



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE
NAME

CENTRE
NUMBER

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CANDIDATE
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COMBINED SCIENCE

0653/31

Paper 3 (Extended)

May/June 2013

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 pencil for any diagrams or graphs.

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 28.

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 **26** printed pages and **2** blank pages.



- 1 (a) Table 1.1 shows the numbers of protons, neutrons and electrons in four atoms, **A**, **B**, **C** and **D**.

For
Examiner's
Use

Table 1.1

atom	protons	neutrons	electrons
A	2	2	2
B	3	4	3
C	1	0	1
D	4	5	4

- (i) Explain which one of the atoms, **A**, **B**, **C** or **D**, has a nucleon number (mass number) of four.

atom

explanation

..... [1]

- (ii) Explain why all atoms do **not** have an overall electrical charge.

.....

.....

..... [2]

(b) Fig. 1.1 shows containers of hydrogen and helium.

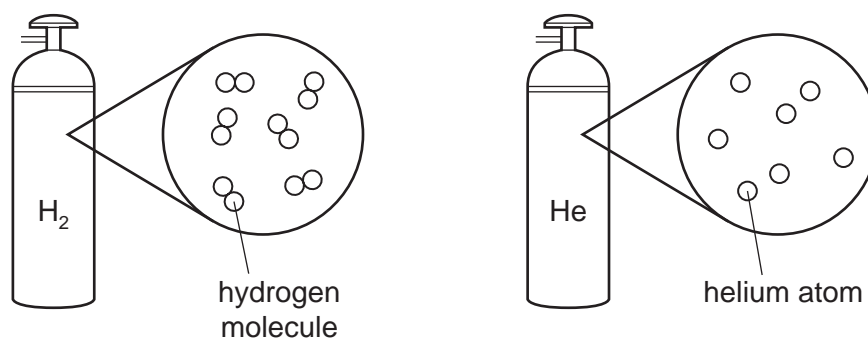


Fig. 1.1

- (i) Describe, in terms of electrons, how a chemical bond forms between two hydrogen atoms.

You may draw a diagram of a hydrogen molecule if it helps you to answer this question.

.....

 [2]

- (ii) Explain why helium exists as single atoms and **not** as molecules.

.....
 [1]

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(c) Hydrogen is often included in the reactivity series of metals.

Use the idea of reactivity to explain the observations shown in Fig. 1.2.

For
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Use

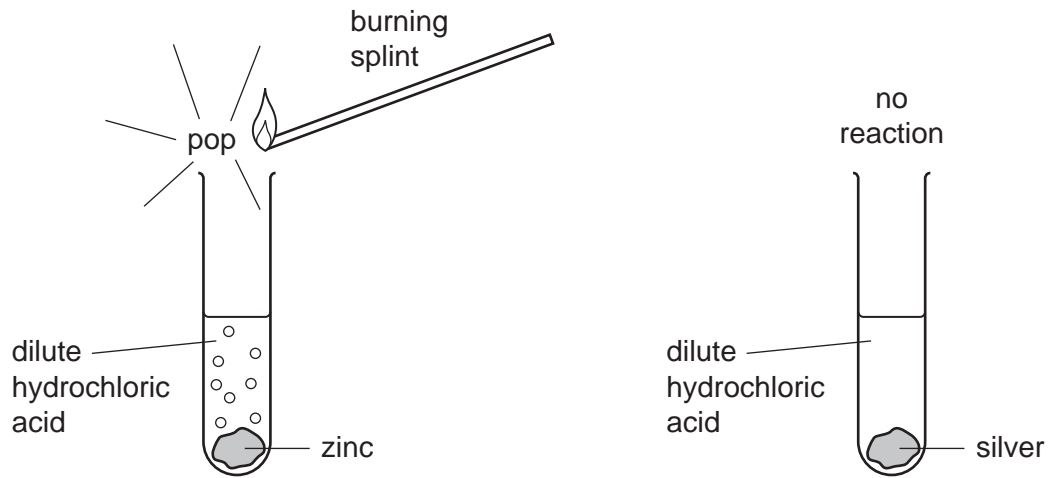


Fig. 1.2

.....

.....

.....

.....

..... [3]

- 2 (a) A fishing boat uses echo sounding to detect a shoal of fish.

This is shown in Fig. 2.1.

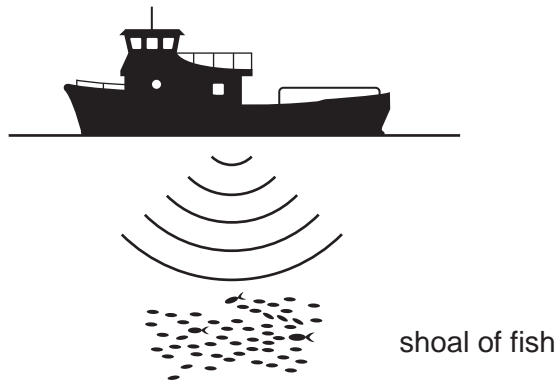


Fig. 2.1

Short pulses of sound are sent out from the boat. The echo from the shoal of fish is detected by a receiver on the boat 0.2 seconds later.

Sound waves travel through water at a speed of 1600 m/s.

- (i) Calculate the distance of the shoal of fish below the boat.

State the formula that you use and show your working.

formula

working

..... [2]

- (ii) The sound waves have a wavelength of 0.25 m.

Calculate the frequency of the waves.

State the formula that you use and show your working.

formula

working

..... [2]

For
Examiner's
Use

(b) (i) Water waves are a renewable energy resource.

Outline **two** advantages of using renewable energy resources.

1

2

..... [2]

(ii) Fig. 2.2 shows how water waves can be used to produce electricity.

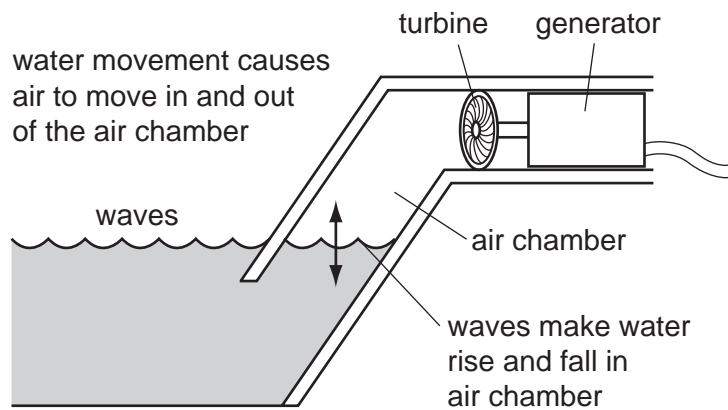


Fig. 2.2

Using the information in Fig. 2.2, describe **two** of the energy transfers that are involved in changing the kinetic energy of the waves into electrical energy.

.....

.....

.....

.....

.....

..... [2]

(c) Fig. 2.3 shows an iceberg floating in the sea.

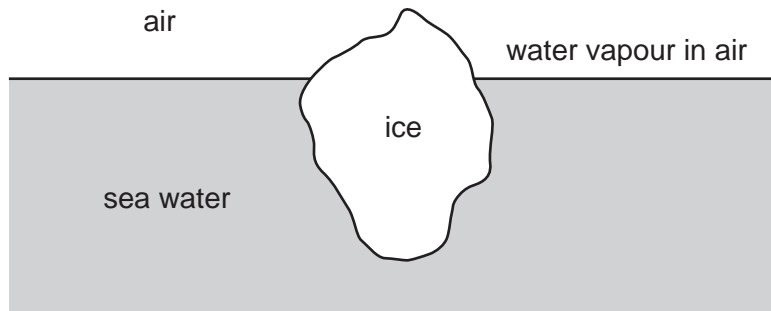


Fig. 2.3

(i) Which material named on Fig. 2.3 best fits the statement below?

“The particles are able to move, are randomly arranged and are closely packed.”

..... [1]

(ii) Name the process by which water molecules in the sea become water molecules in the air.

..... [1]

For
Examiner's
Use

3 The addition of a harmful substance to the environment is called pollution. Three examples of pollution caused by human activities are

- acid rain,
- fertilisers entering rivers and lakes,
- the release of too much carbon dioxide into the atmosphere.

(a) Describe how acid rain is caused.

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

(b) Explain what happens in a lake after large quantities of fertilisers are washed into it.

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

(c) Explain how cutting down forests can result in an increase in the carbon dioxide concentration in the atmosphere.

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

Please turn over for Question 4.

4 Petroleum (crude oil) and rock salt occur naturally in the Earth's crust.

- (a) Petroleum is a mixture that contains thousands of different compounds. Many of these compounds are alkanes.

Draw the structure of the alkane molecule that contains eight hydrogen atoms. Use short lines to represent covalent bonds.

For
Examiner's
Use

[2]

- (b) When petroleum is refined, it is separated into simpler mixtures.

Fig. 4.1 shows a simplified diagram of apparatus that is used to refine petroleum.

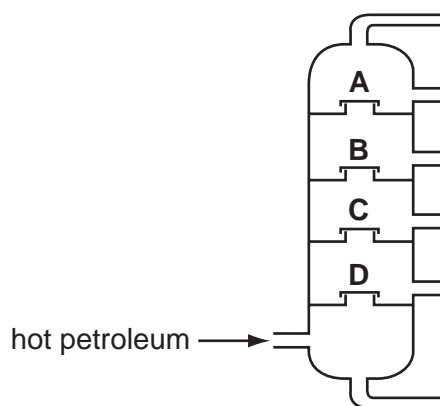


Fig. 4.1

Explain, in terms of intermolecular forces and the size of molecules, why the average boiling point of the fraction at **B** differs from the average boiling point of the fraction at **C**.

.....

.....

.....

.....

.....

..... [3]

(c) Rock salt contains mainly sodium chloride which is a compound of the alkali metal, sodium, and the halogen, chlorine.

For
Examiner's
Use

(i) Explain why the uncombined elements sodium and chlorine are **not** found in the Earth's crust.

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

(ii) Describe the changes in electron configuration when sodium atoms (2,8,1) react with chlorine atoms (2,8,7) to form sodium chloride.

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

5 Milk is a liquid produced by cows, goats and other mammals, on which they feed their young.

For
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Use

(a) Table 5.1 shows the mass of some of the substances in 100g samples of milk from three mammals.

Table 5.1

substance	cow's milk	goat's milk	water-buffalo's milk
protein/g	3.2	3.1	4.5
fat/g	3.9	3.5	8.0
carbohydrate/g	4.8	4.4	4.9
calcium/mg	120	100	195

(i) Which substance shown in Table 5.1 is present in the samples of milk in the smallest quantity?

..... [1]

(ii) Suggest which substance, **not** shown in Table 5.1, is present in the samples of milk in the largest quantity.

..... [1]

(iii) Explain **one** way in which drinking water-buffalo's milk might be better for a person's health than drinking goat's milk.

.....

 [2]

(iv) State and explain which substance in Table 5.1 does **not** need to be digested in the human alimentary canal.

.....

 [2]

(b) Milk can be used for making yoghurt.

- Bacteria are added to the milk. The milk is kept at a temperature of 40 °C.
- The bacteria convert lactose in the milk to lactic acid.
- When the pH has reached about 4.5, the yoghurt is moved to a refrigerator at a temperature of 3 °C.

(i) Explain why the milk is kept at a temperature of 40 °C after the bacteria have been added to it.

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

(ii) Suggest why the yoghurt is kept in a refrigerator at a temperature of 3 °C.

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

(iii) Milk has a pH of about 6.5. Explain why the pH of milk changes during the manufacture of yoghurt.

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

- 6 (a) In a store, two workers are lifting 5 kg bags of flour onto the shelves. There are five shelves, 0.4 m apart. The lowest shelf is 0.4 m from the floor.

For
Examiner's
Use

Fig. 6.1 shows the two workers.

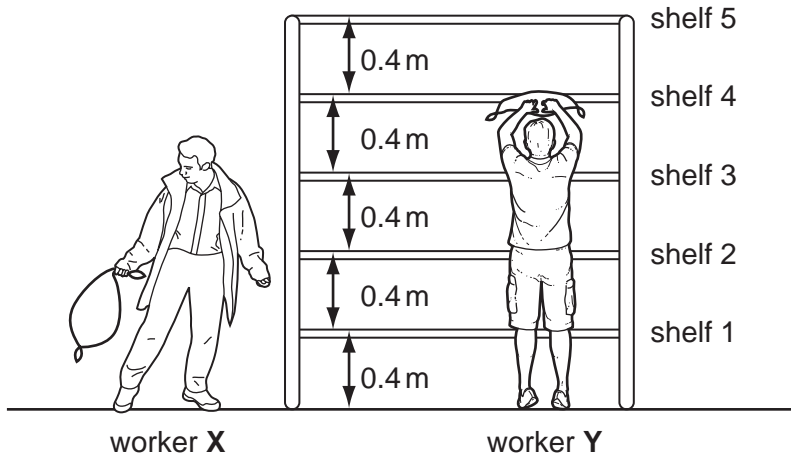


Fig. 6.1

- (i) Worker X lifts three bags from the floor to shelf 2. Worker Y lifts one bag from the floor to shelf 5.

Worker X says that he has done more work than worker Y.

Use calculations of the work done to explain whether or not he is correct.

State the formula that you use.

formula

.....
 [2]

- (ii) Each worker lifts one bag from the floor to shelf 2. Worker X does this more quickly than worker Y.

Which worker exerted the higher power during their lift?

Explain your answer.

.....
 [1]

- (iii) Each 5 kg bag of flour has a volume of 5500 cm^3 .

Calculate the average density of the bag of flour.

State your answer in g/cm^3 .

State the formula that you use and show your working.

formula

working

..... g/cm^3 [2]

*For
Examiner's
Use*

(b) Three boys, **A**, **B** and **C**, walk together from their school to a store. They stay at the store for a few minutes and then return to school.

When they leave the store,

- one boy walks back to school at a steady pace,
- one boy walks back to school at a slower steady pace,
- one boy slows down gradually as he walks back to school.

The graph in Fig. 6.2 shows how their speeds vary with time during the whole journey to the store and back again.

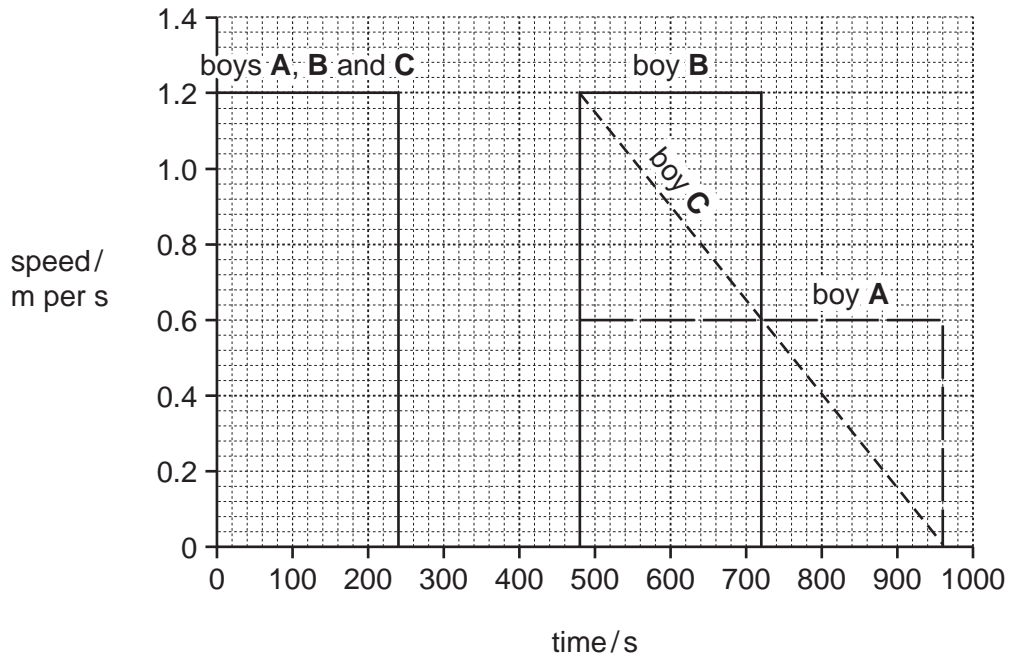


Fig. 6.2

(i) Calculate the distance of the store from the school.

Show your working.

..... [2]

(ii) For how many seconds do the boys stay in the store?

..... s [1]

(iii) Which boy slowed down on his way back to school?

State a reason for your answer.

boy because

..... [1]

- 7 (a) Fig. 7.1 shows apparatus a student used to investigate the reaction between a white powder and dilute hydrochloric acid.

For
Examiner's
Use

The student predicted that a gas would be given off in her experiment and chose to test the gas using limewater.

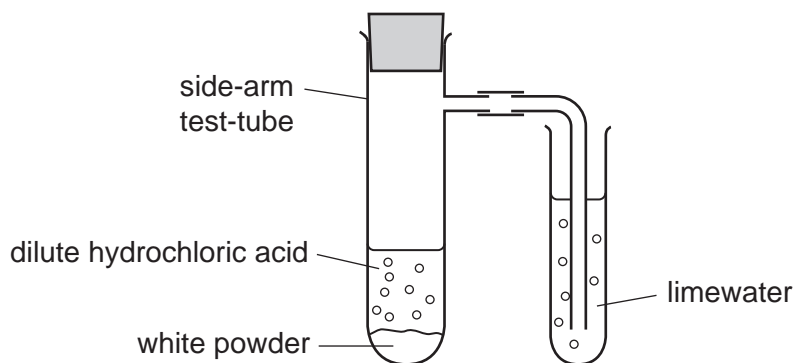


Fig. 7.1

State the gas that the student predicted would be given off.

Explain your answer.

name of gas

explanation

.....

..... [2]

- (b) The student investigated the temperature change when sodium hydrogencarbonate was added to excess dilute hydrochloric acid.

For
Examiner's
Use

Fig. 7.2 shows the apparatus she used.

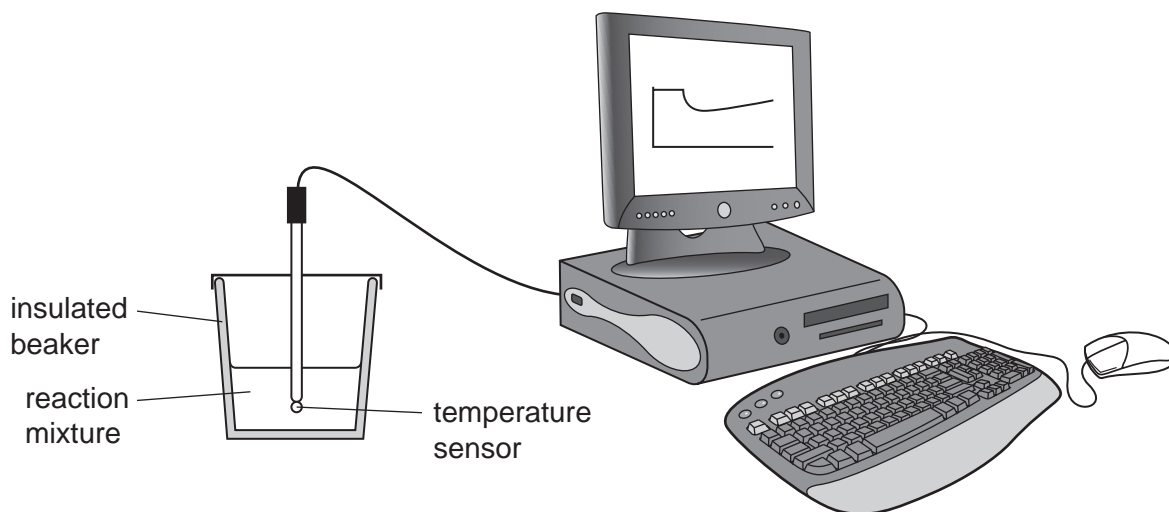


Fig. 7.2

Temperature measurements were displayed on the computer screen as a graph of temperature against time.

This graph is shown in Fig. 7.3.

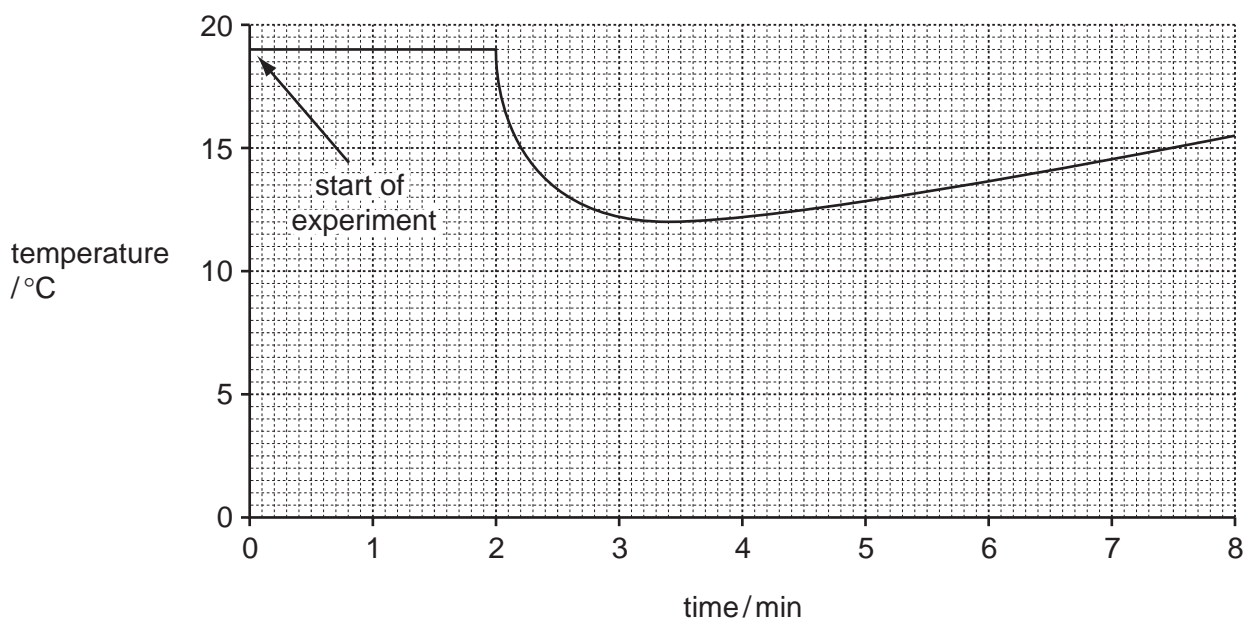


Fig. 7.3

- (i) On the graph, mark with an **X** the point where sodium hydrogencarbonate was added to the dilute hydrochloric acid. [1]

- (ii) Calculate the temperature change shown in Fig. 7.3 that occurred during the reaction.

..... [2]

- (iii) Use the results shown in Fig. 7.3 to explain, in terms of chemical energy and heat energy, the energy transformation that occurred during the reaction.

.....

.....

..... [2]

- (c) Sodium hydrogencarbonate, NaHCO_3 , is a solid compound made of sodium ions and hydrogencarbonate ions. Sodium is a metal in Group 1 of the Periodic Table.

Deduce the formula and electrical charge of a hydrogencarbonate ion.

Explain your answer.

.....

.....

..... [3]

8 Fig. 8.1 shows the human gas exchange system.

For
Examiner's
Use

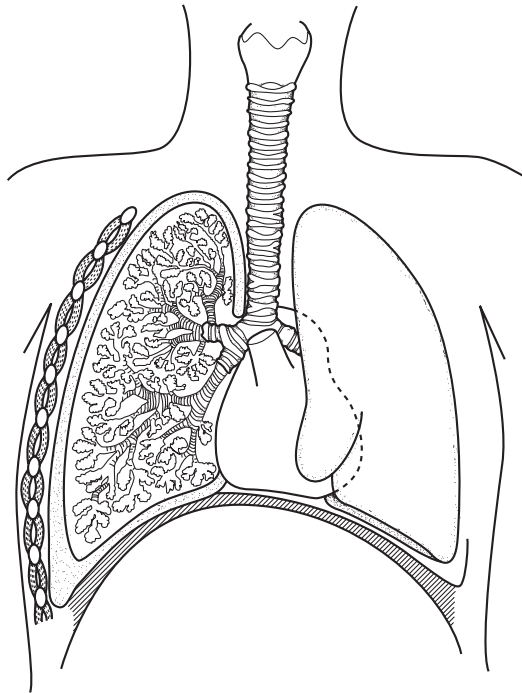


Fig. 8.1

(a) Use label lines to label each of these structures on Fig. 8.1.

trachea

bronchus

[2]

(b) Gas exchange takes place across the surface of the alveoli in the lungs.

List **two** features of alveoli that help gas exchange to take place quickly.

1

2 [2]

- (c) The gas exchange system is protected from pathogens and harmful substances by a tissue, containing goblet cells and ciliated cells, that lines the nose, trachea and bronchi.

For
Examiner's
Use

Fig. 8.2 shows part of this tissue inside the nose.

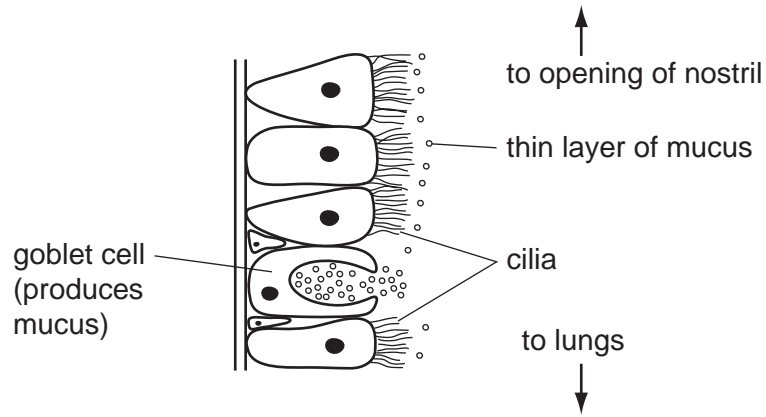


Fig. 8.2

Describe how the tissue shown in Fig. 8.2 helps to stop harmful substances getting into the lungs.

.....

.....

.....

..... [2]

- (d) An experiment was carried out to find out how passive smoking affects the activity of the goblet cells and cilia.

Six people sat in a closed room. On day 1, they breathed normal, clean air. On day 2, they breathed air containing cigarette smoke.

After one hour, a substance was sprayed into each person's nose. After 40 minutes, the researchers measured the percentage of the substance that remained in each person's nose. This was done on both days.

The faster the cilia and goblet cells were working, the faster the substance was removed from the nose.

Table 8.1 shows the results.

Table 8.1

person	percentage of substance remaining after 40 minutes	
	day 1 after breathing clean air	day 2 after breathing air containing cigarette smoke
1	65	26
2	84	49
3	67	96
4	23	51
5	40	91
6	78	24

- (ii) Which three persons' results showed that breathing air containing cigarette smoke slowed down the rate at which their cilia and goblet cells worked?

..... [1]

- (ii) Suggest how exposure to cigarette smoke could affect the health of these three people.

.....

 [3]

Please turn over for Question 9.

- 9 (a) A student investigated how a change in potential difference across a lamp affected the current flowing through the lamp.

For
Examiner's
Use

She used wires to connect the components shown in Fig. 9.1 to make a circuit.

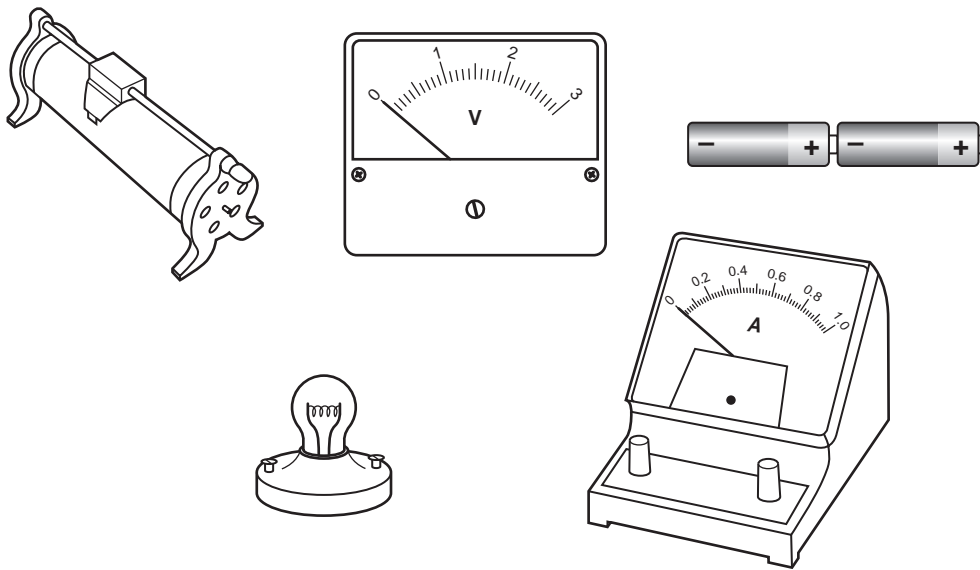


Fig. 9.1

- (i) Using the correct circuit symbols, draw a diagram to show the circuit she used.

[3]

- (ii) The student measured the current passing through a wire when a potential difference was applied across it.

Calculate the resistance of the wire when a potential difference of 0.3V is applied and the current measured is 0.5A.

State the formula that you use and show your working.

formula

working

..... [2]

- (b) Electricity is often transmitted through overhead power cables hung from pylons. If these cables are put up on a hot summer day, they are hung loosely from the pylons as shown in Fig. 9.2.

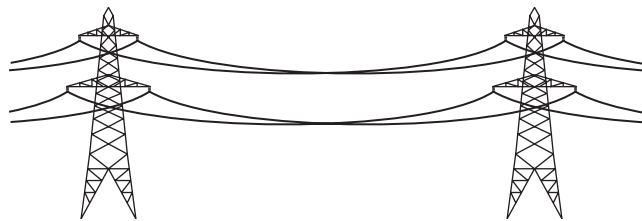


Fig. 9.2

Suggest why the cables are hung loosely.

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

DATA SHEET
The Periodic Table of the Elements

		Group																		
		I	II	III	IV	V	VI	VII	VIII	IX	X									
		1 H Hydrogen 1																		
7	9	3	4	5	6	7	8	9	10	11	12									
Li Lithium	Be Beryllium	B Boron	C Carbon	N Nitrogen	O Oxygen	F Fluorine	Ne Neon	Na Sodium	Mg Magnesium	Al Aluminium	Si Silicon	P Phosphorus	S Sulfur	Cl Chlorine	Ar Argon					
11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26					
K Potassium	Ca Calcium	Sc Scandium	Ti Titanium	V Vanadium	Cr Chromium	Mn Manganese	Fe Iron	Co Cobalt	Ni Nickel	Cu Copper	Zn Zinc	Ga Gallium	Ge Germanium	As Arsenic	Se Selenium	Br Bromine	Kr Krypton			
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55		
Rb Rubidium	Sr Strontium	Y Yttrium	Zr Zirconium	Nb Niobium	Mo Molybdenum	Tc Technetium	Ru Ruthenium	Rh Rhodium	Pd Palladium	Ag Silver	Cd Cadmium	In Indium	Sn Tin	Sb Antimony	Te Tellurium	I Iodine	Xe Xenon	Cs Caesium		
55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73		
Fr Francium	Ra Radium	Ac Actinium	La Lanthanum	Ce Cerium	Pr Praseodymium	Nd Neodymium	Pm Promethium	Sm Samarium	Eu Europium	Gd Gadolinium	Tb Terbium	Dy Dysprosium	Ho Holmium	Er Erbium	Tm Thulium	Yb Ytterbium	Lu Lutetium	Rn Radon		
87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105		
Fr Francium	Ra Radium	Ac Actinium	Th Thorium	Pa Protactinium	U Uranium	Np Neptunium	Pu Plutonium	Am Americium	Cm Curium	Bk Berkelium	Cf Californium	Es Einsteinium	Fm Fermium	Md Mendelevium	No Nobelium	Lr Lawrencium	Rn Radon	Lu Lutetium	Uuo Ununoctium	
117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	
Uue Ununseptium	Uuo Ununoctium	Uu1 Ununennium	Uu2 Unbinilium	Uu3 Untrium	Uu4 Unquadrium	Uu5 Unquadium	Uu6 Unsextilium	Uu7 Unseptilium	Uu8 Unoctilium	Uu9 Unennium	Uu10 Unbinilium	Uu11 Untrium	Uu12 Unquadrium	Uu13 Unquadium	Uu14 Unsextilium	Uu15 Unseptilium	Uu16 Unoctilium	Uu17 Unennium	Uu18 Unbinilium	Uu19 Untrium
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	
Uut Ununtrium	Uuq Ununquadium	Uuq Ununquadium	Uuq Ununquadium	Uuq Ununquadium	Uuq Ununquadium	Uuq Ununquadium	Uuq Ununquadium	Uuq Ununquadium	Uuq Ununquadium	Uuq Ununquadium	Uuq Ununquadium	Uuq Ununquadium	Uuq Ununquadium	Uuq Ununquadium	Uuq Ununquadium	Uuq Ununquadium	Uuq Ununquadium	Uuq Ununquadium	Uuq Ununquadium	Uuq Ununquadium
171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191
Uu1 Ununseptium	Uu2 Unbinilium	Uu3 Untrium	Uu4 Unquadrium	Uu5 Unquadium	Uu6 Unsextilium	Uu7 Unseptilium	Uu8 Unoctilium	Uu9 Unennium	Uu10 Unbinilium	Uu11 Untrium	Uu12 Unquadrium	Uu13 Unquadium	Uu14 Unsextilium	Uu15 Unseptilium	Uu16 Unoctilium	Uu17 Unennium	Uu18 Unbinilium	Uu19 Untrium	Uu20 Unquadrium	Uu21 Unquadium
191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211
Uu22 Unbium	Uu23 Unbinilium	Uu24 Untrium	Uu25 Unquadrium	Uu26 Unquadium	Uu27 Unsextilium	Uu28 Unseptilium	Uu29 Unoctilium	Uu30 Unennium	Uu31 Unbinilium	Uu32 Untrium	Uu33 Unquadrium	Uu34 Unquadium	Uu35 Unsextilium	Uu36 Unseptilium	Uu37 Unoctilium	Uu38 Unennium	Uu39 Unbinilium	Uu40 Untrium	Uu41 Unquadrium	Uu42 Unquadium
211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231
Uu43 Unquadium	Uu44 Unsextilium	Uu45 Unseptilium	Uu46 Unoctilium	Uu47 Unennium	Uu48 Unbinilium	Uu49 Untrium	Uu50 Unquadrium	Uu51 Unquadium	Uu52 Unsextilium	Uu53 Unseptilium	Uu54 Unoctilium	Uu55 Unennium	Uu56 Unbinilium	Uu57 Untrium	Uu58 Unquadrium	Uu59 Unquadium	Uu60 Unsextilium	Uu61 Unseptilium	Uu62 Unoctilium	Uu63 Unennium
231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251
Uu64 Unbinilium	Uu65 Untrium	Uu66 Unquadrium	Uu67 Unquadium	Uu68 Unsextilium	Uu69 Unseptilium	Uu70 Unoctilium	Uu71 Unennium	Uu72 Unbinilium	Uu73 Untrium	Uu74 Unquadrium	Uu75 Unquadium	Uu76 Unsextilium	Uu77 Unseptilium	Uu78 Unoctilium	Uu79 Unennium	Uu80 Unbinilium	Uu81 Untrium	Uu82 Unquadrium	Uu83 Unquadium	Uu84 Unsextilium
251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271
Uu85 Unquadium	Uu86 Unsextilium	Uu87 Unseptilium	Uu88 Unoctilium	Uu89 Unennium	Uu90 Unbinilium	Uu91 Untrium	Uu92 Unquadrium	Uu93 Unquadium	Uu94 Unsextilium	Uu95 Unseptilium	Uu96 Unoctilium	Uu97 Unennium	Uu98 Unbinilium	Uu99 Untrium	Uu100 Unquadrium	Uu101 Unquadium	Uu102 Unsextilium	Uu103 Unseptilium	Uu104 Unoctilium	Uu105 Unennium

*58-71 Lanthanoid series
†90-103 Actinoid series

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

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

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