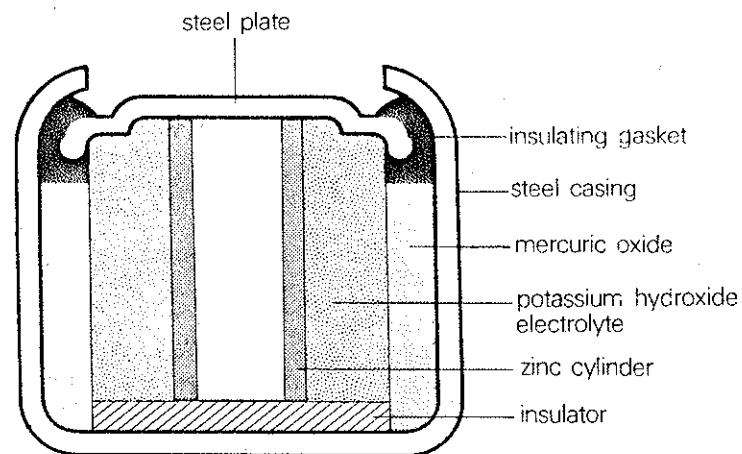
drill 2

What's on the top of the cell?

A steel plate.

What's around the outside of the cell?

A steel casing.



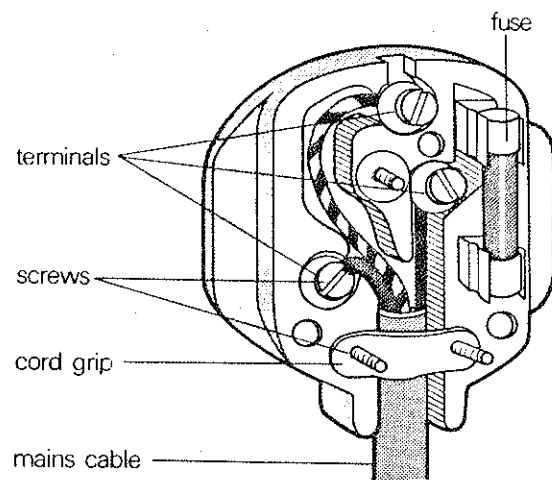
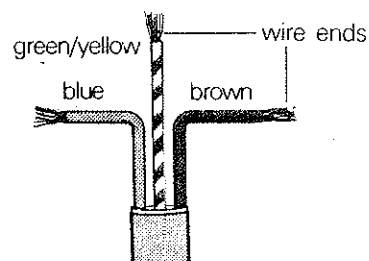
unit 3

drills

drill 2

unit 3
drills
drill 3

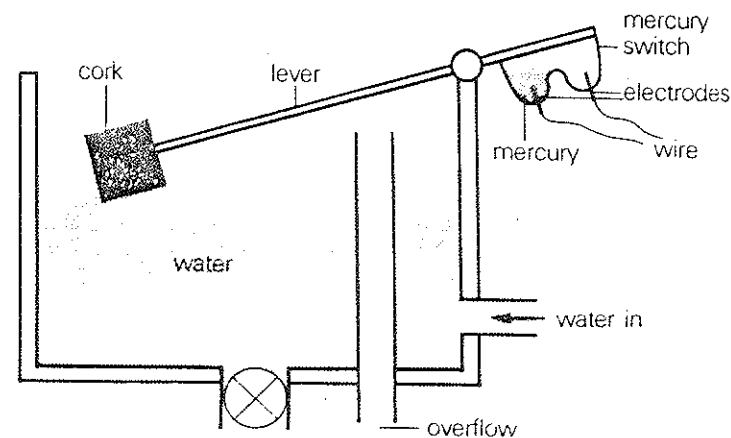
drill 3 Listen to how to fit wires to a standard British electric plug.



Now complete these sentences:

- 1 You _____ the ends of the wires.
 - 2 You _____ the wires under the cord grip.
 - 3 You _____ the wires, as shown.
 - 4 You _____ the ends of the wires into the terminals.
 - 5 You _____ the terminal and cord grip screws.
- Now answer the questions you hear. Listen carefully.

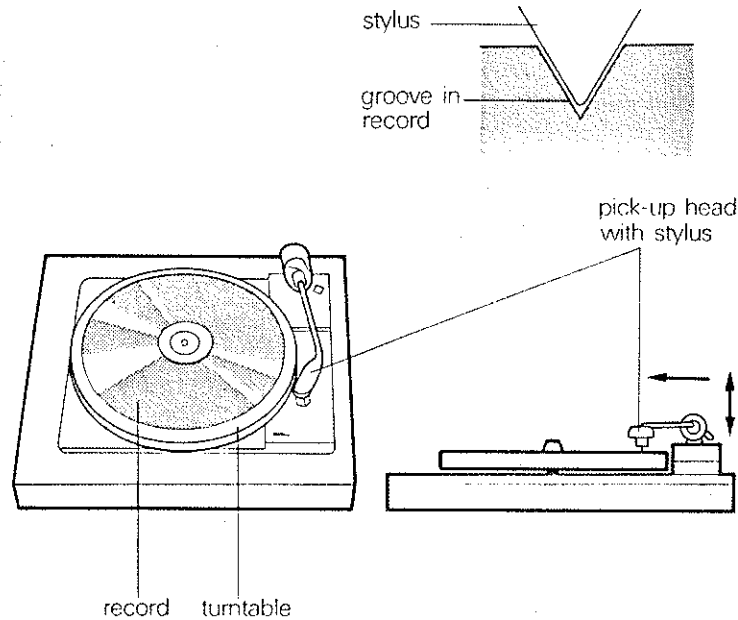
drill 4 First listen to the description of the action of this safety-switch.



Now listen again, and answer the following questions in the pauses:

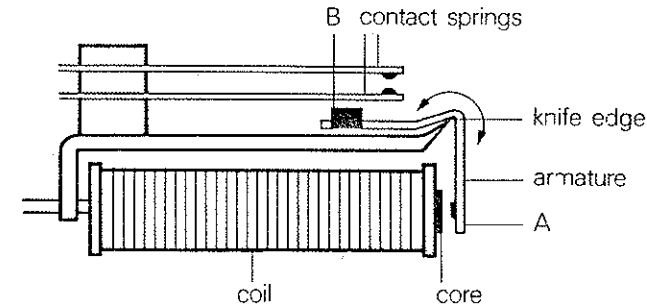
- 1 Where does water enter the tank?
- 2 What happens to the cork when the water level rises?
- 3 What does the lever move around?
- 4 What happens to the mercury switch as the cork rises?
- 5 What happens when the lever is horizontal?
- 6 What happens when the level of the water falls?
- 7 What happens to the mercury switch as the water level falls?
- 8 What happens when the mercury switch rises?

drill 5 Listen to the description of the operation of a record-player. After each sentence, supply the missing words in the sentences below.



- 1 A record is placed _____ the turntable, which _____ in a _____ direction.
- 2 The pickup head is _____ and moved _____ the record.
- 3 When the stylus is _____ the record, it is _____ until it touches the groove.
- 4 The stylus moves _____ the record as the record _____.
- 5 When the stylus is _____ the centre of the record, the pickup head is _____ and moved _____ the centre of the turntable _____ its original position.

drill 6 Study this diagram of an electrical relay, and then use the notes to answer the questions.



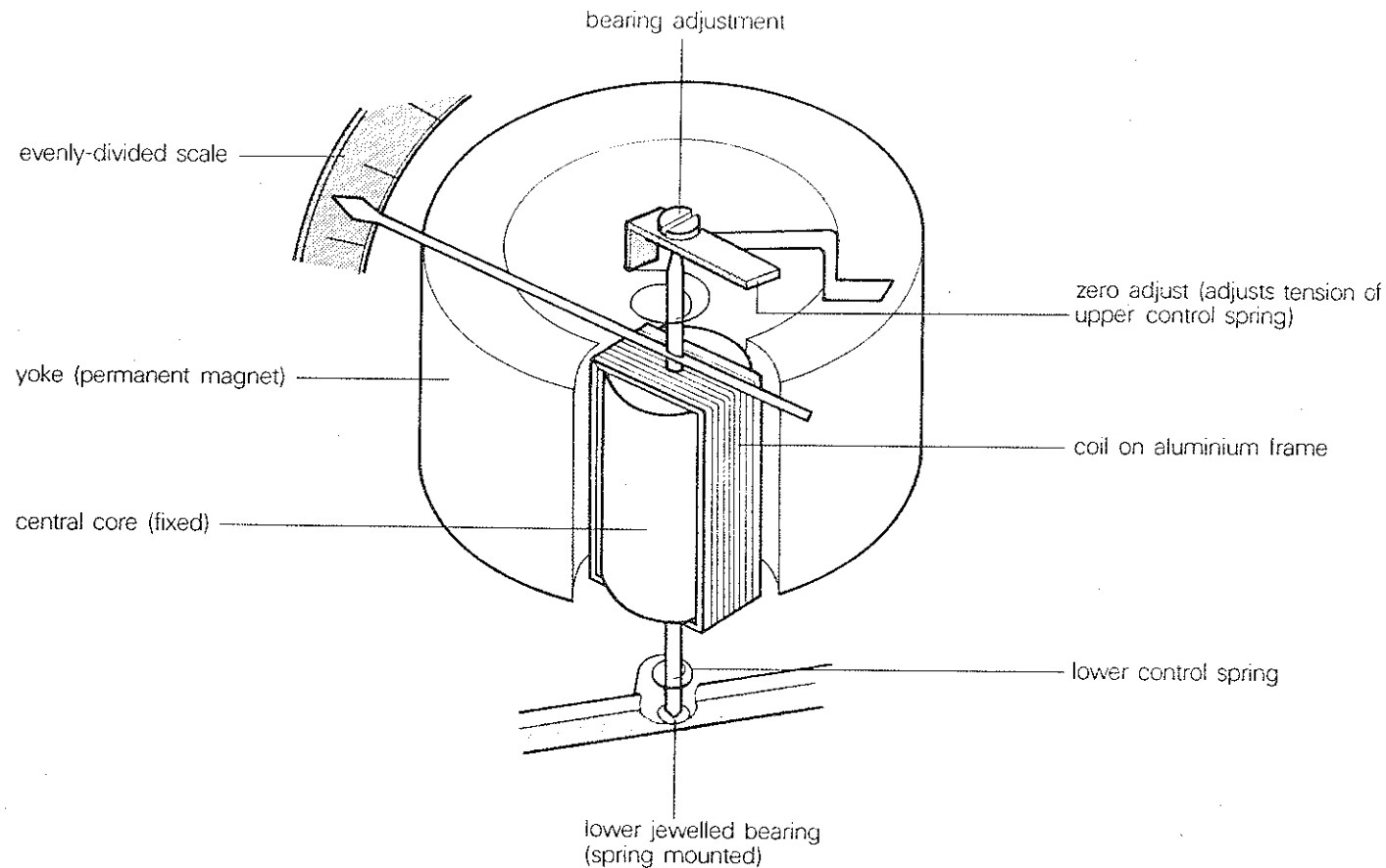
Where is the armature pivoted?
Around the knife-edge.

When current is passed through the coil, what happens to the end of the armature A?
It moves towards the coil.

- 1 around/ _____
- 2 towards/ _____
- 3 raise
- 4 push/ _____ /upwards
- 5 bend/upwards/towards/ _____
- 6 end/armature A/away from/ _____
- 7 lower
- 8 bend/back

activity**unit 3**
activity

Here is a diagram of a moving-coil meter used for measuring electric current. Together with your teacher, build up a description of its construction.



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classwork

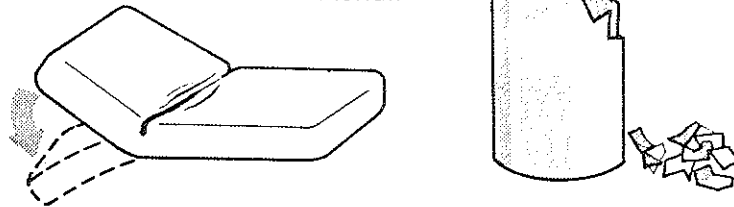
unit 4
classwork
section 1

SECTION 1 describing qualities of materials

A All materials (glass, wood, rubber, steel, etc) have various properties. What words are used to describe these properties?

Rubber is _____.
Rubber is a _____ material.

Glass is _____.
Glass is a _____ material.



Here are some materials and some properties. Make statements to describe the properties of the materials. For example, *Steel is strong* or *Steel is a strong material*.

Materials	Properties	
glass	stiff	elastic
rubber	flimsy	rigid
steel	strong	pliable
polythene	weak	soft
wood	resilient	hard
wool	tough	fragile
paper	brittle	
porcelain	flexible	

Notice that many materials can be described by more than one property. For example, Steel is strong and rigid. We therefore say: *Steel is a strong rigid material*.

Make similar sentences about other materials, describing them with more than one property if possible.

B We often want to **modify** statements about the properties of materials. For example,

Glass is **extremely** brittle.
Polythene is **very** resilient.
Wood is **fairly** strong.
Rubber is **quite** tough.
Paper is **not very** strong.

We can therefore also say:

Glass is **an extremely** brittle material.
Polythene is **a very** resilient material.
Wood is **a fairly** strong material.

But notice that we must say:

Rubber is **quite a tough** material.
Paper is **not a very strong** material.

Make statements about various materials again, but this time modify the statements with the following words: *extremely, very, fairly, quite, not very*.

C Ask and answer questions about the properties of various materials, using the **modifiers** above. For example,

Is glass very resilient?
No, it isn't, it's very brittle.

Is wool an extremely rigid material?
No, it isn't, it's a very soft pliable material.

Isn't paper very strong?
No, it isn't, it's quite weak.

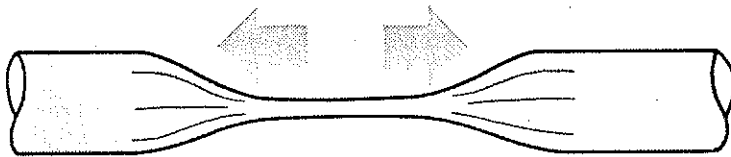
Use the following notes to help you ask the questions:

- | | |
|----------------------|-----------------|
| 1 glass/resilient? | 4 wool/hard? |
| 2 polythene/brittle? | 5 paper/strong? |
| 3 rubber/rigid? | 6 wood/soft? |

- 7 paper/tough?
8 steel/weak?
9 wool/rigid?
10 rubber/brittle?

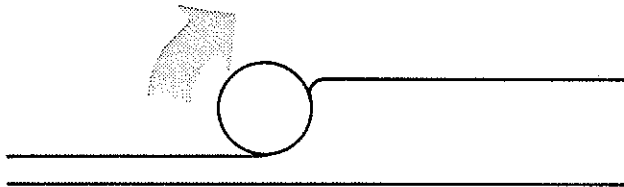
D What words are used to describe the following properties?

A material which can be easily pulled out, or stretched into a long wire or strand, is said to be _____.

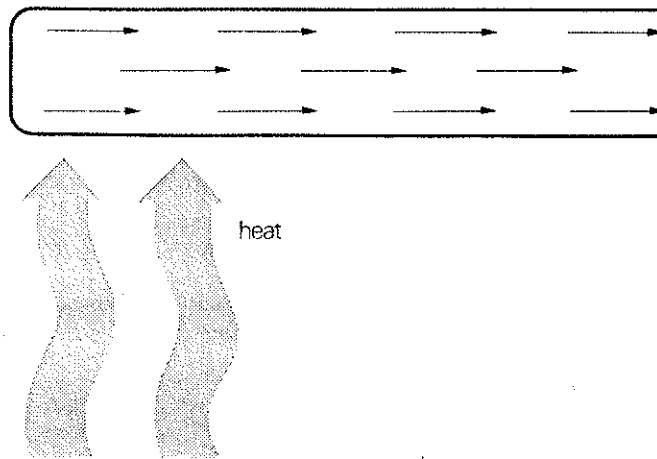


Materials which are used for wires, such as copper and aluminium, must therefore have this property.

A material which can be easily deformed by hammering or rolling is said to be _____.



When a substance allows heat or electricity to pass along it, it is said to _____ heat or electricity.



Copper (Cu) and aluminium (Al) are _____, but glass and porcelain are _____.

Make sentences from this table.

Copper (Cu)	is	a	extremely	good	insulator.
Aluminium (Al)					
Lead (Pb)					
Glass					
Porcelain					
		an	very	poor	conductor.
			fairly		

unit 4
classwork
section 1

E You know that we can say: *Wood is fairly strong* and *Steel is very strong*. If we wish to **compare** steel and wood, we can say:

Steel is _____ wood.

Now look at these comparisons:

Cardboard is quite strong. Paper is not very strong.
Cardboard is **slightly stronger** than paper.

Steel is very strong. Wood is not very strong.
Steel is **much stronger** than wood.

or:

Steel is **a lot stronger** than wood.

Wool is very soft. Wood is not very soft.
Wool is **considerably softer** than wood.

Rubber is very tough. Paper is not very tough.
Rubber is **far tougher** than paper.

But notice what we say with these properties:

Steel is slightly **less ductile/slightly more resilient** than copper.

Rubber is **much more flexible/much less rigid** than steel.

or:

Rubber is **a lot more flexible/a lot less rigid** than steel.

Glass is **considerably more brittle/considerably less resilient** than wood.

Polythene is **far more resilient/far less fragile** than glass.

Make statements comparing these materials:

- 1 glass/fragile/steel
- 2 _____ /wood

- 3 copper/ductile/iron
- 4 rubber/rigid/steel
- 5 cardboard/stiff/paper
- 6 polythene/brittle/material/glass
- 7 iron/malleable/wood
- 8 paper/strong/cardboard
- 9 porcelain/resilient/material/plastic
- 10 wood/hard/cardboard
- 11 copper/good/conductor/lead
- 12 iron/poor/conductor/aluminium

F All the substances described so far are solids. But, of course, we must be able to describe the properties of other substances. Here are some properties of **liquids and fluids**:

oily thick viscous thin creamy
runny sticky free-flowing

Name some substances which have some of the properties in the list above. For example,

Milk is a free-flowing white liquid.

Some substances are between solid and liquid form. Such substances may be in the following forms:

gel (jelly)	(adjective: gelatinous)
cream	(adjective: creamy)
paste	

Some solids may be found in the following forms:

powder	(adjective: powdery)
crystals	(adjective: crystalline)
granules	(adjective: granular)
filings	
chips	
flakes	(adjective: flaky)

We sometimes describe these further by using *fine* or *coarse*. For example,

Refined sugar consists of fine white granules.
Fine iron filings are used to show the presence of a magnetic field.
A substance such as sand may be either fine or coarse.

Now use the words above to describe the following substances as fully as possible.

- | | |
|--------------|-----------------------|
| 1 jam | 6 oil for a motor car |
| 2 toothpaste | 7 sand |
| 3 butter | 8 instant coffee |
| 4 salt | 9 honey |
| 5 glue | 10 chalk |

SECTION 2 describing colours and appearance

A What are the three colours of light which together form white light? They are printed on the back cover. What colours are made by mixing these three colours? What are the colours of the spectrum called in English? These are also shown on the back cover.

B We can modify our descriptions of colours by saying:

light blue *or* pale blue
dark blue *or* deep blue
bright yellow
dull brown

Describe the colours of some objects in the

classroom. Ask and answer questions using this table. For example,

What colour is the chair?
It's dark brown.

Is the floor light green?
No, it isn't. It's dark blue.

light	red
dark	blue
pale	green
deep	yellow
bright	orange
dull	purple
	brown
	grey
	pink

C When an object is not exactly one colour, we can add *-ish* to the colour. For example,

red reddish
blue bluish
yellow yellowish
(but: silver silvery)

When an object is between two colours, we often say: *reddish-brown*, *bluish-yellow*, *greyish-green*, etc. (We can also say: *lightish blue*, *darkish grey*, etc.) For example,

Copper is a reddish-brown colour.

The sea is a bluish-green (*or* greenish-blue) colour.

Describe more of the objects in the room, and objects your teacher presents, using these approximate expressions of colour. Ask and answer questions about the colours of things.

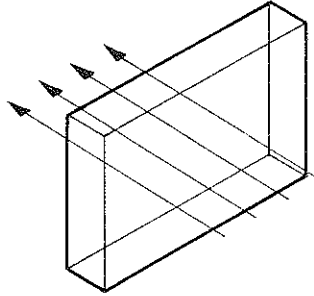
What colours are these?

amber mauve
bronze turquoise
crimson khaki

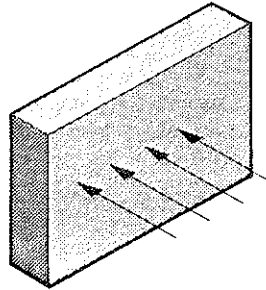
unit 4
classwork
section 2

D Complete these statements.

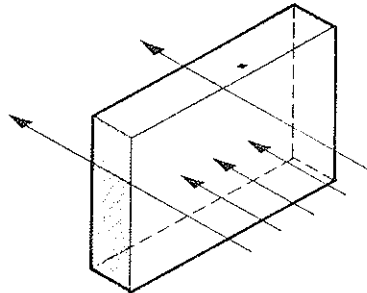
A material which allows light to pass through it is _____. Glass is _____. (Glass is a _____ substance.)



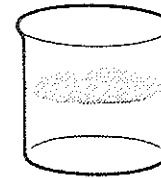
A material which does not allow light to pass through it is _____. Steel is _____.



A material which allows **some** light to pass through it is _____. Ground glass or 'frosted' glass is _____.



Substances which have no colour (like water) are _____. Water is a _____ liquid.



A white liquid is sometimes said to be _____ or _____. Carbon dioxide turns lime water _____.

When an object or a substance is dirty, it is said to be _____.

E As well as colour, objects have different types of **surface** or **appearance**. Surfaces can be:

bright	glossy
shiny	mat/matt
dull	

They can also be:

smooth	grainy
rough	corrugated
uneven	pitted
coarse	abrasive

Complete these descriptions together with your teacher. Your teacher will help you with new words.

- 1 Glass is a _____ solid which usually has a _____ surface.
- 2 Chalk is a porous solid which has a _____ surface.
- 3 Some cardboard is _____ to give it extra strength.
- 4 The inside of a camera has a _____ surface.
- 5 Mercury is a liquid metal which has a _____ surface.

- 6 Sandpaper has a _____ surface.
 7 An unplanned piece of wood has a _____ surface.
 8 A piece of rubber has a _____ surface.

Describe the appearance and texture of:

- 1 this paper
 2 the walls of the room
 3 the floor
 4 the surface of a tree-trunk
 5 a leaf.

F Here is a table giving descriptions of four metals. Ask and answer questions about the metals' properties, colour and appearance.

Aluminium (Al)	Bluish-white solid, very soft, light, malleable and ductile. Very good conductor. Shiny when clean.
Copper (Cu)	Reddish solid, malleable and ductile. Shiny when clean. Very good conductor.
Iron (Fe)	Greyish-white solid, soft, malleable and ductile. Magnetic. Shiny when clean.
Lead (Pb)	Greyish solid, soft, heavy, ductile. Dull.

G Describe the colour, appearance and texture of the objects your teacher shows you. Use the following headings: *Colour, Appearance, Texture*.

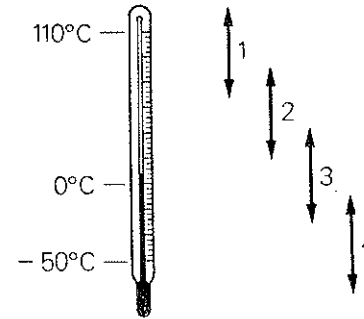
SECTION 3 describing a simple process and experiment

A Complete these statements:

2,000°C is a very _____ temperature.

-50°C is an extremely _____ temperature.

What adjectives can we use for these **ranges** of temperature? (They are very approximate.)



When we are talking about the weather, how do we describe these temperatures?

54°C: extremely _____

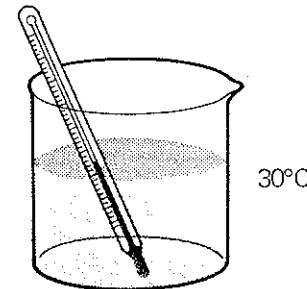
-30°C: extremely _____

25°C: quite _____

15°C: fairly _____

-5°C: quite _____

The water in this beaker is _____ (or _____).



unit 4
classwork
section 3

Complete this table:

Adjective	Verb	Noun
hot warm cool cold		

Complete these statements:

- At normal temperatures, iron is a solid. However, when it is _____ above $1,537^{\circ}\text{C}$, it _____.
- Water is a liquid at normal temperatures. However, when it is _____ below 0°C , it _____.
- When water is _____ to 100°C , it _____.
- When a substance changes from a solid to a liquid, it is said to _____.
- When a substance changes from a liquid to a solid, it is said to _____.
- When a substance changes from a liquid to a gas, it is said to _____.

C We can also form nouns and verbs from the adjectives in this table. Study the table and write out a completed copy.

Adjective	Verb	Noun
weak tough soft hard rough coarse	weaken	weakness

However, not all nouns and verbs can be formed in this way. What are the missing words from this table? (In some cases we cannot form a verb directly from an adjective, for instance with *resilient*. In this case we have to say *make something resilient*.)

Adjective	Verb	Noun
strong resilient brittle flexible elastic pliable smooth rigid ductile malleable		

D Fill in the missing words in the following passage:

Hardening. Medium and high carbon steel are not very h_____, and so they must be h_____. They are h_____ slowly to a h_____ temperature (above 700°C), and then rapidly c_____ (or 'quenched'). Fully h_____ steel is, however, extremely brittle, and has poor shock resistance. The b_____ of h_____ steel can be reduced and the quality of the metal increased by tempering. This process is described below.

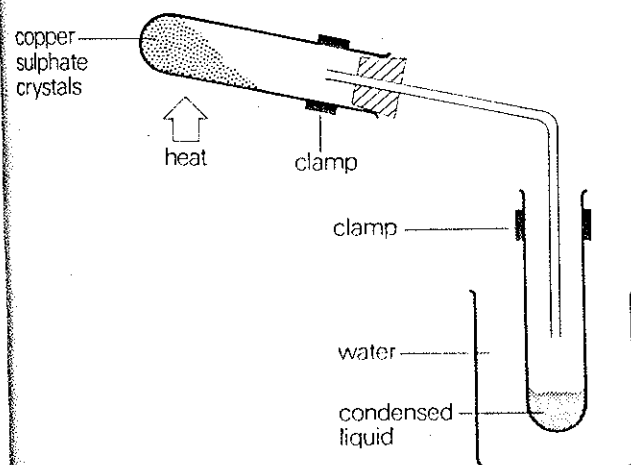
Tempering. The metal is re-h_____ to a comparatively l_____ temperature and again q_____ at a carefully controlled temperature. The colour of the film of oxide on the brightened surface of the h_____ steel gives a good approximation of the temperature of the

steel. The oxide first turns a very pale yellow, and changes through a range of colours to dark blue as it is h_____.

Ask and answer questions about this table, which shows the colour of the film of oxide at different temperatures:

Temp. °C	Colour
220	pale yellow
230	straw
240	dark straw
250	light brown
260	purple/brown
270	purple
290	bright blue
300	dark blue

E Study this diagram and the following passage carefully, and then answer the questions.



Experiment to show the presence of water of crystallization in a salt

Dry crystals of copper sulphate in the test-tube are heated. The colour of the crystals before heating is dark blue. When they are heated, the dark blue colour fades and the crystals turn white. At the same time, a colourless liquid is collected in the water-cooled tube. If the boiling-point and freezing-point of this liquid are measured, they are found to be the same as for water.

If water is added to the cold dry white copper sulphate crystals, they turn blue and much heat is produced. This shows that blue copper sulphate crystals contain water, which is removed when the crystals are heated.

- 1 Describe the apparatus used in this experiment.
- 2 What is the colour of the crystals before heating?
- 3 What happens when they are heated?
- 4 What tests are carried out with the liquid which is collected?
- 5 What do the tests show?
- 6 What can be done to the cold dry white copper sulphate crystals?
- 7 What happens when this is done?
- 8 Write down a series of steps for carrying out the experiment. For instance:
 - (i) Dry crystals of blue copper sulphate are placed in the test-tube.

exercises

unit 4 exercises exercise 1

exercise 1 Read this passage carefully, and then complete the exercise.

Steel is an alloy of iron (Fe) and carbon (C). The carbon content must not be more than 1.7%. Steel is very strong and ductile. When the carbon content is high, the steel is stronger and harder than when it is low, but steel with a high carbon content is less ductile and less resistant to shock. Steel which contains less than 0.1% carbon is known as **dead mild steel**. It is soft and ductile. Steel which contains up to 0.35% carbon is known as **mild steel**. It is harder and less ductile than dead mild steel. Steel with a carbon content of 0.35% to 0.7% is called **medium carbon steel**. It is harder, stronger and less ductile than mild steel. Steel with a carbon content of 0.7% to 1.5% is called **high carbon steel**. It is harder and less ductile than low carbon steels.

Now make these notes into sentences. For example,

mild steel/ductile/medium carbon steel
Mild steel is more ductile than medium carbon steel.

- 1 steel/high carbon content/ductile/steel/low carbon content
- 2 dead mild steel/soft/mild steel
- 3 medium carbon steel/hard/mild steel
- 4 high carbon steel/ductile/dead mild steel/mild steel
- 5 medium carbon steel/ductile/mild steel
- 6 medium carbon steel/hard/high carbon steel
- 7 mild steel/hard/dead mild steel
- 8 high carbon steel/much/hard/dead mild steel
- 9 dead mild steel/far/soft/high carbon steel
- 10 considerably/ductile/high carbon steel

exercise 2 Construct statements which give the main properties and appearance of these substances. For example,

Mercury is a bright shiny white liquid metal.

- | | |
|---------------|--------------------------------|
| 1 Silver | 7 Sulphur (S) |
| 2 Water | 8 Milk |
| 3 Copper (Cu) | 9 Sulphuric acid (H_2SO_4) |
| 4 Iron (Fe) | 10 Coal |
| 5 Coffee | 11 Sand |
| 6 Glass | 12 Sugar. |

exercise 3 From the notes, make sentences like this example:

water/heat/100°C/boil
When water is heated to 100°C, it boils.

- 1 aluminium/heat/659-70°C/melt
- 2 water/cool/0°C/freeze
- 3 steel/hard/become/brittle
- 4 hardened steel/heat/270°C/turn/purple
- 5 water/heat/above/100°C/vaporize
- 6 ice/heat/0°C/melt
- 7 liquid steel/cool/solidify
- 8 rubber/vulcanize/become/tougher
- 9 copper/heat/become/more ductile
- 10 glass/tough/become/more resilient
- 11 blue copper sulphate crystals/heat/turn/white
- 12 steel/heat/300°C/film of oxide/turn/dark blue

drills

drill 1 Here is a table which compares the properties of aluminium and copper. Use it to help you make statements about the metals in answer to the questions you hear. For example,

What about strength?

Aluminium is less strong than copper.

What about resistance?

Aluminium has a higher resistance than copper.

Aluminium	Copper
Light	Not very light
Fairly strong	Very strong
Good conductor	Very good conductor
Fairly cheap	Not very cheap
Fairly low resistance	Very low resistance
Very high corrosion resistance	Fairly high corrosion resistance
Not very easy to solder	Very easy to solder

drill 2 Here is a list of substances, showing which are good conductors of heat and which are poor conductors. Use the notes to help you answer the questions.

Copper	GOOD
Aluminium	
Brass	
Zinc	
Lead	
Glass	POOR

Is copper a better conductor than lead?
Yes, it's far better.

Is brass a better conductor than copper?
No, it's much poorer.

- | | |
|------------|------------|
| 1 far | 5 slightly |
| 2 much | 6 far |
| 3 much | 7 much |
| 4 slightly | 8 slightly |

drill 3 Here is a table showing the colours of metallic elements. Use it to help you answer the questions.

Copper's brown, isn't it?

No, it's not; it's a reddish colour.

Gold's a dull white, isn't it?

No, it's not; it's a bright yellow colour.

Element	Colour
copper (Cu)	reddish
mercury (Hg)	silvery-white
aluminium (Al)	light white
zinc (Zn)	bluish-white
sulphur (S)	pale yellow
gold (Au)	bright yellow
lead (Pb)	bluish-white
magnesium (Mg)	silvery-white
silver (Ag)	bright white
tin (Sn)	silvery-white

unit 4
drills
drill 4

drill 4 Correct the statements.

Glass is opaque.
No it isn't, it's transparent.

Silver is dull.
No it isn't, it's shiny.

drill 5

What's done to water to make it hot?
It's heated.

What's done to steel to make it hard?
It's hardened.

drill 6 Use the notes below to help you answer the questions.

What does heating do to the metal?
Heating increases its ductility.

What does hardening do to the metal?
Hardening reduces its toughness.

- 1 more ductile
- 2 less tough
- 3 more resilient
- 4 less flexible
- 5 less weak
- 6 stronger
- 7 harder
- 8 smoother
- 9 more malleable
- 10 less soft

activity

Your teacher will give you examples of a number of different substances. Discuss the qualities and attributes of each of these as fully as you can. Note down any new words and expressions you are given. Where you can, compare the qualities and attributes of the different substances.

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classwork

unit 5 classwork section 1

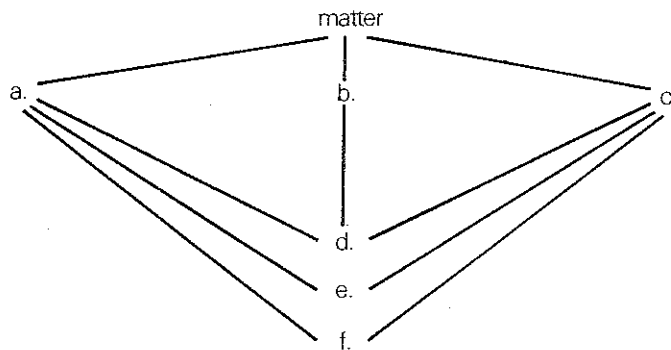
SECTION 1 classification, definition and description

A Complete these statements:

The basic constituents of all matter are e _____.
Some of these exist freely in nature (carbon, iron, copper, etc). When two or more e _____ are chemically joined together, they form a c _____.
For example, *oxygen + hydrogen → water*.

When two or more e _____ or c _____ are mixed together but not chemically combined, they form a m _____. E _____, c _____ and m _____ can be either solids, liquids or gases.

B Copy out this diagram, completing the spaces to show the relationship between solids, liquids and gases, and elements, compounds and mixtures.



The diagram illustrates the relationship between solids, liquids and gases, and compounds, mixtures and elements.

We can use it to make statements which express general truth, like these:

Matter exists in three **states**: solid, liquid and gas.

All matter can be divided into three **classes**: compounds, mixtures and elements.

Solids, liquids and gases can be compounds, mixtures or elements.

Solids, liquids and gases are all **forms** of matter.

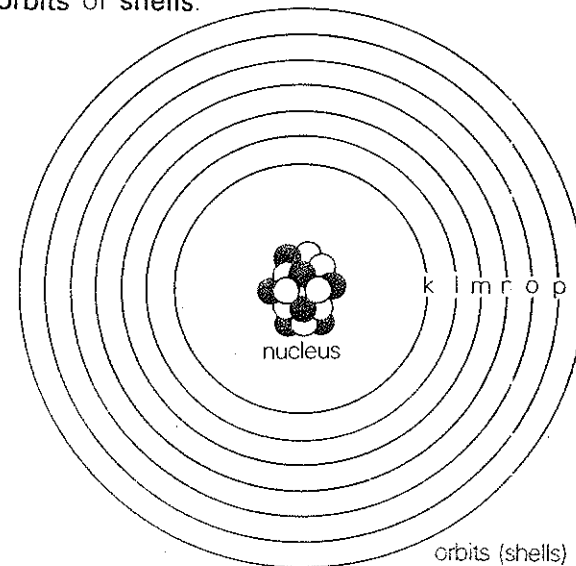
Now look at these **definitions**:

A molecule is defined as the smallest unit into which any matter may be split without losing its original properties.

An atom is defined as the smallest part into which an element may be split without losing its identity as part of the element from which it is divided.

C Look at this **description** of an atom, and the diagram.

An atom consists of **protons** and **neutrons** forming a central **nucleus**, around which **electrons** revolve in **orbits** or **shells**.



Here are some statements about the atom:

The proton has a positive electrical charge and a mass of 1.672×10^{-27} kg.

The neutron has no electrical charge and a mass equal to that of the proton.

The electron has a negative electrical charge and a negligible mass.

When the number of electrons is equal to the number of protons, the atom is neutral.

When an atom loses an electron, it becomes a positive ion.

When an atom gains an electron, it becomes a negative ion.

The number of protons in an atom of an element is the atomic number of that element.

The atomic weight of an atom is equal to the number of protons plus the number of neutrons in the nucleus of the atom.

Now make statements about the atom, using these notes:

- 1 atom/consist/nucleus/electrons
- 2 nucleus/consist/protons/neutrons
- 3 proton/positive charge
- 4 proton/mass/ 1.672×10^{-27} kg
- 5 neutron/no electrical charge
- 6 mass/proton/equal to/mass/neutron
- 7 electron/negative electrical charge/negligible mass
- 8 when/number/electrons/equal to/number/protons,/atom/neutral
- 9 when/atom/gain/electron,/become/negative/ion
- 10 when/atom/lose/electron,/become/positive/ion
- 11 atomic weight/atom/equal to/number/protons/plus/number/neutrons
- 12 atomic number/atom/equal to/number/protons/in/atom

D Study this description carefully:

Radioactivity Certain heavy elements (eg radium, uranium) disintegrate spontaneously, emitting high energy radiation. This radiation consists of three types of rays: alpha-rays, beta-rays and gamma-rays. These three types of radiation can be shown to exist by their behaviour in a magnetic field.

Alpha-rays consist of alpha particles. These particles are helium atoms which have lost two electrons. This means they are just the nuclei and are therefore positively charged.

Beta-rays consist of beta particles, which are fast-moving electrons. They are therefore negatively-charged. The alpha and beta particles are deflected in opposite directions by the magnetic field.

Gamma-rays have a very short wavelength (about 10^{-12} cm) and high penetrating power. They are therefore not deflected by the magnetic field.

All three types of radiation cause blackening of a photographic plate. They can therefore be detected by photographic methods.

(In the diagrams, the magnetic field is perpendicular to the page.)

Now answer these questions, using the passage and the diagrams.

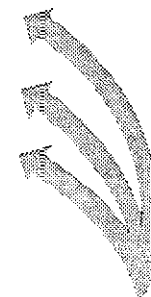
- 1 What substances emit high energy radiation?
- 2 What does this radiation consist of?
- 3 How can the radiation be shown to exist?
- 4 What do alpha-rays consist of?
- 5 What are alpha particles?
- 6 What do beta-rays consist of?
- 7 What are the properties of gamma-rays?
- 8 How can alpha-, beta- and gamma-rays be detected?
- 9 What charge do alpha particles have?
- 10 What charge do beta particles have?

unit 5

classwork

section 1

Magnetic field causes small dispersion of radiation



α -rays (+)

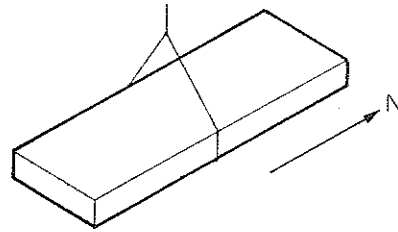
No dispersion of radiation



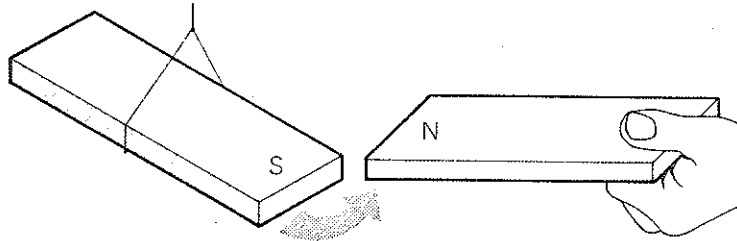
γ -rays (uncharged)

Large dispersion of radiation



SECTION 2 **describing and predicting****A** Read the following description carefully.

When a bar magnet is suspended freely about its centre, it will turn to point north-south. It is then said to be pointing to **magnetic north**

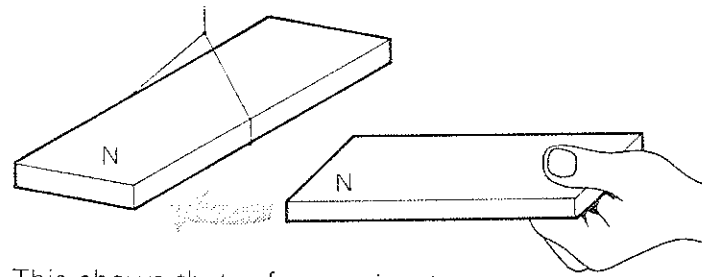


However, if a second magnet is brought near to the suspended magnet, this will alter the direction in which it points.

If the north pole of one magnet is brought near to the south pole of the other, the poles will be **attracted** to each other.

However, if the south pole of one magnet is brought near to the south pole of the other, the south pole of the suspended magnet will swing away from the south pole of the second magnet. The poles are said to **repel** each other.

Similarly, if a north pole is brought near to the north pole of the suspended magnet, the poles will repel each other and the north pole of the suspended magnet will turn away from the second magnet.



This shows that a force exists between two magnetic poles, which causes **like** poles (ie both north or both south) to repel each other, and **unlike** poles (ie one north and one south) to attract each other. This can be summarized as follows:

Like magnetic poles repel each other; unlike magnetic poles attract each other.

Given the statement above, what sentences can you make from this table?

If a

north
south

 pole is brought near to a

north
south

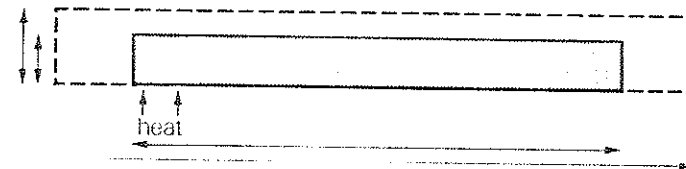
pole, the poles will

attract
repel

 each other.

B Complete this description by supplying the missing words.

If a metal bar is heated, its dimensions will _____

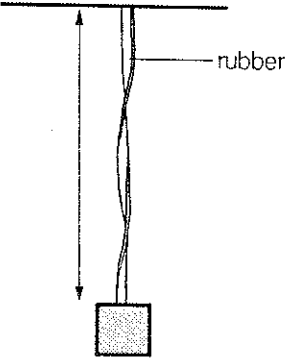


When substances _____ their dimensions (volume, area or length) when they are heated, they are said to _____. This phenomenon is known as _____. When a substance decreases in length, area or volume, it is said to _____. This phenomenon is known as _____.

Make sentences from this table. For example,
If water is heated, it will expand.

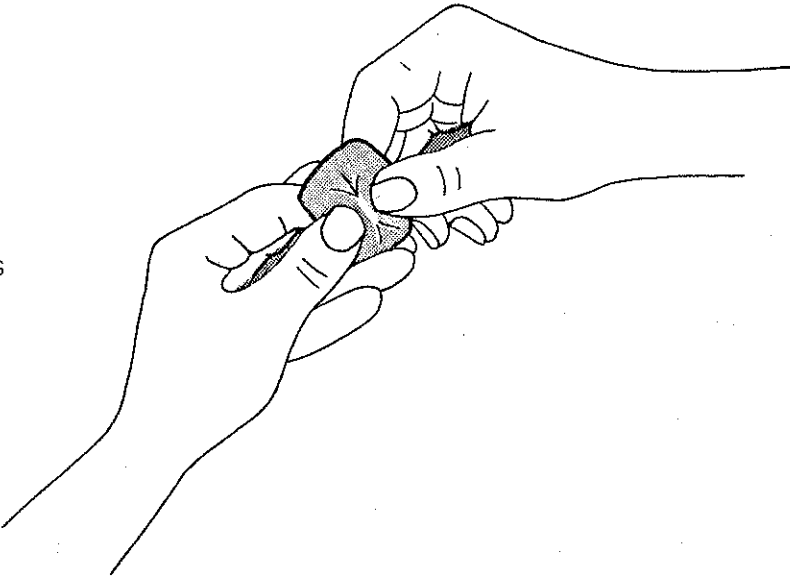
If	water	heat	expand.
	steel		
	mercury	cool	contract.
	alcohol		

C The following description contains statements of effect, and defines several terms. Find suitable words to complete the description.



A material is said to be **in tension** when the forces applied to it tend to _____ the material. For example, if a mass is hung on the end of a length of rubber, the rubber will be in tension. A force which _____ tension is known as a **tensile** force. A tensile force will _____ the length of the material on which it acts.

A material is said to be **in compression** when the forces applied to it tend to _____ or _____ the material. For example, if a rubber eraser is _____ between the fingers, the rubber will be in compression. A force which _____ compression is known as a **compressive** force. A compressive force will _____ the length of the material on which it acts.



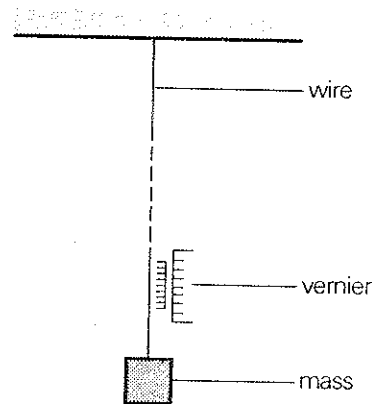
If a force is applied to a metal wire which is _____ vertically, the wire will _____ in length, according to the magnitude of the force. The wire is then said to _____, and the increase in length is said to be the _____.

unit 5
classwork
section 2

D Read this passage carefully, and then answer the questions after it.

The relationship between the load applied to the wire and the extension of the wire may be investigated as follows.

A wire of the material under test is fixed at one of its ends, and a number of masses are added to the free end. A force therefore acts vertically down the wire. The masses are added to the wire so that the force is increased regularly. The length of the wire is measured carefully for each value of the load. This is done by means of a vernier scale, which allows accurate measurements to be made easily.



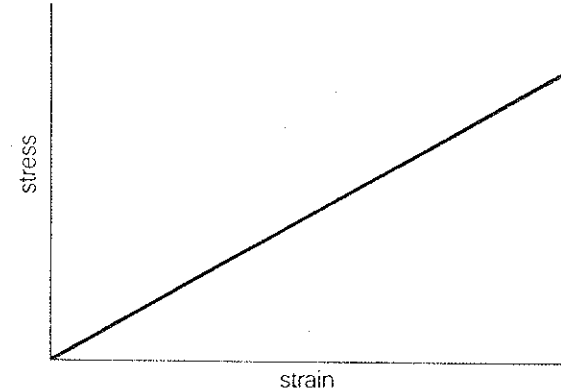
If the load is not too great, the wire will return to its original length when the load is removed. The wire is then said to be **elastic**.

From the values of load and extension, the values of stress and strain can be calculated as follows:

$$\text{stress} = \frac{\text{load}}{\text{cross-sectional area of wire}}$$

$$\text{strain} = \frac{\text{extension}}{\text{original length}}$$

If a graph of these values is plotted, it will be found to be a straight line.



If the load applied is too great, the wire will not return to its original length when the load is removed. If this happens, the graph will not be a straight line. The maximum stress that can be applied for stress to be proportional to strain is known as the **elastic limit**. If the elastic limit is exceeded, the wire will not return to its original length. This is summarized by Hook's Law, which states that:

Within the elastic limit, the strain is directly proportional to the stress producing it.

Make sentences from these notes. (Think carefully about the meaning of what you are saying, as you may have to change the order of the phrases.) For example,

wire extended—load applied to wire

If a load is applied to the wire, the wire will be extended.

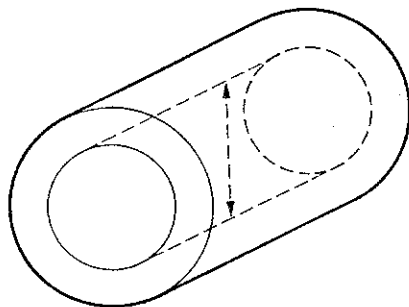
It is not correct to say: *If the wire is extended, a load will be applied to the wire.*

- 1 masses added to wire—force in wire increases
- 2 load applied to wire—wire extended
- 3 measurement of length more accurate—vernier scale used
- 4 stress less than elastic limit—wire returns to original length
- 5 elastic limit not exceeded—stress proportional to strain
- 6 graph of stress against strain plotted—found to be straight line
- 7 elastic limit exceeded—load too great
- 8 stress not proportional to strain—load too great

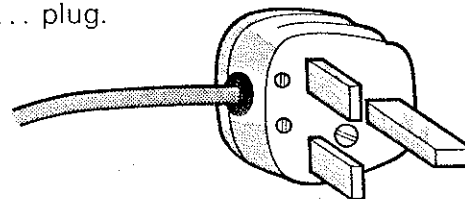
SECTION 3 detailed description

A Write out the statements describing these objects.

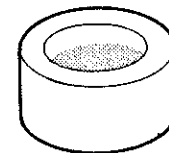
- 1 The internal diameter of a tube is sometimes called the _____. The diameter of this tube is the same all along its length. It is therefore said to be _____, and we can say: The tube has a _____ We can also say: It's a _____ tube.



- 2 This plug has three _____. We can therefore say: It's a _____ plug. It can carry a current of 13 amps, so we can say: It's a ... plug.



- 3 This container is cylindrical. It is made of metal. We can therefore say: It's a _____ container



- 4 This tube has a large diameter. It's made of steel. We can therefore say: It's a ... tube.



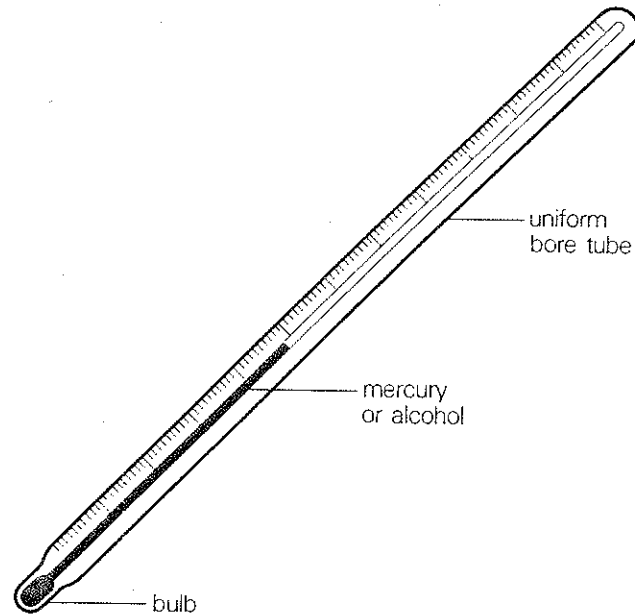
How can you describe these objects?

- 1 A thermometer which contains mercury.
A ... thermometer.
- 2 A bar made of steel, rectangular in shape.
A ... bar.
- 3 A tube made of glass and with a small bore.
A ... tube.
- 4 A motor which is driven by electricity and has three speeds.
A ... motor.
- 5 A disc, made of plastic, black in colour, twelve inches in diameter.
A ... disc.

unit 5
classwork
section 3

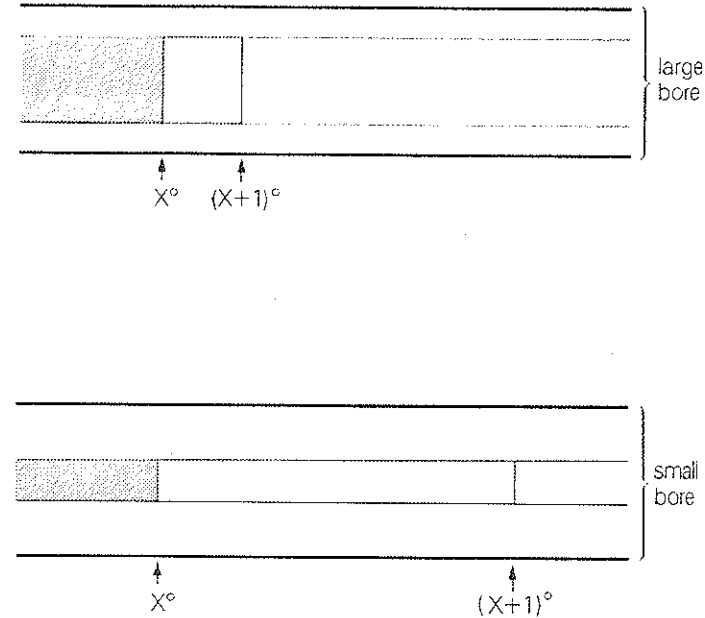
B An instrument used for measuring temperature is known as a thermometer. There are various types of thermometer, but the most common is the mercury (or alcohol) thermometer.

Use the notes in 1, 2 and 3 to help you describe the construction of a mercury or alcohol-in-glass thermometer in three sentences.



- 1 laboratory thermometer/consist of/sealed glass tube with/bulb/at one end
- 2 tube/has/small, uniform bore/and/air/removed/it
- 3 bulb/contain/mercury or alcohol/which can pass

Now describe the operation of the thermometer, using the words given in brackets to start each sentence.



- 4 Temperature increases/mercury or alcohol expands (As)
- 5 liquid expands/travels along tube (As)
- 6 tube has a uniform bore/distances measured along the tube/proportional to changes in temperature (Since)
- 7 side of the tube is marked with a scale/temperature can/read/directly from the position of mercury or alcohol (As)

- 8 liquid expands a certain amount for a unit rise in temperature/liquid/travel/further along a small bore tube for a given rise in temperature (*Since*)

If the tube has a small bore, the length of the temperature scale will be greater than if the tube has a large bore. We can therefore say that for a given range of temperature:

small bore=long thermometer
large bore=short thermometer

We can express this relationship by saying that, for a given range of temperature:

The smaller the bore, the longer the thermometer.
The larger the bore, the shorter the thermometer.

C Use these notes to help you make statements like those in **B**. For example,

metal block/heated/high temperature/large expansion

When a metal block is heated, the higher the temperature the larger the expansion.

- 1 metal/compressed/large force/great compression
- 2 metal/heated./high temperature/ductile material
- 3 two magnets/brought together./near poles/great force
- 4 force/applied to a wire./large force/great extension
- 5 current/passed through a wire./high current/great heating effect
- 6 gas/compressed./high pressure/small volume
- 7 thermometer/heated./high temperature/long column of mercury
- 8 steel/made/high carbon content/hard steel

exercises

exercise 1 Use these notes to make statements of general fact about matter. For example,

elements/basic constituents/all matter
Elements are the basic constituents of all matter.

molecule/group/atom
A molecule is a group of atoms.

- 1 matter/exists/three states
- 2 all matter/can/divide/compounds/mixtures/elements
- 3 all matter/made up of/atoms/molecules
- 4 atom/consist of/nucleus/one or more electrons
- 5 electrons/revolve around/nucleus/atom
- 6 nucleus/consist of/neutrons/protons
- 7 protons/have/positive charge
- 8 neutrons/not/have/electrical charge
- 9 atomic weight/of/element/equal to/number of protons/plus/number of neutrons/in/nucleus/of/atom/of/element
- 10 radiation/emitted/certain/heavy elements/consist of/three types/ray

exercise 2 Make sentences from the notes in the same way as in this example:

steel bar/cooled/contract
If a steel bar is cooled, it will contract.

- 1 block of ice/heated/above 0°C/melt
- 2 oxygen/cooled/to -182.97°/boil
- 3 tensile force/applied/metal wire/length/increase
- 4 rectangular metal block/heated/volume/increase
- 5 north pole/magnet/brought near/south pole/another magnet/poles/attract/each other
- 6 south pole/magnet/brought near/south pole/another magnet/poles/repel/each other
- 7 end of/copper bar/heated/heat/travel/along/bar
- 8 electric current/passed/along/conductor/conductor/become/hot

unit 5
exercises
exercise 3

exercise 3 Look at how we can re-write this sentence:

Alcohol boils at 78°C, therefore an alcohol thermometer cannot be used above this temperature.

Since alcohol boils at 78°C, an alcohol thermometer cannot be used above this temperature.

Now re-write these sentences, beginning them with *Since*.

- 1 Mercury freezes at about -39°C, therefore a mercury thermometer cannot be used below this temperature.
- 2 Temperatures in laboratory work are often higher than 78°C, therefore an alcohol thermometer cannot be used for this work.
- 3 A mercury thermometer can be used between -39°C and 357°C, therefore it can be used for laboratory work.
- 4 Room temperatures are normally less than 78°C, therefore alcohol thermometers can be used for measuring room temperature.
- 5 Alcohol is fairly cheap, therefore alcohol thermometers are used more than mercury thermometers to measure room temperature.

drills

drill 1

Is carbon a mixture?

No, carbon's an element.

Are protons neutral?

No, protons are positive.

carbon
protons
water
electrons
helium
glass
sulphur
neutrons

drill 2

What do atoms consist of?

Atoms consist of electrons, protons and neutrons.

What does steel consist of?

Steel consists of iron and carbon.

- 1 electrons/protons/neutrons
- 2 iron/carbon
- 3 hydrogen/oxygen
- 4 alpha particles
- 5 fast-moving electrons
- 6 all/colours/spectrum
- 7 numbers/atoms
- 8 two/more/elements

drill 3

What will happen to water if it is cooled below 0°C?

It will freeze.

What will happen to a steel bar if it is heated?

drill 4

Will steel expand if it's heated?

Yes, it will.

Will steel wire increase in length if it's compressed?

No, it won't, it will decrease.

drill 5

Does the tube have a uniform bore?

Yes, it's a uniform-bore tube.

Does the plug have three pins?

Yes, it's a three-pin plug.

drill 6

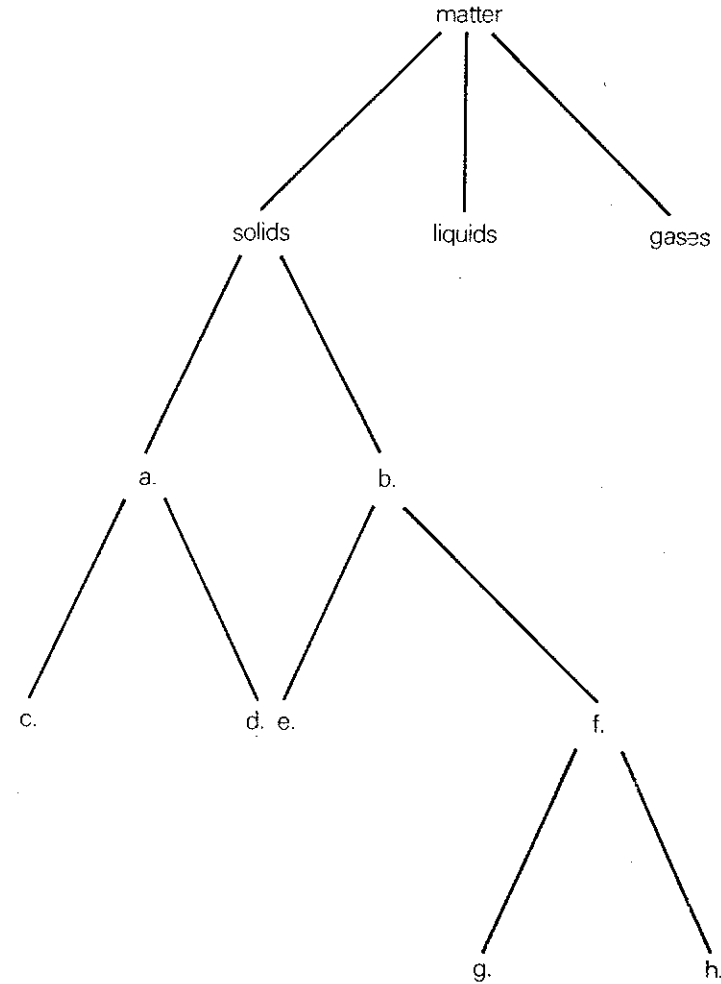
If the temperature of the metal bar is high, will the expansion be great?

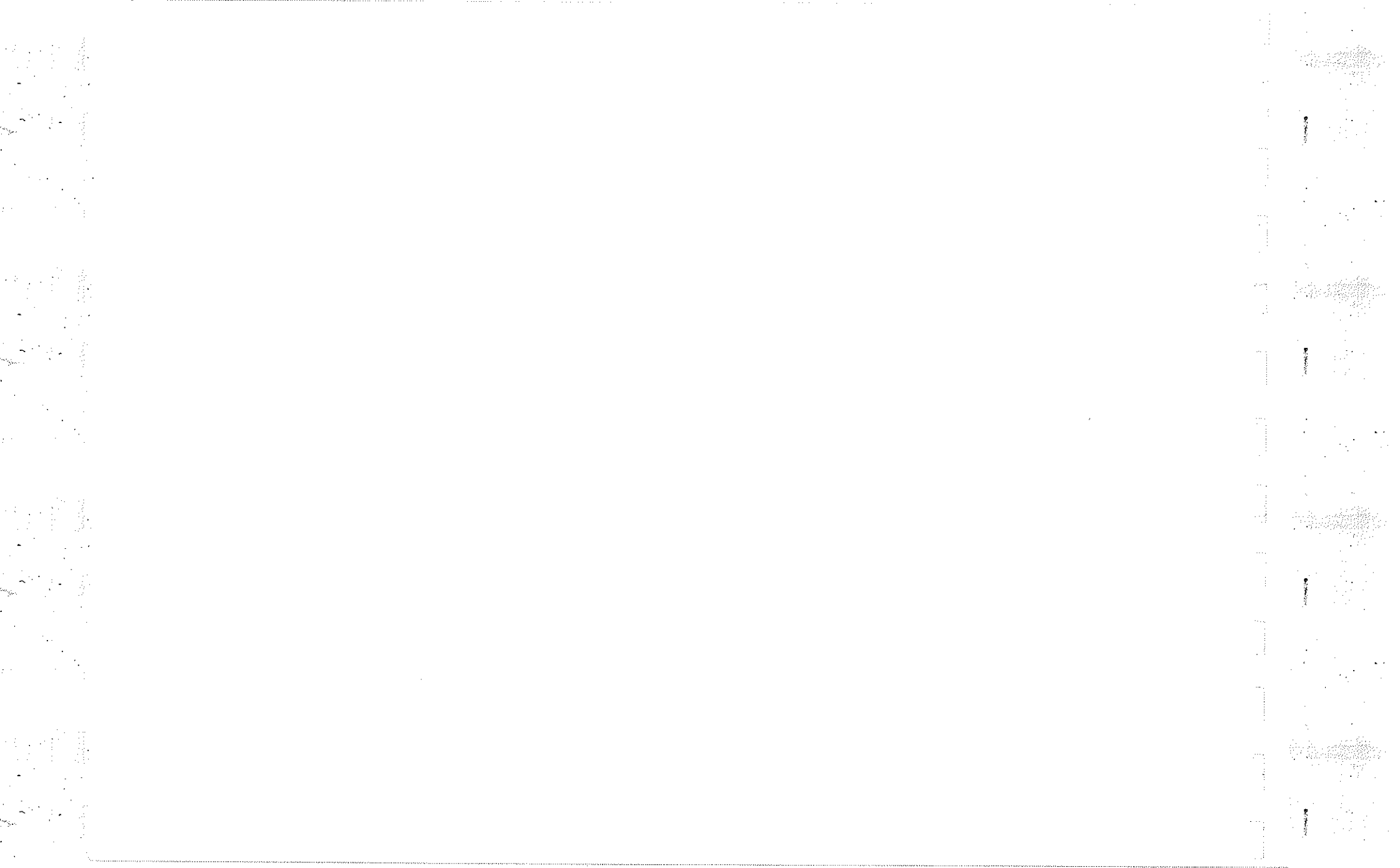
Yes, the higher the temperature, the greater the expansion.

If a large force is applied to the wire, will the extension be large?

Yes, the larger the force, the larger the extension.

Discuss the different types of solid materials which exist. Then draw this scheme of classification, filling in the blanks.





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classwork

unit 6 classwork section 1

SECTION 1 simple instructions

A When we want people to do things, we use instructions. Instructions can be given in different ways. Spoken instructions can be very direct, for example: *Open the window; Close the door.*

Give instructions to other people in the class, using this table. Make sure the instructions are followed correctly. Make up some instructions of your own.

Open	your book.
Close	the window.
Shut	the door.
	the cupboard.

Many verbs which are used for instructions are followed by a preposition. For example, *Turn the light on; Switch the radio off.*

Give more instructions, using this table. Again, make sure they are carried out correctly.

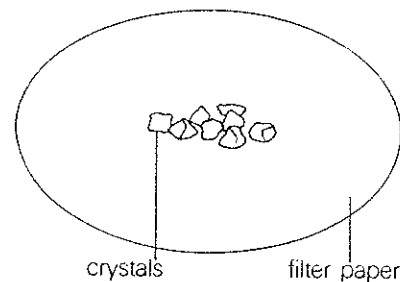
Turn	the chair	up.
Switch	the light	on.
Put	your book	off.
Pick	your hand	down.
	your pen	round.
	your desk	upside down.

Now make up your own instructions with these verbs and prepositions:

take ... off
switch/turn ... off/on
pick ... up
put ... down
turn ... round

B In scientific English, we often say _____ instead of *put*. For example,

_____ some copper sulphate crystals on a filter paper.



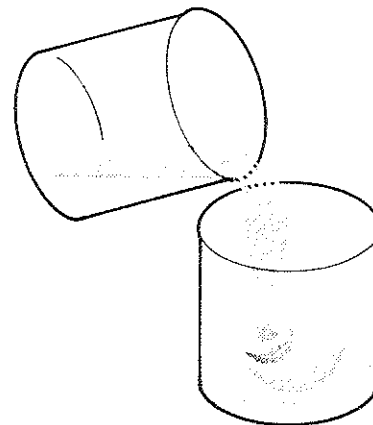
In everyday English we could say
Put some sugar in your coffee.

What verbs would we use for these instructions?

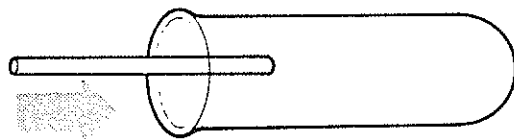
1 _____ some water into a beaker.

or:

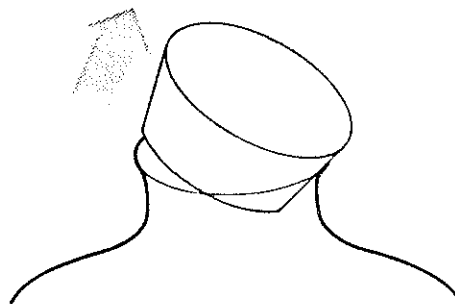
_____ a beaker with water.



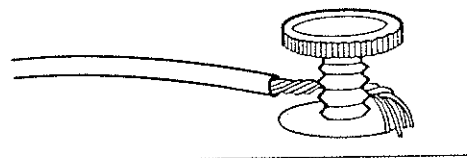
2 _____ a tube into a test-tube.



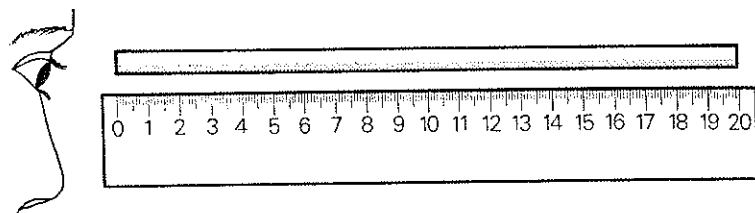
3 _____ the stopper from the container.



4 _____ the wire to the terminal.



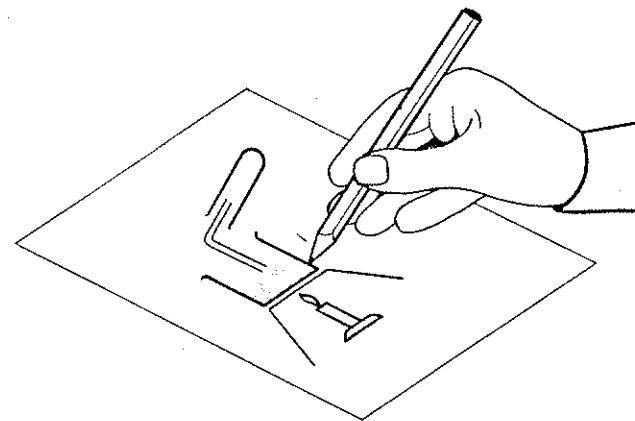
5 _____ the length of the rod.



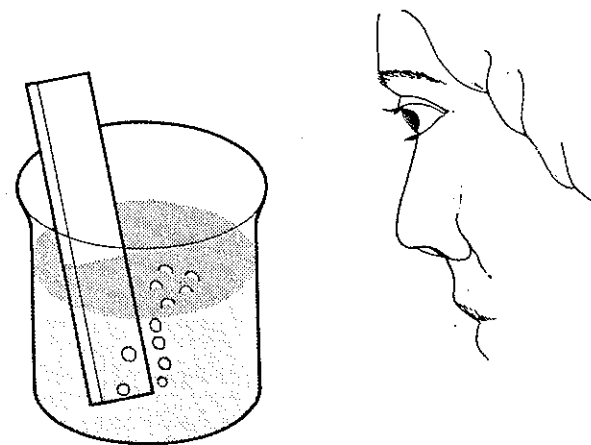
6 _____ the result of the equation.

$$x^2 + y^2 + 2^2 = ?$$

7 _____ a diagram of the apparatus.

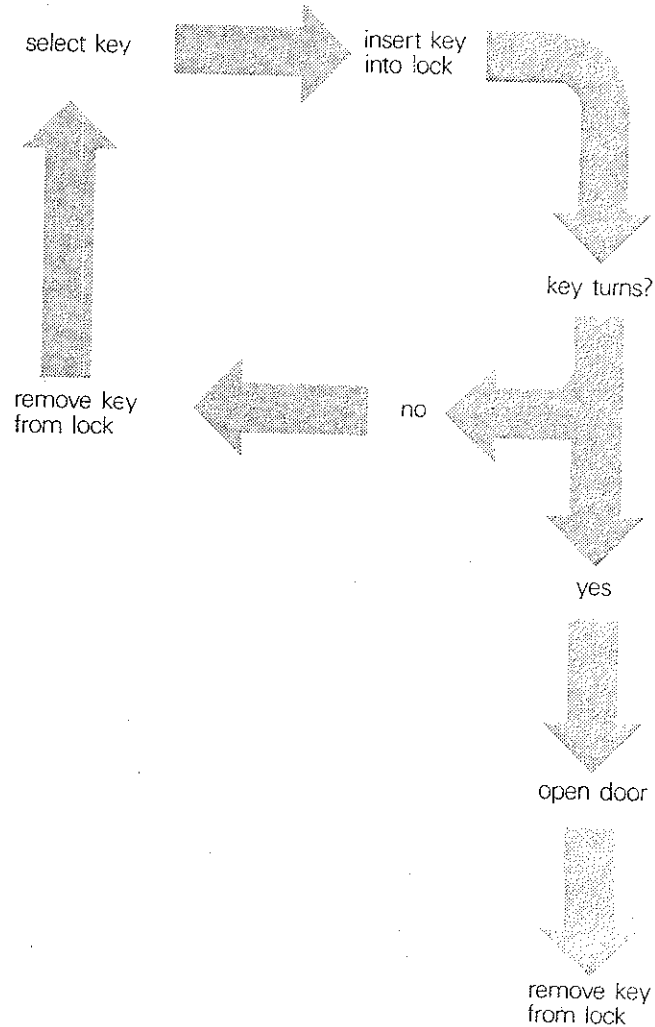


8 _____ the reaction which takes place.



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C We can illustrate the stages or steps in a sequence of operations by means of a flow chart. Here is a flow chart which shows how to use a key to open a door.



Use the flow chart to help you give instructions to open the door.

Next, ask someone to give you instructions to open the door. For example,

What should I do first?

What should I do after that?

What should I do if the key doesn't turn?

You can also say:

What should I do after I have selected the key?

After you have selected the key, you should insert it into the lock.

These are all very **direct** ways of giving instructions. But often instructions are given in an **indirect** form. Study the paragraph below, which refers again to the flow chart.

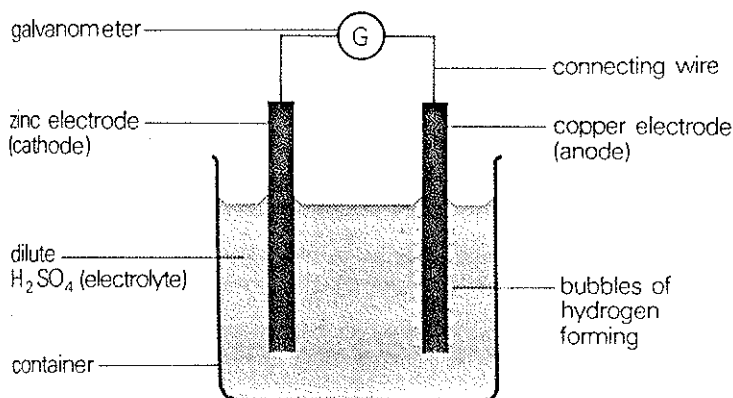
First the key is selected and inserted into the lock. The key is then turned and the door opened. Once the door is open, the key should be removed from the lock. If the key does not turn in the lock, it should be removed from the lock and the correct one should be selected.

D Now draw up your own flow chart for a simple operation. Do this with your teacher and the rest of the class.

SECTION 2 instruction and explanation

A Here are a list of instructions for setting up a simple voltaic cell. Use the diagram to help you complete the instructions. Choose words from this list:

note	fill
wait	observe
connect	arrange



- 1 _____ a container with dilute sulphuric acid.
- 2 _____ two electrodes in the electrolyte so that they are vertical and at a distance from each other.
- 3 _____ a galvanometer across the plates by means of two wires.
- 4 _____ the reading indicated by the galvanometer deflection.
- 5 _____ for a short time.
- 6 _____ the action of the acid and the copper.

Now complete these instructions for repeating the experiment with different electrodes. This time, find your own words.

- 7 R_____ the electrodes from the container.
- 8 D_____ the wires.
- 9 R_____ the copper and zinc electrodes with carbon and iron electrodes.
- 10 Re-_____ the galvanometer.
- 11 R_____ the value of the galvanometer deflection.
- 12 C_____ this value with the value for copper and zinc.

B Instead of writing instructions 1–6 in this direct way, it is also possible for them to be written in an indirect way, in a paragraph.

A container is filled with dilute sulphuric acid and electrodes of copper and zinc are arranged so that they are immersed in the acid upright and parallel to each other. They should be as far apart as possible. Their upper ends should be above the surface of the acid. Wires are then attached to the ends of the electrodes, and the wires are in turn connected to a galvanometer. The value of the galvanometer deflection should be recorded, and after a period of time the action of the acid and the copper should be observed.

Now re-write instructions 7–12 in the same way using these notes to help you. When you have done that you will have a paragraph of four sentences.
electrodes/remove/container/wires/disconnect
copper and zinc electrodes/should/replace/carbon and zinc electrodes
galvanometer/then/reconnect/value/deflection/should/
note
value/deflection/should/then/compare/value/copper
and zinc

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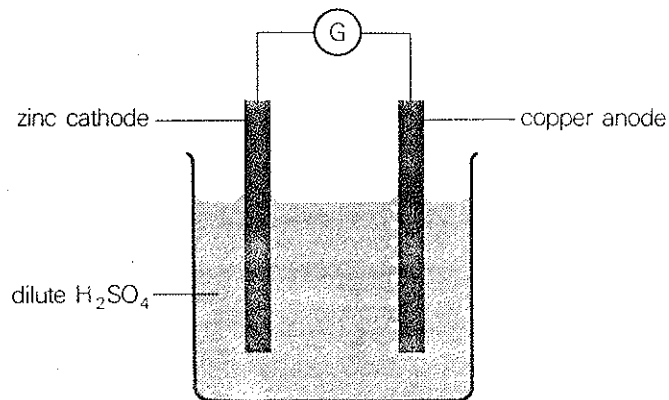
C Here is a paragraph of instructions for repeating the experiment. Read it carefully and then write your own set of six **direct** instructions.

The experiment should be repeated, again using copper and zinc electrodes, but weighing the electrodes before and after the experiment. The cell should be allowed to function for some time before the electrodes are weighed for the second time. The weights of the electrodes before and after the experiment should be compared. The results should then be considered carefully and a deduction made as to what has happened in the cell during the course of the experiment.

Begin each instruction with the following words:

- 1 Repeat ...
- 2 Weigh ...
- 3 Allow ...
- 4 Compare ...
- 5 Consider ...
- 6 Try to deduce ...

D Here is an explanation of the action of a simple voltaic cell. Study it carefully. The numbers in brackets refer to the diagrams.



When a simple cell is set up as shown in diagram (1), the galvanometer indicates the presence of an electric current. Since an electric current consists of a drift of electrons round a circuit, it follows that an electron drift must take place within the cell. This can be explained as follows.

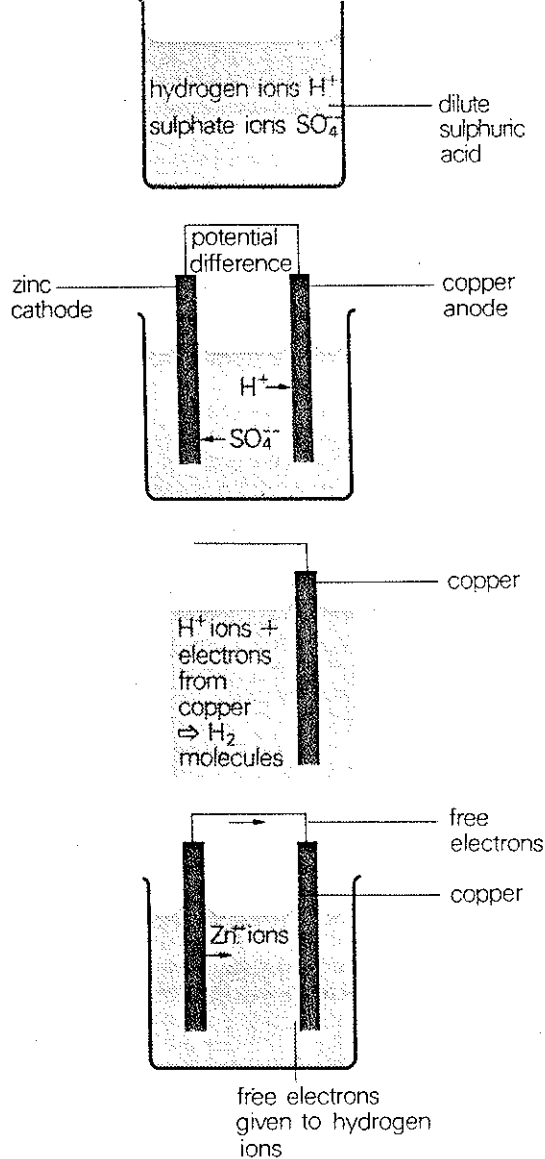
Dilute sulphuric acid is composed of hydrogen ions and sulphate ions. (2) The electrolyte is therefore said to be 'ionized', and it is the drift of these ions which constitutes the flow of electric current in the cell.

When the external circuit is completed by connecting a wire across the terminals, a potential difference exists between the electrodes. This causes the positive hydrogen ions to move towards the copper electrode, and the negative sulphate ions to move towards the zinc electrode. (3) As the positive hydrogen ions arrive at the copper anode, they receive electrons from it. As a result, hydrogen atoms are formed, and these combine to form hydrogen molecules which appear on the surface of the copper in the form of bubbles of hydrogen gas. (4)

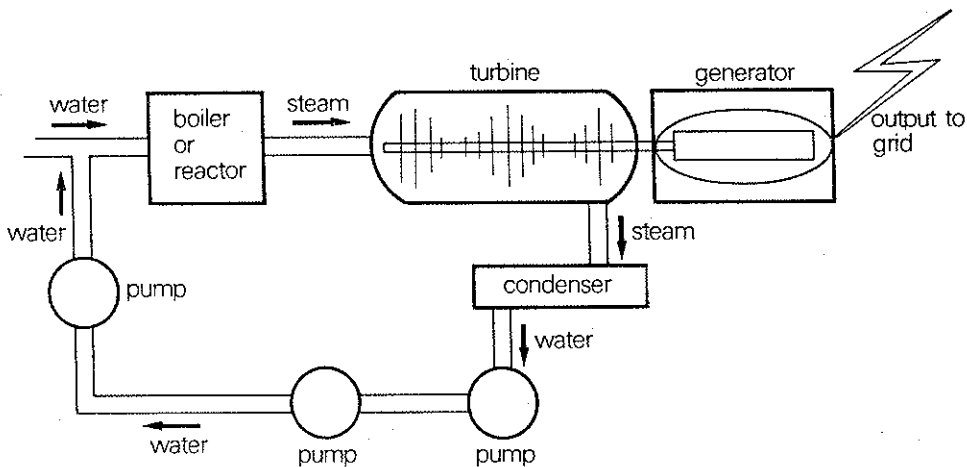
At the same time, zinc atoms from the cathode enter the electrolyte as positive ions. Free electrons are therefore released at the cathode, and these start to drift round the external circuit to replace the electrons given to the hydrogen ions. As a result, the total number of electrons in the external circuit is constant. (5) The total positive ion content of the electrolyte is also constant, since the lost hydrogen ions are replaced by positive zinc ions from the cathode.

SECTION 3 description of a process

A Study this description of a process. (The passage describes the different _____ in the process of generating electricity.)



E When you are sure that you understand the action of a simple cell, **use the diagrams only** to help you to explain what happens when the cell is connected up. Try to include connecting words like *when*, *since*, *as*, *at the same time*, and *as a result*, in your explanation.



Steam is produced in either a boiler or a nuclear reactor. In the case of a boiler, this may be fuelled by either coal or oil.

The steam travels along pipes to a turbine, where it drives the shaft at high speed. The shaft of the turbine is coupled to the rotor of the generator, and the rapid revolution of the rotor induces an electric current in the outer part of the generator, which is known as the stator. This electricity is then fed into the electricity grid system.

When it has passed through the turbine, the steam enters the condenser. Here it is passed over tubes containing cooling water. The steam is therefore cooled, and it condenses back to water. The water is then returned to the boiler by means of a series of pumps.

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section 3

Now use only the diagram on the previous page and the notes below to help you write your own description of the process of generating electricity. Describe each step separately, and introduce each step with *first*, *then*, *next*, etc.

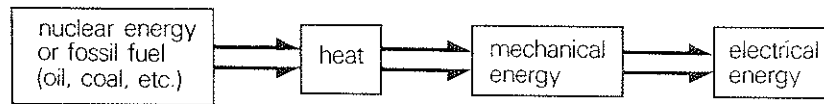
- 1 steam produced in boiler or reactor
- 2 steam→turbine, drives shaft at high speed—this drives generator
- 3 steam→condenser, cooled, becomes water
- 4 water→back to boiler, by means of pumps
- 5 electricity produced by generator→into grid system

B The sequence of stages in the process of generating electricity can be represented in the following way:

water heated→steam→steam drives turbine→turbine drives generator→generator produces electrical power

Describe in full the sequence of stages outlined above.

C The process of generating electricity involves a _____ of energy.



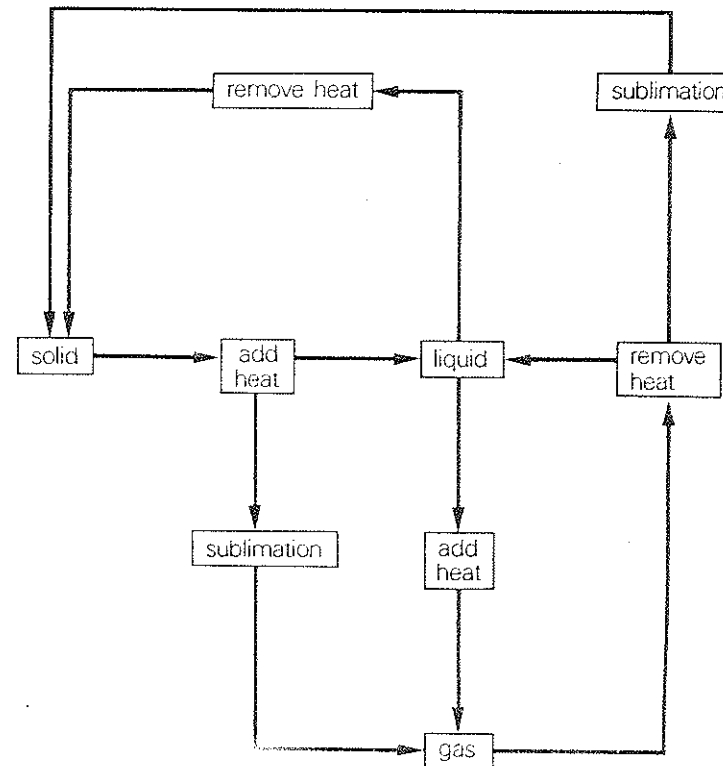
Complete this description of the process shown above:

Nuclear or fossil fuel is used to _____ heat.
This heat is used to _____ steam, which in turn _____ mechanical energy in the turbine. The mechanical energy is _____ into electrical energy by means of a generator.

D When matter changes state, it does so in stages. Here is a diagram which sets out these stages. Use it to describe the stages of change when ice melts, when sulphur is heated, when water is used in an electricity generator, etc. The following words will be useful:

melt	vaporize
liquefy	condense
evaporate	freeze
sublimate	solidify

Use also words of sequence: *first*, *then*, *next*, etc.



E When we describe the steps in a process, instead of always saying *first steam passes through the turbine and then it enters the condenser*, we often say:

After the steam has passed through the turbine, it enters the condenser.

or:

Once the steam has passed through the turbine, it enters the condenser.

We can also say:

After passing through the turbine, the steam enters the condenser.

These three statements all have the same meaning. They are **alternative** ways of expressing the same idea.

Re-write the following statements in the three ways outlined above, using *after* and *once*.

- 1 The steam leaves the boiler or reactor and then enters the turbine.
- 2 The steam condenses and then it is pumped back to the boiler.

F From the description of this process, we know that if more steam is used, the turbine will turn faster. If the turbine turns faster, the generator rotor will also turn faster and therefore more electricity will be produced. We can therefore say:

The more steam that is used the faster the turbine will rotate.

and:

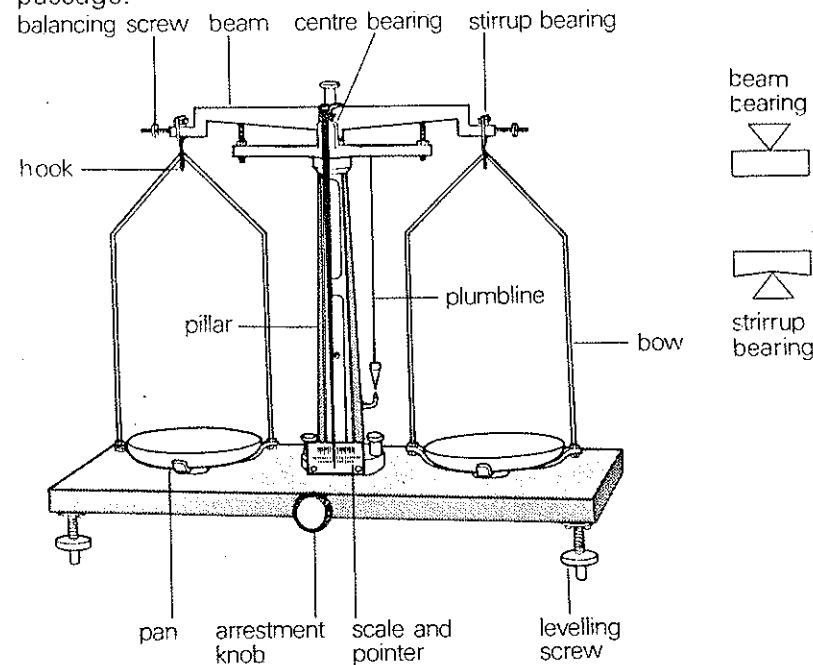
The faster the turbine rotates, the more electricity will be generated.

We often express this sort of relationship by saying: The speed of the turbine _____ the amount of steam used.

The amount of electricity produced _____ the speed of the turbine.

The amount of steam used _____ the amount of electricity required.

G Here is a description of a laboratory beam balance. Some of the words are missing from the first section. They are connecting words such as: *therefore*, *since*, etc. Supply the appropriate words as you read the passage.



The weight of a body is proportional to its mass, and (1) _____ the mass of a body can be measured by comparing the earth's pull on it with the pull on a standard mass. This can be done by means of a laboratory beam balance and a set of standard masses (usually called simply 'weights'). (2) _____ laboratory balances are more sensitive

unit 6
classwork
section 3

than balances used, for instance, in shops; they respond to very small changes in weight. The bearings of the beam and the scale-pan stirrups are made of very hard materials such as agate or synthetic sapphire. (3)_____ the design of these bearings and the materials used, they possess very little friction. They also increase the accuracy of the balance. (4)_____ the sharpness of the knife-edges ensures that the distances between the stirrup bearings and the beam bearing remain constant (5)_____ the beam swings.

(6)_____ the knife-edges are fragile and easily blunted, they must be protected from damage.

(7)_____ the beam must be brought to rest before anything is placed on or removed from the pans. This is done by turning the arrestment knob, which lowers the centre bearing and brings the knife-edges out of contact with it and the stirrups.

(8)_____ the scale-pans wear through constant use and cleaning, their mass alters. Balancing screws are (9)_____ provided at the ends of the beam. These may be adjusted to compensate for changes in the mass of the pans.

Now read this paragraph describing how the balance should be used:

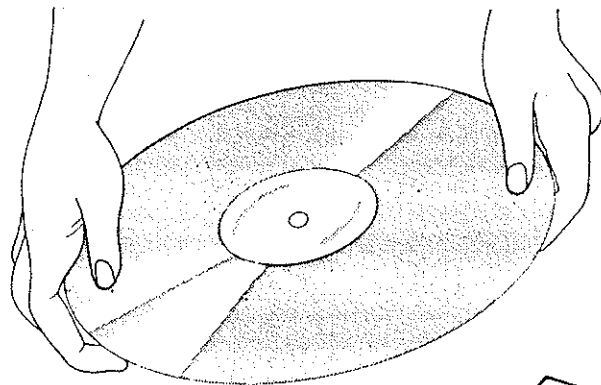
Before anything is weighed on the balance, the levelling screws at the base of the balance must be adjusted until the plumbline hangs through the centre of its ring. When the beam is raised, the pointer should swing through an equal number of divisions on each side of the central mark on the scale. If it fails to do so, the stirrups should be checked to see that they have not been displaced. If these are in place, the balancing screws may require a slight adjustment. Before anything is placed on the pans, the beam must be lowered. The object to be weighed is then placed in the

left-hand pan. Forceps should always be used to handle the weights, since fingers are always slightly greasy, and this grease will be transferred to the weights. Weights are always placed in the right-hand pan. A weight should be found which is slightly less than the weight of the object, and extra weights added in decreasing order of magnitude until the pointer swings through an equal number of divisions on either side of the central mark on the scale. The beam must be lowered every time before weights are added to or removed from the pan. When a weighing is complete, the result should be written down and checked carefully before the weights are replaced in the box. Hot objects should never be weighed, and the outsides of bottles or beakers containing liquid should always be wiped before they are placed on the pan.

Now answer these questions:

- 1 In what way is a laboratory balance different from a balance found in a shop?
- 2 Why are special kinds of bearings used for pivoting the beam and the stirrups?
- 3 How do these increase the accuracy of the balance?
- 4 How are the knife-edges protected from damage when the balance is out of use?
- 5 What can cause the beam to become unbalanced? How can this be corrected?
- 6 Why should forceps always be used for handling weights?
- 7 What should be done to vessels containing liquid before these are weighed?
- 8 Using the paragraph as a guide, write down a list of instructions for weighing things on a laboratory balance.

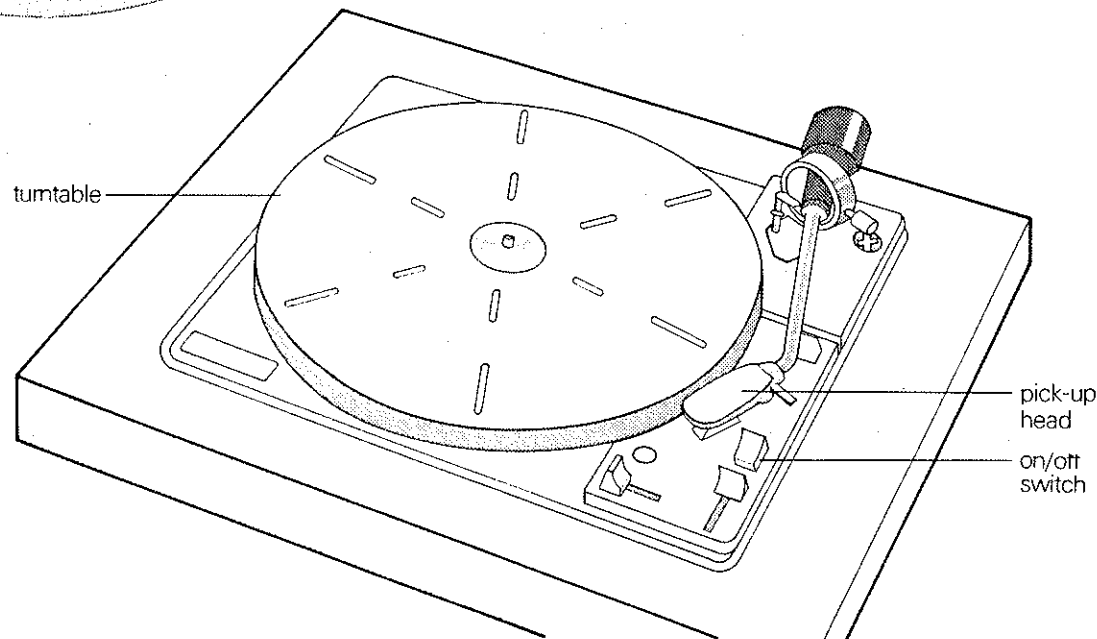
exercise 1 Here is a paragraph of instructions for operating a record-player. Read it through, using the diagram to help you understand it. Then re-write the instructions in the **direct** form, using the underlined verbs as the instruction words. The first one has been done for you as an example.



A record is placed on the turntable and the motor is started. The pick up head is then lifted and moved towards the edge of the record. The head is positioned above the beginning of the record and then lowered carefully onto the record. When the pickup has travelled to the centre of the record, the head is lifted and returned to its original position. The turntable is then stopped and the record removed.

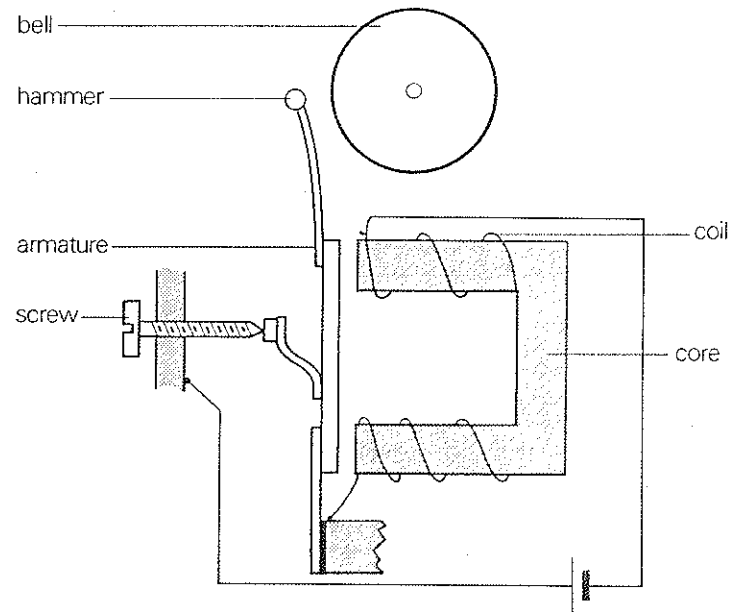
Begin like this:

- 1 Place a record on the turntable.



unit 6
exercises
exercise 2

exercise 2 Here is a diagram showing the principle of operation of an electric bell. It is followed by a sequence of the stages in the operation of the bell. Study these carefully and then write out complete sentences, joining the notes with the words provided. The first one is done for you as an example.



- 1 current flows in coil—core becomes magnetized
- 2 armature attracted to core
- 3 hammer attached to armature—bell struck
- 4 armature moves towards core—contact leaves adjusting screw
- 5 circuit broken
- 6 no current through coil—no magnetic field
- 7 armature returns to original position
- 8 armature touches screw—electrical circuit completed
- 9 sequence repeated

- 1 When current flows in the coil, the core becomes magnetized.
- 2 Therefore ...
- 3 Since ...
- 4 When ...
- 5 Therefore ...
- 6 Since ...
- 7 Therefore ...
- 8 When ...
- 9 Thus ...

exercise 3 Very often in English we can express the same idea in different ways. You have studied this type of sentence before:

When steam is produced in a boiler, the greater the heat used, the greater the amount of steam produced.

We can also say:

When steam is produced in a boiler, the amount of heat used **determines** the amount of steam produced.

Now, we can also re-phrase this statement, using the expression *depends on*:

When steam is produced in a boiler, the amount of steam produced **depends** on the amount of heat used.

Now re-phrase all of these different statements, using the expression *depend(s) on*.

- 1 When measuring temperatures, the range of temperatures to be measured determines the type of thermometer used.
- 2 When electricity is generated in a cell, the materials used as electrodes determine the amount of electricity produced.
- 3 In an electrical circuit, the amount of electricity flowing in the circuit determines the deflection of the galvanometer.
- 4 If a metal bar is heated, the greater the heat applied, the larger the expansion.
- 5 If steam is used to turn a turbine, the more steam used the faster the speed of rotation of the shaft.
- 6 If a turbine is used to drive a generator, the faster the speed of the turbine, the greater the amount of electricity produced.
- 7 If a material is stretched, the larger the force applied, the longer the extension.
- 8 When a material conducts electricity, the nature of the material determines the quantity of electricity which can pass along it.

drills

unit 6

drills

drill 1

drill 1

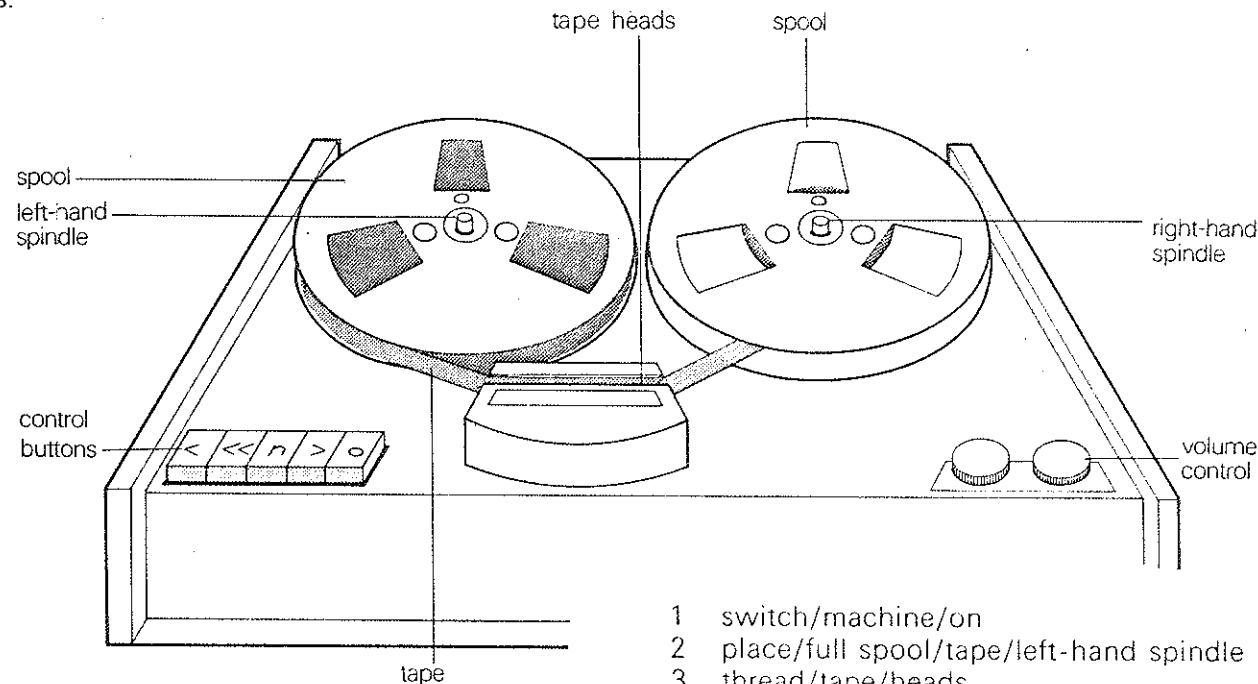
Should I pour some water into the beaker?

Yes, fill the beaker with water.

Should I put the tube into the test-tube?

Yes, insert the tube into the test-tube.

drill 2 Below is a list of steps for operating a tape recorder. Study the diagram and then answer the questions.



What do I do first?

First you should switch the machine on.

Then what do I do?

Then you should place a full spool of tape on the left-hand spindle.

- 1 switch/machine/on
- 2 place/full spool/tape/left-hand spindle
- 3 thread/tape/heads
- 4 join/tape/take-up spool
- 5 press/'play' button
- 6 adjust/volume control
- 7 listen/tape
- 8 press/'stop' button
- 9 rewind/tape
- 10 remove/full spool
- 11

drill 3 You will hear some instructions for carrying out the experiment with a simple cell. The instructions are in the **indirect** form. You should re-phrase them in a direct way.

A container is first filled with dilute sulphuric acid.
First fill a container with dilute sulphuric acid.

Copper and zinc electrodes are then immersed in the electrolyte.

Then immerse copper and zinc electrodes in the electrolyte.

drill 4 The flow chart on the right shows how to start a car and drive away. Study it carefully and then listen to the examples. You must answer the questions you hear.

What should I do first?

First insert the key into the ignition switch.

Yes, I've done that. What should I do next?

Next check the gear and handbrake.

drill 5 Use the notes to help you describe the sequence of stages in the generation of electricity.

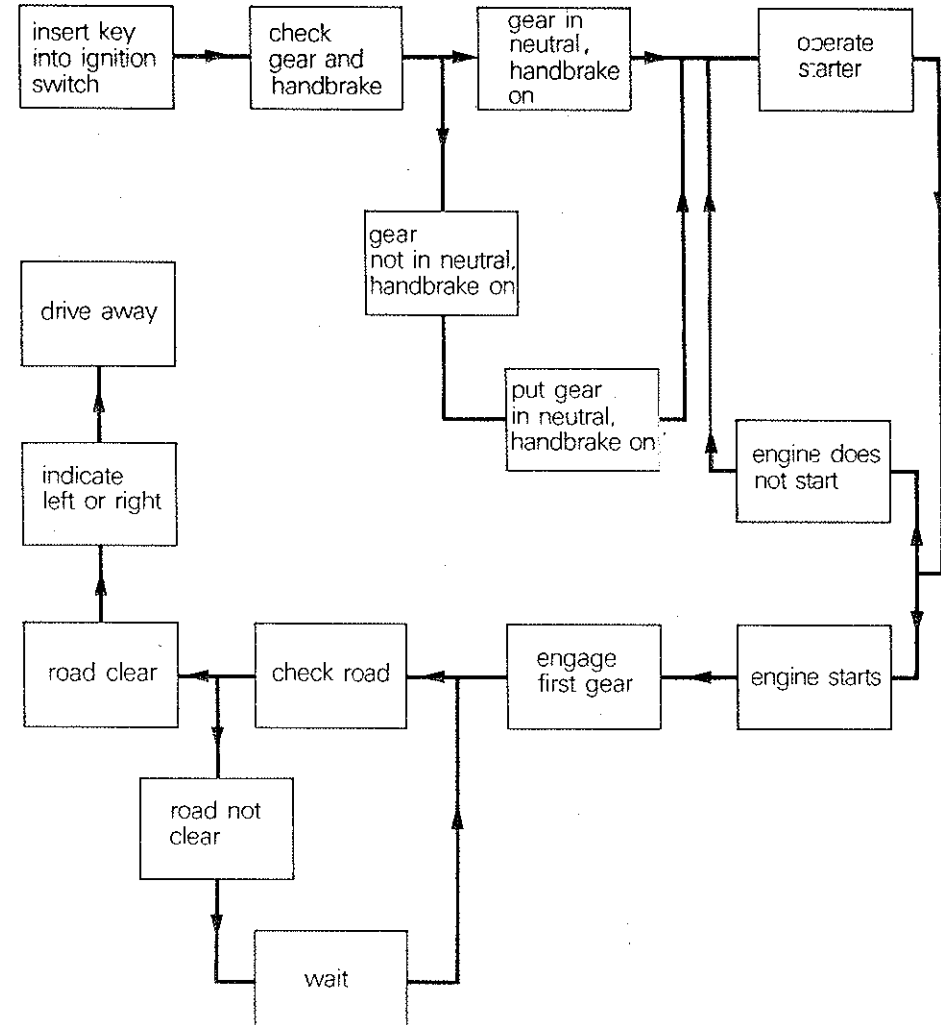
What happens first?

First, steam is heated in a boiler or reactor.

I see. And then what happens?

Then the steam passes into the turbine.

- 1 steam/heated/boiler or reactor
- 2 steam passes/turbine
- 3 steam drives/turbine shaft
- 4 shaft drives/rotor/of/generator
- 5 steam/enters/condenser
- 6 it/pumped back/boiler or reactor
- 7 it/re-heated
- 8 it/fed/grid system



unit 6
drills
drill 6

drill 6

What does the speed of rotation of the turbine depend on?

The speed of rotation depends on the amount of steam used.

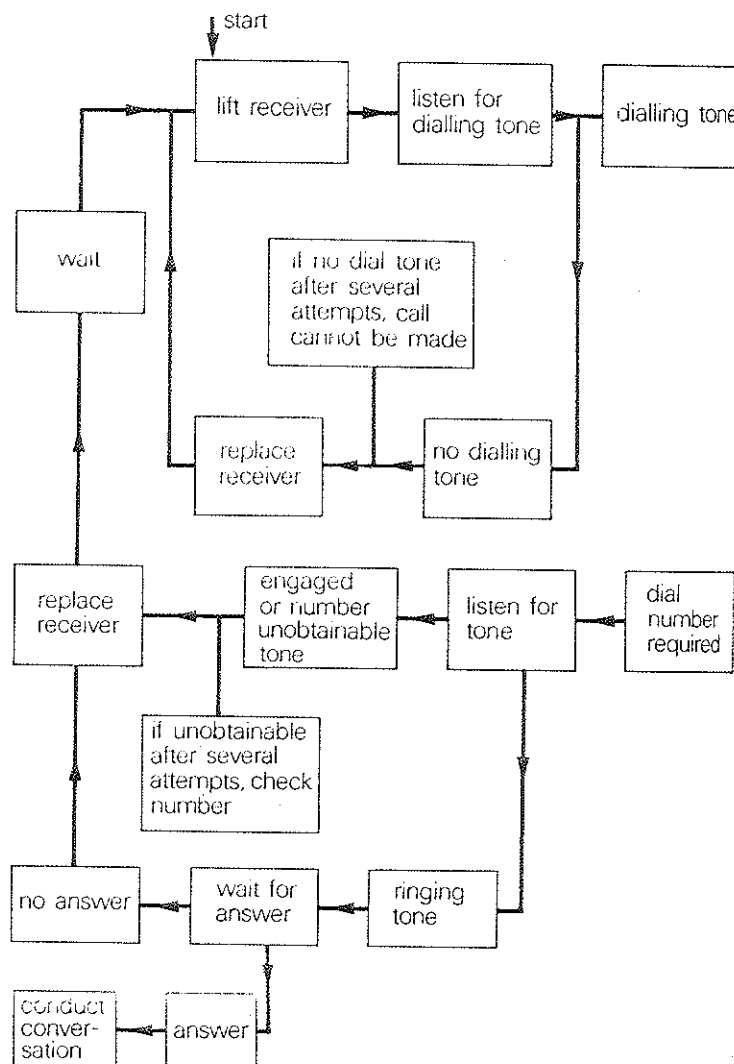
What determines the expansion of a metal when heated?

The quantity of heat supplied determines the expansion.

- 1 speed of rotation—amount of steam used
- 2 quantity of heat supplied—expansion
- 3 extension of wire—load applied
- 4 electrodes used—voltage produced
- 5 speed of turbine—amount of electricity produced
- 6 amount of steam produced—heat supplied
- 7 heat supplied—type of fuel used
- 8 pressure in condenser—rate of cooling

activity

Use this flow chart showing how to make a telephone call to ask and answer questions and give instructions.



L

L

L

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L

classwork

unit 7 classwork section 1

SECTION 1 cause and reason

A When we ask a question beginning with *why*, we want to know the **cause** of something or the reason for it.

Ask these questions, and choose the correct answers from the list of **reasons** given below. Begin the answers with *because*.

Why	does	copper bend easily? an electric current flow through a conductor?
	do	unlike magnetic poles repel each other? gases expand when heated? glass break when it is hit? a balloon filled with helium float?
Because		there is a magnetic force between them. there is a movement of electrons through it. helium is lighter than air. it is extremely brittle. it is very ductile. they absorb energy from the heat.

When we have a question and an answer like this:

Why does a copper wire extend when a weight is suspended from one end?

Because copper is very ductile.

we can make a statement of the cause by saying:

A copper wire extends when a weight is suspended from one end because copper is very ductile.

Here, the second part of the sentence gives the **reason** for what happens in the first part.

Make similar statements, beginning with these words:

- 1 Unlike magnetic poles repel each other because ...
- 2 Gases expand when they are heated because ...
- 3 Glass breaks when it is hit because ...
- 4 A balloon filled with helium floats because ...
- 5 Copper can be stretched easily because ...
- 6 When a copper wire is connected to a cell, it conducts electricity because ...

B Now ask and answer questions with *why* and *because*, using these words. For example,

alcohol/used in room thermometers
less expensive than mercury

Why is alcohol used in room thermometers?
Because it is less expensive than mercury.

- 1 copper/used in electrical connections
an extremely good conductor
- 2 a suction pad/stick/to a flat surface
no air between the pad and the surface
- 3 steel/tempered
brittle when hardened
- 4 heat/pass along a conductor
the molecules of the conductor vibrate
- 5 rubber/not break when it is hit
extremely resilient
- 6 the earth/have/day and night
revolve/about its own axis
- 7 mercury/used in laboratory thermometers
have/high boiling point
- 8 hydrogen/dangerous
highly inflammable

Now look at the notes in numbers 1–8 again. This time, use the notes to help you make statements of **reason**. For example,

alcohol/used in room thermometers
less expensive than mercury

Alcohol is used in room thermometers because it is less expensive than mercury.

You can make similar sentences for each set of notes.

C As well as stating the reason for something, we often want to state the **cause** of something. You know that we can say: *If a copper bar is heated, it will expand.* If we want to make the **cause** very clear, (ie if we want to **emphasize** the cause), we re-phrase this statement and say: *Heating a copper bar will cause it to expand.* In the same way, complete these examples:

- Hitting a piece of glass ... break.
- Applying a tensile force to a wire ... extend.
- Cooling a metal bar ... contract.

Complete these statements of cause:

- 1 Heating water to 100°C ...
- 2 Cooling water to 0°C ...
- 3 Filling a balloon with air ...
- 4 Holding a piece of wood in a flame ...
- 5 Placing sugar in hot coffee ...
- 6 Puncturing a balloon ...

If you consider some of the sentences you have just made, you will see that it is not always clear what is meant. For instance, if you say: *Placing sugar in hot coffee causes it to dissolve* 'it' could refer to either sugar or coffee. In fact in this case we know from our everyday experience that 'it' refers to the sugar, but in some sentences our meaning may not be so obvious. For example, if we say: *Adding carbon dioxide to lime water will cause it to turn cloudy* it may not be clear to the reader what the 'it' refers to. We therefore say: *Adding carbon dioxide to lime water will cause the lime water to turn cloudy.* Similarly we say: *Turning a key in a lock will cause the lock to open.*

Therefore, when we use the construction *Cause something to happen*, we must make it clear what we mean. Sometimes we can use 'it', but sometimes we must say exactly what is caused.

Make statements beginning with these words:

- 1 Hitting a piece of glass with a hammer ...
- 2 Dropping an egg on the floor ...
- 3 Placing blue litmus paper in an acid ...
- 4 Striking a match on a matchbox ...
- 5 Bringing the north pole of a magnet near the north pole of a suspended magnet ...
- 6 Passing a current through a coil around a soft iron core ...
- 7 Lighting a cigarette with a match ...
- 8 Sucking a liquid through a straw ...

D As well as the construction *cause something to happen*, we can also use the verb *cause* followed by a noun. For example,

The action of water on some metals causes **corrosion**.

Removing air from a container will cause a **vacuum**.

In this case, we can say *bring about* or *result in* as well as *cause*. Make sentences from this table:

Heating hydrogen			a release of energy.
Cooling a gas			a change in pressure.
Splitting an atom			an explosion.
Heating a copper bar	will	cause bring about result in	a flow of current.
Completing an electric circuit			an increase in volume.

unit 7
classwork
section 1

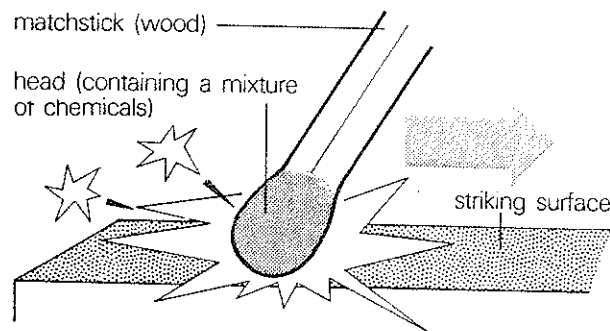
Now ask and answer questions, using the phrases on the left-hand side of the table. Use these patterns:

What will ... **cause/bring about/result in**?
It will **cause/bring about/result in** ...

Example:

What will heating hydrogen result in?
It will result in an explosion.

E the safety match Study this diagram and the description of the principle of a safety match.



The head of the match is rubbed rapidly (or *struck*) against the striking surface. The friction generated causes heat to be produced. The heat brings about a chemical reaction in the head, and oxygen is liberated. This oxygen combines with sulphur, which is contained in the head, and this causes more heat to be generated. This in turn causes more oxygen and sulphur to react. This process results in combustion, and the matchstick catches light.

Now ask and answer questions on this process. Use the expressions you have practised.

Why does ... ?
Because ...

What does ... **cause/bring about/result in**?
It **causes/brings about/results in** ...
What causes ... ?

Now give your own account of what happens when a match is struck, using only the outline below. Try not to refer to the text.

friction → heat
heat → oxygen
oxygen + sulphur → more heat
more heat → more oxygen + more sulphur → combustion

SECTION 2 comparison and contrast

A You know that we can make statements such as: *Rubber is flexible, but glass is brittle.* Statements like this make a **comparison** between two things. There are other words we can use to **compare** things. For example, we can say:

Rubber is flexible, **whereas** glass is brittle.
Carbon is an element, **while/whilst** carbon dioxide is a compound.

Make comparisons in the same way, using these notes. You can use either *whereas*, *while* or *whilst*.

- 1 Copper is a conductor, _____ glass ...
- 2 Iron is a solid, _____ mercury ...
- 3 Carbon is an element, _____ carbon dioxide ...
- 4 Iron is cheap, _____ gold ...
- 5 Water is colourless, _____ sulphur ...
- 6 Zinc is a solid, _____ hydrogen ...
- 7 Aluminium is light, _____ lead ...
- 8 Paper is weak, _____ steel ...
- 9 Wool is soft, _____ wood ...
- 10 Protons are positively charged, _____ electrons ...

In these sentences, we are not only comparing, but also **contrasting**, because we are stating the **differences** between two things.

B If we want to ask about the difference between two things, we can do this in two ways. We can say:

What is the difference between ... and ... ?

or:

How do ... and ... differ?

Example:

What's the difference between iron and mercury?

or:

How do iron and mercury differ?

We can then make the statement:

Iron is a solid, whereas mercury is a liquid.

When we compare things in this way we can obviously state not just one difference between them but many. For example,

glass/wood

What's the difference between glass and wood?

How do glass and wood differ?

Glass is transparent, whereas wood is opaque.

Glass is brittle, but wood isn't.

Wood is a natural material, whilst glass is a manufactured material.

Ask about the difference between these things, and give as many differences as you can think of.

- 1 polythene/glass
- 2 air/oxygen
- 3 copper/porcelain
- 4 rubber/copper
- 5 water/hydrogen
- 6 iron/steel

7 mercury/alcohol

8 protons/neutrons

C Now look at this sentence:

Mercury is a metal, but it is liquid at room temperature.

This statement tells us something that is unusual. All other metals are solid at room temperature. Mercury is the only metal which is liquid at room temperature. Mercury is an **exception** to the rule that metals are solid at room temperature. We can change the structure of the sentence above to emphasize that mercury is different from other metals:

Although mercury is a metal, it is liquid at room temperature.

Look at these examples:

Copper and aluminium are both good conductors, but aluminium is used in overhead transmission cables because it is far lighter.

Although copper and aluminium are both good conductors, aluminium is used in overhead transmission cables because it is far lighter.

Iron and aluminium are both metallic elements. They are both found naturally in ores, or compounds, which are chemically similar, but it is far more difficult to extract pure aluminium from its ore than it is to extract pure iron.

Although iron ore and aluminium ore are chemically similar, it is far more difficult to extract pure aluminium than it is to extract pure iron.

As well as the word *although*, we can also say *though* or *even though*. For example,

Although/Even though/though mercury is a metal, it is liquid at room temperature.

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section 2

D Use this table to make sentences beginning with *although*, *even though* or *though*. (There is only one correct sentence possible in each line.)

Although	carbon dioxide is a colourless and odourless gas		is widely used as a conductor.
Even though	steel is brittle when hardened	it	can be toughened by tempering.
Though	glass is brittle	they	can be detected with lime water.
	copper is expensive		are not widely used for laboratory work.
	alcohol thermometers are inexpensive		cannot be created or destroyed.
	energy can be converted into other forms		can be made more resilient by toughening.

E It is possible to change the order of the words in these statements. Instead of saying:

Although/Even though/Though mercury is a metal, it is liquid at room temperature

we can say:

Mercury is liquid at room temperature, **although/even though/though** it is a metal.

In the same way, we can say:

A complete atom has no electrical charge, **although/even though/though** many of its particles are charged.

Now look at the table in **D** again. Use it to make sentences like these. For example,

Carbon dioxide can be detected with lime water, even though it is a colourless and odourless gas.

F Let us look again at the first statement we studied: *Rubber is flexible but glass is brittle*. Here we are making a contrast, so we can say:

Rubber is flexible. H_____, glass is brittle.

Mercury is a metal. H_____, it is liquid at room temperature.

Make pairs of sentences in the same way, using these words:

- 1 mercury/metal
liquid at room temperature
- 2 copper/ductile
break/if subjected to/high tensile force
- 3 glass/extremely brittle
can be toughened/using/special process
- 4 particles/of/atom/charge
complete atom/not/have/charge
- 5 in/simple cell/sulphate ions/and/copper ions/
discharge
copper ions/discharge/more easily than/sulphate ions
- 6 metals/contract/when/cool/to/0°C
water/expands/when/cool/from 4°C/to 0°C
- 7 air/not/conduct heat very well
air/can/heat/by/convection
- 8 atom/extremely small
consist of/much smaller particles

In the sentences you have just made, *however* is placed first. It can, if you wish, come later. For example, instead of saying:

Rubber is flexible. However, glass is brittle.
Mercury is a metal. However, it is liquid at room temperature.

we can say:

Rubber is flexible. Glass, however, is brittle.
Mercury is a metal. It is, however, liquid at room temperature.

Now go back over the last exercise and use *however* in this way, putting it later in the sentence.

G You now know that there are these ways of making a comparison or a contrast between things:

Carbon is an element, **but/while/whilst/whereas** carbon dioxide is a compound.

Although/Even though/Though mercury is a metal, it is liquid at room temperature.

Copper is very ductile. **However**, it will break if subjected to a high tensile force.

Use suitable words from the above examples to complete these descriptions of (1) the carbon dioxide cycle and (2) the nitrogen cycle.

1 _____ the quantity of carbon dioxide in the earth's atmosphere is relatively small, the gas is essential for supporting life. Plants require carbon dioxide, and they remove it from the air in a process known as photosynthesis. _____ carbon dioxide is therefore being removed from the atmosphere continuously, it is _____ continuously replaced by animal and plant respiration and decay.

2 Nitrogen is essential for life, since it is needed in the formation of proteins, which are vital constituents of animal and plant cells. _____, atmospheric nitrogen cannot be used directly by plants and animals. _____ it is an essential element. Men and animals obtain their nitrogen by eating plants and other animals. _____ plants absorb soluble nitrogen compounds from the soil, through their roots.

SECTION 3 similarity

A In Section 2 we looked at how things can be contrasted, or how the difference between things can be stated. However, we often want to state that two things are **similar**. For example, carbon dioxide is a gas and hydrogen is a gas. We can therefore state the **similarities** between carbon dioxide and hydrogen:

Both carbon dioxide and hydrogen are gases.

or:

Carbon dioxide and hydrogen are both gases.

In the same way, we can say:

Both copper and aluminium are metals.

Copper and aluminium are both metals.

But there are other similarities:

Both copper and aluminium are ductile.

Copper and aluminium are both good conductors.

They are both resistant to corrosion.

Make statements giving the similarities between these things:

water	sulphuric acid
rubber	polythene
glass	perspex
salt	chalk
helium	hydrogen
paper	cardboard
china	porcelain
iron	steel
zinc	lead
polythene	nylon

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B We can use *both ... and ...* to list the qualities or attributes of things. For example,

Copper is both malleable and ductile.
Water is both colourless and odourless.

Make similar statements using these notes:

- 1 aluminium/strong/light
- 2 copper/good conductor of heat/good conductor of electricity
- 3 solids/definite shape/definite volume
- 4 nylon/tough/inexpensive
- 5 electric current in a wire/heating effect/magnetic effect
- 6 nucleus of an atom/protons/neutrons
- 7 vector quantity/direction/magnitude
atom/consists of/negatively charged particles/
positively charged particles

It is also possible to state this relationship in other ways:

Copper is **not only** malleable, **but** ductile **as well**.
Water is **not only** colourless, **but** odourless **as well**.

or:

Copper is **not only** malleable, **but also** ductile.
Water is **not only** colourless, **but also** odourless.

Use these two alternative forms of expression to make statements using the notes in 1–7. For example,

Aluminium is not only strong, but light as well.
Aluminium is not only strong, but also light.

C Look at these statements:

Copper and aluminium are both good conductors.
Therefore, **either** copper **or** aluminium can be used in electrical wires.

Solids have definite volume and shape. However,

gases have **neither** definite volume **nor** definite shape.

Either ... or are used where there are different possibilities or alternatives.

Neither ... nor are used where there are no alternatives.

Both of these constructions can be used to list several things:

Insulators can be made of either glass or porcelain or mica, or different forms of plastic.
Neither copper nor zinc nor tin are alloys of other metals.

Make statements with *either ... or* or *neither ... nor* from these notes.

- 1 elements—solids, liquids, gases
- 2 air, carbon dioxide, water—not elements
- 3 liquids, gases—no definite shape
- 4 copper and zinc, carbon and iron—electrodes in a cell
- 5 atoms, neutrons—no electrical charge
- 6 steel, copper, lead—not magnetic
- 7 glass, porcelain, mica—used as insulators
- 8 iron and hydrochloric acid, zinc and hydrochloric acid—produce hydrogen

D Now we can see how all these expressions of comparison and contrast can be used to express similarities and differences between things.
Here is a passage about the three states of matter: solid, liquid and gas. It compares the properties of matter in these three states. Study the passage carefully.

In the solid state, a material has both definite shape and definite volume (at a given temperature).

In the liquid state, the material has no definite

shape, although it has definite volume (at a given temperature).

In the gaseous state, a material has neither definite shape nor definite volume, and will completely fill the container in which it is placed, although its concentration will decrease as the volume of the container is increased.

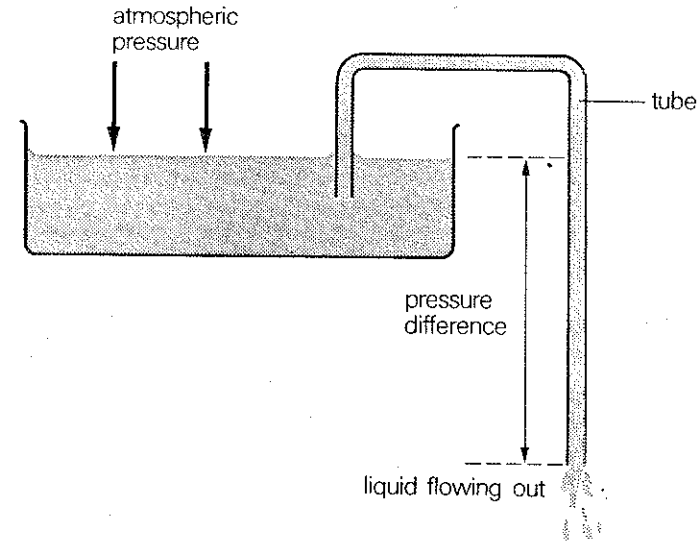
Different materials exist naturally in each of these three states. (eg iron is normally in the solid state, water in the liquid state and oxygen in the gaseous state.) However, it is possible to change the state of materials by changing their temperature.

For example, when the temperature of water is lowered, the water will solidify as ice, whilst when it is heated, it will boil and form steam. Therefore the state of water can be changed either by heating or cooling.

However, the temperatures at which changes of state occur for different materials are widely different. For example, a very low temperature is required to change a gas into the solid state, whereas an extremely high temperature is normally required to change a metal into the liquid state.

When you have studied this passage carefully, answer the questions your teacher asks you about it.

exercise 1 Study this description of the action of a siphon, and then answer the questions.



Atmospheric pressure can be used to cause a liquid to flow along a tube, out of a container. One end of the tube is inserted into the liquid, and the other end of the tube is placed outside the container, but with its end below the level of the liquid in the container. Air is removed from the tube, and this causes the liquid to rise up the tube and travel along it. It does this because the atmospheric pressure acting down on the liquid is greater than the pressure inside the tube. Because the end of the tube outside the container is below the level of liquid inside it, there is a difference in pressure between the end of the tube and the surface of the liquid. This difference in pressure causes the liquid to continue to flow out of the tube. If the end of the tube is raised to the level of the liquid inside the container, this will result in the liquid ceasing to flow along the tube.

unit 7
exercises
exercise 2

- 1 What can be used to cause a flow of liquid out of a container?
- 2 What is used for the liquid to travel along?
- 3 What is done to cause the liquid to rise up the tube?
- 4 Why does the liquid rise up along the tube?
- 5 Why is there a difference in pressure between the end of the tube outside the container and the surface of the liquid?
- 6 What does this difference in pressure cause?
- 7 What will be the result of raising the end of the tube to the level of the liquid?

exercise 2 Study this table which compares the properties of aluminium and copper. Use it to help you answer the questions on these materials. Use the words you are given in the brackets.

Aluminium	Copper
light	not very light
fairly strong	very strong
good conductor	very good conductor
fairly cheap	not very cheap
fairly low resistance	very low resistance
very high corrosion resistance	fairly high corrosion resistance
not very easy to solder	very easy to solder

example:

Are aluminium and copper both light?
(*whereas*)

Aluminium is light, whereas copper is not very light.

- 1 Are aluminium and copper both strong?
(*whilst*)
- 2 Are aluminium and copper both cheap?
()

- 3 Are aluminium and copper both easy to solder?
(*however*)
- 4 Is copper very light and very strong?
(*although*)
- 5 Is aluminium cheap and easy to solder?
(*though*)
- 6 Is copper both very cheap and a very good conductor?
(*although*)
- 7 Does copper have a very low resistance? Is it very light?
(*however*)
- 8 Are aluminium and copper both good conductors?
(*while*)
- 9 Do both aluminium and copper have a low resistance?
(*but*)
- 10 Do both copper and aluminium have a high resistance to corrosion?
(*whereas*)

exercise 3 Use these notes to help you make sentences using:

either ... or
neither ... nor
not only ... but also
both ... and

example:

energy—cannot be created
cannot be destroyed
(*neither ... nor*)

Energy can be neither created nor destroyed.

Now do the same with these:

- 1 ions—can be negatively charged
can be positively charged
(*either ... or*)
- 2 steel—can be hardened
can be tempered
(*not only ... but also*)
- 3 hydrogen—can be produced by iron and
hydrochloric acid
can be produced by zinc and
hydrochloric acid
(*both ... and*)
- 4 metals—can be ferrous
can be non-ferrous
(*either ... or*)
- 5 electric current—can be alternating current
can be direct current
(*either ... or*)
- 6 electricity—can heat a wire
can have a magnetic effect
(*both ... and*)
- 7 energy—cannot be created
cannot be destroyed
(*neither ... nor*)
- 8 vector quantities—have magnitude
have direction
(*not only ... but also*)
- 9 gold—not cheap
not common
(*neither ... nor*)
- 10 paper—not strong
not rigid
(*neither ... nor*)

drill 1

Why is alcohol often used in thermometers?
Because it is less expensive than mercury.

Why are copper and aluminium used for electrical connections?
Because they are good conductors.

- 1 less expensive/mercury
- 2 good conductors
- 3 extremely brittle
- 4 high boiling point
- 5 very resilient
- 6 absorb heat energy
- 7 only strike against special surfaces
- 8 react chemically
- 9 very ductile
- 10 good insulators

drill 2

What will dropping a piece of glass do?
It will cause it to extend.

What will stretching a length of copper wire do?
It will cause it to extend.

drill 3

Are both rubber and glass resilient?
No, rubber is resilient, whereas glass is brittle.

Are air and oxygen both mixtures?
No, air is a mixture, but oxygen is an element.

- | | |
|-----------|-----------|
| 1 whereas | 6 whereas |
| 2 but | 7 but |
| 3 while | 8 while |
| 4 whilst | 9 whereas |
| 5 but | 10 but |

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drill 4

drill 4

Mercury is a metal. Is it normally a solid?

No, although mercury is a metal, it isn't normally a solid.

The particles of an atom have charges. Is the atom itself charged?

No, although the particles of an atom have charges, the atom itself isn't charged.

drill 5 Confirm what the speaker says, and give another quality of the thing he is talking about.

Aluminium is strong, isn't it?

Yes, it's not only strong, but light as well.

Copper's very malleable.

Yes, it's not only very malleable, but also very ductile.

Use these notes to help you:

- 1 light—as well
- 2 also—very ductile
- 3 also—odourless
- 4 definite volume—as well
- 5 relatively inexpensive—as well
- 6 also—electricity
- 7 also—direction
- 8 nucleus—as well

drill 6

Gases have both definite volume and definite shape, don't they?

No, gases have neither definite volume nor definite shape.

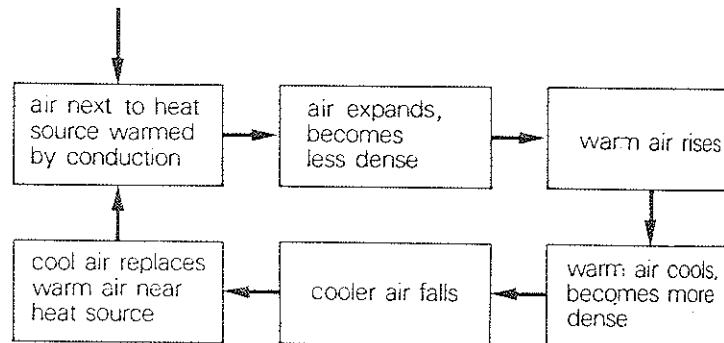
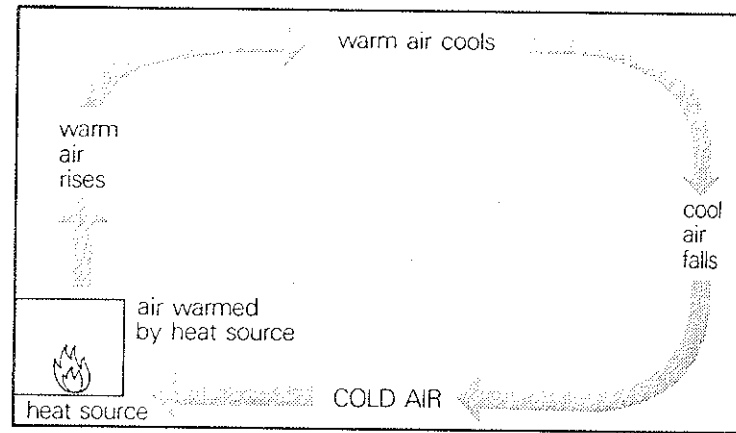
Air and oxygen are both compounds, aren't they?

No, neither air nor oxygen are compounds.

activity

Here are two diagrams showing how the air in a room is heated by convection. The first shows diagrammatically what happens inside the room, while the second sets out the sequence from which convection currents arise.

Study both of the diagrams and use them to account for the phenomenon of convection, explaining what causes air to rise, fall, expand, etc. Ask and answer questions about the sequence.



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classwork

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SECTION 1 likely or probable result

A You know how we can state the **definite** result which an action will have. You have practised making statements like these:

If zinc is placed in dilute hydrochloric acid, hydrogen will be evolved.

Stretching a material beyond its elastic limit will produce a permanent deformation of the material.

However, we are not always certain that an action will have a definite result, although we can say what is **likely** to happen. For example, if hydrogen in a test-tube is ignited, it is possible that it will explode. We cannot say for certain that it will explode, but we think it will. We therefore state:

If the hydrogen is ignited, it is likely to explode.
or:

If the hydrogen is ignited, it will probably explode.

Say what you think will happen if your teacher performs various actions. For example,

What will happen if I bend this ruler?

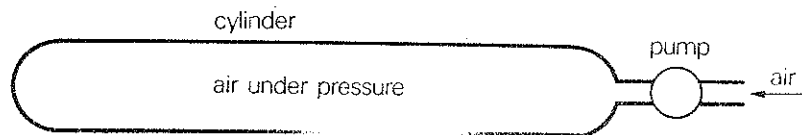
It is **likely to/will probably** ...

What will happen if I stand on this piece of chalk?

It is **likely to/will probably** ...

Your teacher will ask you for some more probable results.

B Study this description:



Air is being pumped into a cylinder. The pressure of the air inside the cylinder is getting higher, but the cylinder is not very strong. If the pressure is increased, the cylinder will probably fracture. In fact, it is in a dangerous state now, and it is likely to fracture at any moment because the pressure is too high. Therefore it is important that the pressure is reduced immediately. If the pressure is not reduced, the cylinder is likely to fracture.

We can therefore state:

The cylinder is likely to fracture _____ the pressure is **reduced**.

Make similar statements in the same way, using *is likely to* and *unless*, from these situations. In each case, there is likely to be an adverse result unless something is reduced.

1 An electric current is being passed through a wire. The current is quite high, and the wire is getting very hot. The wire will probably melt soon.

2 A gas is being pumped into a cylinder. The pressure is becoming very high, and therefore the cylinder will probably explode soon.

3 A liquid is being heated in a container. It is important that the liquid does not boil, but it is becoming hotter and will probably boil at any minute.

4 A metal wire is being stretched by a high tensile force. It will probably undergo permanent deformation very soon, although we do not want this to happen.

5 A piece of plastic is being heated. Its temperature is getting higher, and it will probably begin to melt very soon.

6 A piece of wood is being held near a strong flame and will probably catch light very soon, although we do not want this to happen.

7 Gas is being pumped into a cylinder. It is reaching a high pressure, and soon the cylinder will

probably fracture, although it is important that this does not happen.

8 A metal bar is fixed at one end and held horizontally. A large force is applied to the free end. Since the downward force on this end is extremely great, the bar will probably bend soon.

C Sometimes a certain result will only occur if there are certain conditions. For instance, we cannot simply state: *Water will freeze if it is cooled*, because it will only freeze if it is cooled to a definite temperature. It will only freeze if the temperature is **low enough**. We therefore state:

Water will freeze **provided** it is cooled to a low enough temperature.

Here are some more examples:

Copper will melt provided it is heated to a high enough temperature.

Carbon dioxide will solidify provided it is cooled to a low enough temperature.

Make similar statements with these notes:

- 1 steel/stretch—subject/high enough tensile force
- 2 oxygen/freeze—cool/low enough temperature
- 3 helium/liquefy—subject/high enough pressure
- 4 rubber/melt—heat/high enough temperature
- 5 sulphur/vaporize—heat/high enough temperature

D When a current is passed through a wire, the wire becomes hot. However, there will only be a significant heating effect if the current is large. We can therefore state:

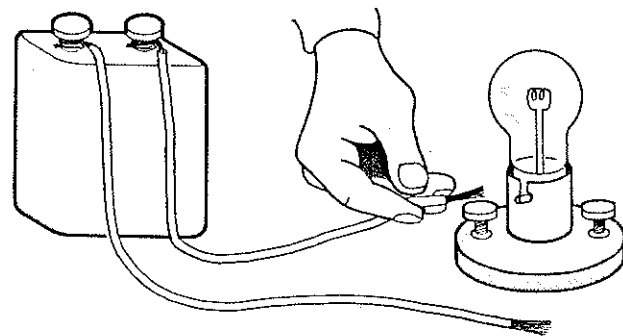
When a current is passed through a wire, there will be a significant heating effect provided the current is large enough.

Re-phrase these statements in the same way, using *provided* and *enough*.

- 1 When a metal bar is stretched, it will only extend if the force is large.
- 2 When carbon dioxide is cooled, it will only solidify if the temperature is low.
- 3 When copper is heated, it will only melt if the temperature is high.
- 4 When salt is placed in water, it will only dissolve if the water is warm.
- 5 When helium is compressed, it will only become liquid if the pressure is high.

E Sometimes we are asked what we think the likely result of an action will be. We are asked to say if we think something will happen. For example, *If I drop this glass, will it break?* The answer here will probably be *Yes, it will*, if we are certain that this will be the result. However, sometimes we are less sure, although we think the result is very likely. For example,

If this bulb is connected to the battery, will it light up?



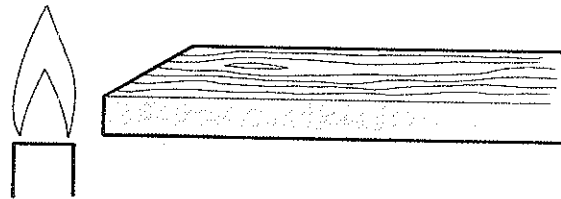
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Here we will probably say:

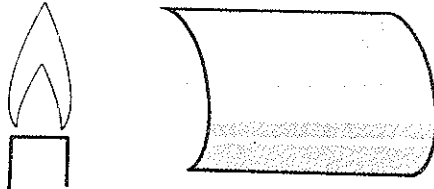
Yes, it **ought to/should do**.
(Provided the battery is powerful enough, the connections are correct and the bulb is a good one.)

We say *it ought to* or *it should*, because we are not certain that it will happen. It depends on the other factors. But we think it will happen. Look at these examples:

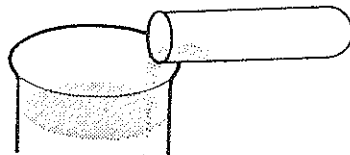
Will this piece of wood burn if it is lit?
Yes, it **ought to/should do**, provided it's dry.



Will this piece of aluminium reflect heat?
Yes, it **ought to/should do**, provided it's clean.



Will salt dissolve if it's placed in water?
Yes, it **ought to/should do**, provided the water's warm enough.



Now answer your teacher's questions in the same way, saying that you think the result is likely, but saying what the result *depends on*.

SECTION 2 hypothetical result

A When we make a statement such as: *If a piece of metal is heated it will expand* we are stating a general rule about something which will always happen. If you actually have a piece of metal in your hand, you can say: *If I heat this piece of metal it will expand*. When you say this, it does not always mean that you are going to heat it, but you are saying what will happen if you do.

Sometimes we want to emphasize the fact that we are not really going to perform an action. The situation is **hypothetical**, and we are imagining what *would* happen if the action took place. For example,

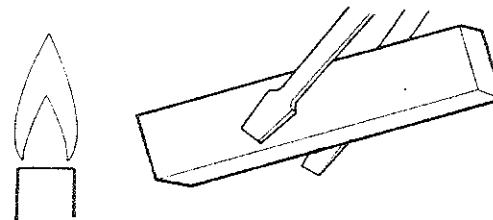
If I threw a stone at the window, it would break.
If I set fire to this book, it would burn.

If we want to ask questions about hypothetical situations, we can say:

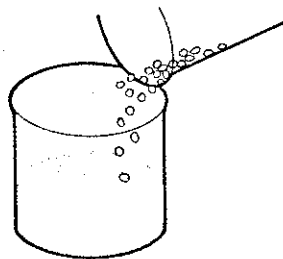
What would happen if I threw a stone at the window?
It would break.
What would happen if I set fire to this book?
It would burn.

Now complete these examples of questions (Q) and answers (A):

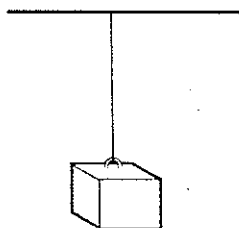
- Q. what/happen/I/heat/this piece/aluminium/
1,800°C
A. it/melt



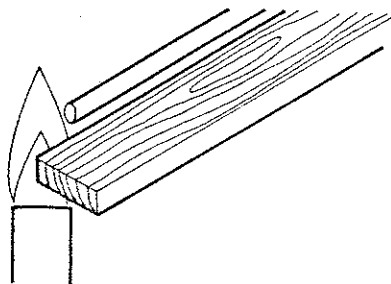
- 2 Q. what/happen/I/place/zinc/dilute hydrochloric acid
A. zinc/react/acid



- 3 Q. what/happen/I/stretch/this copper wire/beyond/elastic limit
A. it/undergo/permanent deformation



- 4 Q. what/happen/I/hold/some glass and some wood together/flame
A. glass/melt/and/wood/burn



All of these situations are hypothetical. We are asked to imagine what *would* happen.

B Ask people to imagine what would happen if you performed these actions with the objects your teacher gives you.

What would happen if I	threw this stone at the window? bent this ruler? stood on this piece of chalk? lit this piece of paper? stretched this piece of elastic?
------------------------	--

You can reply: *The ... would ...* or *It would ...*

C Notice how we can make this kind of statement in a more impersonal way. Instead of saying: *If I placed pieces of zinc in dilute hydrochloric acid they would react with the acid* a more **general** statement would be:

If pieces of zinc were placed in dilute hydrochloric acid they would react with the acid.

In the same way, we would state:

If a piece of copper wire were stretched beyond its elastic limit, it would undergo permanent deformation.

If a piece of glass were held in a flame, it would melt after a time.

If a high current were passed through a very thin wire, the wire would melt.

We sometimes want to say what we think is **likely** to happen in a hypothetical situation. We state:

If too high a current were passed through a wire, the wire **would probably** melt.

If a gas cylinder were subjected to too high a pressure, it **would probably** explode.

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Make these notes into questions, beginning with:
What do you think would happen if ... ?
Say what you think **would probably** happen in the hypothetical situations:

- 1 cylinder/hydrogen/heated
- 2 salt/added/water
- 3 thin copper wire/subjected to/high tensile force
- 4 piece of glass/heated/then cooled quickly
- 5 carbon dioxide/'poured'/over/fire
- 6 bar of steel/bent/extremely large force
- 7 too high a current/passed/through/coil
- 8 piece of wood/heated/too high a temperature

D Sometimes we want to give a reason for the result of a hypothetical situation:

If zinc were added to dilute hydrochloric acid, hydrogen would be evolved **owing to/as a result of/because of** the chemical reaction which would take place.

If air were pumped into a cylinder for a long time, the cylinder would probably explode **due to/as a result of/because of** the build-up of pressure inside.

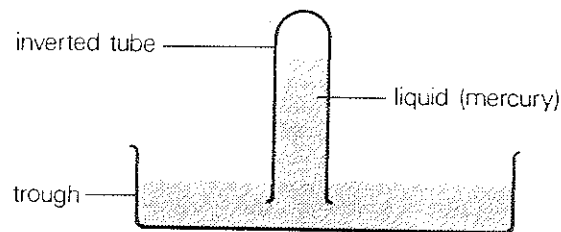
If sugar were added to water, the sugar would dissolve **because/since/as** it is soluble in water.

If iron were left in water for a length of time, it would corrode, **because/since/as** it oxidizes very easily.

What is the difference between the sentences using *due to*, *as a result of*, and *because of*, and the sentences using *because*, *since*, *as*?

Now repeat the exercise in **C**, asking questions from the notes, but giving reasons for what would probably happen.

E Study this description of a simple barometer:



Atmospheric pressure may be used to support a column of liquid. This is the principle used in a barometer.

A simple barometer consists of a tube, closed at one end, which is filled with liquid and then inverted in a trough of the liquid. The pressure due to the column of liquid in the tube is equal to the pressure acting on the surface of the liquid. Since this pressure is atmospheric pressure, the height of the column of liquid represents the pressure of the atmosphere.

Various liquids may be used, but if water were used, normal atmospheric pressure would support a column about 10.4 m high, and therefore the instrument would be extremely inconvenient to use. For this reason, mercury is usually used as the liquid in barometers, since the length of the column of mercury which the atmosphere will support is usually about 760 mm.

The length of the column of mercury is directly proportional to the atmospheric pressure, and will therefore vary according to where the barometer is set up. If a mercury barometer were set up on top of a mountain, the column of mercury would be shorter than one set up at sea-level, since the air pressure on top of a mountain is less than at sea-level.

F In the description in E, there are two statements with *would*. We can make these in a slightly different way:

Using water in a barometer would result in too long a column of liquid.

Setting up a barometer on top of a mountain would result in a shorter column of mercury than at ground-level.

Make similar statements from this table:

Adding zinc to hydrochloric acid	would	cause result in bring about	an explosion.
Igniting a cylinder of hydrogen			corrosion.
Immersing iron in water			an extension.
Stretching copper wire			a chemical reaction.

Make similar statements to say what the following actions would **cause** or **result in**:

- 1 Plunging a glowing splint into a gas-jar of oxygen.
- 2 Blowing too much air into a balloon.
- 3 Passing carbon dioxide through lime water.
- 4 Splitting an atom.
- 5 Dropping a test-tube onto a hard surface.

SECTION 3 suggesting possible cause and result

A We have looked at how to say what **will probably** happen or what **is likely to** happen if an action is performed, and what **would** happen if an action **were** performed.

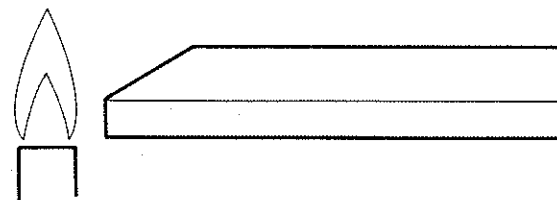
Sometimes we do not know what would happen if an action were performed. For instance, in this situation: *What would happen if I heated this piece of plastic?*

It is not possible to give a definite answer, as the result depends on various factors—the temperature, the kind of plastic, etc. We would therefore reply:

I don't know. Perhaps it would melt.

or:

I don't know. Perhaps it would burn.



We use *perhaps* to suggest a possible result. Use this table to ask questions, and answer them by suggesting a possible result.

What would happen if	a piece of metal were placed in some acid?
	a powder were mixed with some water?
	a cylinder of gas were heated?
	a gas were cooled to -180°C ?
	a wire were subjected to a high tensile force?
	a piece of metal were heated to 500°C ?

Answer:

I don't know. Perhaps it would ...

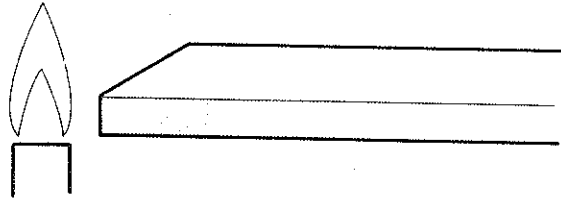
Suggest some possible results of the actions your teacher asks about.

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B There is another way of expressing a possibility. We can say what **might** happen. For example,

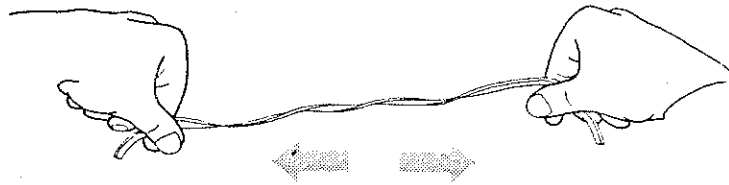
What would happen if this piece of plastic were heated?

It **might** burn, or it **might** melt.



What would happen if this material were stretched?

It **might** extend, or it **might** break.

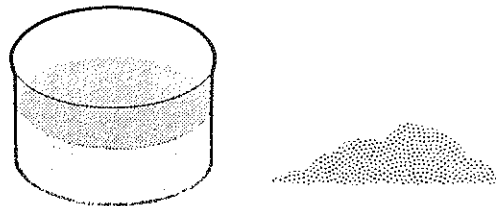


Now look at the table in **A** again. Answer the questions using **might** this time.

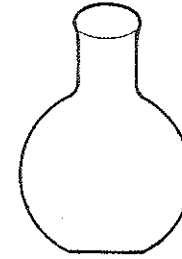
C As well as using **might**, we can also use **may** to suggest a possibility.

What will happen if the solid is mixed with the liquid?

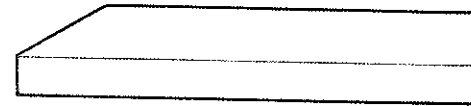
It **may/might** dissolve.



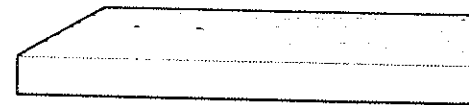
What will happen if this object is dropped?
It **may/might** break.



Will this material conduct electricity?
It **may/might** do.



Will this material burn if it is ignited?
It **may/might** do.



Ask and answer similar questions about things that are around you in the

D As well as saying *may* and *might* to suggest a possible result, we sometimes use *could* in the same way. Look at this situation:

A cylinder of a gas is standing near a source of heat. It is possible that it will explode unless it is removed.

If the cylinder is not removed, the gas **may/might/could** explode.

Study the following situations, and say what may, might or could happen if an action is either carried out or not carried out.

- 1 An unknown substance is very near some acid. It is possible that it will react if it comes in contact with the acid.
- 2 A transistor is being connected in a circuit. However, the connections are wrong, and it is possible that the transistor will be ruined unless the connections are altered.
- 3 A material is being heated. It is possible that it will burn if the temperature is raised any more.
- 4 A metal is being stretched. It is possible that it will undergo permanent deformation unless the force is removed soon.
- 5 A plastic container is very near a source of heat. It is possible that it will melt if it remains there.
- 6 A cylinder contains a gas under pressure. However, there is a small crack in the cylinder, and it is possible that the gas will escape unless the crack is sealed.
- 7 A glass bottle is near the edge of a shelf. It is so near the edge that it is possible that it will fall unless it is moved.
- 8 A container holds a quantity of liquid. If the liquid is left in the container, it is possible that it will solidify, although this is not desirable.

E If we look at the example in **D** again, we can rephrase the statement with *may*, *might* or *could* in the following way:

A cylinder of a gas is standing near a source of heat. It is possible that it will explode unless it is removed.

The cylinder must be removed, otherwise it **may/might/could** explode.

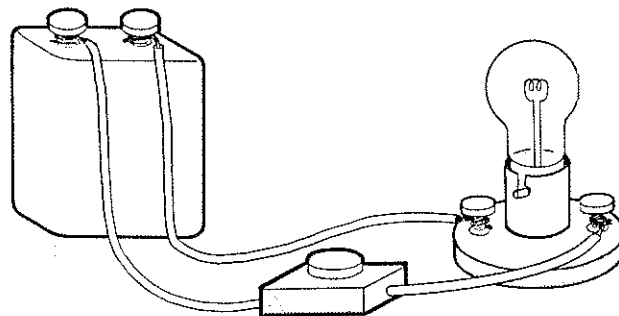
or:

The cylinder must not be left near the source of heat, otherwise it **may/might/could** explode.

Now look at the situations in **E** again, and make statements like the ones above, using *otherwise*. In some of the statements you will have to say what **must be** done, and in others you will have to say what **must not be** done.

F We sometimes use *may*, *might* or *could* to suggest a possible reason, instead of a possible result. For example,

When the switch is pressed, the lamp doesn't light.



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We can suggest possible reasons:

The battery	may might could	be	weak (flat).
The switch			faulty.
The wires			broken.
The lamp			damaged.
The connections			wrong.

We can phrase these in a different way:

It	may might be	due to because of	a flat battery. a faulty switch. a broken wire. a wrong connection. a broken lamp.
		because	the battery is flat. the switch is faulty. a wire is broken. a connection is wrong. the lamp is damaged.

G Imagine that you have a car, and that there is something wrong with it. Ask someone else to suggest what the cause of the trouble might be. Use these sentences in your conversation:

A: There's something **wrong/the matter** with my car.

B: Oh, what's **wrong?/the trouble?/the matter?**

A: Well, it won't start.

B: I see.

It	may might could	be	due to because of	lack of petrol in the carburettor. insufficient oil pressure. unclean electrical contacts a break in a wire.
			because	the starter motor's broken. there's no petrol in the tank. the battery's flat. there's a leak in the petrol pipe.

A: No, it can't be ... because I've checked
it/them.

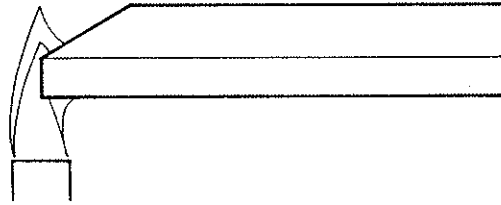
When you have practised this dialogue several times with different people, close your book and ask someone what they think is wrong with your car.

exercises

exercise 1 Look at this situation. We do not have precise information, therefore we can only say what we think is **likely** to happen.

X is a material in solid form. It is being heated. Will it melt?

It will probably melt, provided the temperature is high enough.



Make similar statements to say what is likely to happen in these situations:

- 1 A material is being stretched by a tensile force. Is it likely to break?
- 2 A gas is being cooled. Is it possible that it will solidify?
- 3 A current is being passed through a wire. Will the wire become very hot?
- 4 A material is being held in a flame. The flame is quite hot. Will the material catch fire?
- 5 A container which is fairly resilient is being subjected to shock. Will it withstand the shock?
- 6 A gas is being compressed. Will it become a liquid?
- 7 A battery is connected to a lamp. The battery is fairly powerful. Will the lamp light?
- 8 A sheet of metal is placed near a source of heat. The metal is fairly clean and shiny. Will it reflect the heat?

exercise 2 Make statements from these notes. Say what **would probably** happen if an action **were** performed, and give the reason. For example,

cylinder of gas heated—explode—too high a pressure (*because of*)

If a cylinder of gas were heated, it would probably explode due to too high a pressure.

- 1 carbon dioxide poured over a fire—fire go out—carbon dioxide cannot support combustion (*because*)
- 2 high current passed through a wire—wire melt—heating effect of the current (*because of*)
- 3 salt added to water—dissolve—salt soluble in water (*since*)
- 4 iron left in contact with water—corrode—oxidation (*as a result of*)
- 5 copper wire subjected to a tensile force—extend—copper fairly elastic (*as*)
- 6 test-tube of hydrogen ignited—explode—hydrogen extremely inflammable (*because*)
- 7 polythene container placed near a source of heat—melt—low melting point of polythene (*because of*)
- 8 glass bottle dropped onto the floor—shatter—glass extremely brittle (*since*)

exercise 3 Below are some notes which show the **possibility** or the **risk** (or **danger**) of what might happen in various situations. For example,

substance heated—possibility of explosion

From these notes we can make the statement:

The substance must not be heated, otherwise it may/might/could explode.

Make similar statements from these notes in exactly the same way. State what must not be done, and the reason for it (using *otherwise*).

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- 1 material exposed to water—possibility of corrosion
- 2 transistor wrongly connected—risk of damage
- 3 high current passed through wire—risk of overheating
- 4 liquid cooled too quickly—possibility of solidifying
- 5 plastic too near a source of heat—danger of melting
- 6 gas exposed to a naked flame—risk of burning
- 7 container damaged—danger of gas escaping
- 8 material stretched—possibility of undergoing permanent deformation

drills

drill 1 Say what will probably happen or what is likely to happen in the situations you hear. There is sometimes more than one possible answer, as there are no notes to help you. Where there are several alternatives, these are given in the answers.

Gas is being pumped into a cylinder to a very high pressure. What is likely to happen?

It's likely to explode.

Water is being cooled to a low temperature. What will probably happen?

It will probably freeze (or solidify).

drill 2

Will this lamp light up if I connect the battery?

Yes, it should do, provided the battery is powerful enough.

Will this gas explode?

No, not unless it's heated strongly.

Use these notes to help you:

- | | |
|-----------------------------------|----------------------|
| 1 Yes—powerful | 5 No—heated strongly |
| 2 No—heated strongly | 6 Yes—high |
| 3 Yes—strong | 7 No—punctured |
| 4 No—subjected to a violent shock | 8 Yes—warm |

drill 3 Say what **would** happen (where there would be a **definite** result) or what **would probably** happen (where there would be a **likely** result) in these situations.

What would happen if zinc and dilute hydrochloric acid were placed together in a container?

They would react.

What would happen if a piece of glass were dropped onto the floor?

It would break.

drill 4

Copper isn't light enough to be used in overhead power cables.

No, if it were lighter it would probably be used more in overhead power cables.

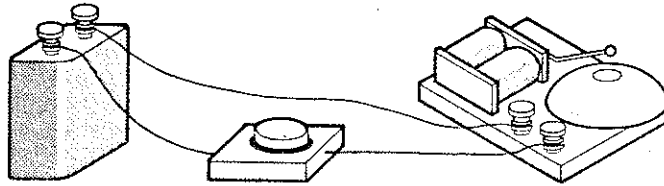
Gold is too expensive to be used as a conductor.

Yes, if it were less expensive it would probably be used more as a conductor.

drill 5 Dialogue—Part 1

Listen carefully to the dialogue, in which two people are talking about the simple circuit shown below.

Now repeat the words and phrases exactly as you hear them. Make your voice go up and down in exactly the same way as the speaker.



drill 6 Dialogue—Part II

Now take the part of the second speaker. You will hear the dialogue again. Speak with him.

Will the bell ring if I press the switch?

Oh—what do you think is wrong with it?

Well, there might be something wrong with the bell.

Oh well, perhaps the wiring's not correct or the connections are broken.

Do you think the switch could be faulty?

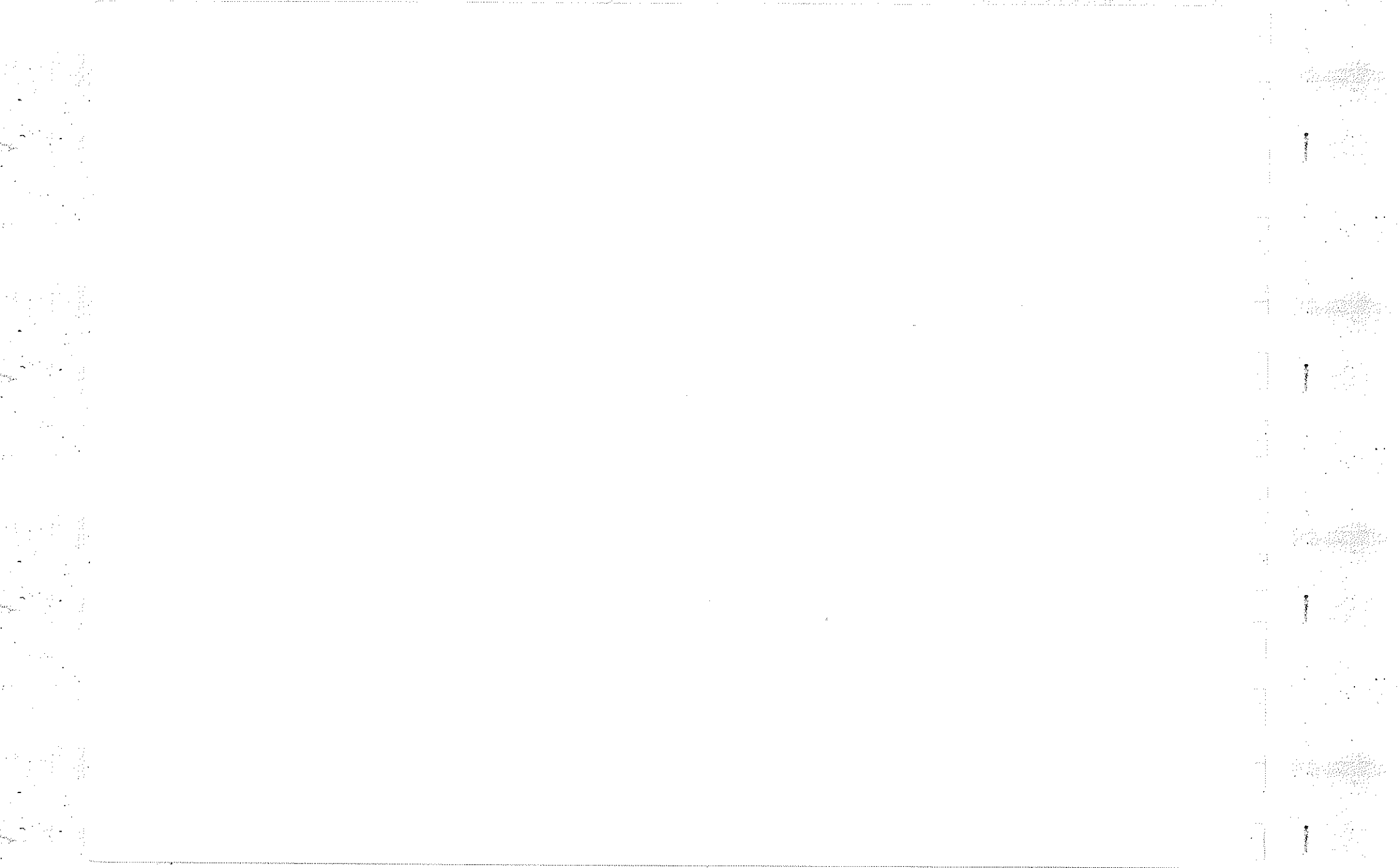
Well, in that case it can only be one thing.

Yes. If you change the battery the circuit ought to work. Now let's try it.

Now you will hear the dialogue again, with pauses for you to speak. Take the part of the second speaker again, and speak in the pauses.

Below are a series of ten situations. Imagine you are in these situations, and discuss what you could do, what you ought to do and what you shouldn't do in order to try to solve the problem. Make your own suggestions but also put up objections to other people's suggestions if you can think of reasons why they wouldn't work, or if it would be wrong to try them. Try to think of unusual and ingenious solutions. Your teacher will help you.

- 1 You are locked out of your house. You have lost your key, there is no one in the house, and all the doors and windows are closed.
- 2 You are driving along a lonely stretch of road when your car stops. You have no more petrol left in the tank. There are no garages near.
- 3 You are sitting at home at night when the electric light suddenly goes out.
- 4 You are trying to telephone a certain number, but you are not getting any tone at all when you dial the number.
- 5 You have put some money in a machine to get a ticket. The machine does not deliver the ticket, and you cannot get your money back.
- 6 You are riding your bicycle along the road when you have a puncture.
- 7 You need to get up very early in the morning, but you have no alarm clock.
- 8 You are in a shop buying a large number of things. When you go to pay for them, you discover you have no money.
- 9 You are driving a car and come to some traffic lights. They are red. You wait for ten minutes and they are still red. They are obviously broken.
- 10 You are clearing out a cupboard and find a library book which you took out three years ago.



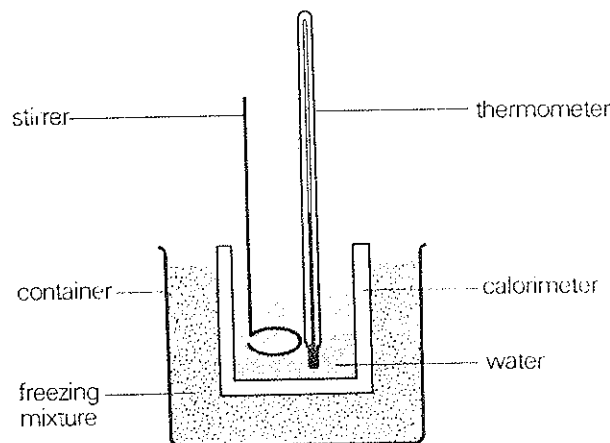
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classwork

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SECTION 1 reporting actions

A Here is a diagram and a series of instructions for carrying out an experiment. Make sure you can understand them clearly. The aim of the experiment is to investigate the behaviour of water when it is cooled.



- 1 Crush some ice and mix it with a small amount of common salt to produce a freezing mixture.
- 2 Place this freezing mixture in a large container.
- 3 Pour a small amount of hot water into a calorimeter and insert this calorimeter into the freezing mixture.
- 4 Allow the water to cool, and by means of a mercury thermometer, take readings of the temperature of the water at regular intervals—eg once every minute. Note the temperature at every reading. The water should be stirred continually throughout the experiment.

5 Continue the experiment until the temperature of the water is well below 0°C . Observe carefully what happens to the water as the temperature approaches 0°C . Continue stirring the water and noting the temperature for several minutes after ice forms in the calorimeter.

6 From the results, plot a graph of temperature against time.

7 From the graph, and from the observations made during the experiment, attempt to make deductions about what takes place when the temperature of water is lowered.

These instructions tell us what to do in order to perform the experiment.

Underline all the instruction words (**imperatives**) in the instructions, like *put*, *take*, *note*, etc.

B When an experiment has been carried out and results are complete, it is usually necessary to write a report of *what was done* during the experiment. The report must be in the past tense, and is usually written in an **impersonal way**. For example,

Carry out an experiment to investigate the behaviour of water when it is cooled.

This is a direct instruction telling us **what to do**. But:

An experiment was carried out to investigate the behaviour of water as it is cooled.

This is an impersonal statement telling us **what was done**. Compare these two similar sentences:

Mix some ice and salt together to form a freezing mixture.

Ice and salt were mixed together to form a freezing mixture.

Now imagine that the experiment is complete and that you are writing a report of the procedure. Look back at the instructions and change them into the form of a report to say *what was done*. Do this in exactly the same way as in the examples above. Follow the outline given below.

- 1 Some ice _____ and _____ with salt to form a freezing mixture.
- 2 This mixture _____ in a large container.
- 3 A small amount of hot water _____ into a calorimeter.
- 4 The calorimeter _____ then _____ into the freezing mixture.
- 5 The water _____ to cool, and readings of the temperature _____ every minute.
- 6 The water _____ continually throughout the experiment.
- 7 The value of the temperature _____ at every reading.
- 8 The experiment _____ until the temperature of the water was well below 0°C .
- 9 The water _____ carefully as the temperature approached 0°C .
- 10 The stirring _____ and the temperature _____ for several minutes after ice formed in the calorimeter.
- 11 A graph of temperature against time _____ from the tabulation of the results.
- 12 From the graph and the observations which _____ during the experiment, deductions _____ as to what takes place when the temperature of water is lowered.

You should now have a complete passage describing how the experiment was carried out.

C Use this table to help you ask questions about the report of the experiment you have written in **B**. Use the passage above to help you answer the questions.

What	was were	used done made	for the experiment?
			first? next? then? throughout the experiment? during the experiment? as the temperature approached 0°C ? after ice formed? from the results?

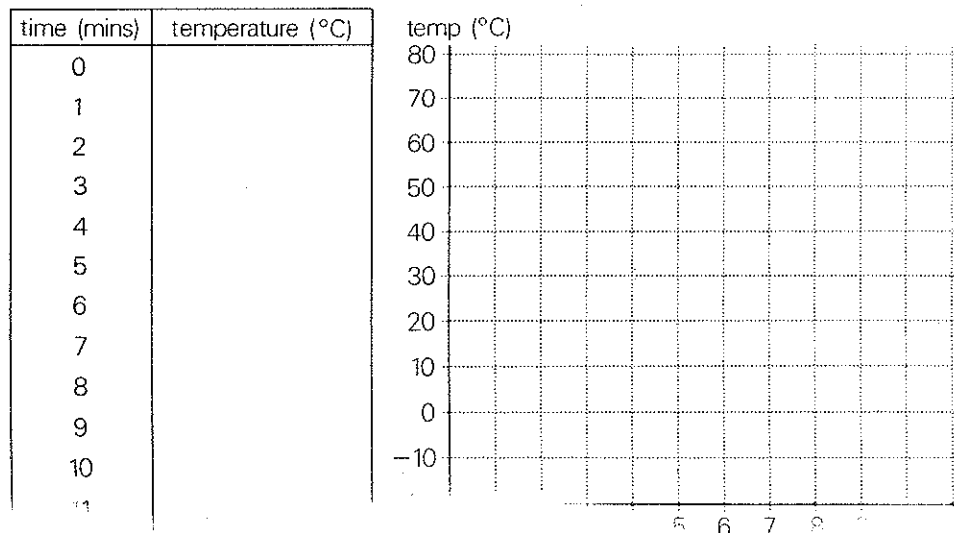
D Now use these two tables to ask and answer questions about the experiment. You are asking the reason **why** certain things were carried out, and so you can begin your answers with: *in order to*, *in order not to*, *so as to*, or *so as not to*.

Why	was wasn't	salt mixed with the ice? a small quantity of hot water used? a mercury thermometer used? the water stirred continually? the thermometer used to stir the water? the water observed carefully around 0°C ? a graph plotted from the results?

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In order (not) to	measure a wide range of temperature. present the results clearly. lower the temperature of the ice. study the action of the water at this temperature.
So as (not) to	melt the freezing mixture. ensure uniform cooling. break the thermometer.

E Here is a blank table and graph for the results of the experiment. Your teacher will read out a set of results, and you should enter these into a table like the one given here. From this tabulated set of results, you should then plot the graph of the cooling curve of water.



SECTION 2 reporting observations and results; stating conclusions

A When the report of the procedure of an experiment is complete, it is then necessary to describe the results, including the observations which were made, and then **draw conclusions** from the results. Here is a description of what was observed during the experiment in Section 1, and a conclusion based on the observations and results. Study it carefully.

The water in the calorimeter was observed carefully as the temperature approached 0°C . It was observed that the temperature continued to fall for a short time without any ice forming. The temperature was seen to fall a few degrees below 0°C while the water remained liquid. It was then noticed that the temperature rose to 0°C and ice began to form. The temperature was found to remain constant at 0°C when ice was present. The behaviour of the temperature of the water can be seen from the graph.

From the results, it can be seen that the temperature fell a few degrees below zero before ice formed. The temperature then rose to zero as the ice formed. A loss of temperature indicates a loss of heat energy, therefore it can be stated that as the temperature of the water fell below zero, the water continued to give out energy to the surrounding freezing mixture.

Since the temperature rose as the ice formed, it can similarly be stated that energy was gained by the water as it became solid.

When the water froze, a change of state took place, as the water changed from a liquid to a solid state. It was noted that the temperature rose during this time. Heat energy must therefore have been absorbed by the water during the change of state.

It can therefore be concluded that energy was required in order to bring about a change of state in the water.

The experiment demonstrates that energy is required to produce a change of state.

Answer these questions about the results:

- 1 What was observed when the temperature was around 0°C?
- 2 When did ice begin to form?
- 3 What does a fall in temperature indicate?
- 4 Why is it possible to state that energy was absorbed by the water as it solidified?
- 5 The water changed from liquid to a solid. What can we say took place?
- 6 What must have happened in order to produce this change?
- 7 How do we know this?
- 8 What is the conclusion of the experiment?

B Look at this sentence from the previous passage:

It was observed that the temperature continued to fall for a short time **without any ice forming**.

This is another way of saying:

The temperature continued to fall for a short time, but no ice formed.

In the same way, we can re-phrase:

The temperature continued to fall for a short time, but no ice was formed.

as:

The temperature continued to fall for a short time, without any ice being formed.

Study these situations, and then re-phrase the sentences using *without*.

- 1 A metal wire was stretched 5 cm, but it didn't break.
- 2 Mercury was cooled to -20°C, but it didn't freeze.
- 3 Sand was added to water and the mixture was heated gently for a long time, but the sand did not dissolve.
- 4 Some aluminium was placed in water and left for some time, but no reaction was observed.
- 5 A current was passed through a wire for a period of time, but no heating effect was detected.
- 6 A substance was heated for a short time, but no rise in temperature was observed.
- 7 Various substances were placed in dilute hydrochloric acid, but no gas was seen to be evolved.
- 8 Some ammonium chloride was heated, but no ammonia was smelt.
- 9 A lighted splint was held over the top of a test-tube of gas, but no explosion was heard.
- 10 A suspended magnet was brought near to a coil of wire, but no effect was noticed on the magnet.

C When a report is made of an experiment, it is necessary to state what was seen, or noticed, or observed, etc. This was done in the report at the beginning of this section. In the passage, the words *observed*, *noticed*, *found*, *seen* and *noted* were used. If a description is made of observations in the present, we can say: *Bubbles of gas can be seen* or: *A reaction is observed* or: *Several substances are produced*. However, if we were writing about the past, we would say:

Bubbles of gas **could be** seen.

A reaction **was** observed.

Several substances **were** formed.

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Imagine you have carried out an experiment, and are writing up the report. Make correct sentences from this table:

During the experiment	bubbles of gas a heating effect effervescence decrepitation a popping sound a pungent smell ammonia	was were could be	seen. observed. heard. detected. felt. melt. noticed.
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D When we look at results, we usually do so in order to reach conclusions. We examine the results and try to **explain** them. For example,

When zinc is placed in dilute hydrochloric acid, bubbles can be observed coming from the zinc.

We can therefore deduce:

The bubbles must be due to a reaction taking place.

The bubbles must be caused by a gas being given off.

However, if we are writing about an experiment in the past, we must try to deduce the reason for what **happened**. For example,

Zinc was placed in dilute hydrochloric acid.

Bubbles could be observed coming from the zinc.

This **must have been** due to a reaction.

It **must have been** caused by a gas being given off.

Here is a table from which you can make deductions about the observations made in the first table.

Make sentences again from the table of observations, and then state your **conclusion**. For example,

bubbles of gas—carbon dioxide

During the experiment, bubbles of gas could be observed. This must have been due to carbon dioxide being given off.

- 1 a pungent smell—hydrogen sulphide
- 2 a heating effect—current
- 3 ammonia—ammonia
- 4 bubbles of gas—oxygen
- 5 an effervescence—carbon dioxide
- 6 a popping sound—bubbles of gas
- 7 decrepitation—water

This must have been	due to because of caused by	hydrogen sulphide being liberated. the current passing through the coil. ammonia being evolved. oxygen being produced. carbon dioxide being given off. bubbles of gas exploding. water within the crystals expanding.
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E You can now describe the complete sequence of:
1. *Procedure* 2. *Observation* 3. *Deduction* 4. *Reason*.
For example,

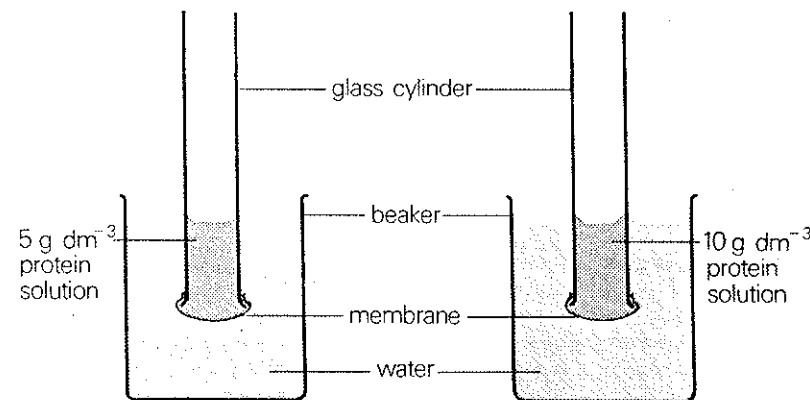
- 1 *Procedure*: Zinc sulphide was placed in dilute sulphuric acid.
- 2 *Observation*: During the experiment, a pungent smell was noticed.
- 3 *Deduction*: This must have been caused by hydrogen sulphide being liberated ...
- 4 *Reason*: ... because of a reaction between the zinc sulphide and the acid.

Make similar statements with the following outlines:

- 1 electric current/pass/coil of wire.
heating effect
current/pass/wire
because/no other source of energy/available
- 2 pieces/marble/place/dilute acid
bubbles of gas
carbon dioxide/evolved
since/gas/turn/lime water/cloudy
- 3 hydrogen peroxide/place/test-tube/with/
manganese dioxide
effervescence
oxygen/liberated
since/gas/cause/glowing splint/ignite
- 4 copper sulphate crystals/heat/test-tube
decrepitation
water in crystals/expand
due to/heat/give/crystals
- 5 some chemicals/heat/test-tube
popping sound
bubbles of gas/explode
since/bubbles of gas/observe/during/experiment
- 6 slaked lime/and/ammonium chloride/heat
pungent smell
ammonia/evolved
because/gas/cause/damp red litmus paper/turn/
blue

SECTION 3 describing and accounting for results

A Here is a report of an experiment. Complete it by supplying the correct forms of the verbs given in brackets (past or present, active or passive).



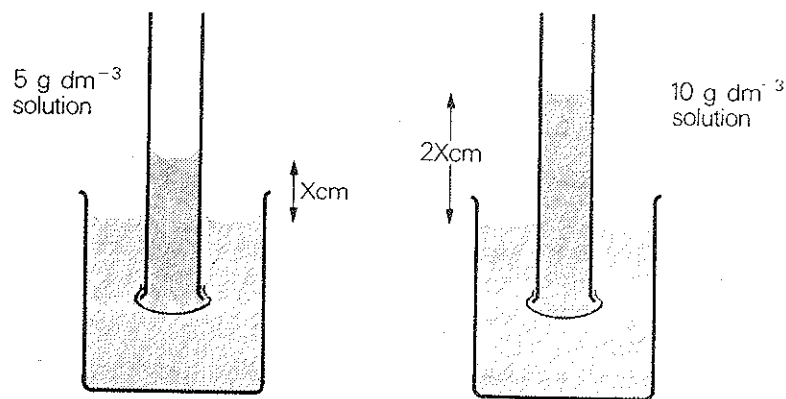
Two beakers _____ (fill) with water. In each beaker a glass cylinder _____ (immerse), across the bottom of which a membrane _____ (tie). The membrane _____ (allow) water to pass through it freely, but it would not allow molecules of dissolved protein to pass through it, since protein molecules _____ (be) larger than molecules of water. A membrane which _____ (allow) molecules to pass through it _____ (be known) as a *permeable* membrane. However, since the membranes used in this experiment _____ (allow) only molecules of the solvent to pass through, they _____ (be known as) *semi-permeable* membranes.

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Two protein solutions _____ then _____ (*make up*), one at a concentration of 5 g dm^{-3} , and the other at 10 g dm^{-3} . Some of the 5 g dm^{-3} solution _____ (*pour*) into one of the glass cylinders, and some of the 10 g dm^{-3} solution into the other cylinder.

The levels of the water in the beakers and the protein solutions in the glass cylinders _____ (*adjust*) until they _____ (*be*) all equal. The experiment _____ then _____ (*leave*) for period of twenty-four hours.

After twenty-four hours, it _____ (*observe*) that the levels of the water and protein solutions _____ (*be*) considerably different from when the experiment _____ (*begin*). The level of liquid in the cylinders _____ (*see*) to be higher than the level of the water in the beakers. Moreover, when the height of the liquid in each cylinder _____ (*measure*), it _____ (*find*) that the height of the column of liquid in the cylinder containing the more concentrated solution _____ (*be*) twice the height of the other solution.



Result after twenty-four hours

B When you have completed the text and think you can understand it clearly, answer these questions:

- 1 What property does a semi-permeable membrane have?
- 2 What solution was placed in the glass cylinders?
- 3 What was the difference between the solutions in the two cylinders?
- 4 What was done after the solutions were poured into the cylinders?
- 5 How long was the experiment allowed to continue?
- 6 What was observed after this period?
- 7 What measurements were made?
- 8 What was discovered from these measurements?
- 9 What do you think happened during the experiment?
- 10 What reasons can you give for what you think happened?

The answers to the last two questions are important, because here you are considering the results of the experiment and *interpreting* them in order to find the cause.

C Now compare your interpretation of the results with this explanation of the experiment:

It appears that water has been transferred through the membranes into the cylinders during the experiment, causing the levels of solution inside the cylinders to rise. Since the membranes used were semi-permeable, no protein could have passed into the solvent in the beakers. The movement was therefore from the solvent across the membrane into the cylinders.

Since, at the end of the experiment, the level of solution in each cylinder was higher than the level of water in the beakers, it can be stated that the membrane must be capable of supporting a certain pressure of solution and preventing the solution from passing through it. Consideration of the diagrams showing the results of the experiment will show that there is a pressure of $X\text{ cm}$ of solution acting on the membrane supporting the solution of concentration 5 g dm^{-3} and a pressure of $2X\text{ cm}$ acting on the membrane containing the solution of concentration 10 g dm^{-3} . There will also be atmospheric pressure acting on both of the membranes.

If the membrane were punctured, the solutions would flow into the beakers until the levels of liquid inside and outside the cylinders were equal.

It therefore seems that there is a driving force which causes the water molecules to pass through the membrane into the solution. However, the passage of water molecules through the membrane clearly stopped at some point when the column of solution reached a certain height. This can be explained as follows: as the column of solution rises up the cylinder, the pressure acting on the membrane will increase. When this pressure is equal to the driving force causing the water molecules to move across the membrane into the solution, a state of equilibrium is obtained. This means that there are the same number of water molecules crossing the membrane from either side and so the height of the column of solution will not increase further.

Does your account of what happened during the experiment agree with this explanation?

D When a question is asked beginning with: *What seems/appears to have happened ...* or: *What seems/appears to be the reason for/cause of/result of ...* etc., we can answer:

It seems/appears that ...

When you think you understand the explanation, try to answer these questions:

- 1 Why can we state that water passed up into the cylinders, but no protein solution passed into the water?
- 2 At the end of the experiment, the height of the liquid in each cylinder was above the level of water in the beakers. What can be deduced from this about the membrane?
- 3 What is the difference in pressure between the two columns of protein solution?
- 4 What would happen if the membranes were punctured?
- 5 What appears to have caused water to pass into the cylinders?
- 6 Did water continue to pass into the cylinders throughout the experiment?
- 7 What forces seem to be acting in this experiment?
- 8 What seems to have happened at a certain point in the experiment?

E When an experiment has been reported, and the results have been considered and explained; it is usual to write a **conclusion** to state the **findings** of the experiment. Here is a conclusion to the experiment described in **A** and **C**.

The phenomenon observed during the experiment is called **osmosis**. This phenomenon, and the results of the experiment, can be explained by considering what is happening in the liquid on either side of a semi-permeable membrane. On

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both sides of the membrane the molecules present in the liquid will bombard the surface of the membrane. If on one side of the membrane there is a pure solvent and on the other a solution (as is the case for the experiment described), more solvent molecules will bombard the surface of the membrane on the pure solvent side than on the solution side. The membrane allows transfer of the solvent molecules from one side to the other and prevents transfer of solute molecules. Thus, solvent molecules will transfer from the solvent to the solution simply because on that side of the membrane more solvent molecules bombard the surface, leading to a greater number transferring across the membrane. Transfer will continue until the pressure exerted on the membrane by the solution (\times and $2\times$ cm in the experiment) increases the number of solvent molecules bombarding the membrane surface in the solution up to a point when there are equal numbers of molecules transferring across the membrane from either side. The pressure exerted under these conditions is called the **osmotic pressure**.

The number of solvent molecules bombarding the membrane in the solution is directly proportional to the number of solute particles in the solution, hence the differing heights of solution in the experiment.

F It is possible to imagine that the experiment was carried out in different ways—with different solutions, different materials, etc. In this case, we often say:

Supposing ... had been used instead of ... ?

or:

What would have happened if ... had been used instead of ... ?

Example:

Supposing a glucose solution had been used instead of the protein solution?

What would have happened if a glucose solution had been used instead of the protein solution?

We would then answer:

The results **would have been** similar.

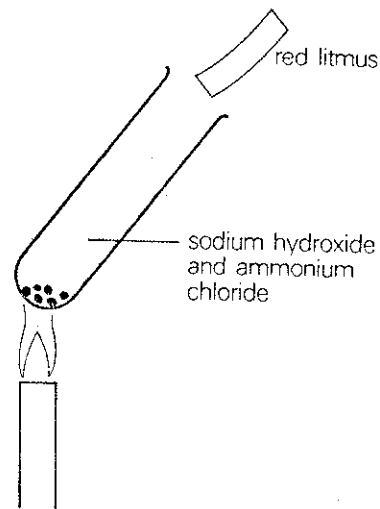
or:

The results **would probably have been** similar (if we are not certain).

Ask what would have happened if these things had been done or used in the experiment. Say what would have happened. Ask questions beginning with *Supposing* ... as well. If you don't know for certain what would have happened, you can use *probably* in your answers.

- 1 rubber membrane used
- 2 5 g dm^{-3} protein solution placed in beaker as well as in cylinder
- 3 water placed in cylinder and protein solution placed in beaker
- 4 completely permeable membrane used
- 5 sodium hydrogen-carbonate solution used in cylinder
- 6 sand and water placed in cylinder
- 7 membrane punctured
- 8 5 g dm^{-3} and 20 g dm^{-3} protein solutions used in different cylinders

exercise 1 Here is a set of instructions for carrying out a simple experiment. Imagine you have now completed the experiment and have to write a report of it. Write out the instructions in the form of the opening paragraph of a report. Begin like this: *Some ammonium chloride was placed in a test-tube ...*



Place some ammonium chloride in a test-tube and add some sodium hydroxide. Hold the test-tube over a low bunsen-burner flame and heat the contents gently for a time. Move the test-tube from side to side in the flame in order to ensure a gentle heating action. Observe carefully the reaction which takes place. Hold a piece of dry red litmus paper over the mouth of the test-tube—observe the result. Moisten the litmus paper and again hold it over the mouth of the test-tube. Observe the result again. Take care not to inhale a lot of the gas, but carefully smell the gas given off during the reaction.

exercise 2 Now write an account of the results of the experiment described in Exercise 1. Here is a set of notes from which you can write a series of complete sentences. You will then have a paragraph describing the results of the experiment. For example,

no reaction/observe/until/mixture in the test-tube/heat

No reaction was observed until the mixture in the test-tube was heated.

Now continue your account from this point:

- 1 as/mixture in the test-tube/heat,/reaction/could/detect/due to bubbles of gas which/appear/in/liquid
- 2 when/piece of dry red litmus paper/hold/over/mouth of/test-tube, no change in colour/observe/even though/it/hold there/for some time
- 3 however, when/litmus paper/moisten,/it/turn/blue/when/hold/over/mouth of/test-tube
- 4 this/must/have/be/due to/alkaline gas/be/given off/during/reaction
- 5 when/gas/smell/carefully,/it/find to/have/very strong smell
- 6 this/must/have/be/ammonia,/since/smell/be/unmistakable
- 7 it/can/therefore/conclude/that/during/experiment,/ammonia/give off/as a result of/reaction between/ammonium chloride/and/sodium hydroxide

exercise 3 A to D are a series of statements about osmotic pressure. They state the conditions necessary for osmotic pressure to occur, and the conditions on which the pressure depends. After each of the statements, there are questions asking what would have happened if the experiment described in Section 3 of the Classwork had been carried out differently. Using the statements about osmotic pressure, answer the questions.

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exercises
exercise 3

- A The membrane must allow water to pass through freely, but it must not permit a substance dissolved in the water to pass through. No osmotic pressure can be set up if the membrane is freely permeable to both the water and the dissolved substance, nor if it is completely impermeable to both.
- 1 What would have happened if the membrane used had allowed the dissolved protein to pass through it?
 - 2 What would have happened if the membrane had not been permeable to either the water or the solution?
- B There must be a difference in concentration between the two solutions on the two sides of the membrane. When there is a concentration difference, water passes through the membrane from the weaker solution to the stronger one, thus tending to make both solutions equal in concentration.
- 3 What would have happened if a 20 g dm^{-3} protein solution had been placed in the cylinder, and a 5 g dm^{-3} protein solution had been placed in the beaker?
 - 4 What would have happened if a 10 g dm^{-3} glucose solution had been placed in the beaker and a 5 g dm^{-3} solution had been placed in the cylinder?
- C The size of the osmotic pressure set up depends on the magnitude of the concentration difference between the two solutions. The greater the concentration difference the greater the osmotic pressure will be.
- 5 What would have been the result if a 20 g dm^{-3} solution had been used instead of a 5 g dm^{-3} or 10 g dm^{-3} solution?
 - 6 What would have happened if a 2.5 g dm^{-3} solution had been used?
- D The osmotic forces depend on the concentrations of dissolved particles per litre. They do not depend on the chemical nature of the particles. Many different solutions can be osmotically balanced on either side of a membrane, provided that the two solutions contain the same number of dissolved particles per litre.
- 7 What would have happened if a solution of sodium chloride had been used in the cylinder, and a solution of glucose with the same number of particles per litre had been used in the beaker?
 - 8 What would have happened if solutions of sodium chloride and glucose with different concentrations of dissolved particles per litre had been used?

drills

drill 1 Two speakers are talking about an experiment. Make statements reporting what was done during the experiment.

What did you do first?

I crushed some ice and mixed it with salt.

First some ice was crushed and mixed with salt.

Then what did you do?

I placed the mixture in a large container.

Then the mixture was placed in a large container.

drill 2

The liquid was heated. When the temperature reached 100°C, the heating was stopped.

The liquid was heated until the temperature reached 100°C.

The material was stretched. When it was 50 cm long, the stretching was stopped.

The material was stretched until it was 50 cm long.

drill 3 Describe these sounds, which occurred during an experiment.

When the experiment was carried out, this sound was heard all the time ... (sound)

Throughout the experiment a crackling sound was heard.

Sometimes, this sound was noticed ... (sound)

From time to time during the experiment a popping sound was noticed.

drill 4 Say what you think were the causes of these effects, which were observed during an experiment.

There was a terrible smell during the experiment. Do you think it was due to carbon dioxide or hydrogen sulphide?

It can't have been due to carbon dioxide—it must have been due to hydrogen sulphide.

There was an explosion during the experiment. Do you suppose it was caused by oxygen or hydrogen?

It can't have been caused by oxygen—it must have been caused by hydrogen.

drill 5 You are being asked questions about the osmosis experiment. Say what seems or appears to have had certain effects. Use the notes to help you.

What appears to have caused water to rise up the cylinder?

It appears that a force caused it to rise up the cylinder.

What seems to have prevented the solution mixing with the water?

It seems that the membrane prevented them mixing.

- 1 a force
- 2 the membrane
- 3 fall
- 4 rise
- 5 rise/more than the 5 g dm⁻³ solution
- 6 prevent/further movement of water into the cylinder
- 7 become/equal
- 8 no more water/pass/into the cylinder

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drill 6

drill 6 Use the notes to help you say what would have happened if certain actions had been carried out in the osmosis experiment.

What would have happened to the results if glucose had been used instead of protein?

The results would have been similar.

What would have happened to the liquid in the cylinder if an impermeable membrane had been used?

The liquid in the cylinder would not have risen.

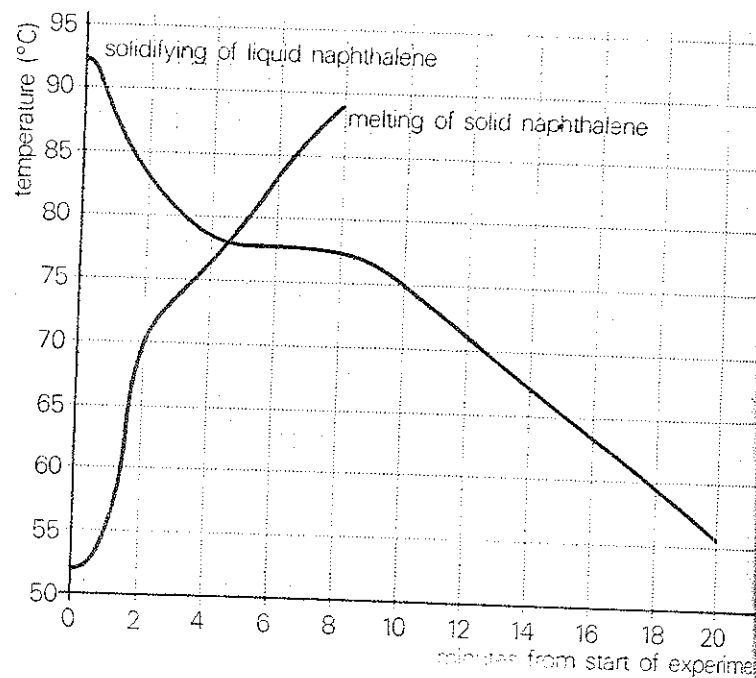
- 1 similar
- 2 not rise
- 3 be four times as high
- 4 not rise
- 5 fall
- 6 mix
- 7 remain the same
- 8 not rise

activity

During an experiment, some naphthalene was heated in a test-tube. Regular measurements of the temperature were taken up to the point when the naphthalene melted. It was then allowed to cool, being stirred continually until it solidified.

Measurements of temperature were again made at regular intervals. From the results of temperature and time, a graph was plotted.

Using the graph, account for what happened during the experiment, both in the liquefying and solidifying stages. Speculate about the reasons for the shape of the curves, and attempt to draw a conclusion about changes of state when substances are heated and then allowed to cool.



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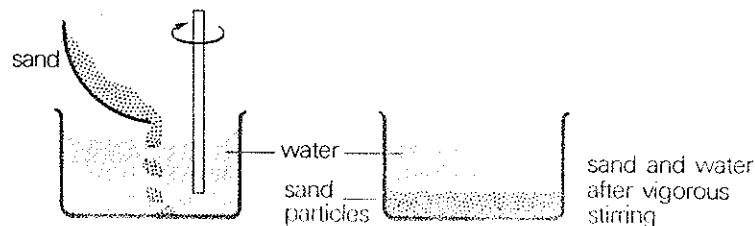
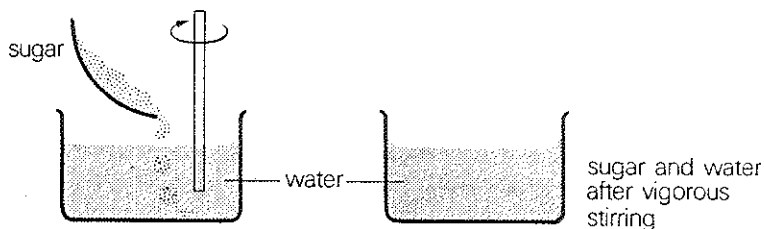
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unit 10
classwork
section 1

SECTION 1 describing an experiment

A Look at this description of a demonstration.

Two beakers are filled with water, and into one a quantity of sugar is stirred. A quantity of sand is placed in the other, and the liquid in both beakers is stirred vigorously. It will be observed that the sugar seems to disappear completely, whereas the sand can still be seen clearly. No matter how vigorously or how long the sand is stirred in the water, it will not disappear, and when the stirring ceases the particles (or grains) of sand start to settle at the bottom of the beaker. In theory, no matter how long the liquid containing sugar is left standing, the sugar will not separate out from the liquid. Even if the sugar and water is left standing for a year or more, no sugar particles will be seen in the liquid. (This assumes that no evaporation of water takes place.) On the other hand, the sand will not dissolve in the water even if this beaker is heated while the mixture is being stirred.



From this demonstration, it can be seen that particles of sugar have dispersed throughout the water, and under normal conditions they will remain dispersed in this way. The sugar and water have formed a **solution**. However, despite vigorous stirring, the sand particles have failed to disperse in the same way. They have remained completely separate and formed a **suspension**.

Now complete this account of what will happen if another experiment involving solutions is carried out. Complete the text with the correct form of the future tense of each verb.

Take some salt and stir it into some water in a beaker. It (*dissolve*) readily. Now do the same with some chalk. Very little (*dissolve*). It (*observe*) that chalk is less soluble than salt; chalk can be said to be relatively insoluble.

Continue to add salt to the salt solution, stirring continually. A point (*reach*) where the salt fails to dissolve. When no more salt (*dissolve*) in the water, the solution is said to be **saturated**. It (*notice*) that adding more salt (*result in*) the salt being deposited as a sediment at the bottom of the beaker.

Consider what (*happen*) if a saturated solution is boiled. As the solution is heated, more salt (*dissolve*) until the boiling point is reached, and the solution is again saturated. Boiling (*cause*) the water to evaporate, and therefore the volume of the water (*reduce*). The salt, however, (*remain*) in the solution, so that the same amount of salt (*be*) present in a smaller volume of water. The smaller volume of water (*not able*) to hold all the salt in solution, so salt (*begin*) to appear as a solid.

When a substance is deposited as a solid while a solution is being heated, it is said to **crystallize out**.

B In the previous two passages, the two expressions *despite* and *fail to* have been used. For example, *Despite vigorous stirring, the sand particles have failed to disperse in the same way.* This can be also written: *The liquid was stirred vigorously, but the sand has not dissolved.*

Instead of *despite* we can say *in spite of*. Now look at the following descriptions of actions, and make statements about them using *despite* or *in spite of* and *fail to*. For example,

A powdered solid is stirred into a liquid, but although it is vigorously stirred and heated, it will not dissolve.

In spite of/Despite being vigorously stirred and heated, the powdered solid failed to dissolve.

- 1 A solid is heated to a high temperature, but it will not melt.
- 2 Two chemicals are heated together. However, no reaction is observed.
- 3 A gas is cooled to a very low temperature. However, it does not liquefy.
- 4 A liquid is cooled to 0°C, but it does not freeze.
- 5 A gas is compressed to a very high pressure, but it does not explode.
- 6 A magnet is brought near to some metal objects, but it does not attract them.
- 7 A wire has a high current passed along it, but it does not melt.
- 8 A lamp is connected to an electric cell, but it does not light up.

C Look at the use of the words *keep*, *remain*, *leave* and *continue* in these examples. They are all words you have met before in this course, and it is

important not to confuse them. They are all used in different ways:

Particles of the dispersed solid will remain visible in the liquid.

Even though the solution is left to stand for a long time, no particles will be visible.

Stirring is continued until all the salt has dissolved.

Throughout the experiment the pressure of the gas must be kept constant.

Now insert the correct word in each of the following sentences:

- 1 The solid was heated to a high temperature, but it _____ solid and did not liquefy.
- 2 The temperature of the substance was _____ constant for a length of time.
- 3 Heating was _____ until the metal changed colour.
- 4 The solution was _____ for a long period of time without any effect being noticed.
- 5 When the mixture reached a certain temperature, it was _____ to cool slowly.
- 6 When the solution was heated, all the water evaporated but solid crystals _____ in the bottom of the dish.
- 7 When the temperature of the liquid reached 0°C, cooling was _____ for some time until a change of state took place.
- 8 The temperature of the liquid was _____ at boiling point for as long as possible so that all the liquid evaporated.
- 9 The substance was allowed to _____ in the acid until it began to react.
- 10 When salt began to dissolve in the water, the experiment was _____ until the solution became saturated.

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- 11 During the experiment, the current through the coil was _____ as low as possible.
- 12 After being stirred, the suspension was _____ until all the solid particles settled at the bottom of the beaker.

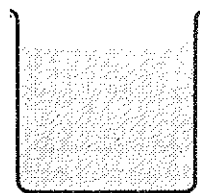
D During this course, you have met words like: *insoluble, impermeable, unlike*. These words are the opposites of *soluble, permeable* and *like*, and they are formed by means of the prefixes *in-*, *im-* and *un-*.

Here is a list of words which can be formed into their opposites with these prefixes. Arrange them into columns according to their prefixes.

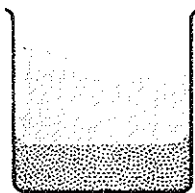
likely	certain	possible	true
valid	exact	pure	perfect
equal	usual	correct	common
visible	practical	suitable	appropriate
direct	usable	able	active
stable	convenient	plausible	accurate
complete	reasonable	significant	known
even	satisfactory	favourable	mistakable
contaminated	identified	sufficient	

SECTION 2 stating results

A Here are two beakers. Water and salt have been stirred together vigorously in beaker A, whilst water and sand have been similarly mixed in beaker B.



beaker (A)



beaker (B)

Answer these questions:

- What do you observe from the diagrams?
- What has happened: (a) to the salt in beaker A? (b) to the sand in beaker B?
- What is the difference between the liquids in the two beakers?

Your answers to question 2 should start:

The salt **has** ...

The sand **has** ...

We use this tense to state what **has happened recently**.

B State what **has happened** during the course of an experiment, using this table:

1 The solid and the acid	has have	reacted together, occurred, appeared in the liquid, turned lime water cloudy, not required heat, not given off any smell.
2 An effervescence		
3 Bubbles of gas		
4 The gas		
5 The reaction		
6 The products of the reaction		

From these observations of results, we can clearly conclude:

Carbon dioxide **has been** produced.

C Here is a series of experimental situations. Say what has happened and what has been caused or produced. For example,

gas tested with lime water

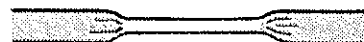
lime water turned cloudy
carbon dioxide produced during experiment

The gas has been tested with lime water. The lime water has turned cloudy, therefore carbon dioxide has been produced during the experiment.

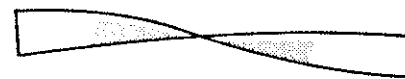
- 1 red litmus paper dampened, held over test-tube
litmus turned blue
ammonia given off during experiment
- 2 current passed through wire
wire become hot
heating effect produced
- 3 two powdered solids stirred into liquid
solids dissolved completely
solution formed
- 4 gas produced as a result of reaction
gas caused glowing splint to catch fire
oxygen given off
- 5 solution left in cylinder separated from beaker of
water by membrane
solution risen up cylinder
force caused water to pass through membrane
- 6 tensile force applied to wire
wire become permanently stretched
elastic limit exceeded
- 7 metal block heated
block become larger
expansion taken place
- 8 magnet suspended freely
second magnet caused suspended magnet to
swing away from it
repulsion taken place

D Say what has happened to these objects. There is sometimes more than one possible answer. For example,

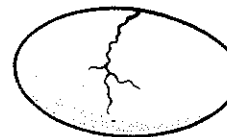
- 1 It's been stretched.



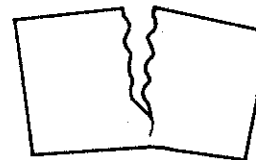
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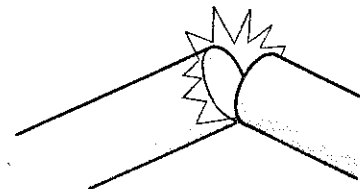
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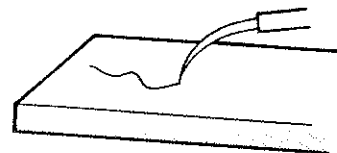
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7



8



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E Very often, it is necessary to use a variety of tenses when describing and discussing something—for example, when outlining the procedure for an experiment and stating what will be observed. You will notice this in the following passage. Read the paragraphs carefully, and answer the questions which follow each one.

Add a quantity of copper sulphate crystals to some cold water in a beaker. Stir the water until all the crystals have dissolved. Continue to add crystals, still stirring the solution, until no more will dissolve and solid crystals are seen to float in the solution.

- 1 What has happened to the solution?
- 2 Why won't any more copper sulphate crystals dissolve?
- 3 What will happen if the stirring is stopped and the solution left to stand?

Now heat the solution gently. It will be noticed that the excess copper sulphate begins to dissolve. Continue heating gently until all the crystals have dissolved, and then begin to add more crystals. It should be possible to dissolve quite a lot more copper sulphate in the heated solution. Without letting the liquid boil, continue to dissolve copper sulphate in the solution until it has absorbed as much as possible.

- 4 What has this procedure demonstrated?

Now allow the solution to cool. As it cools, the solution will be less able to maintain such a high concentration, so that copper sulphate crystals will again begin to appear in the solution. The cooler the solution becomes, the more crystals will appear. When the solution has reached room temperature, there will be a quantity of solid crystals and the solution is saturated.

- 5 Why will more crystals appear as the solution cools?
- 6 What will be the situation when the solution has reached room temperature?

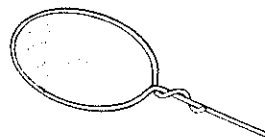
F Complete this passage using the verbs in brackets in appropriate tenses.

Add a moderate quantity of salt to a beaker of water and stir the mixture vigorously until all the salt (*dissolve*). Continue to add salt, still stirring the solution, until no more (*dissolve*) and a deposit of salt (*observe*) in the bottom of the beaker. Heat the solution (which is now saturated) gently. It (*notice*) that the excess salt begins to dissolve. Continue heating gently until all the salt (*dissolve*). Consider what (*demonstrate*) by this procedure. Now transfer the solution to an evaporating dish and heat it more strongly until it (*boil*). After a while it (*observe*) that the liquid level (*reduce*) as the water (*evaporate*), but at the same time salt (*begin*) to appear in solid form. Consider what (*cause*) salt to appear as the water (*evaporate*). Continue to boil the solution until all the water (*evaporate*).

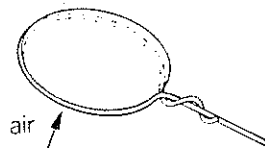
Attempt to deduce from the above discussion of solutions what will cause the solid salt to appear when a saturated solution of salt is boiled.

SECTION 3 describing and accounting for a phenomenon

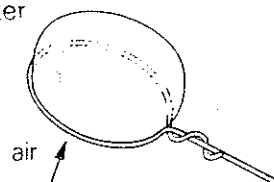
A Study this account of a common phenomenon carefully:



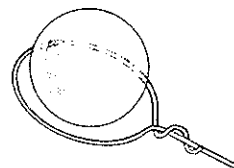
1 Consider what happens when a soap bubble is produced from a thin film of soap on a wire ring. The ring is first dipped into a soap solution so as to form the soap film.



2 Air is then blown gently onto the surface of the film so that it begins to distend. Clearly at this point the film is stretching, since its surface area is becoming greater



3 As air continues to be blown into the film, the film begins to take on a bulbous shape, with the top part becoming almost spherical, while the lower part of the film continues to adhere to the ring.



4 Finally, the soap film forms a perfectly spherical 'bubble' and leaves the ring.

Obviously, since the force of the air acts on the soap film, the film itself must present some kind of a force to oppose it. If the blowing is stopped before the bubble has reached its ultimate spherical shape, the film will return to its original planar form across the surface of the ring. Similarly, if too great a force of air is applied, the film will not be able to withstand it, and the film will 'burst'. It is only when the bubble is a completely sealed sphere, with no outlet for the air inside it, that it will remain stable and float freely away. Again, it will only remain a bubble as long as the surface of the film is intact. As soon as the 'skin' of soap film is pricked or otherwise punctured, the bubble will burst, due to the unequal pressures within and outside it.

From these results it is clear that there is a force exerted by the film of liquid, and that this force tries to resist any opposing force. The film will only remain 'stretched' as long as there is an excess of pressure inside a complete bubble which keeps the surface in a state of tension.

This phenomenon is known as **surface tension**. As the film is stretched, the molecules in it are pulled further apart, but they will always try to resist this change. They can only be kept apart by a continual force, and once this force is removed they will return to their original state.

All liquids exhibit surface tension, and the force may be measured by experimental means.

Now answer these questions relating to the account you have just read:

- 1 Give an account in your own words of the formation of a soap bubble from a film of soap on a ring.
- 2 What effects make it clear that some kind of force exists in the film of soap solution?
- 3 When will the soap film become a stable bubble?

unit 10
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section 3

- 4 What events will cause the bubble to collapse?
- 5 Why will the bubble collapse in such cases?
- 6 What can be concluded from these observations?
- 7 What is this phenomenon known as, and what are the physical causes for it?
- 8 Is soap film unique in exhibiting this phenomenon?
- 9 Is it possible to measure this force quantitatively?
- 10 Why do you think a soap solution has been chosen to illustrate this phenomenon? From your own experience, do you think the same results could have been demonstrated with pure water and if not, why not?

B It has been stated that the force exerted by the surface tension of a liquid may be determined experimentally. This may be done by means of a Du

Noüy tensiometer, a simplified diagram of which is shown below:

Describe the main features of the apparatus from the diagram. State what it consists of and how it is constructed.

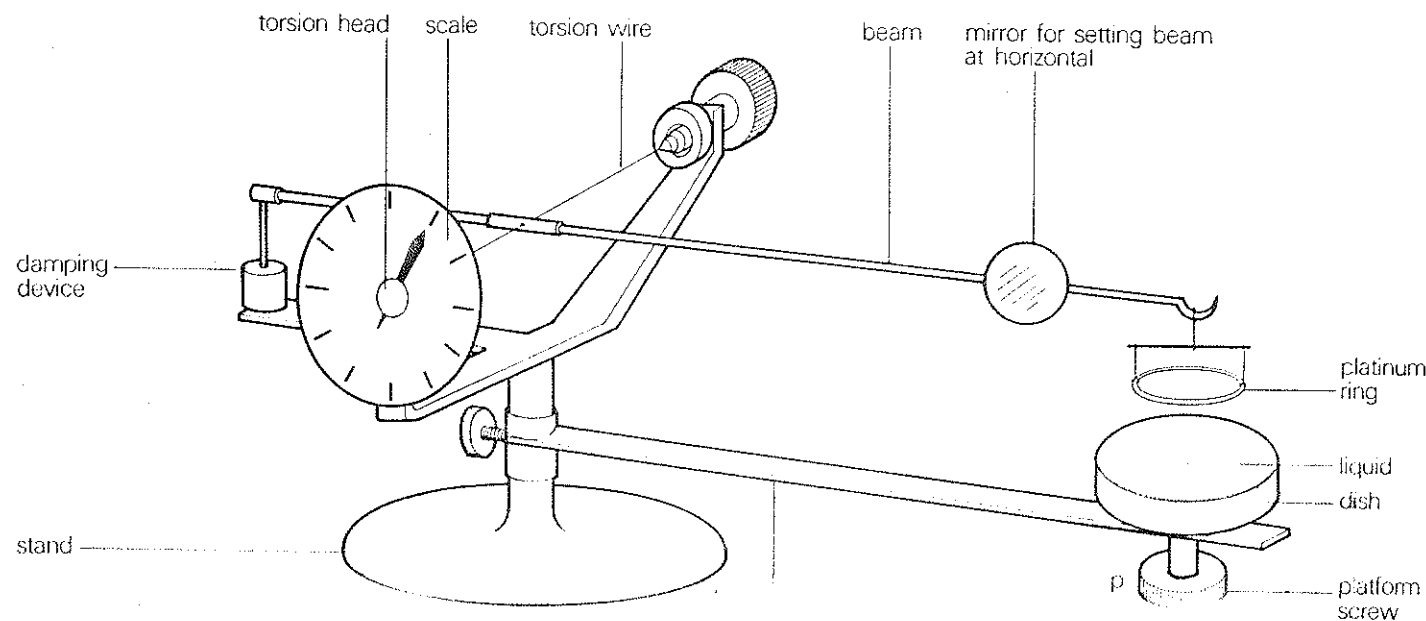
These expressions may help you:

joined
 connected } to supported by
 attached } pivoted about suspended from

The aim of the experiment is to measure the maximum force ($W_0 N$) which the surface tension of water ($\gamma \text{ Nm}^{-1}$) can exert on a wire ring as it is withdrawn from the surface of the water.

Theory

The ring has a radius of $R \text{ cm}$, and the radius of the wire of which it is made ($r \text{ cm}$) is such that $R \gg r$. The plane of the ring is horizontal to within $\pm 1^\circ$, and at the beginning of the experiment it coincides with



the surface of the water. The ring must be actually in contact with the surface of the water at this initial stage.

As the ring is allowed to rise, surface tension will cause a column of water to be suspended from it. If the suspended column of water were cylindrical in shape, the maximum mass (m_0g) of water which could be supported by the ring would be related to surface tension by the expression:

$$W_0 = m_0g = 4\pi R\gamma \quad (1)$$

(where g is the acceleration due to gravity)

The expression $4\pi R\gamma$ on the right-hand side of the equation is due to the fact that surface tension would act on the surface of the ring ($2\pi R$) but that the wire is in effect two-sided so this value must be doubled.

In actual fact, the column of water supported by the ring is much more complex in shape, and a factor of F must be introduced into the equation in order to account for this. This factor has been predetermined, and may be obtained from tables.

The equation then becomes:

$$\gamma = \frac{W_0}{4\pi R} F \quad (2)$$

Method

The experiment should be carried out in the following way. The torsion wire should be checked to ensure that it is taut, and the ring examined to ensure it is not buckled. The plane of the suspended ring may be checked to see that it is horizontal by examining it in relation to its reflection in the water as it is lowered towards the surface of the water.

Before beginning the experiment, the tensiometer dish and the platinum ring must be thoroughly cleaned by soaking in chromic acid, so that they are both completely wetted by the water. If they are not absolutely clean, then complete wetting will not take place.

The dish and ring should then be thoroughly rinsed with water, and excess water removed from the ring by means of a filter paper. The dish should then be placed on its platform, and should contain at least 1 cm depth of water. When the platform has been raised as far as possible by means of the knob P, the level of the arm should be raised so that the ring is about 0.5 cm below the surface of the water.

Now the torsion head should be set to zero and the beam accurately brought into the horizontal position by adjusting knob Z. The torsion head is then rotated until the ring meets the surface of the water. The beam is then returned to the horizontal by lowering the platform (by means of knob P).

At this point, T and P should be rotated simultaneously as smoothly as possible so as to maintain the horizontal position of the beam. As soon as the critical setting of T has been reached, the column of water suspended from the ring will break, and the end of the beam will jump upwards. As this critical value is closely approached the ring should be withdrawn very gradually. The setting of the torsion head scale should be read.

The procedure should now be repeated, without any water being placed in the dish. Weights are suspended from the beam instead of the platinum ring. The value of the weights is adjusted until the setting of the torsion head scale is exactly the same as when the experiment was carried out using the water. The value of the weights is then read, and this value is substituted as M_0 in equation (1).

The procedure should be repeated several times and the temperature at which the experiments were carried out should be noted. The values of the results for the repeated experiments should be compared.

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C Activities

- 1 Read the section on **theory** aloud. Make sure you can read all the formulae and abbreviations correctly.
- 2 Answer these questions on the **theory**:
 - (a) What will happen as the ring rises from the surface of the water?
 - (b) What shape is the column of water supported by the ring?
 - (c) Why is the factor F introduced into the equation?
- 3 Answer these questions about the **method**:
 - (a) How is the plane of the suspended ring checked?
 - (b) How are the ring and dish cleaned before the experiment?
 - (c) Why must the ring and dish be cleaned thoroughly?
 - (d) What should be done when the platform (P) has been raised as far as possible?
 - (e) What is done when the ring has just come into contact with the surface of the liquid?
 - (f) What will happen as soon as the critical value of T has been reached?

- 4 Look at the use of the words *approach* and *reach* in these two sentences:
 The knobs should be turned carefully as the critical value of T is approached.
 The beam will jump up when the critical value has been reached.

Complete these sentences with the appropriate form of either *approach* or *reach*:

- (a) At 'standard' atmospheric pressure, pure water boils when the temperature _____ 100°C .
- (b) The north pole of a suspended magnet will be repelled as another north pole _____ it.
- (c) Crystals began to appear in the liquid when the saturation point _____.
- (d) The liquid was not allowed to freeze, but observations were made as the freezing point _____.
- (e) As the melting point _____, the solid began to change colour before it actually liquefied.

exercises

exercise 1 Write out these passages with words which have the prefix *in-*, *im-* or *un-* instead of the words in brackets. Do not refer back to your classwork while doing this exercise.

1 When carrying out any experiment involving chemicals it is important to ensure that the chemicals used are (*not contaminated*). Chemicals which are (*not pure*) may be (*not stable*) or (*not active*), so that they are in fact (*not usable*). If the experimenter is (*not able*) to use fresh, pure chemicals, he may find that it is (*not possible*) to perform the experiment, or that the results are (*not satisfactory*).

2 In any experiment, the accuracy with which measurements are made is vital. (*not accurate*) or (*not complete*) measurements are likely to make the whole experiment (*not valid*), since (*not exact*) measurements are (*not likely*) to produce a satisfactory set of results.

3 Sometimes during an experiment an (*not known*) gas is given off. If the experimenter is (*not certain*) about the nature of a gas he should be extremely careful when testing it. However, it is (*not usual*) for a gas such as hydrogen sulphide or ammonia to be (*not identified*), as the smell of these gases is (*not mistakable*.)

exercise 2 Write out this text, saying either what **will happen** or what **has happened**, using the verbs given in brackets.

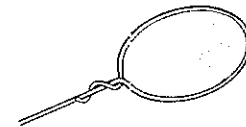
Place some naphthalene in a test-tube and allow the tube to remain in a container of boiling water until all of the solid (*melt*). When all of the naphthalene (*liquefy*), allow it to cool, stirring it continually and taking regular measurements of the temperature. As it cools, the naphthalene (*solidify*). When it (*completely solidify*), the thermometer (*be*) 'stuck' in the solid mass. It (*then be possible*) to

repeat the experiment, taking measurements of temperature while the naphthalene is being heated in order to obtain similar results for the melting of the solid. When the results of the experiment for both melting and solidifying (*plot*) on a graph, the cooling and melting curves (*both/show*). It (*be apparent*) from the curves that energy (*require*) for the melting and cooling stages.

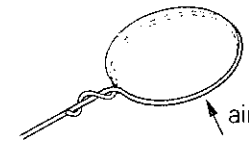
exercise 3 Using these diagrams, state what **has happened** at each of these stages in the formation of a soap bubble. For example,

ring/dip/soap solution

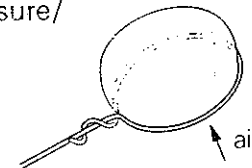
The ring has been dipped in soap solution.



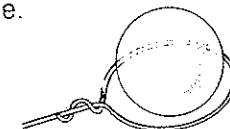
1 ring/dip/soap solution.
film/soap/form/across/ring.



2 air/blow/gently/onto/surface/film.
film/stretch/into/rounded shape/due to/pressure/air.



3 more air/blow/into/film.
film/stretch/further/and take on/bulbous shape.
not yet/separate/itself/ring.



4 film/sealed/itself/into/sphere.
it/completely/enclose/air inside/and/float/away from/wire ring.
5 surface tension/in/film/allow/it/to stretch.
it/then/enclose/air/within it/and/form/bubble.

drills

unit 10 drills drill 1

drill 1

Will the solid remain in suspension even if it is stirred vigorously?

Yes, it will remain in suspension no matter how vigorously it is stirred.

Will the substance remain in solution even if it is left standing for a long time?

Yes, it will remain in solution no matter how long it is left standing.

drill 2

Did the water remain liquid even though heat was lost?

Yes, it remained liquid despite the loss of heat.

Did the temperature continue to rise even though there was a lack of heat?

Yes, it continued to rise despite the lack of heat.

drill 3

How do you know that carbon dioxide is present?
Because the lime water has turned cloudy.

How can you be sure that ammonia has been produced?

Because damp red litmus paper has turned blue.

Now you answer the questions, using the notes to help you. You will need to study the notes before you do the drill.

the colour of the metal—blue

both solids—liquid

the lime water—cloudy

blue litmus paper—red

red litmus paper—blue

white crystals—blue

photographic paper—black

the liquid—solid

drill 4 Answer these questions, using *completely* instead of *all* wherever you can.

Has all of the solid dissolved in the liquid?

Yes, it has completely dissolved.

Have all of the results been collected?

Yes, they have all been collected.

drill 5

Is it possible to manufacture gold from other metals?

No, it's quite impossible.

Is it likely these chemicals will react?

No, it's highly unlikely.

Include these words in your answers:

1 quite	5 fairly	9 completely
2 highly	6 quite	10 highly
3 extremely	7 very	11 quite
4 rather	8 extremely	12 absolutely

drill 6 Air is being blown into a film of soap solution to produce a bubble. Answer the questions, using the notes to help you.

part 1

Will the film of liquid form with any liquid?

No, it will only form if the liquid has a low surface tension.

- 1 liquid—low surface tension
- 2 air—blown into it
- 3 air—blown into it gently
- 4 air—blown into it

part 2

Will the bubble continue to grow without air being blown into it?

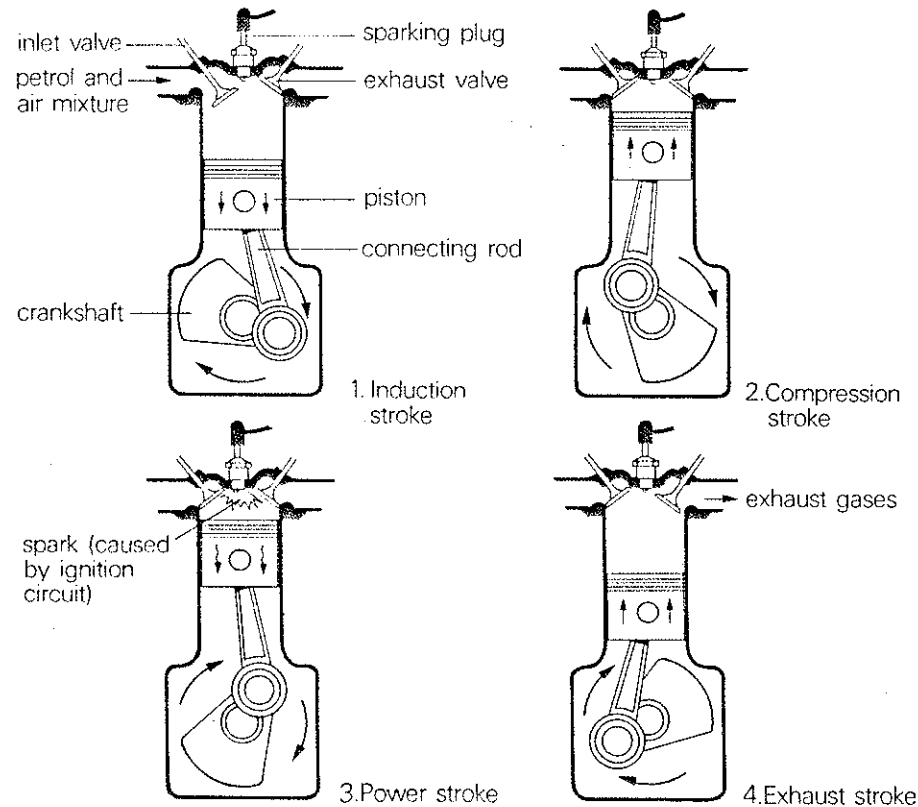
No, it will only continue to grow as long as air is blown into it.

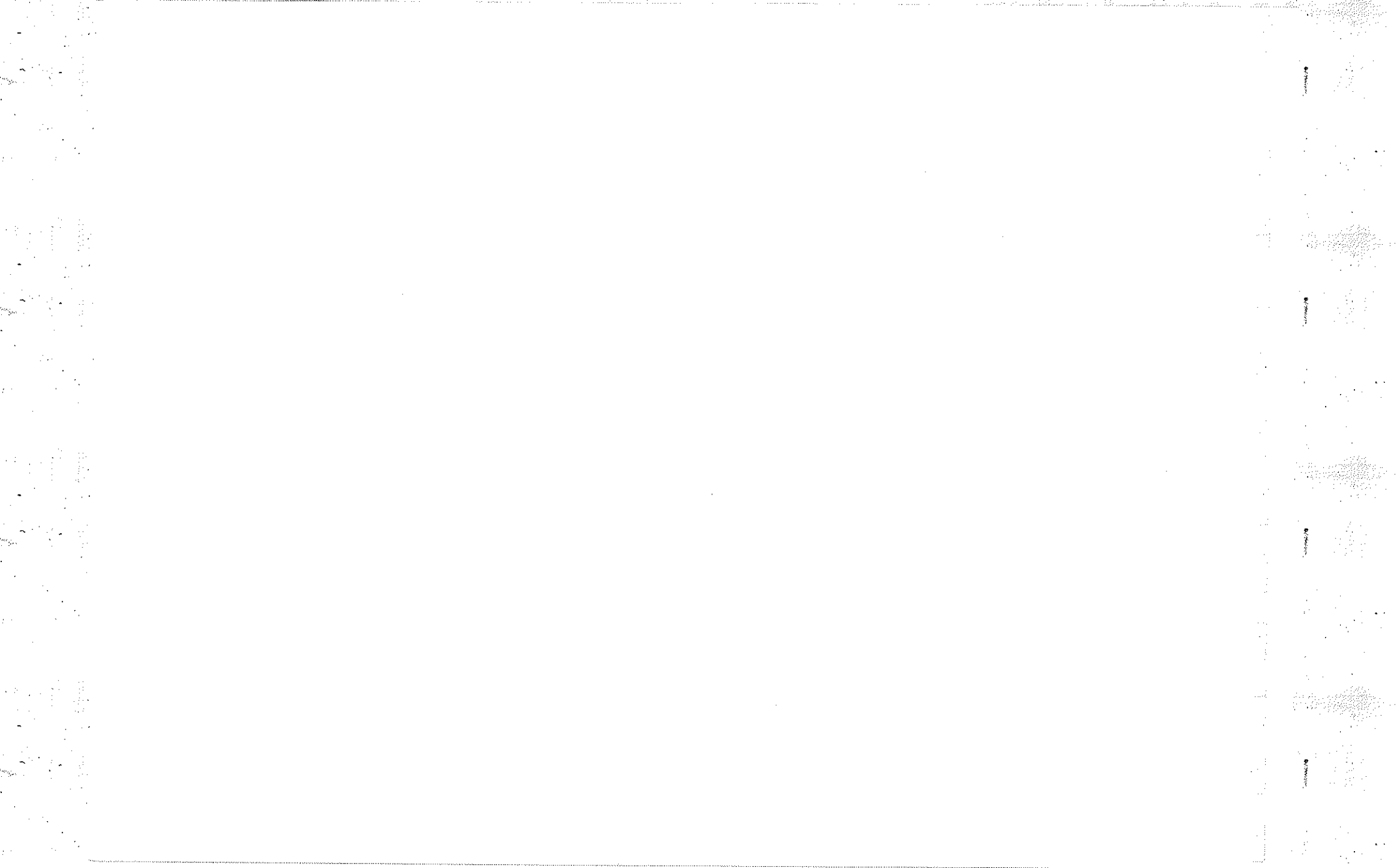
- 1 air—blown into it
- 2 film—stay intact
- 3 a force—applied to film
- 4 pressure inside—greater than pressure outside

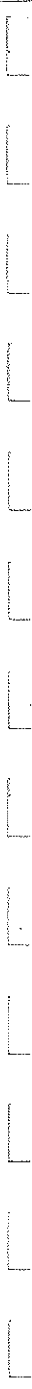
Below is a series of four diagrams illustrating the sequence of operation of a four-stroke engine. Use them to build up a description of this sequence. You will need to use a variety of tenses, but in particular you should use the present perfect tense. For example,

In Figure 1, the piston has begun to move downwards and the inlet valve has opened. This allows the petrol and air mixture to be drawn into the cylinder.

Describe each stage of the sequence as fully as possible.



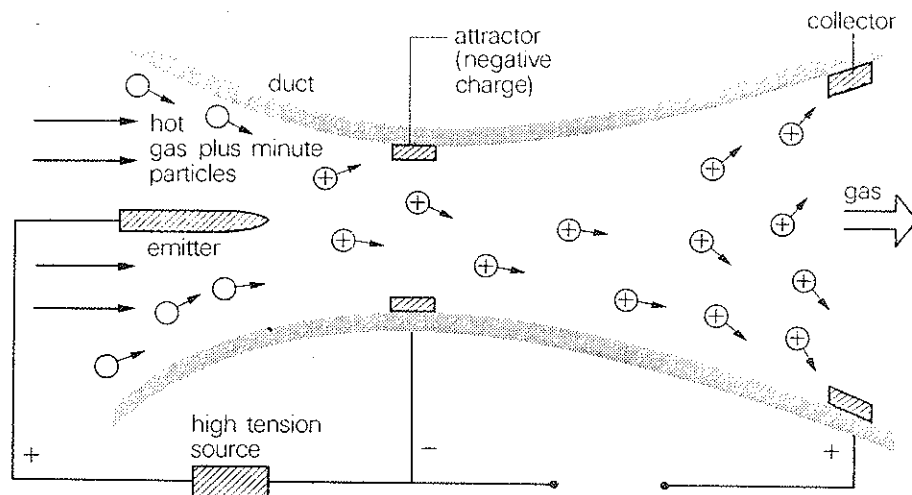




unit 11
classwork
section 1

SECTION 1 understanding an explanation

A Here is a description of a technique which has been suggested for generating electrical power. Study the passage carefully, and then answer the questions following it. When you have done that, you will be asked to give an account of the process in your own words.



The device used in this technique is known as an EFD generator, which consists of a duct with an electrically-charged emitter, attractor and collector. Hot gas under pressure enters the duct at the emitter end. The gas contains minute (very small) particles of dust which collect electric charges as the gas carries them past the emitter. In this example, the charges are positive, and so the attractor electrode must be made negative. This

polarity is determined by the connection of a high voltage across these two electrodes. If the charged particles were not carried along at high speed by the force of the gas, they would all be drawn towards the attractor. However, because of their forward velocity most of them pass this electrode and reach the collector, where they give up their charges to the external circuit. This transfer of electric charges to the external circuit results in a flow of current in that circuit. Current is therefore generated as a result of this process.

Although most of the particles are not collected by the attractor, they are attracted by this negative voltage, and some are repelled by the positive voltage of the collector. This positive charge is due to the positive charges of the particles which have reached it. This results in an electric field being set up in the duct between the collector and the emitter which tends to push the particles back *against* the flow of the gas. The gas must therefore do work in order to overcome this electrostatic force. As a result it loses both heat and speed, and this loss of energy is converted into electrical energy at the output terminals in the form of an electric current.

A small fraction of this output current is used to provide the high voltage source across the emitter and attractor, unless this source is supplied separately.

B Now choose the correct phrase to complete the sentence in each of these statements:

- 1 This device is designed to
 - (a) heat gas.
 - (b) produce hot gas under pressure.
 - (c) generate electricity.
- 2 A high voltage charge is applied externally across

- (a) the emitter and attractor.
 - (b) the attractor and collector.
 - (c) the emitter and collector.
- 3 The gas is forced through the duct
 - (a) from the collector to the emitter.
 - (b) from the emitter to the collector.
 - (c) from the emitter to the attractor.
 - 4 The gas contains minute particles which
 - (a) already have an electric charge.
 - (b) become charged at the attractor.
 - (c) become charged at the emitter.
 - 5 The polarity of the charged particles is determined by
 - (a) the connections of the external circuit.
 - (b) the speed of the gas.
 - (c) the type of particles in the gas.
 - 6 If the speed of the gas wasn't high enough, the particles
 - (a) would not become charged.
 - (b) would not reach the collector.
 - (c) would not pass the emitter.
 - 7 When the particles reach the collector, they
 - (a) become charged.
 - (b) begin to travel back to the attractor.
 - (c) give up their charges.
 - 8 The attractor
 - (a) has no effect on the charged particles.
 - (b) attracts all the charged particles.
 - (c) attracts most of the charged particles.
 - 9 At the collector,
 - (a) some of the charged particles are repelled.
 - (b) all of the charged particles are repelled.
 - (c) none of the charged particles are repelled.
 - 10 Because some of the particles drift back towards the emitter,
 - (a) the gas is prevented from flowing.
 - (b) they become negatively charged.
 - (c) the gas loses energy.

C Now use these notes to describe *in your own words* how the EFD generator functions.

duct—emitter, attractor, collector
 high voltage—emitter/attractor
 emitter positive, attractor negative
 hot pressurized gas—emitter end of duct
 gas—minute dust particles
 particles—charged at emitter
 force of gas—charged particles towards collector
 charges—current to external circuit
 electrical field—between emitter and collector
 particles—against gas flow
 gas does work—particles
 gas—loses energy
 heat energy—electrical energy

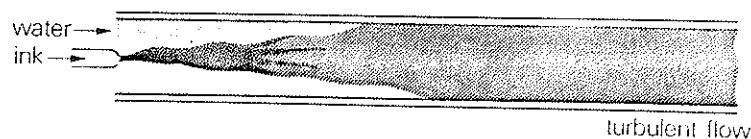
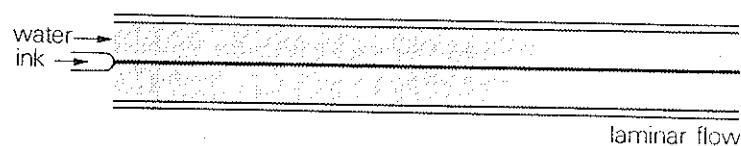
D Read this explanation carefully, and when you have understood the principle involved, complete the exercise which follows it.

When a liquid travels along a tube, it may do so in either of two ways. It may travel by means of **laminar flow** or **turbulent flow**. These two forms of flow can be demonstrated by an experiment in which a very fine stream of coloured ink is injected into a tube of water. When the pressure of this jet of ink is at the correct level, the ink will form a uniform stream which passes through the water without mixing with it. It remains a separate layer, or **lamina** of liquid—hence the term **laminar flow**—and the force of the liquid is used to push it forward through the water. None of the force is used to push the liquid sideways into the water. However, if the pressure of the flow of ink is increased beyond a certain value, the ink will mix with the water as soon as it enters the tube. Much of the force of the liquid is in this case used in side-to-side movement in mixing with the water

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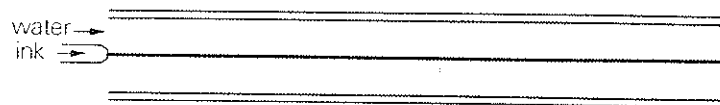
and striking the sides of the tube. The ink becomes thoroughly mixed with the water, and in this case the flow is known as **turbulent flow**. Various factors will determine whether the flow of liquid through a tube will be turbulent or laminar. As will be seen if the pressure of the ink is increased as it enters the water, the greater the force of the liquid, the more likely turbulence is to occur. If the experiment is carried out with tubes of different diameter while the pressure of the liquid is kept constant, it will be seen that the diameter of the tube has an effect on whether laminar or turbulent flow takes place.

It will be found that turbulent flow is more likely to occur as the tube becomes narrower. Thirdly, if the diameter of the tube is irregular, or if the tube is bent, turbulent flow is more likely to occur than in a uniform diameter tube.

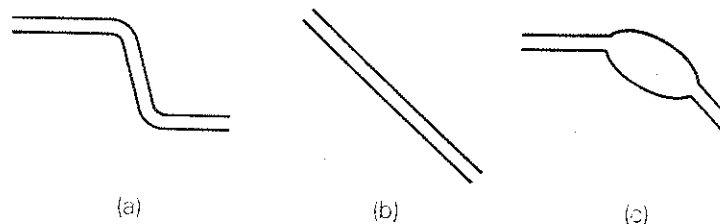


E Answer these questions:

- 1 In the case below, what is likely to happen if the diameter of the tube is:
 - (a) reduced?
 - (b) increased?



- 2 In the above diagram, what is likely to happen if the pressure of the flow of ink is:
 - (a) increased?
 - (b) decreased?
- 3 How many different factors can influence whether the flow of liquid in a tube is laminar or turbulent?
- 4 Which of these tubes is more likely to give rise to turbulent flow?

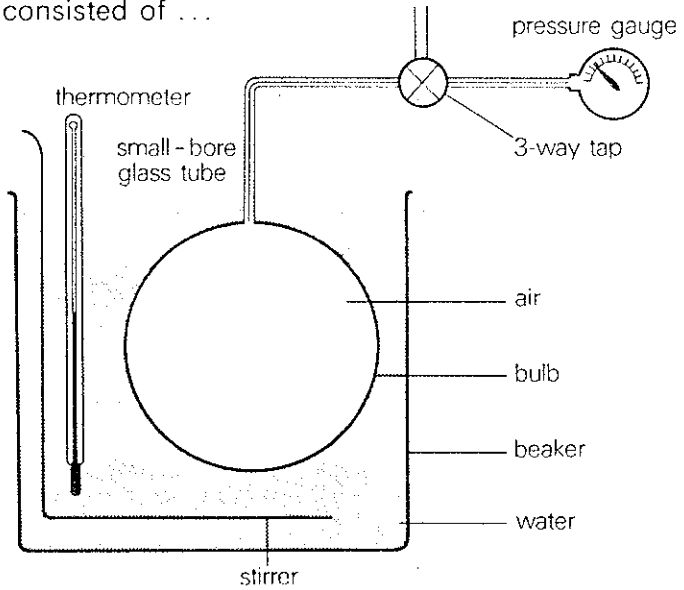


- 5 Which of the following statements is incorrect:
 - (a) The higher the rate of flow of liquid, the greater the risk of turbulence.
 - (b) The lower the rate of flow of liquid, the greater the risk of turbulence.
 - (c) The narrower the tube, the greater the risk of turbulence.
 - (d) The more uniform the tube, the less the risk of turbulence.
- 6 What does the force of the liquid do when the flow is:
 - (a) laminar?

SECTION 2 **describing apparatus and an experiment**

A Describe this piece of apparatus in as much detail as you can. Put your description in the past tense by beginning:

The apparatus used in the experiment consisted of ...



B Now write a report of the method used for the experiment, as if it was carried out last week. The aim of the experiment was to investigate the relationship between the pressure and temperature of a gas. Again, you should **report** the procedure in the past tense. Use these notes to help you:

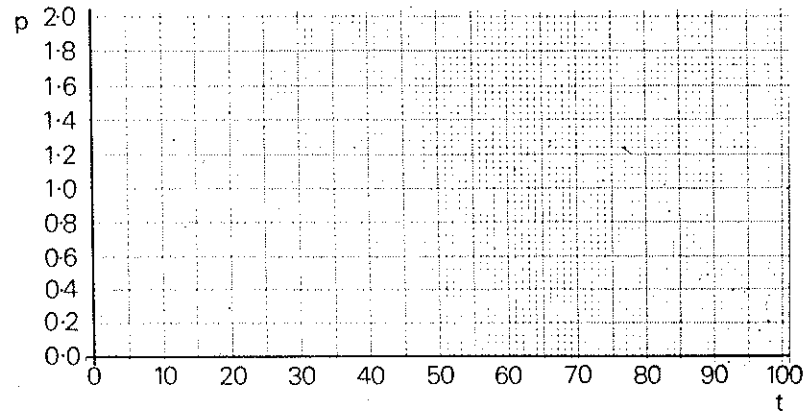
apparatus/set up/describe above
flask/large volume/use/so as to/minimize/effect of/
unheated air/in/connecting tube/and/pressure
gauge
pressure/indicated/pressure gauge/note

temperature/water/record
water/heat
readings/temperature/pressure/take/regular intervals/
throughout/experiment
values/temperature/corresponding/values/pressure/
record/table
water/stir/vigorously/throughout/experiment
since/temperature/water/could not/raise/above
100°C/experiment/stop/when/water/boil
graph/pressure against temperature/plot/from/results

C Here is a table in which you can enter the results of the experiment in **B** as they are dictated by your teacher.

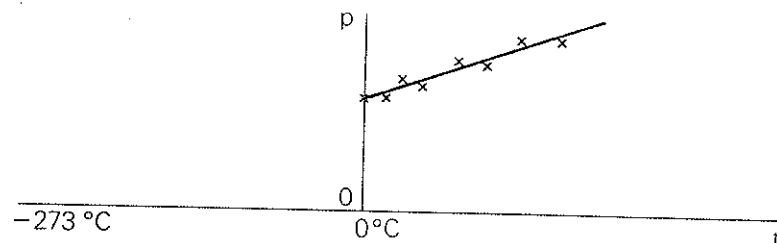
Pressure (p) $\text{Nm}^{-2} (\times 10^5)$									
Temp (t) °C									

Plot the results on the graph below, and then answer the questions.



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- 1 What sort of graph is this?
- 2 What relationship does it show?
- 3 What can therefore be deduced about the relationship between the pressure and temperature of a fixed mass of gas (in this case air), the volume of which is kept constant?
- 4 It can be stated that during the experiment, the gas e_____ due to the e_____ it absorbed from the heat.
- 5 What will happen if the graph below is extrapolated (extended) to the left?
- 6 What will the pressure of the gas be at -273°C ?



- 7 Complete this statement:
If/gas/cool/to -273°C /pressure/gas/would become/zero
- 8 Complete this statement:
Similar results/would/obtain/if/number of/different gases/investigate
- 9 Complete this statement of a law governing the properties of a gas:
The p_____ of a f_____ mass of gas at c_____ volume is d_____ p_____ to its t_____. At -273°C , the pressure becomes z_____.

- 10 Your teacher will read out two expressions of the law in 9 as formulae. Write them down.

The law can be written as:

... if t is the centigrade temperature.

or:

... = a constant value.

- D** Put the verbs in this passage into the appropriate tenses. The passage concerns the relationship between magnetic and electrical forces.

If a conductor is moved across a magnetic field, an electromotive force (e.m.f.) (*produce*) in the conductor. If the conductor (*form*) part of a closed electrical circuit, the e.m.f. (*cause*) an electric current to flow round the circuit. This effect (*known as*) **electromagnetic induction**, and the e.m.f. (*say/to be*) 'induced' in the conductor as a result of its motion across the magnetic field.

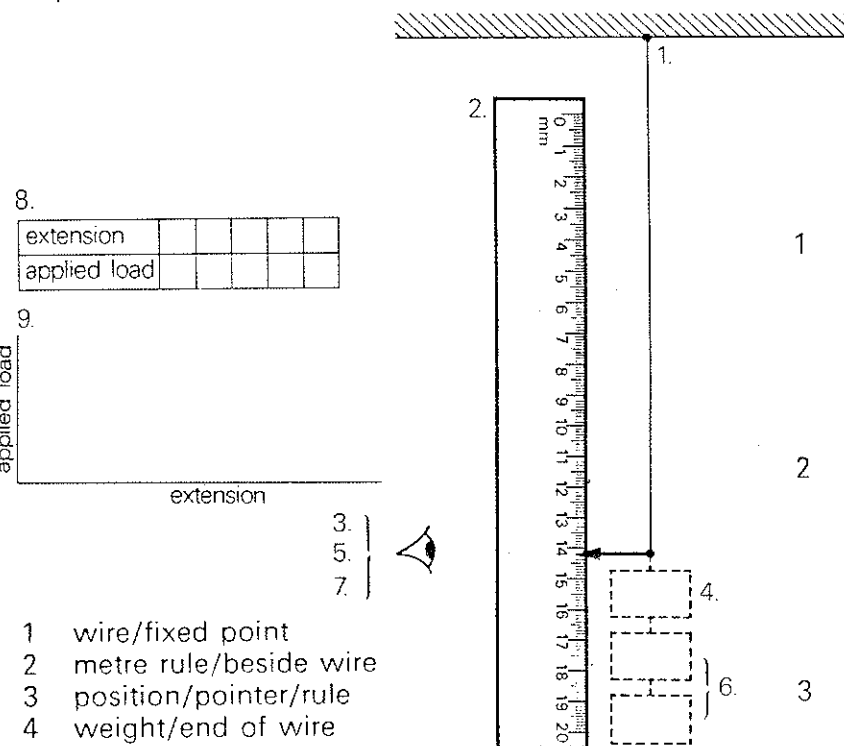
If the following simple experiment (*carry out*) the presence of an induced e.m.f. (*demonstrate*). If the two ends of a coil of wire (*connect*) to the terminals of a galvanometer, and a bar magnet (*bring*) towards the coil, a deflection (*observe*) on the galvanometer. As the magnet (*move*) away from the coil, a deflection in the opposite direction (*notice*). However, if the magnet (*hold*) stationary, no deflection (*notice*), no matter how near the magnet (*be*) to the coil.

Similarly, if the opposite pole of the magnet (*bring*) towards the coil, the galvanometer deflection (*be*) in the opposite direction. It (*find*) that the quicker the magnet (*move*) towards the coil, the greater the deflection (*be*).

If possible, the effects of using coils with different numbers of turns (*should/investigate*), as well as different magnet lengths.

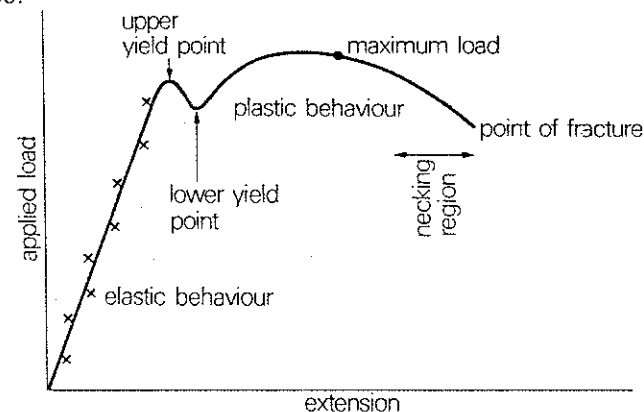
SECTION 3 giving instructions, interpreting results, describing attributes

A Below is a diagram of the apparatus used to investigate the behaviour of a material when an increasing force is applied to it. Using the diagram and the notes, write a series of instructions on how to carry out the experiment to investigate the properties of a metal wire. Use sequence words such as *first*, *next*, *then* etc.



- 1 wire/fixed point
- 2 metre rule/beside wire
- 3 position/pointer/rule
- 4 weight/end of wire
- 5 position/pointer/rule
- 6 more weights
- 7 position/pointer/rule
- 8 values/extension/load/table
- 9 tabulated results/graph

B Here is a graph drawn from a set of results of an experiment like the one you have written instructions for in **A**. Study the graph carefully and then do the exercises.



- 1 Which is the correct statement?
 - (a) The wire continued to extend uniformly throughout the experiment.
 - (b) The wire extended uniformly up to a certain point.
 - (c) The wire did not extend uniformly at all during the experiment.
- 2 Which is the correct statement?
 - (a) The upper yield point occurred at a higher load than the lower yield point.
 - (b) The upper yield point occurred at a lower load than the lower yield point.
 - (c) The lower yield point occurred before the upper yield point.
- 3 During the plastic behaviour,
 - (a) a very large load produced a fairly small extension.
 - (b) a fairly small load produced quite a large extension.
 - (c) a fairly small load produced a very small extension.

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- 4 After the maximum load was applied,
(a) the material continued to extend.
(b) the material ceased to extend.
(c) the material began to contract.
- 5 The 'necking region' occurs
(a) before the maximum load is applied.
(b) after the plastic behaviour.
(c) at the point of fracture.

C Complete these statements of the attributes of various substances, using appropriate adjectives (eg *strong*), nouns (eg *strength*) or verbs (eg *strengthen*).

1 Glass is a b_____ t_____ solid which usually has a s_____ surface. Although it is not usually very s_____, it can be t_____ in order to make it more r_____ so that it can be used, for instance, in car windscreens. However, in the liquid state, glass is extremely d_____ and can be formed into almost any shape. It only becomes b_____ when it h_____.

2 Copper is very ductile and malleable, and usually has a s_____ yellow-orange appearance. Its s_____ allows it to be formed into a variety of shapes, often without the need to heat it. However, where s_____ is necessary, it is often alloyed with other metals such as cadmium in order to s_____ it.

3 Polythene is an extremely r_____ material, and is often used where high s_____ combined with f_____ is required. It can be made either t_____, t_____ or o_____ according to whether it is required to see through it. Although usually very s_____, it does become much w_____ when heated, and will melt at relatively low temperatures.

4 Wood is a relatively w_____ substance, but its s_____ depends on its thickness and variety. Some wood is extremely p_____ when in the form of thin sheets, while other wood is extremely h_____ and s_____, particularly when it is old. It is an o_____ substance, and in its natural form its surface is rather r_____. although for most uses it is first s_____ before being used.

D Now make similar statements about the following metals, using the notes.

1 **Aluminium** ductile, light, very good electrical conductor, very good thermal conductor, very good corrosion resistance, soft, weak in pure state, mostly extracted from bauxite.

2 **Lead** heavy, grey, weak, soft, high corrosion resistance, mostly obtained from lead sulphide (PbS) called galena.

3 **Tin** expensive, weak, high corrosion resistance, mostly used as coating for other metals (*tinplate*), nearly always found as SnO_2 (cassiterite).
From the following notes, state what a **mineral** and an ore is.

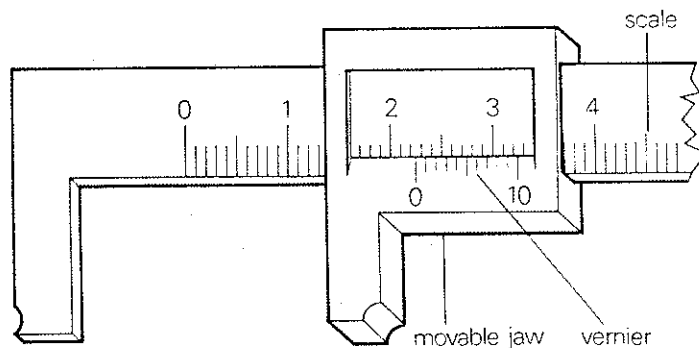
4 **Mineral** substance/occur/naturally/earth/often/contain/elements/compound form

5 **Ore** mineral/contain/metal/(sometimes non-metal—eg sulphur)/used/source/obtain/metal

E Using statements 4 and 5 from **D**, draw this diagram and insert the words *ore*, *metal*, *non-metal*, *mineral* in the appropriate places so as to show the relationship between them.



drill 1 You will hear a description of vernier calipers. Most of the text is written out below, but many of the words and figures are missing. Complete the text by listening to the description and supplying the missing words.



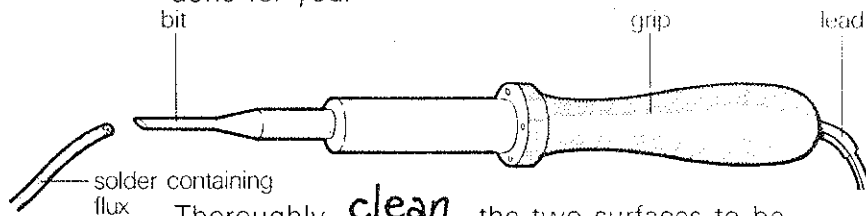
The diagram shows a _____ of vernier calipers, which can be used for the _____ of a _____. The specimen _____ between the jaws, and the movable jaw _____ until the specimen is just _____. The movable jaw carries a vernier which moves over the _____. The vernier is marked at _____ so that the fixed scale can be _____. The vernier has a length equal to _____ of each unit and is subdivided into _____.

drill 2 You will hear fifteen statements about the gases listed in the table below. Decide whether the statements are true or false. If a statement is correct, write down *true*; if it is incorrect, write down *false*.

Hydrogen	Oxygen	Carbon dioxide	Ammonia
inflammable	non-inflammable but supports combustion	non-inflammable	non-inflammable
odourless	odourless	odourless	strong odour
forms explosive mixture with air	will cause a glowing splint to light	will turn lime water cloudy	will turn damp red litmus paper blue
insoluble in water	slightly soluble in water	soluble in water	very soluble in water
lightest substance known	lighter than air	heavier than air	lighter than air
used in making ammonia	used in welding	used in fire extinguishers	used in explosives

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drill 3

drill 3 You will hear a passage describing how two components can be joined together by soldering. Below is a series of instructions for carrying out this operation, but the words of instruction are missing. As you listen to the description, complete the instructions with suitable verbs. The first one has been done for you.



Thoroughly clean the two surfaces to be soldered. _____ the soldering iron and _____ it to heat up. While it is heating up, _____ the bit of the iron. _____ this by melting a small amount of solder which contains flux over the bit. When the iron has reached its working temperature, _____ the two surfaces to be jointed with a small amount of solder and flux. Then _____ them in contact with each other and _____ the soldering iron against them; at the same time, _____ more solder to melt and flow over the join. Now _____ the iron and _____ the two components together for a few moments until the solder has hardened. _____ to speed up the cooling by blowing on the join. This may cause air bubbles to form in the join, and electrical and mechanical contact will therefore be poor.

drill 4 You will hear a passage about soldering and types of solder. It is divided into five parts, and after each part you will be asked to answer two questions. Either choose the correct answer from the alternatives or write out your answer, according to the type of question.

- 1 Soldering allows
 - (a) all metals
 - (b) some metals to be joined easily.
 - (c) copper
- 2 It is often used in electrical work
 - (a) for making components.
 - (b) instead of copper.
 - (c) to connect wires.
- 3 What qualities does good solder have?
- 4 Where should solder **not** be used?
- 5 The constituents of solder are
 - (a) tin and copper.
 - (b) tin and lead.
 - (c) tin and lead and another substance.
- 6 If there is a lot of tin in the solder, it will:
 - (a) have a high melting point.
 - (b) have a low melting point.
 - (c) be very strong.
- 7 Solder is
 - (a) always
 - (b) sometimes required to solidify slowly.
 - (c) never
- 8 What happens if the solder has a high lead content?
- 9 Why must the surfaces to be joined be perfectly clean?
- 10 What is the function of the 'flux'?

drill 5 Below is a table showing values for various properties of six metals. You will hear different types of questions about these metals and their properties, and you should try to answer these questions as precisely as possible.

What's the difference between the density of lead and the density of gold?

8.000 kilograms metres to the minus three.

activity

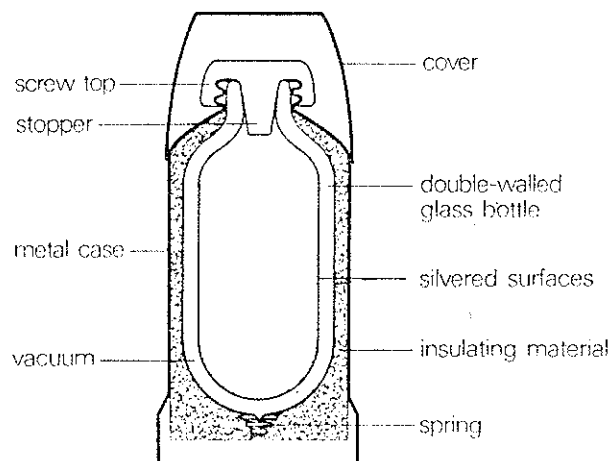
unit 11
activity

What does the figure of 96 kiloNewtons millimetres to the minus two represent?

The modulus of elasticity of copper.

Material	Modulus of elasticity (kN mm^{-2})	Density (kg m^{-3})	Coefficient of linear expansion ($\times 10^{-6} \text{ } ^\circ\text{C}^{-1}$)
Aluminium	70	2.700	23
Copper	96	8.900	17
Gold	79	19.300	14
Iron	205	7.830	12
Lead	15.7	11.300	29
Mercury	—	13.600	60

drill 6 Study the diagram of the vacuum flask below. As you probably know, this is a container which is designed to keep the temperature of its contents as constant as possible. When you have become familiar with the diagram, listen to the questions and answer them carefully.



Here are two graphs representing the demand for electricity from the mains supply in Great Britain. Study each of these graphs carefully, and then, taking each one in turn, attempt to account for the variations (or fluctuations) in the demand for electricity over a winter's day and a summer's day in Britain. Discuss the different possibilities with each other in your class. Try to deduce reasons for the low points (troughs) and the high points (peaks) in the graphs. If you cannot come to conclusions, suggest as many possible reasons for the fluctuations as you can think of (eg the time people get up/go to work, what winters are like/what summers are like in Britain).

