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0653/31

October/November 2014

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.

Write in dark blue or black pen.

You may use a soft pencil for any diagrams, graphs, tables or rough working.

Do not use staples, paper clips, glue or correction fluid.

DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.

Electronic calculators may be used.

You may lose marks if you do not show your working or if you do not use appropriate units.

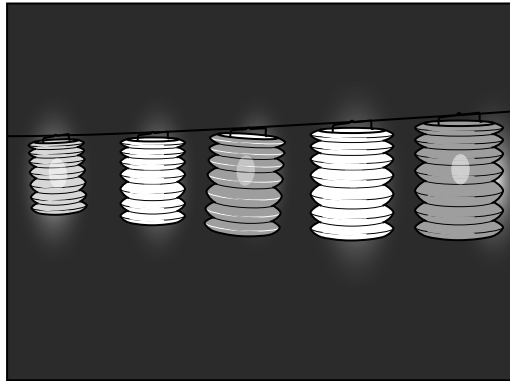
A copy of the Periodic Table is printed on page 24.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [] at the end of each question or part question.

This document consists of **21** printed pages and **3** blank pages.

- 1 Party lights add light and colour to festive occasions.



A set of party lights has a switch and a battery connected to five lamps in parallel.

The battery consists of four cells in series.

- (a) Draw the circuit diagram using standard circuit symbols for this set of party lights.

[2]

(b) The p.d. across the battery of four cells is 6V.

(i) Each lamp in the set is labelled 6V, 0.5A.

Find the current from the source required to light this set of lamps.

current from source = ... A [1]

(ii) Use your answer to (i) to calculate the total resistance of the set of lights.

State the formula that you use and show your working.

formula

working

total resistance = ... Ω [2]

(c) Most sets of party lights have lamps that are connected in parallel but some sets are connected in series.

State what happens to the set of lights if one lamp breaks when the lamps are connected in series,

.....

parallel.

.....[1]

- 2 Gasoline and petroleum jelly are products obtained from petroleum (crude oil) following fractional distillation at an oil refinery.

- (a) Statements **A** to **D** below describe the processes which occur during fractional distillation to produce gasoline.

The processes have been written in the wrong order.

A	gasoline vapour condenses into a liquid at its boiling point
B	petroleum mixture is heated in a furnace
C	vapour mixture enters the fractionating column
D	vapour mixture rises and cools

In the boxes in Fig. 2.1 write the letters **A** to **D** to show the correct order of the processes.

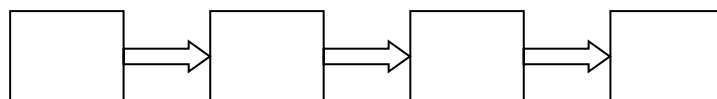


Fig. 2.1

[2]

- (b) A process called *cracking* is also carried out at an oil refinery.

Fig. 2.2 shows the apparatus used to demonstrate the cracking of petroleum jelly.

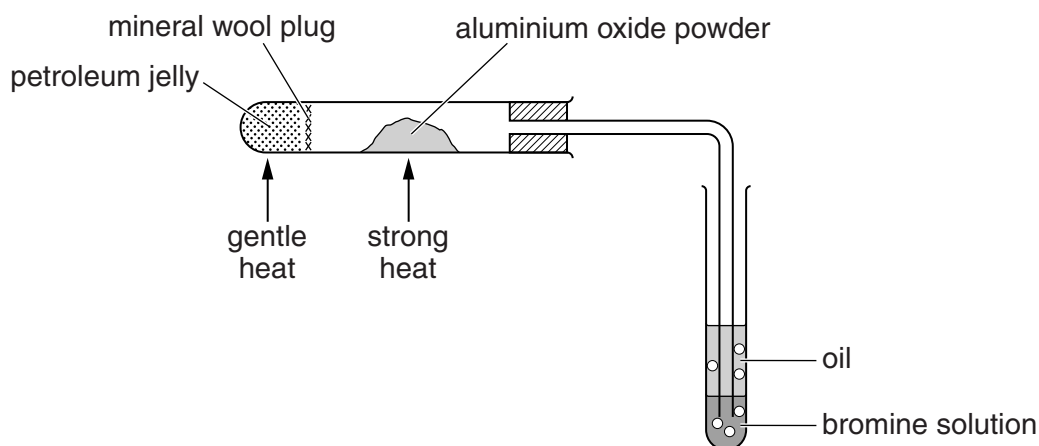


Fig. 2.2

Petroleum jelly is gently heated until it melts and then boils.

The vapour passes over aluminium oxide powder, which is strongly heated.

The gas formed reacts with bromine solution.

An oil forms on top of the bromine solution.

- (i) State the function of the aluminium oxide.

.....[1]

- (ii) Explain, in terms of collisions of reacting particles, why the aluminium oxide is powdered.

.....

.....

.....[2]

- (iii) List petroleum jelly, diesel oil and refinery gas in order of their boiling points.

highest boiling point

.....

lowest boiling point

[1]

- (iv) List petroleum jelly, diesel oil and refinery gas in order of the average length of their molecules.

longest molecules

.....

shortest molecules

[1]

- (v) State the relationship between boiling point and length of molecules.

Explain your answer.

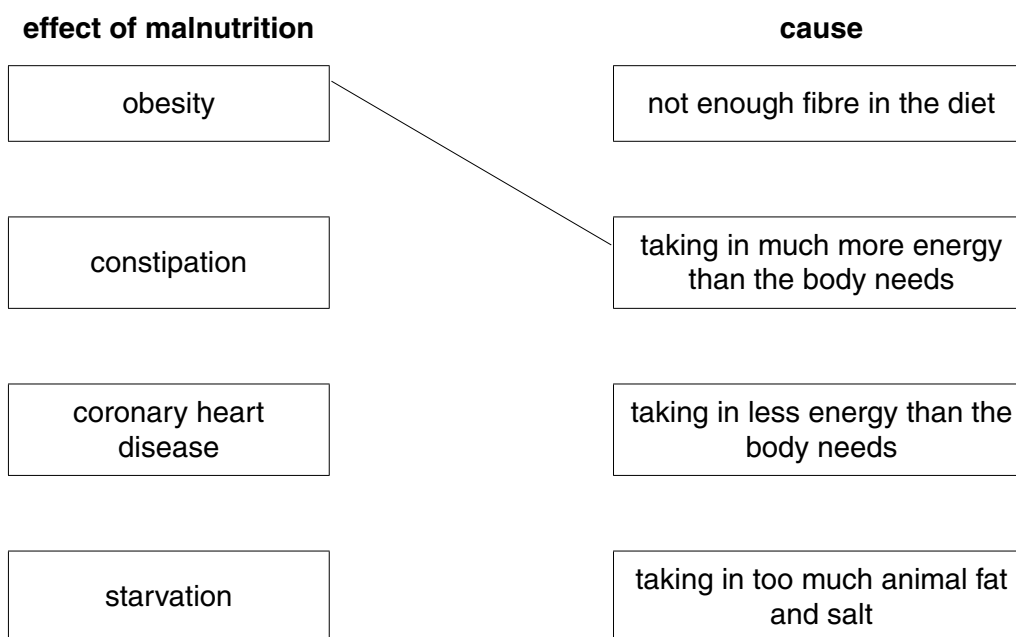
.....

.....

.....[2]

3 (a) If a person does not eat a balanced diet, they can suffer from malnutrition.

(i) Use straight lines to match the effects of malnutrition to their causes. One line is drawn for you.



[2]

(ii) A person has constipation.

Suggest **one** food that may be missing from their diet and explain how this food prevents constipation.

food

explanation

.....[2]

(iii) Obese people are extremely overweight because they are taking in more energy than they need.

Suggest **one** food an obese person should avoid eating regularly and explain your answer.

food

explanation

.....[1]

- (b) Taking exercise is recommended for people who are overweight.

A survey was carried out to compare the amounts of exercise taken by two groups of people. The first group was made up from people of normal weight and the second group was made up from overweight people. Each group contained 100 men and women.

The survey determined how many people took exercise at least twice a week. To count as exercise, an activity had to raise a person's heart rate for at least 20 minutes.

The results are shown in Fig. 3.1.

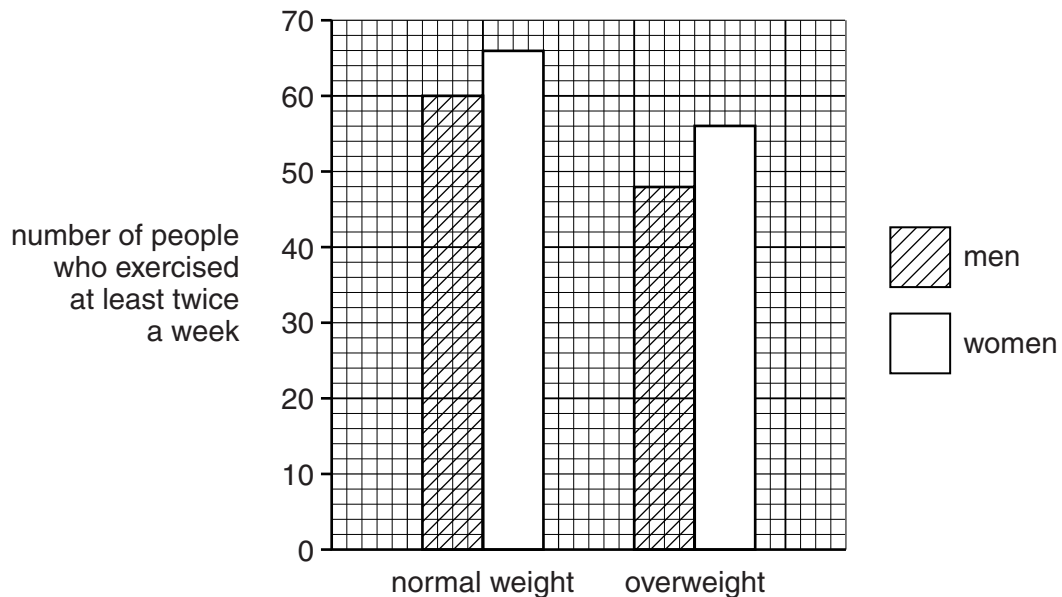


Fig. 3.1

- (i) Use the information in Fig. 3.1 to compare the level of exercise people did in terms of their sex,

.....

.....

their weight.

.....

.....[2]

- (ii) Suggest why there is not enough evidence in the survey to conclude that exercise prevents people from being overweight.

.....

.....

.....[2]

- 4 (a) A student investigates the neutralisation reaction between hydrochloric acid and potassium hydroxide.

Fig. 4.1 shows the apparatus she uses.

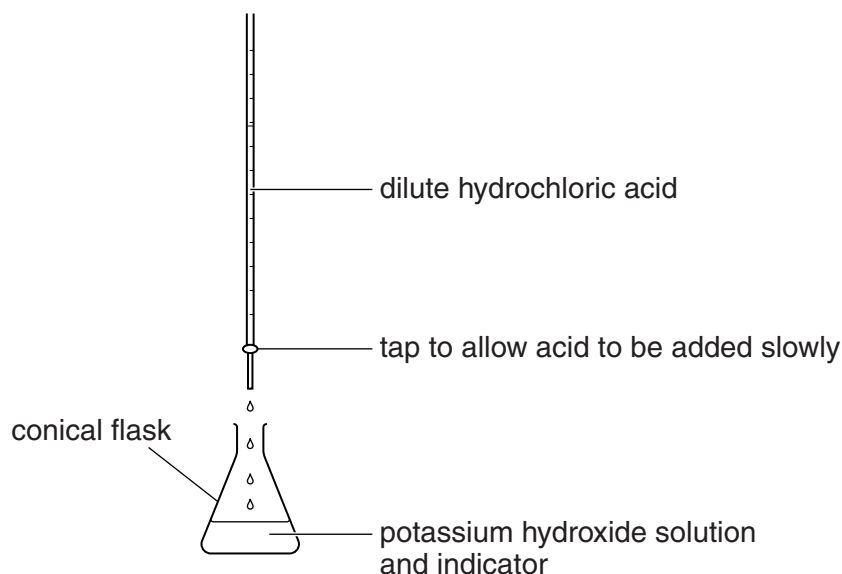


Fig. 4.1

She adds full range indicator (Universal Indicator) solution to the potassium hydroxide solution. Potassium hydroxide solution is alkaline.

She slowly adds some dilute hydrochloric acid to the potassium hydroxide solution until the solution in the flask is neutral.

The colour of the indicator changes as she adds the acid.

Fig. 4.2 shows how the colour of the indicator changes with pH.

pH	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
colour	RED		ORANGE			GREEN			BLUE			PURPLE			

Fig. 4.2

- (i) State the initial and final values of the pH of the solution in the flask.

initial

final

[1]

- (ii) State the initial and final colour of the indicator in the solution in the flask.

initial

final

[1]

(b) The reaction between hydrochloric acid and potassium hydroxide forms potassium chloride.

(i) Complete the balanced chemical equation for the reaction.



(ii) The student repeats part (a) in order to prepare a colourless sample of crystals of potassium chloride.

She changes the method described in part (a) slightly, using information obtained from the first time she carried out the experiment.

Describe the change in method and explain how she uses the results of her first experiment.

.....

[3]

(c) The melting point of crystals of potassium chloride is 770 °C.

Explain, in terms of the forces between particles, why potassium chloride forms crystals with a high melting point.

.....

[2]

- 5 (a) Fig. 5.1 shows cells **X** and **Y** which were taken from different areas of the same leaf.

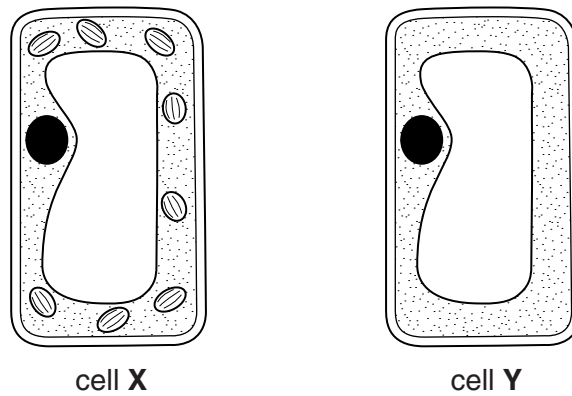


Fig. 5.1

Fig. 5.2 shows a leaf similar to the one from which these cells were taken.



Fig. 5.2

On Fig. 5.2, use label lines and the letters **X** and **Y** to show where these leaf cells came from.

Explain your answer below.

.....

.....

.....[2]

(b) The leaf in Fig. 5.2 was then tested with iodine solution for the presence of starch.

(i) On Fig. 5.3 draw the result of the starch test on this leaf.

Label the leaf with the colours that are observed in different areas.

[1]

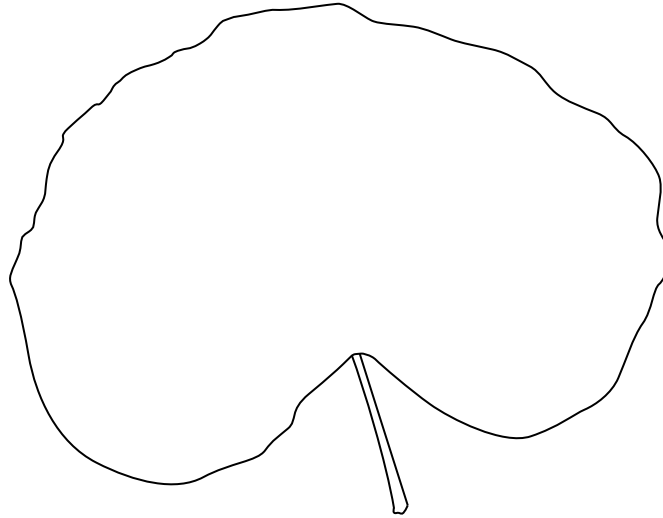


Fig. 5.3

(ii) Explain why only parts of the leaf show the presence of starch.

.....

.....

.....

.....[3]

(c) In humans, starch is digested by the enzyme amylase which starts its action while food is in the mouth cavity.

Explain in detail why amylase stops working after the food is swallowed and reaches the acidic conditions in the stomach.

.....

.....

.....

.....[3]

- 6 (a) Fig. 6.1 shows an aircraft accelerating along the airport runway.

The aircraft, fully loaded, has a total mass of 205 000 kg.

The diagram shows four forces, labelled **P**, **Q**, **R** and **S**, acting on the aircraft as it moves along the runway before taking off.

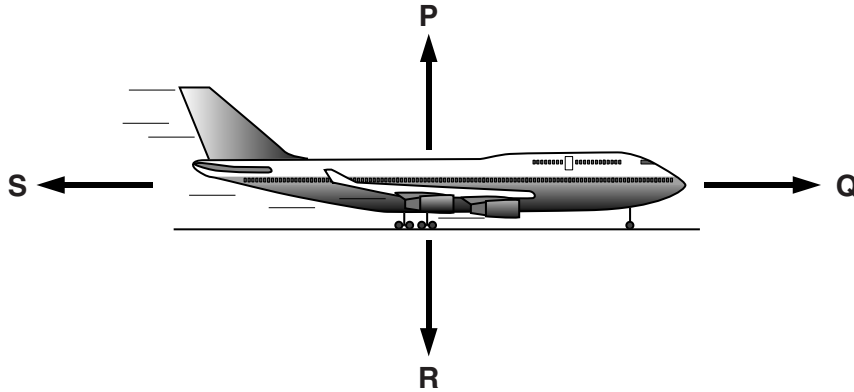


Fig. 6.1

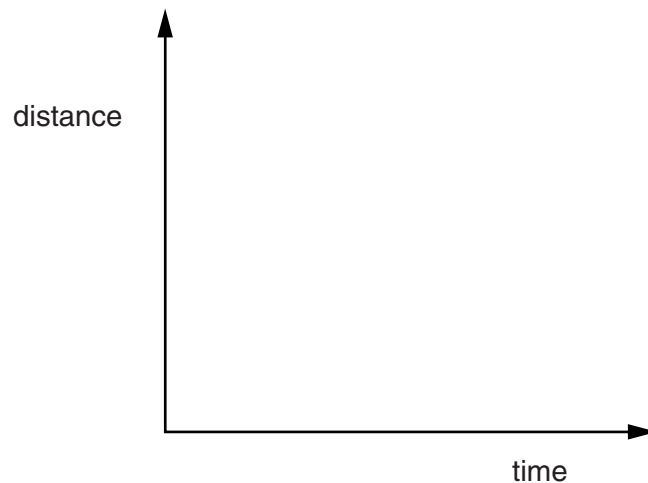
- (i) State **two** forces from **P**, **Q**, **R** and **S** that are equal and opposite while the aircraft accelerates along the airport runway.

..... and [1]

- (ii) State which force from **P**, **Q**, **R** and **S** is the result of a gravitational field acting on the mass of the aircraft and give the name of this force.

.....
[2]

- (iii) On the axes below, sketch a distance/time graph for the aircraft as it moves along the runway from rest to take-off.



[1]

- (b) The aircraft takes off and climbs to a height of 5000 m.

The chemical energy in the aircraft's fuel is transferred to the aircraft as it takes off and climbs.

- (i) State **two** useful forms of energy gained by the aircraft as a result of this transfer.

..... and [1]

- (ii) The forms of energy in (b)(i) add up to less energy than the energy transferred from the fuel.

The principle of energy conservation applies to the energy transferred from the fuel.

State what happens to the remainder of the energy from the fuel.

.....[1]

- (c) When the aircraft levels out at a height of 5000m, it has burned some fuel and now has a reduced total mass of 200 000 kg.

The aircraft flies at constant speed of 720 km/hr.

- (i) Calculate the speed of the aircraft in metres per second.

speed = ... m/s [1]

- (ii) Use your answer from (c)(i) to calculate the kinetic energy of the aircraft.

State the formula you use and show your working.

formula

working

kinetic energy = ... J [2]

7 (a) Fig. 7.1 shows the carbon cycle.

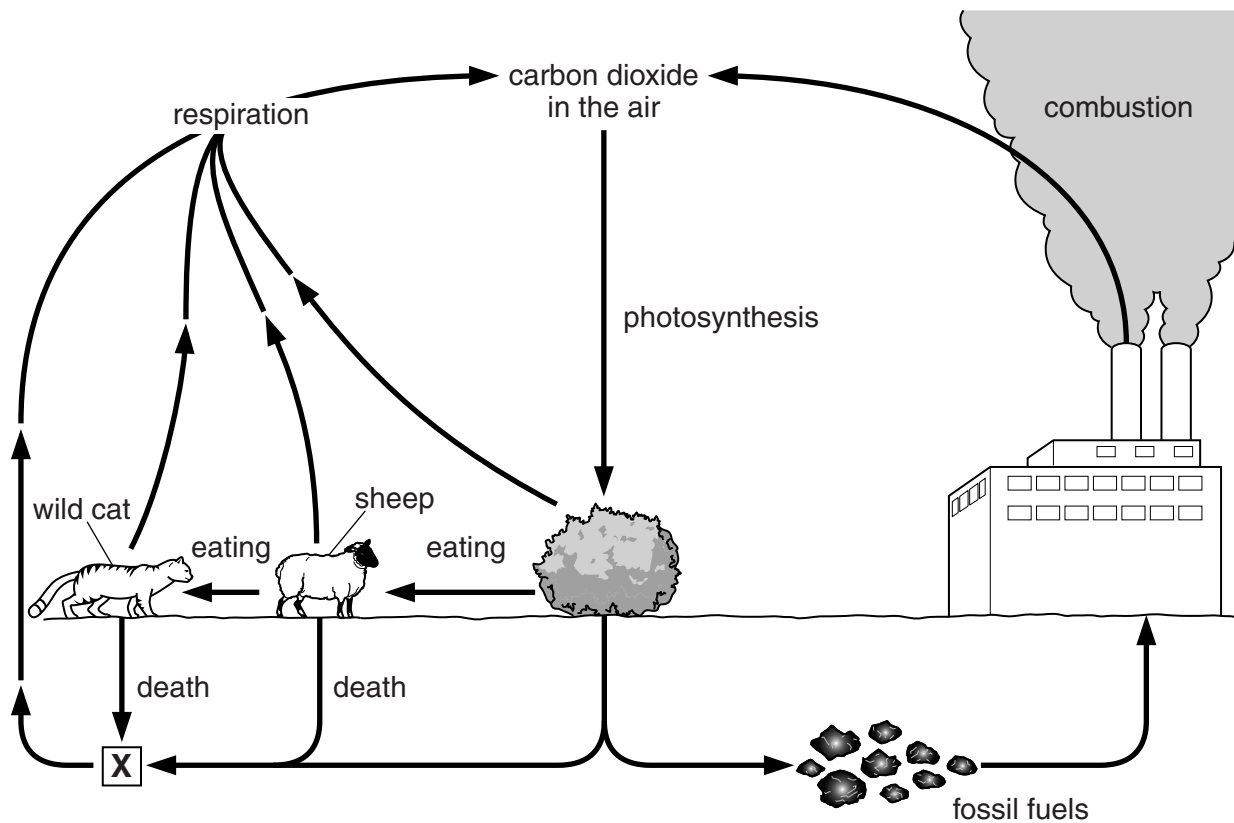


Fig. 7.1

- (i) The sheep eats a plant leaf. A carbon atom from the starch in this leaf enters the air shortly after the leaf is eaten.

Describe a possible pathway taken by the carbon atom. Explain your answer fully.

.....

[3]

- (ii) The organisms labelled **X** are found in the soil.

Describe in detail the role these organisms play in the carbon cycle.

.....

[3]

- (b) (i) With reference to Fig. 7.1 and your own knowledge, state **two** ways in which the burning of fossil fuels can change the composition of the gases in the atmosphere.

1

2[2]

- (ii) Suggest **one** way in which the environment can be harmed by one of the changes you have stated in part (b)(i).

.....

.....[1]

- 8 The Sun emits many different frequencies of electromagnetic radiation including visible light, infra-red, ultra-violet and X-rays.

(a) (i) State the meaning of the term *frequency*.

.....
[1]

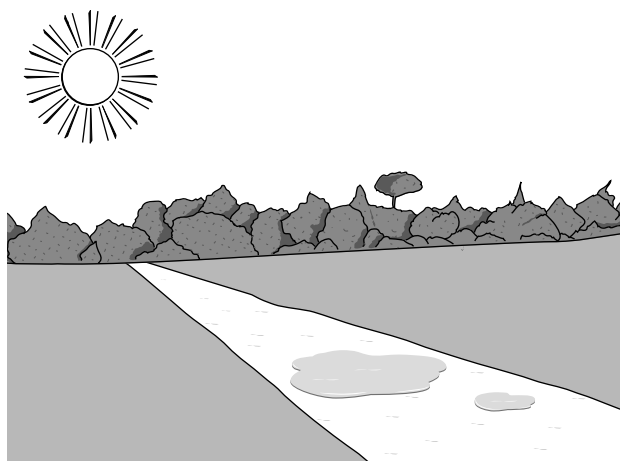
(ii) Complete Table 8.1 to show the types of electromagnetic radiation emitted by the Sun.

Table 8.1

highest frequency				lowest frequency		
gamma radiation			visible light		microwaves	radio waves

[2]

- (b) After rain has fallen, puddles of water are left on the ground. When the Sun shines, it warms the air and the water in the puddles and dries the ground.



- (i) Complete the following sentences about the forces and distances between molecules, using words or phrases.

When the Sun warms the water in a puddle on the ground, the water expands because the water molecules

When the water expands, the forces between the molecules

As the air above the puddle gets warmer, the molecules in the air move

[3]

- (ii) Use your answers to (b)(i) to explain why the Sun dries the ground.

.....

.....

.....[2]

- (c) The Sun produces sound waves as well as electromagnetic radiation.

- (i) Explain why we cannot hear any sound from the Sun.

.....

.....[2]

- (ii) It takes eight minutes for the visible light emitted from the Sun to travel to the Earth.

Suggest how long it would take for a burst of X-rays emitted by the Sun to travel to the Earth. Give a reason for your answer.

.....

.....[1]

- 9 (a) The Thermite reaction occurs between aluminium and iron oxide powders.

It is an example of a redox reaction.

Fig. 9.1 shows how a furnace in which the Thermite reaction is occurring can be used to repair a broken steel rail.

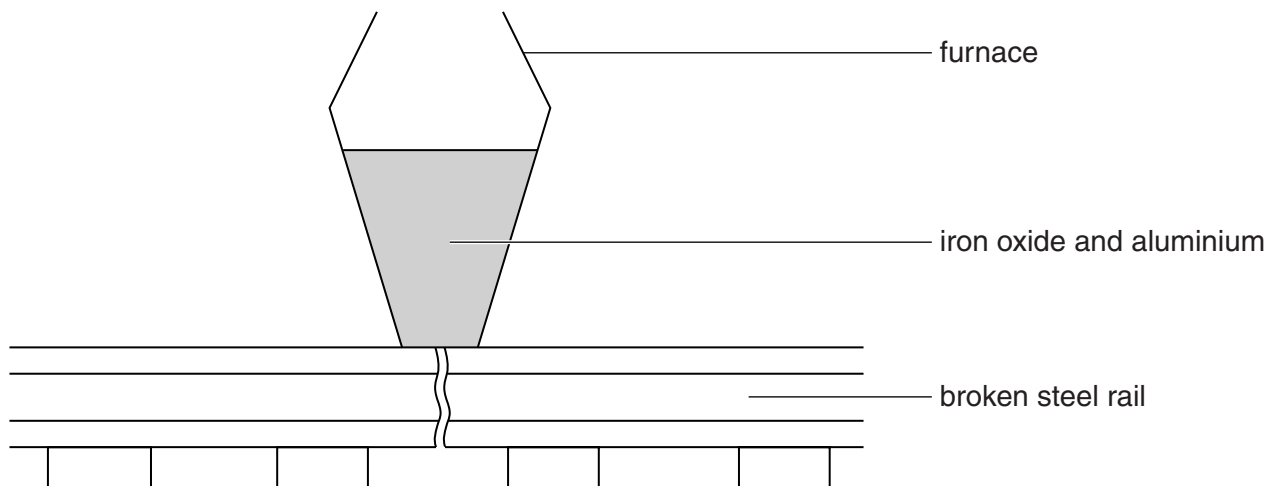


Fig. 9.1

The Thermite reaction produces molten iron that runs down into the broken rail and welds (joins) the ends together.

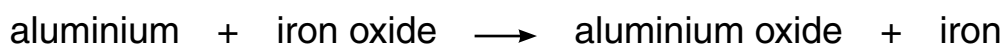
- (i) State the type of chemical reaction that causes the temperature to increase.

.....[1]

- (ii) State the energy transfer occurring during the reaction.

..... → [1]

- (iii) The word equation for the Thermite reaction is shown below.



Explain why the Thermite reaction is an example of a redox reaction.

.....

[2]

- (iv) Aluminium ore contains aluminium oxide.

A student suggests that metallic iron could be used to extract aluminium from its ore.

State whether or not this would work.

Explain your answer by referring to the information contained in part (a)(iii).

.....

[2]

- (b) In industry, aluminium is extracted from aluminium oxide by electrolysis.

Fig. 9.2 shows the apparatus used.

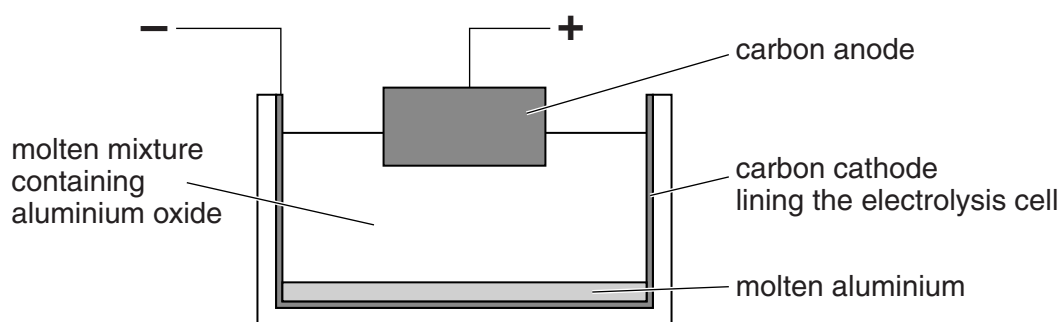


Fig. 9.2

- (i) Aluminium is deposited on the cathode.

Describe, by referring to the movement of ions and electrons, how these aluminium atoms are formed.

.....

[2]

- (ii) Name the other substance formed by this electrolysis process.

.....[1]

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DATA SHEET

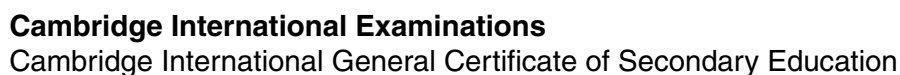
Group

I	II											III	IV	V	VI	VII	0																							
		1 H Hydrogen 1																																						
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10																							
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18																							
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36																							
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	101 Ru Ruthenium 44	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	119 Sn Tin 50	122 Sb Antimony 51	127 I Iodine 53	131 Xe Xenon 54	137 Ba Barium 56	139 La Lanthanum 57	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86										
223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89											227 Ac Actinium 89																											

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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- 1 Fig. 1.1 is a diagram of the blast furnace used to extract iron from iron ore.

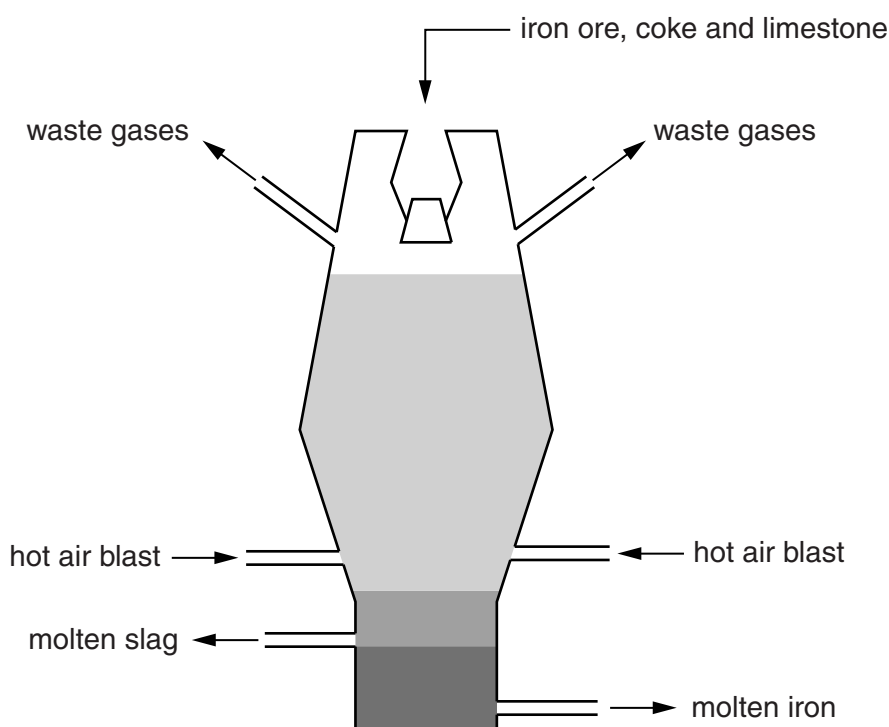


Fig. 1.1

- (a) Table 1.1 lists the raw materials used in the furnace.

Choose words or phrases from the list to show which chemical substance is provided by each raw material used in the blast furnace.

Complete Table 1.1 by writing your choices in the right hand column.

You may use each term once, more than once or not at all.

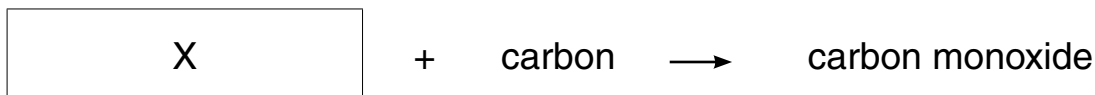
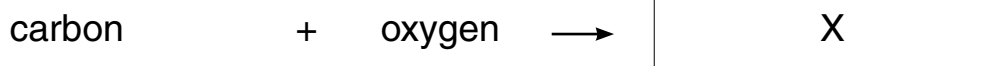
calcium carbonate	calcium silicate	carbon	carbon dioxide
iron	iron oxide	nitrogen	oxygen

Table 1.1

raw material	chemical substance
iron ore	
coke	
air	
limestone	

[2]

- (b) (i) The word equations for two of the reactions occurring in the furnace are shown below.



Name substance X.

..... [1]

- (ii) The word equation for another reaction occurring in the furnace is shown below.



Explain why this reaction is an example of a redox reaction.

.....

 [2]

- (iii) Carbon dioxide produced by a blast furnace escapes into the atmosphere.

Describe how the addition of carbon dioxide to the atmosphere is affecting the environment.

.....

 [2]

- (c) An iron nail is placed into some blue copper sulfate solution.

- (i) Describe the observations that provide evidence that a chemical reaction is occurring.

.....

 [2]

- (ii) Explain the observations in (i) in terms of the particles reacting and formed.

.....

 [2]

- 2 Fig 2.1 shows a special bicycle used to break the speed record for a human-powered bicycle.

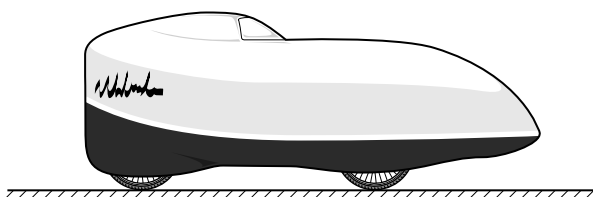


Fig. 2.1

- (a) The rider sets a new speed record of 135 km/h.

Calculate the rider's speed in metres per second (m/s).

speed = ... m/s [2]

- (b) The record-breaking run has three stages.

Stage 1: the rider accelerates the bicycle from rest for the first 500 m.

Stage 2: he maintains a constant speed for the next 200 m.

Stage 3: he applies the brakes to slow the bicycle for the last 300 m.

The acceleration is not constant, but the braking involves constant deceleration to rest.

On the axes below, complete the sketch of the speed/time graph for this record-breaking run.



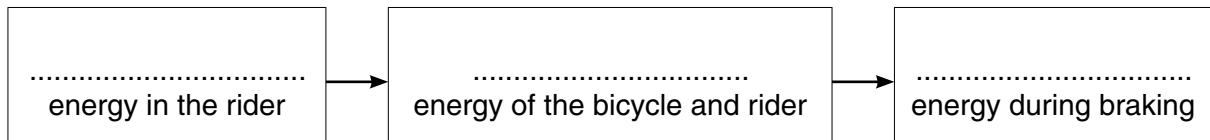
[3]

(c) Throughout the run, the cyclist exerts a constant force to move the bicycle against the opposing forces.

- (i) Identify the stage in the run during which the driving force of the cyclist is greater than the opposing forces. Give a reason for your answer.

.....
[1]

- (ii) Complete the sequence of energy transfers that occurs during the run.



[2]

- 3 (a) Fig. 3.1 shows the human gas exchange system.

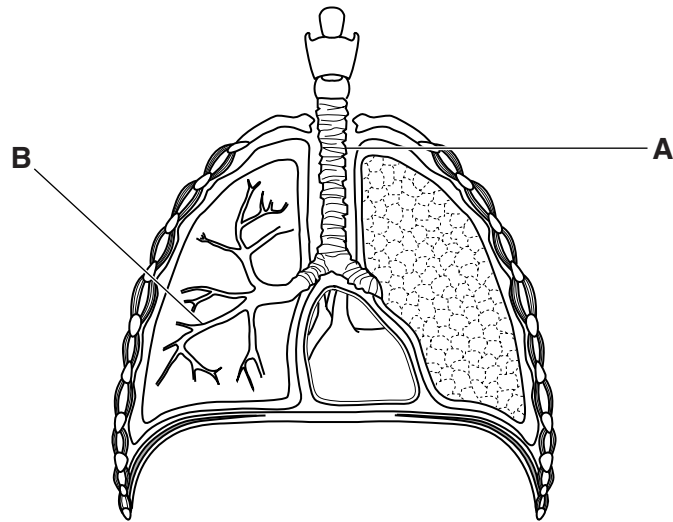


Fig. 3.1

Name structures **A** and **B**.

A

B

[2]

(b) Fig. 3.2 shows an alveolus where gas exchange takes place in the lungs.

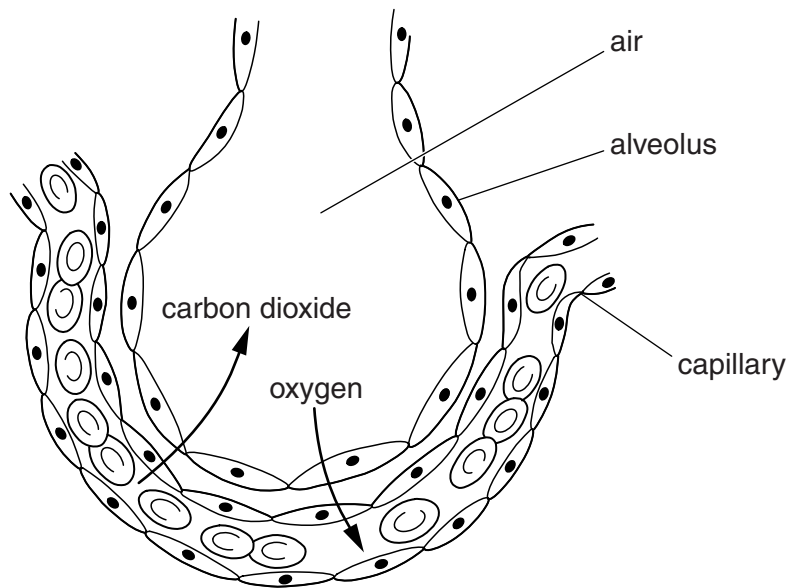


Fig. 3.2

Describe **two** features of the alveolus visible in Fig. 3.2 that adapt it for gaseous exchange.

- 1
-
- 2
-[2]

- (c) A student investigates his breathing before and after exercise. He measures the number of breaths taken during one minute. He also measures the average volume of one breath during this minute.

His results are shown in Table 3.1.

Table 3.1

	number of breaths per minute	average volume of one breath/dm ³	total volume of air breathed per minute/dm ³
at rest	20		10
immediately after exercise	35	1.2	

- (i) Calculate

the average volume of one breath at rest,

volume = ... dm³

the total volume of air breathed per minute immediately after exercise.

volume = ... dm³ [2]

- (ii) Explain fully why the changes in breathing rate and volume (depth) are needed by the body during exercise.

.....

.....

.....

.....[3]

- 4 Fig. 4.1 shows the circuit symbols for an electric bell and a push-switch.

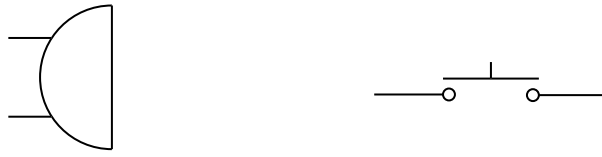


Fig. 4.1

- (a) (i) Draw a circuit diagram for a circuit for a battery-powered door-bell with a push-switch for the front door of a house.

Label the switch 'front door'.

[2]

- (ii) The owner of the house wishes the bell to be rung **either** from the front door **or** from the back door.

Add to your circuit diagram in (i) a second push-switch for the back door.

Use the label 'back door' to label the second push-switch.

[1]

(b) The ringing bell emits a sound of frequency 400 Hz.

(i) State the meaning of the term *frequency*.

.....
[1]

(ii) The speed of sound in air is 330 m/s.

Calculate the wavelength of the sound made by the bell in air.

State the formula you use and show your working.

formula

working

wavelength = ... m [2]

(c) The bell uses four 1.5V cells. When the push-switch is on, and the bell is ringing, there is a current of 2A.

(i) Calculate the resistance of the bell.

State the formula you use, show your working and state the unit of your answer.

formula

working

resistance = ... unit [3]

- (ii) A visitor arrives at the door and rings the bell for 10 seconds.

Calculate the electrical energy transferred by the bell in 10 seconds.

State the formula you use, show your working and state the units of your answer.

formula

working

energy = ... unit [3]

5 (a) An atom of the element silicon has a proton number 14 and nucleon number 28.

(i) Complete Table 5.1 to show the structure of this silicon atom.

Table 5.1

	in nucleus	outside nucleus
number of protons		
number of neutrons		
number of electrons		

[2]

(ii) Use the Periodic Table to predict how many electrons are in the outer shell of a silicon atom. Describe how you made your prediction.

.....

[2]

(b) (i) Draw a diagram showing the arrangement of the outer electrons of the atoms bonded in a methane molecule, CH₄.

[2]

(ii) Write a balanced symbol equation for the complete combustion of methane in air.

.....[2]

- 6 Fig. 6.1 shows a method that uses solar energy to purify drinking water. The method is used in hot desert countries.

The impure water is heated by the sun and distilled. The pure water is collected separately, while the impurities are left behind.

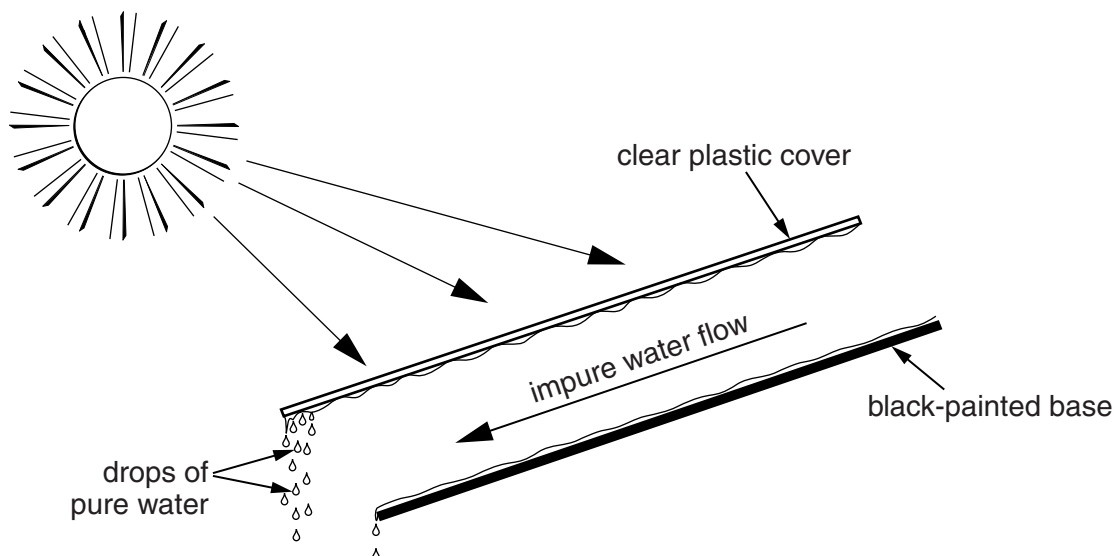


Fig. 6.1

- (a) (i) State the part of the Sun's electromagnetic spectrum that heats the water.

.....[1]

- (ii) The impure water flows down over a black-painted base.

Explain why a black-painted base is used.

.....
[1]

- (b) Solar energy produces water vapour from the impure water.

Explain in terms of water molecules why heating the impure water produces water vapour.

.....

[2]

(c) Fig. 6.2 shows a ray of sunlight incident on the clear plastic cover just before sunset.

The refracted ray passes through the plastic. At the lower face of the plastic, part of the ray is reflected and part is refracted.

Draw the path of the ray from the point where it reaches the lower face of the plastic.

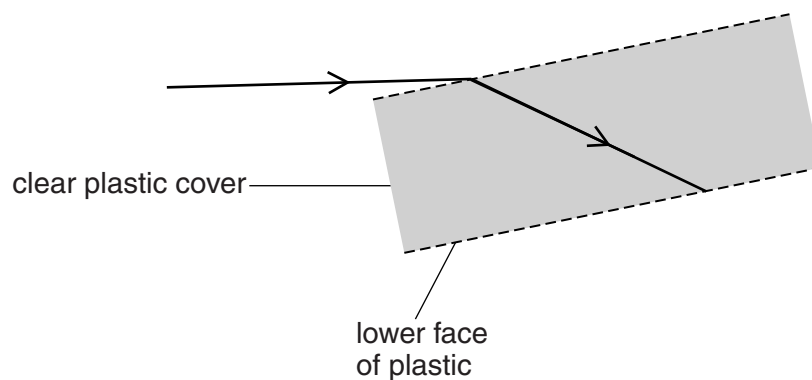


Fig. 6.2

[3]

- 7 Fig. 7.1 shows what happens when a plant is placed near a window where bright light is coming from one side.

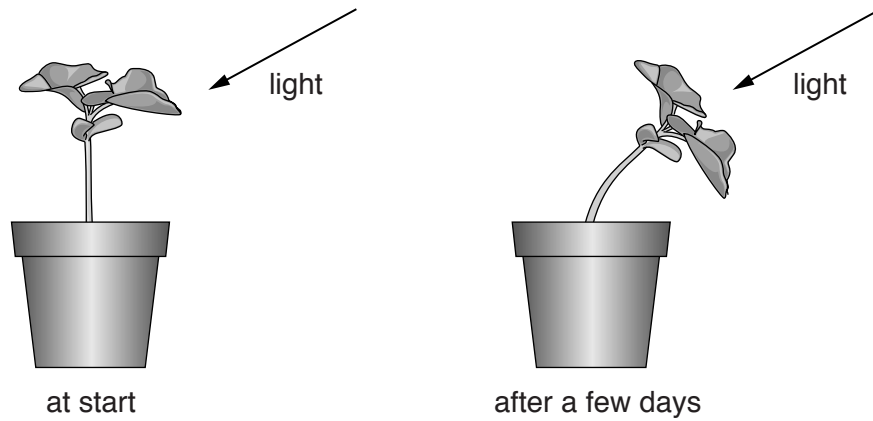


Fig. 7.1

- (a) Name the response shown by the plant.

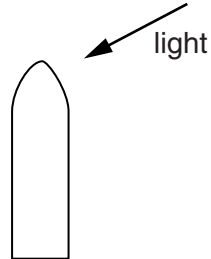
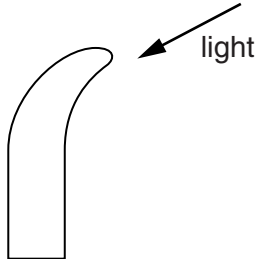
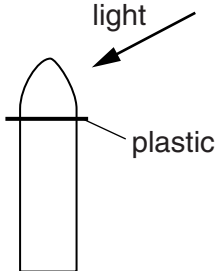
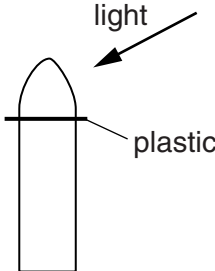
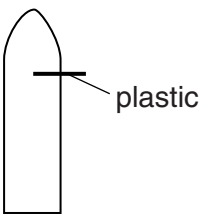
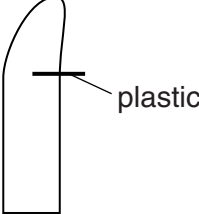
.....[1]

- (b) The response shown in Fig. 7.1 is caused by plant hormones called auxins which are produced at the tip of the shoot of the plant.

A student sets up three experiments using young shoots. In two experiments a lamp produces light from one side. Some shoots have pieces of plastic inserted into their stems.

Table 7.1 shows the shoots at the start and after a few days.

Table 7.1

at the start	after a few days
 shoot X	 shoot X
 shoot Y	 shoot Y
in the dark  shoot Z	in the dark  shoot Z

- (i) Explain fully what causes the response shown by shoot X.

.....

.....

.....

.....[3]

- (ii) Explain why there is no response shown by shoot **Y**.

.....
.....[1]

- (iii) Shoot **Z** has grown less than shoot **X** but has bent in the same direction.

Explain these two observations.

.....
.....
.....
.....[2]

- (c) Hormones are also present in animals. An example is adrenaline.

Adrenaline is secreted into the blood when an athlete starts to run a race.

Suggest how this helps the athlete to run fast.

.....
.....
.....[2]

- 8 (a) Table 8.1 shows physical properties of some substances.

Table 8.1

substance	solubility in water	boiling point/°C
ethanol	soluble	78
potassium nitrate	soluble	decomposes on heating
sodium chloride	soluble	1413
water	—	100
zinc carbonate	insoluble	decomposes on heating

Some mixtures of these substances and some methods that could be used to separate them are shown below.

mixture	method of separation
<u>zinc carbonate</u> from zinc carbonate and water	crystallisation
<u>potassium nitrate</u> from potassium nitrate and water	distillation
<u>water</u> from sodium chloride and water	filtration
<u>ethanol</u> from ethanol and water	fractional distillation

Draw straight lines to connect each mixture with the most suitable method of separating the **underlined** substance. [2]

(b) Some types of ink are made from different combinations of dyes dissolved in water.

The dyes must not be toxic because they are used in colouring pens for children.

Fig. 8.1 shows a chromatogram used to test if three inks **A**, **B** and **C** contain a toxic dye **X**.

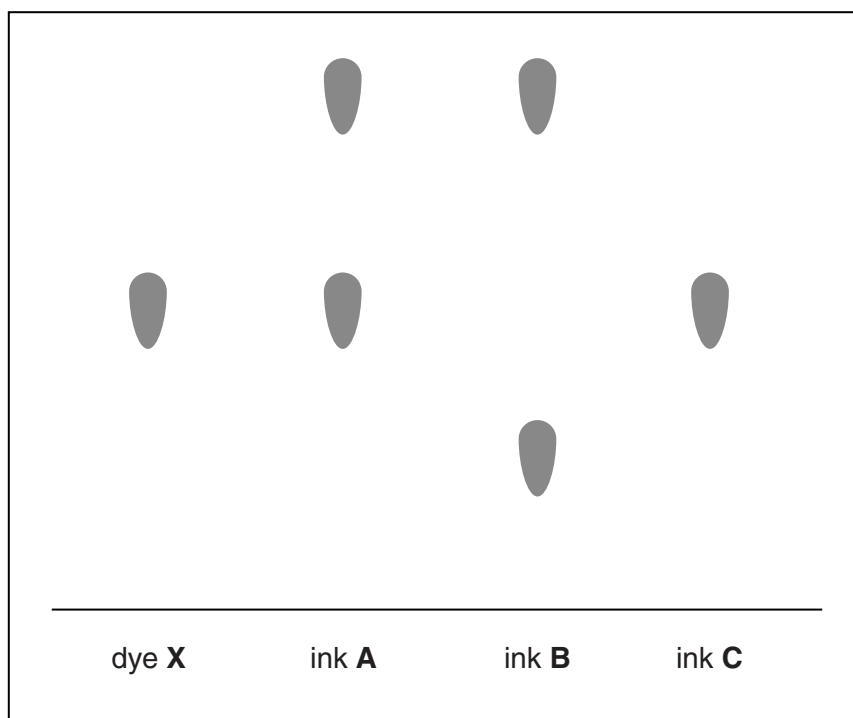


Fig. 8.1

(i) Describe and explain the procedure used to obtain this chromatogram.

You may draw a diagram to support your description.

.....

.....

.....

.....[3]

- (ii) State which ink(s) must not be used in the colouring pens.

.....[1]

- (iii) Explain your answer to (ii).

.....

.....[1]

- 9 (a) Fig. 9.1 shows how the emission of acidic gases from a power station can lead to the formation of acid rain.

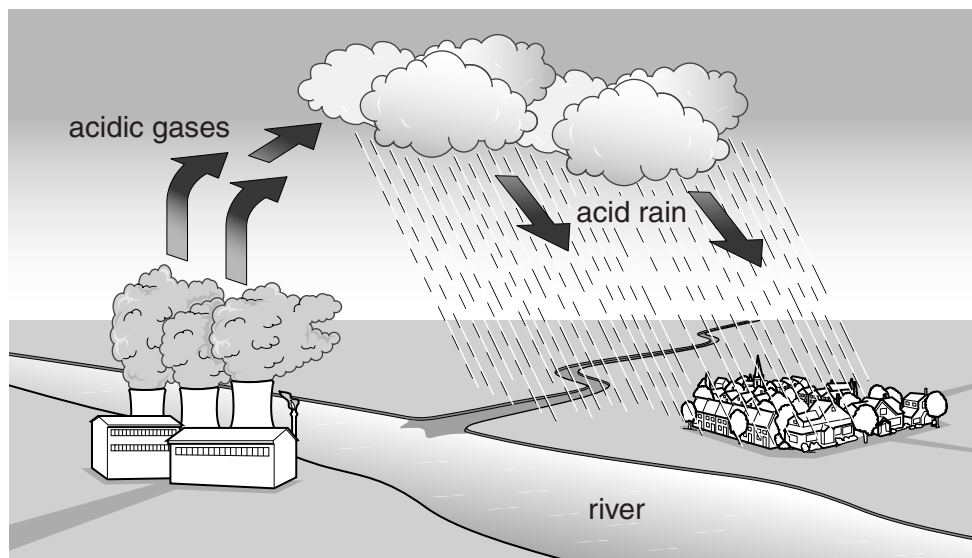


Fig. 9.1

- (i) State how the acidic gases are produced in the power station.

.....
.....[1]

- (ii) The water in the river becomes acidic.

Describe how this could have resulted from the power station's activities.

.....
.....
.....[2]

- (b) A scientist is concerned about the acidity of the river and the effect it might have on living organisms.

The scientist found ten species of animal that lived in local rivers. He looked up how many of these species were able to live in water of different pH values.

The results are shown in Fig. 9.2.

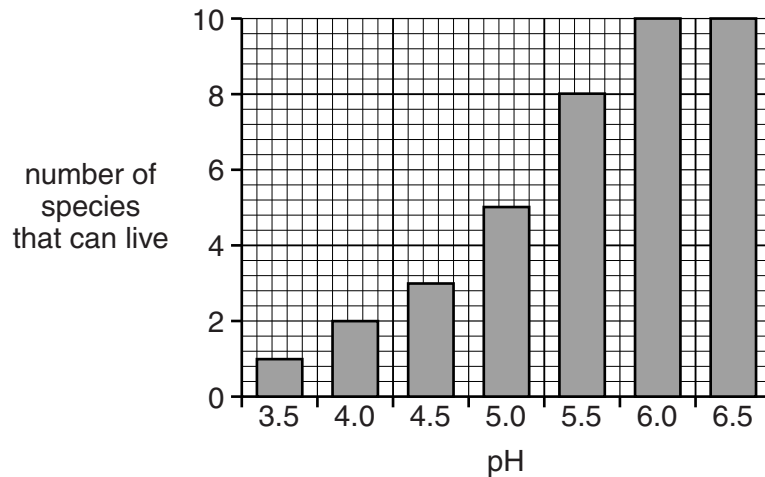


Fig. 9.2

The pH of the river near the factory varies between pH 4.5 and 6.0.

- (i) Suggest **two** reasons why the pH of the river varies.

1

.....

2

.....[2]

- (ii) Use the information in Fig. 9.2 to find how many of the species studied would be able to survive the changes in pH of the river. Explain your answer.

number of species

.....

.....[2]

- (iii) The acid in the water may enter the cells of the animals living in the river.
Suggest how this may affect the enzymes in their cells. Explain your answer.

.....

.....

.....[2]

DATA SHEET
The Periodic Table of the Elements

Group																		
I	II											III	IV	V	VI	VII	0	
		1 H Hydrogen 1																4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10	
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18	
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36	
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	101 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54	
133 Cs Cesium 55	137 Ba Barium 56	139 La Lanthanum 57	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86	
223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89																
* 58–71 Lanthanoid series † 90–103 Actinoid series																		
		140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	147 Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71			
		232 Th Thorium 90	231 Pa Protactinium 91	238 U Uranium 92	237 Np Neptunium 93	244 Pu Plutonium 94	243 Am Americum 95	247 Cm Curium 96	247 Bk Berkelium 97	251 Cf Californium 98	252 Es Einsteinium 99	257 Fm Fermium 100	258 Md Mendelevium 101	259 No Nobelium 102	260 Lr Lawrencium 103			
Key	a	X	a = relative atomic mass X = atomic symbol b = atomic (proton) number															

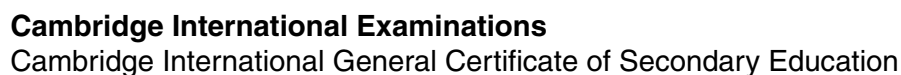
Key

a	X	a = relative atomic mass
	X	X = atomic symbol
b		b = atomic (proton) number

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).

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0653/33

October/November 2014

1 hour 15 minutes

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

DO **NOT** WRITE IN ANY BARCODES.

A copy of the Periodic Table is printed on page 24.

The number of marks is given in brackets [] at the end of each question or part question.

This document consists of **24** printed pages.

1 (a) A student performs some experiments to find out what makes iron rust.

(i) Fig. 1.1 shows his first experiment.

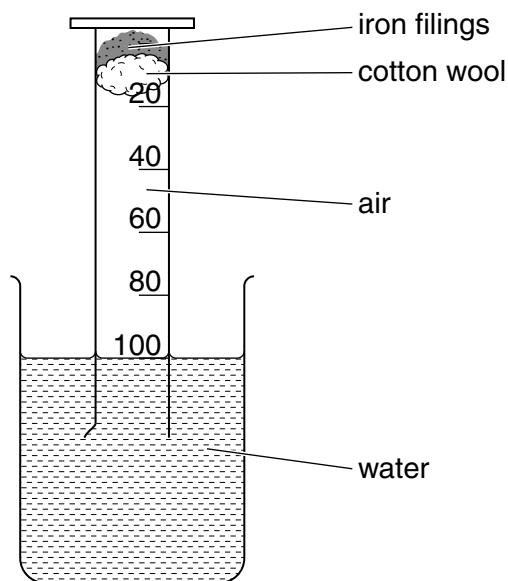


Fig. 1.1

Fig. 1.2 shows the apparatus after one week. The iron has rusted and the water has risen up the cylinder.

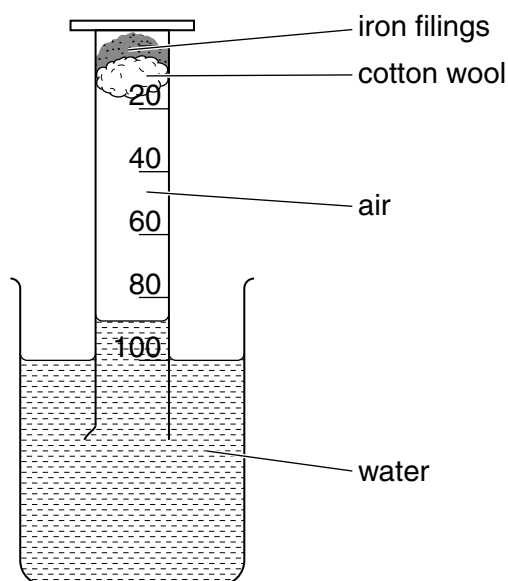


Fig. 1.2

Explain why the water has risen up the cylinder.

.....
.....[1]

- (ii) The student repeats the experiment using helium in the cylinder instead of air.

Fig. 1.3 shows the results after one week.

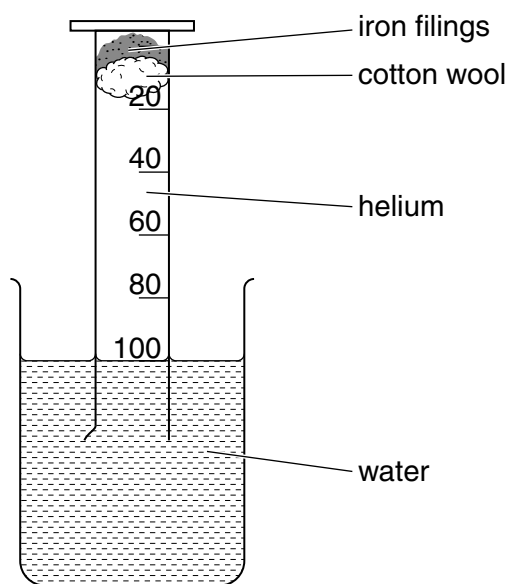


Fig. 1.3

The iron has not rusted and the water has not risen up the cylinder.

Explain why the water has not risen up the cylinder.

.....
.....[1]

(b) The student writes in his notebook:

*“When sodium burns in chlorine it forms **ions** that are like neon **atoms**.”*

- (i) State **two** similarities in the arrangement of electrons in a sodium **ion** and a neon **atom**.
The Periodic Table on page 24 may help you to answer this question.

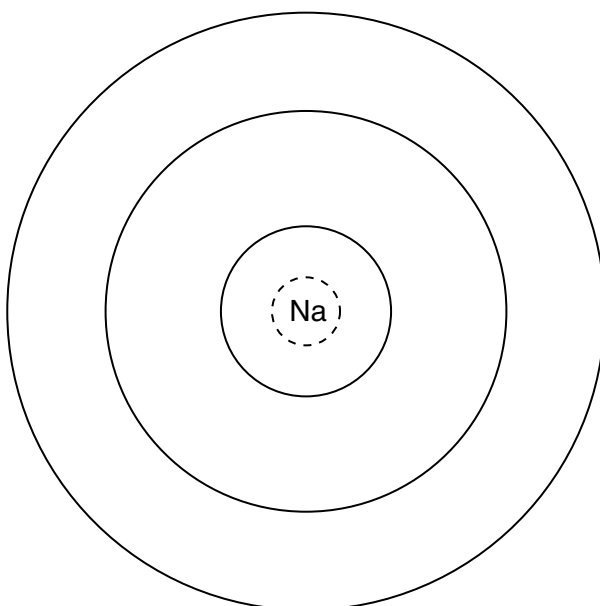
1

.....

2

.....[2]

- (ii) Complete the diagram of the electronic structure of a sodium **atom**.



[1]

- (iii) Describe what happens when a sodium **atom** becomes a sodium **ion**.

.....

.....[1]

- (iv) Some sodium chloride is dropped into a container filled with chlorine.

Predict whether or not the sodium **ions** in sodium chloride would react with chlorine **atoms**.

Explain your answer.

.....

.....[1]

(c) Name a noble gas.

State and explain a use for this noble gas.

name

use

explanation

.....[2]

- 2 (a) Fig. 2.1 shows a man paddling a canoe across a lake.

The man is paddling hard to gain speed from rest.

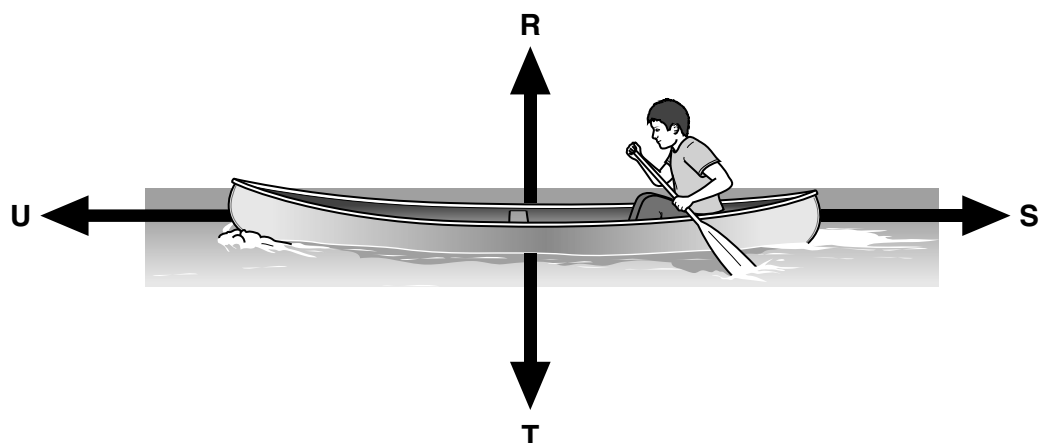


Fig. 2.1

- (i) State **two** forces from **R**, **S**, **T** and **U** that are equal and opposite.
 and [1]
- (ii) Explain which force from **R**, **S**, **T** and **U** is the result of a gravitational field acting on the combined mass of the canoe and man.

 [2]
- (iii) The canoe moves across the lake from rest to maximum speed with decreasing acceleration, then continues across the lake at a constant speed.

Sketch a speed/time graph for this journey.



[3]

- (b) The man's energy is transferred to the canoe as it gains speed.

The kinetic energy gained by the canoe is less than the energy transferred from the man.

The principle of energy conservation applies to these energy transfers.

State what happens to the man's energy that is **not** transferred into kinetic energy of the canoe.

.....[1]

- (c) The man paddles the canoe at a steady speed of 2 m/s.

The canoe and man together have a mass of 250 kg.

Calculate the kinetic energy of the canoe.

State the formula you use and show your working.

formula

working

kinetic energy = ... J [2]

- 3 (a) Fig. 3.1 shows a diagram of the uterus in a pregnant female.

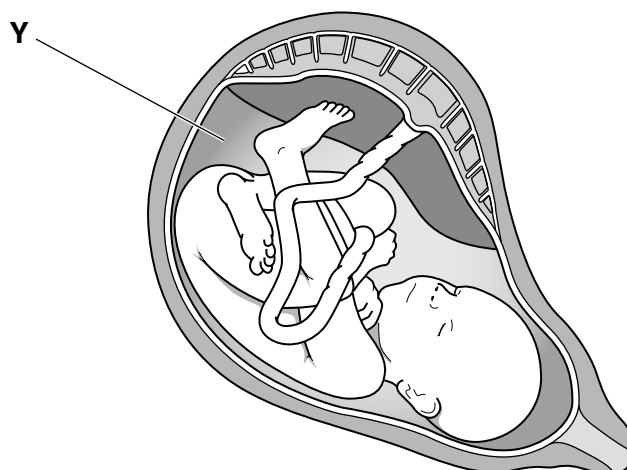


Fig. 3.1

- (i) Using label lines, label the placenta and cervix on Fig. 3.1. [2]

- (ii) Complete the sentences using words or phrases from the list.

You may use each word or phrase once, more than once or not at all.

bacteria carbon dioxide cells glucose viruses

The placenta allows dissolved nutrients such as to pass through to the baby. Other small molecules such as are also able to pass through the placenta. [2]

- (iii) Name the liquid found at position **Y** and state its function.

name

function

.....[2]

(b) Some of the nutrients that pass through the placenta result from the chemical digestion of large food molecules in the digestive system of the mother.

(i) Complete Table 3.1 with ticks (✓) and crosses (✗) to predict whether the digesting enzymes amylase (starch-digesting enzyme) and protease (protein-digesting enzyme) are active in the parts of the digestive system shown.

Table 3.1

type of enzyme	in the small intestine	in the large intestine
amylase		
protease		

key

✓ = enzyme active

✗ = enzyme inactive

[2]

(ii) Explain your answers to part **(b)(i)**.

.....

[2]

(c) The human immunodeficiency virus (HIV) can be transmitted through sexual intercourse.

Describe how HIV affects the immune system.

.....

[2]

- 4 Fig. 4.1 shows an electric hairdryer that uses mains electricity.



Fig. 4.1

A heater inside the hairdryer warms the air. A fan blows the warm air out of the hairdryer.

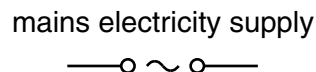
- (a) The hairdryer contains a switch, a heater to warm the air and an electric motor to drive the fan. The heater and the motor are connected in parallel.

Fig. 4.2 shows the circuit symbols for a heater and an electric motor.



Fig. 4.2

Complete the circuit diagram for the hairdryer. The circuit has been started for you.



[2]

- (b) The flow of warm air dries the wet hair by evaporation.

Describe in terms of molecules how the flow of warm air speeds up the drying of wet hair.

.....

.....

.....

.....[3]

- (c) If the heated air was not blown out sideways by a fan, it would simply move upwards.

Explain why heated air rises.

.....

.....

.....[2]

- (d) Fig. 4.3 shows information on a label fixed to the hairdryer.

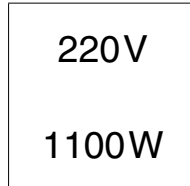


Fig. 4.3

- (i) State the name of the unit whose symbol is W.

.....[1]

- (ii) Use the formula $P = IV$ to show that the current in the hairdryer when in use is 5 A.
Show your working.

[1]

- (e) The plug on the lead of the hairdryer is fitted with a fuse. One day, the fuse blows while the hairdryer is being used.

- (i) Give **one** possible cause for the fuse blowing.

.....
[1]

- (ii) The fuse has to be replaced.

The current through the hairdryer when in use is 5 A. Several new fuses with different current ratings are available.

2 A 5 A 10 A 15 A

Explain which of these four fuses should be used.

Fuse because

[2]

- 5 (a) A student investigates the effect of gravity on the growth of a seedling.

The student germinates a seed. When the radicle is clearly visible, he pins the seedling to a board, as shown in Fig. 5.1 (a). He positions the board on its side so that the radical is horizontal.

The radicle continues to grow and curves downwards, as shown in Fig. 5.1 (b).

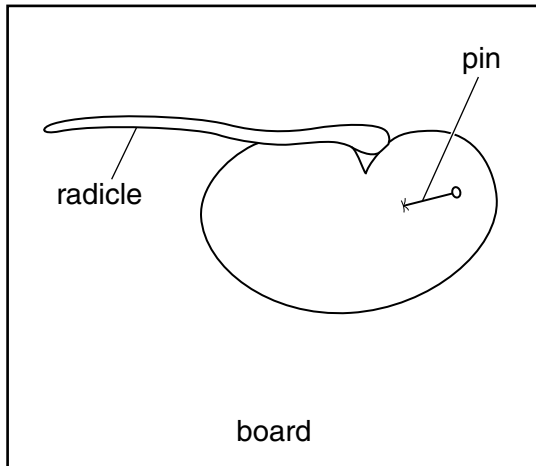


Fig. 5.1 (a)

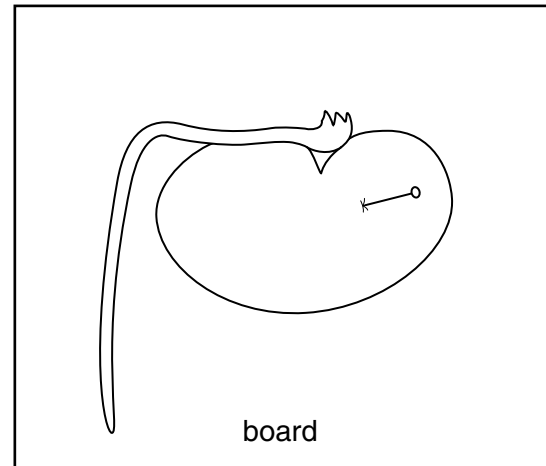


Fig. 5.1 (b)

- (i) Name the growth response shown by the seedling.

.....[1]

- (ii) Explain why this growth response is an advantage to the seedling.

.....

[2]

- (b) Fig. 5.2 shows a diagram of a radicle similar to the one in Fig. 5.1 (a). The shaded area shows the location of hormones that cause the response in (a)(i).

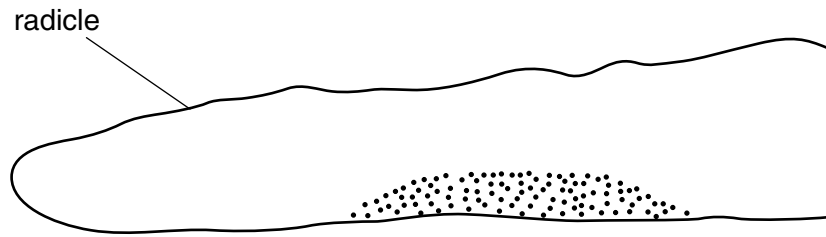


Fig. 5.2

Describe fully how the hormones act to cause the response shown by the radicle.

.....

.....

.....[2]

- (c) Roots usually get their energy from aerobic respiration.

The soil around a seedling becomes waterlogged so there are no air spaces.

- (i) Suggest how this affects the rate of aerobic respiration.

Explain your answer.

.....

.....[1]

- (ii) Predict and explain the effect this will have on the rate of growth of the seedling.

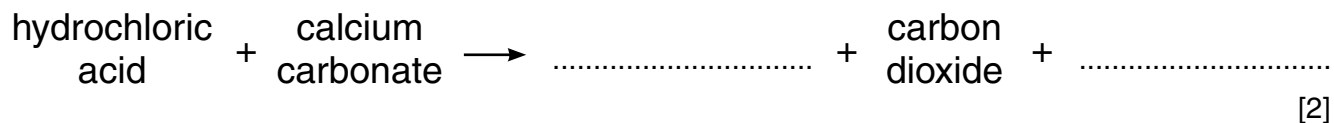
.....

.....[1]

Question 6 begins on page 16

6 Dilute hydrochloric acid reacts with calcium carbonate to produce carbon dioxide gas.

(a) Complete the word equation for the reaction.



(b) Fig. 6.1 shows the apparatus a student uses to investigate the effect of changing the initial temperature of the acid on the rate of reaction.

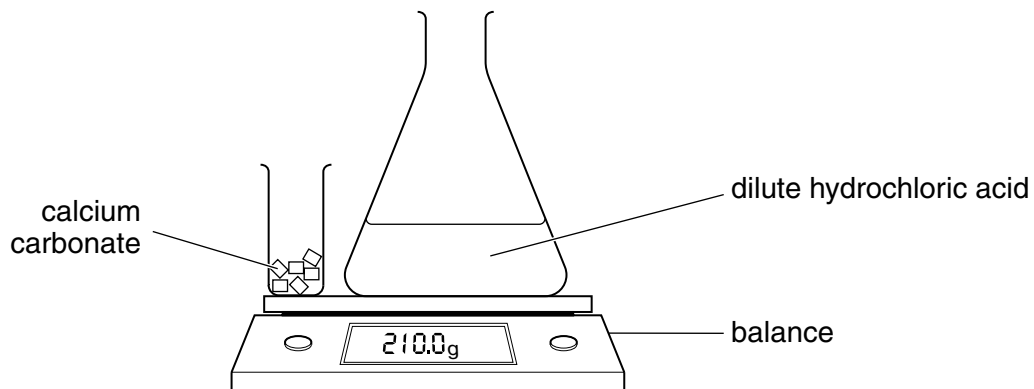


Fig. 6.1

The student adds the calcium carbonate to excess acid at a temperature of 20 °C.

She records the reading of the balance every minute for 7 minutes.

Fig. 6.2 shows the results obtained in the first experiment.

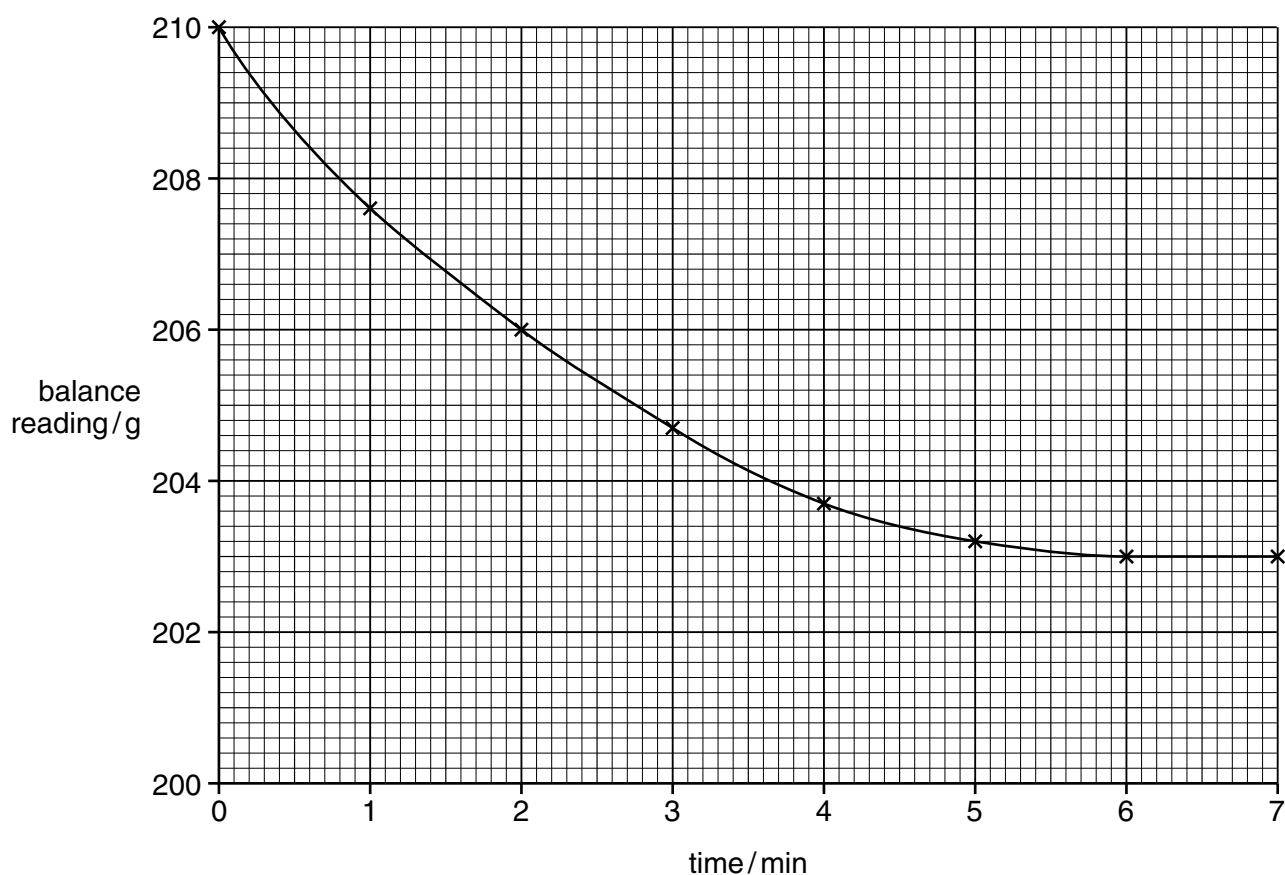


Fig. 6.2

- (i) Explain why the mass of the apparatus decreases during the experiment.

.....
.....[1]

- (ii) Describe and explain how the rate of reaction changes during the experiment.

.....
.....
.....
.....[3]

(c) The experiment is repeated with the same mass of calcium carbonate and excess acid at a temperature of 30 °C.

- (i) Use the information from Fig. 6.2 to predict the **final mass** of the apparatus when the acid has an initial temperature of 30 °C.

.....[1]

- (ii) The student finds that the rate of reaction increases as the temperature of the acid increases.

Use the idea of particle collision to explain the effect of temperature on the rate of reaction.

.....

.....

.....[2]

- 7 Astronomers use telescopes to study the electromagnetic radiation that reaches the Earth from the stars.

- (a) (i) Complete the sentences below using words or phrases from the list. You may use each term once, more than once or not at all.

radio waves sound waves ultra-violet visible light water waves

People can see stars with their eyes because the stars emit

Astronomers need special telescopes to see other types of electromagnetic radiation from stars. Examples of such types of radiation are and [2]

- (ii) We are able to see the Moon, even though the Moon itself does not emit electromagnetic radiation.

State a characteristic behaviour of electromagnetic radiation that enables us to see the Moon.

.....[1]

- (b) Some stars emit electromagnetic radiation with a very high frequency, such as X-rays.

- (i) Fig. 7.1 shows an incomplete diagram of the electromagnetic spectrum.

gamma radiation					microwaves	
-----------------	--	--	--	--	------------	--

Fig. 7.1

Mark with an **X** on Fig. 7.1 the part of the spectrum where X-rays are situated. [1]

- (ii) A binary consists of two stars close together. In one particular binary, one star emits mainly light, while the other emits mainly X-rays.

The light and X-rays leave this binary at the same time.

Tick the box next to the correct statement in the list below and give a reason for your answer.

X-rays will reach the Earth first.

☐

Light will reach the Earth first.

☐

X-rays and light will reach the Earth at the same time.

☐

reason

.....

.....[2]

- 8 (a) Fig. 8.1 shows an experiment to investigate the effect of changing light intensity on the rate of photosynthesis of a water plant called *Elodea*.

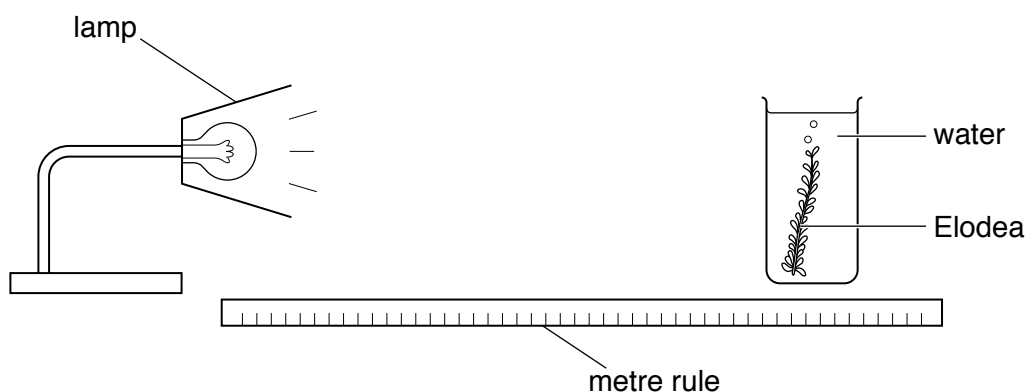


Fig. 8.1

The light intensity is altered by changing the distance between the lamp and the plant.

The number of bubbles of oxygen produced by the plant per minute is used to find the rate of photosynthesis.

The results are shown in Fig. 8.2.

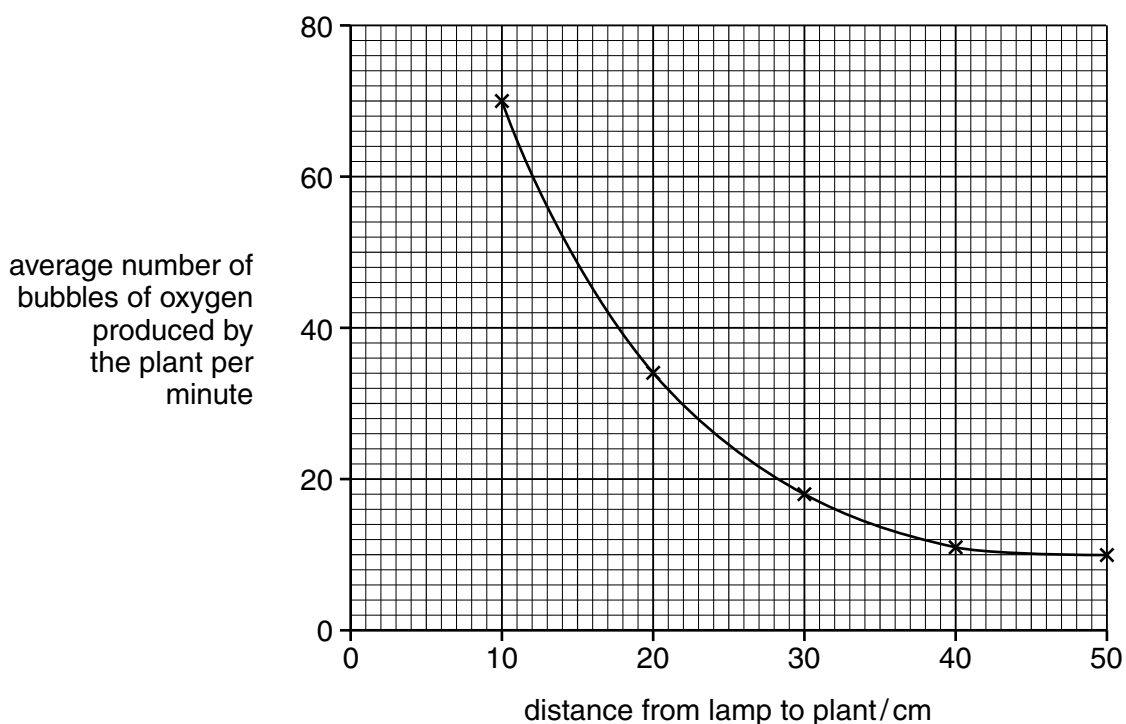


Fig. 8.2

Use Fig. 8.2 to describe how the rate of photosynthesis of the plant changes as the light intensity is varied.

.....

.....

.....[2]

(b) Fig. 8.3 shows some of the living organisms in a pond.

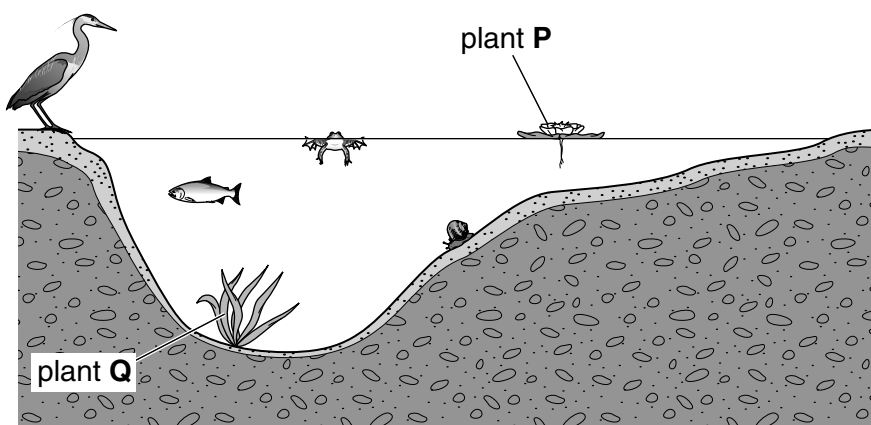


Fig. 8.3

Suggest how the rate of photosynthesis of plant **P** compares with plant **Q**. Explain your answer.

.....

.....

.....[2]

(c) The pollution of water by fertilisers can cause *eutrophication*.

(i) Some fertiliser is added to a pond. Describe the effect this will have on the plants that live on the surface of the pond.

.....

.....[1]

(ii) Use your answer to (b)(i) to predict how eutrophication will affect plant **Q** in Fig. 8.3.

.....

.....

.....[2]

- 9 Aluminium is extracted from an ore called bauxite.

Bauxite is a mixture of aluminium oxide and other compounds.

The element aluminium is extracted from molten aluminium oxide by electrolysis.

The element oxygen is also formed during the electrolysis.

- (a) Using examples taken from the sentences above, explain

- (i) **one** difference between an element and a compound,

.....
.....[1]

- (ii) **one** difference between a compound and a mixture.

.....
.....[1]

- (b) Aluminium oxide consists of Al^{3+} ions and O^{2-} ions.

Deduce the formula of aluminium oxide. Explain your answer.

.....[2]

- (c) In industry aluminium is extracted from aluminium oxide by electrolysis.

Fig. 9.1 shows the apparatus used.

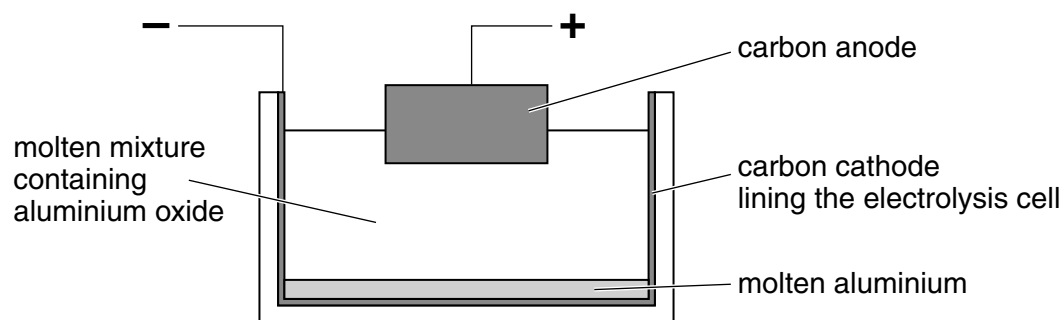


Fig. 9.1

Explain, in terms of the ions present, how aluminium is formed at one of the electrodes.

.....

.....

.....

.....[3]

- (d) Copper can be extracted from an ore containing copper oxide by heating it with carbon.

Explain why aluminium cannot be obtained from aluminium oxide in the same way.

.....

.....

.....[2]

DATA SHEET
The Periodic Table of the Elements

Group																											
I	II											III	IV	V	VI	VII	0										
																	1 H Hydrogen 1										
7 Li Lithium 3	9 Be Beryllium 4																11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10					
23 Na Sodium 11	24 Mg Magnesium 12																27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18					
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36										
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	98 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54										
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	209 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86										
223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89																									
* 58–71 Lanthanoid series † 90–103 Actinoid series																											
a X b a = relative atomic mass X = atomic symbol b = atomic (proton) number																											
			140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	147 Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71											
			232 Th Thorium 90	231 Pa Protactinium 91	238 U Uranium 92	237 Np Neptunium 93	244 Pu Plutonium 94	243 Am Americium 95	247 Cm Curium 96	247 Bk Berkelium 97	251 Cf Californium 98	252 Es Einsteinium 99	257 Fm Fermium 100	258 Md Mendelevium 101	259 No Nobelium 102	260 Lr Lawrencium 103											

Key

a	X	b
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a = relative atomic mass

X = atomic symbol

b = atomic (proton) number

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).

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