Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

COMBINED SCIENCE **0653/32**

Paper 3 (Extended) **May/June 2015**

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 an HB 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.

DC (LK/CGW) 98907/3

1 **(a)** Table 1.1 gives some facts about the element astatine and its position in the Periodic Table.

Table 1.1

element	period	Group	proton number
astatine	6	VII	85

From the information in Table 1.1, deduce the number of electrons in the outer shell of an astatine atom.

number ....

explanation ....

....[2]

(b) Fig. 1.1 shows a demonstration of the reaction between hydrogen and the oxygen in air.

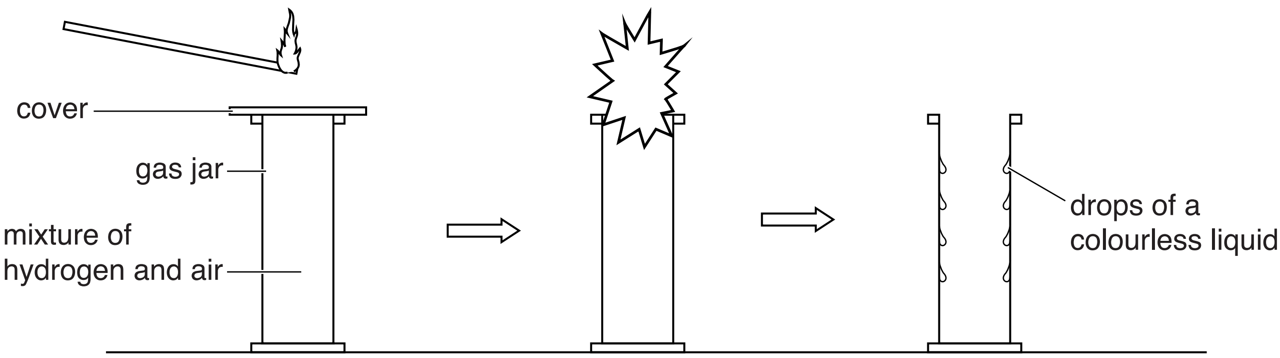


Fig. 1.1

A burning splint is placed over a gas jar containing a mixture of hydrogen and air.

The cover is removed.

The mixture explodes.

(i) Drops of a colourless liquid are observed inside the gas jar.

Describe a chemical test and the result that shows that the liquid is water.

test ....

....

result ....[2]

(ii) Write a symbolic chemical equation for the reaction between hydrogen and oxygen, including state symbols.

....[3]

(iii) Fig. 1.2 shows the arrangement of electrons in the outer shells of a hydrogen atom and an oxygen atom.

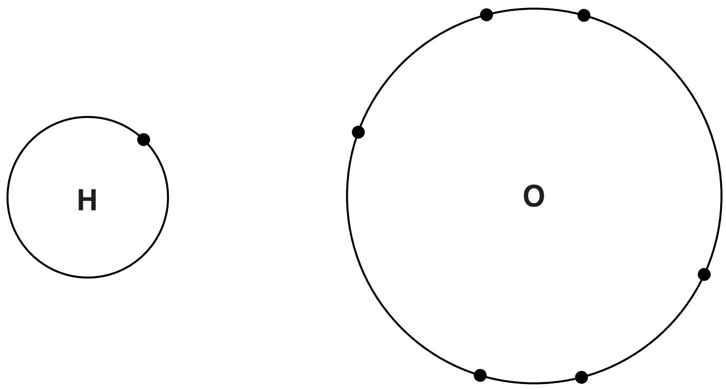


Fig. 1.2

Draw a diagram to show the arrangement of outer electrons in a water molecule.

[2]

2 **(a)** The element nitrogen is needed by all living things to make protein. Nitrogen is absorbed by plant roots in the form of nitrate ions that are dissolved in the water in the soil.

Fig. 2.1 shows a root hair cell.

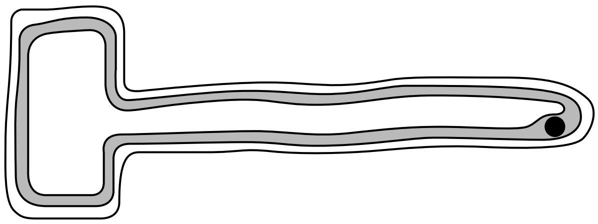


Fig 2.1

Describe how the shape of the root hair cell is important for its function.

....

....

....[2]

(b) In some areas of the world the soil does not have enough nitrogen.

Fig. 2.2 shows a Venus flytrap. This plant can grow in areas of low nitrogen by capturing insects and digesting the protein in their bodies to obtain the nitrogen it needs.

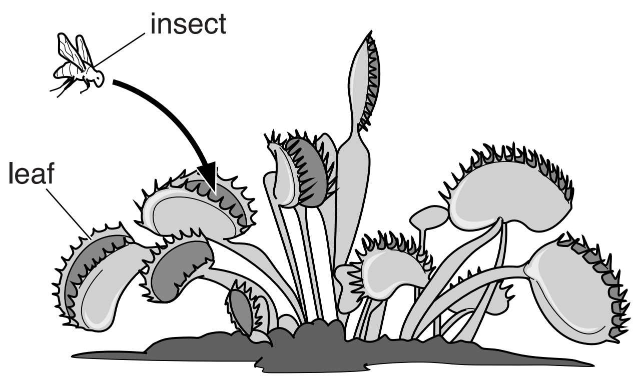


Fig 2.2

The leaves produce an enzyme which breaks down the protein in the insect's body by chemical digestion.

Describe what is meant by *chemical digestion*.

....

....

....[2]

(c) Some students are studying how temperature affects an enzyme similar to the one produced by the Venus flytrap. They add a solution of the enzyme to cubes of protein and incubate the cubes at a range of temperatures.

The time taken to digest each cube is shown in Table 2.1.

Table 2.1

temperature / °C	time taken / minutes
10	5.8
20	3.6
30	2.1
40	1.7
50	1.9
60	3.5

(i) State which temperature shows the fastest digestion.

....[1]

(ii) In terms of particles, describe and explain fully what happens to the speed of digestion

when the temperature is increased from 10 °C to 30 °C,

....

....

....

when the temperature is increased above 50 °C.

....

....

....[4]

3 The pole vault is an athletics event in which the athlete attempts to get over a very high bar with the help of a long pole.

Fig. 3.1 shows an athlete at five stages during a pole vault.

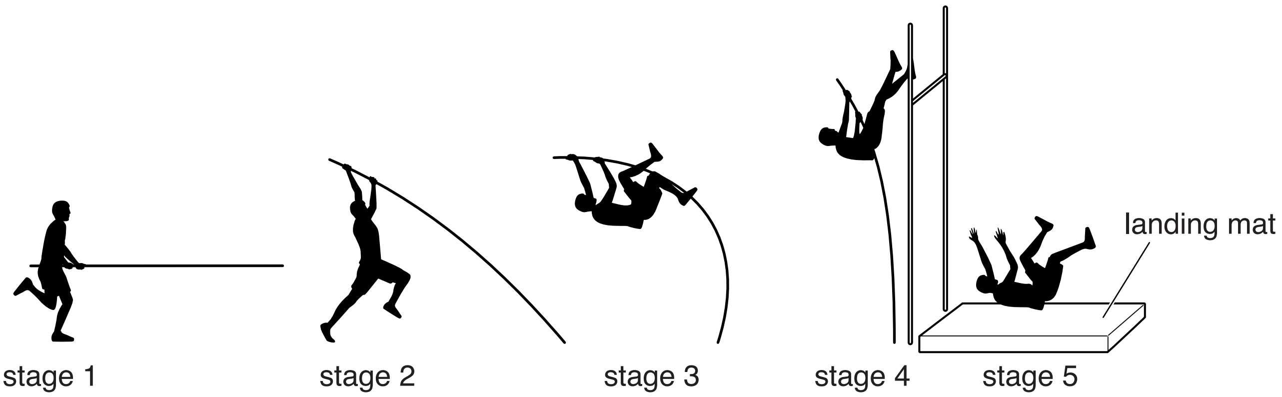


Fig. 3.1

The athlete runs with his pole, places the pole in the ground and pushes himself upwards. He rises to the height of the bar, remains there for a brief moment, then falls over the bar to the landing mat.

Fig. 3.2 shows a simplified graph of the athlete's speed during the pole vault.

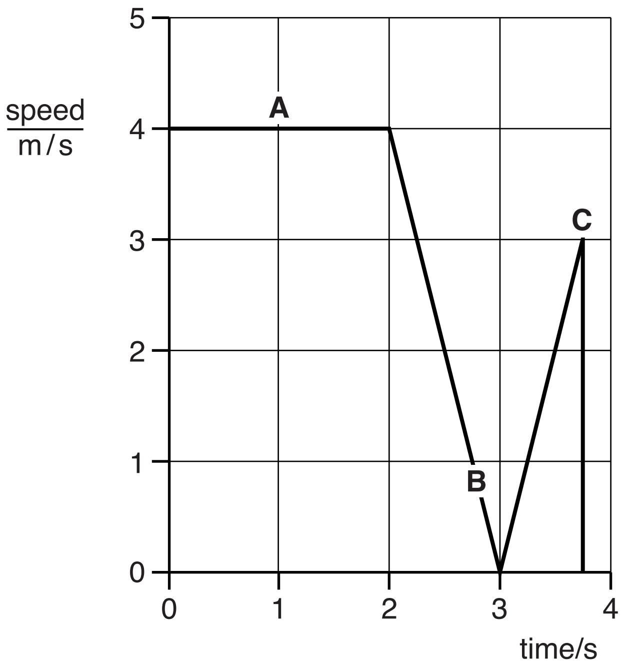


Fig. 3.2

(a) The letters **A**, **B** and **C** on the graph in Fig. 3.2 correspond to three of the five stages in the pole vault shown in Fig. 3.1.

(i) Explain why **A** on the graph corresponds to stage 1.

....

....[1]

(ii) Explain why **B** on the graph corresponds to stage 4.

....

....[1]

(b) The energy of the athlete changes during this pole vault. He starts with chemical energy in his muscles.

State the main energy changes that follow before he lands on the mat.

from chemical energy to kinetic energy to .... energy

to .... energy [2]

(c) Describe the motion of the athlete between points **B** and **C**.

....[1]

(d) Using the graph in Fig. 3.2, calculate the distance travelled by the athlete between 2 seconds and 3 seconds.

Show your working.

distance = ... m [2]

(e) The athlete uses a long metal vaulting pole. On a hot day, the length of the metal pole is a few millimetres longer than its length on a cold day.

Explain why this happens in terms of the particle structure of the metal.

....

....

....[2]

4 **(a)** Fig. 4.1 shows a sample of rock containing bands of iron oxide.

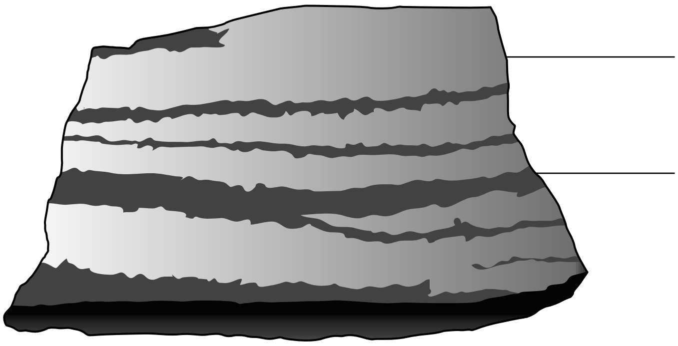


Fig. 4.1

Some information about the formation of this rock is shown below:

- this rock was formed about 2.5 billion years ago;
- oxygen was produced by bacteria in the oceans;
- iron compounds were dissolved in the oceans;
- iron compounds were oxidised by reacting with oxygen to make insoluble iron oxide;
- iron oxide settled on the ocean bed to produce the dark layers in the rock.

(i) State **one** physical change and **one** chemical change that occurred when the rock shown in Fig. 4.1 was formed.

physical change ....

....

chemical change ....

....[2]

(ii) Describe the difference between a physical change and a chemical change.

....

....[1]

(b) For a long time, very little of the oxygen produced by bacteria in part **(a)** was released into the atmosphere.

Fig. 4.2 shows the approximate composition of the Earth's atmosphere 3 billion years ago.

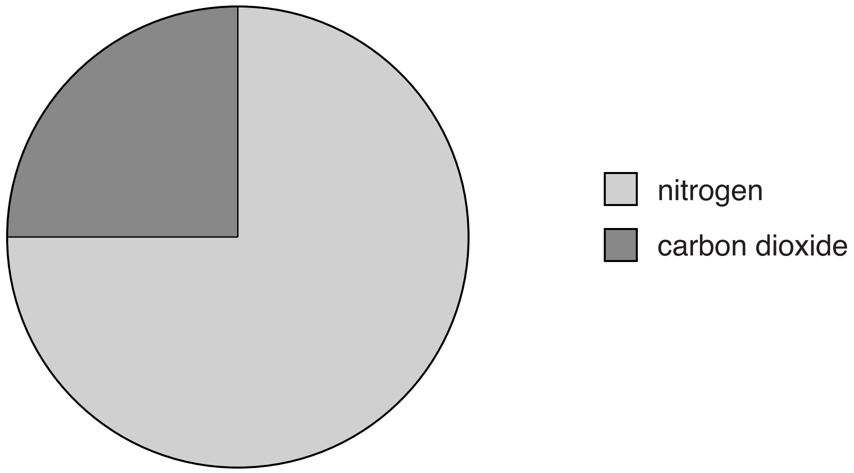


Fig. 4.2

Apart from the difference in oxygen content, describe one main difference and one main similarity between the composition of the atmosphere 3 billion years ago and our present day atmosphere.

difference ....

similarity ....[2]

(c) Iron can be extracted from iron oxide in a blast furnace.

(i) State the name of a gaseous substance which reduces the iron oxide to iron in the furnace.

....[1]

(ii) State the raw material(s) that are used by the furnace to supply this gaseous substance.

....[1]

(iii) The temperature in a blast furnace can reach 1300°C.

Copper can be extracted from copper oxide in the laboratory at a lower temperature.

Explain why less energy is needed to extract copper from copper oxide than is needed to extract iron from iron oxide.

....

....

.... [2]

(iv) The molten iron extracted from iron oxide contains silicon dioxide as an impurity.

Explain how silicon dioxide is removed from the molten iron in the blast furnace.

....

....

.... [2]

5 **(a)** Fig. 5.1 shows the external view of the heart, including the blood vessels that take blood into and out of the heart. The coronary arteries are also shown.

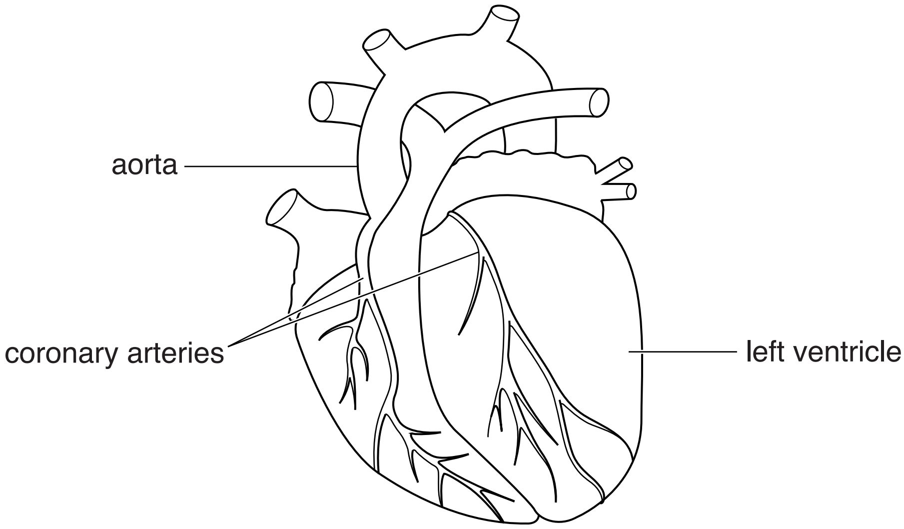


Fig. 5.1

(i) On Fig. 5.1 use label lines to label

a pulmonary artery,

the vena cava. [2]

(ii) Some people suffer from coronary heart disease.

Explain what is meant by *coronary heart disease*.

....

....

....[2]

(b) Table 5.1 shows the average number of cigarettes smoked per adult each day in four countries. The number of deaths due to coronary heart disease per 100 000 of the population per year is also shown.

Table 5.1

country	average number of cigarettes smoked per adult each day	number of deaths per year / 100 000 population
A	7.4	185
B	4.1	76
C	3.3	35
D	5.5	152

(i) Use the data in Table 5.1 to describe the relationship between smoking cigarettes and coronary heart disease.

....

....

....[2]

(ii) Country **E**, not included in the table, had different results.

The adults in country **E** smoked on average 4.6 cigarettes per day. The number of deaths from coronary heart disease per 100 000 of the population / year was 23.

Suggest **two** possible reasons why the results for country **E** do **not** follow the relationship you identified in part **(i)**.

1 ....

....

2 ....

....

[2]

(c) Cigarette smoking can cause infections of the lungs.

Fig. 5.2 shows two types of cell in the lining of the airway leading to the lungs.

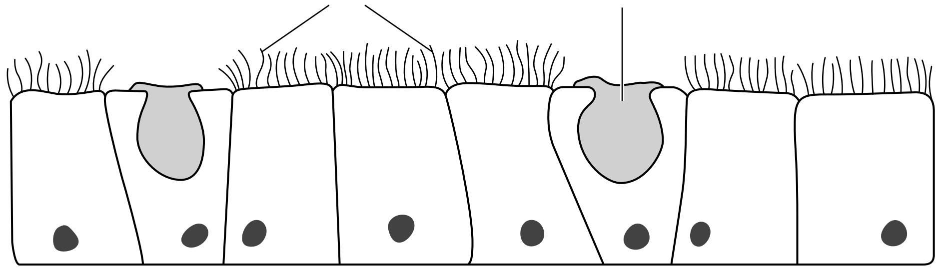


Fig. 5.2

Smoking damages the cilia and also encourages more mucus to be produced.

Explain how **both** of these effects can increase the chances of infection in the lungs.

cilia damage..

....

....

extra mucus production ....

....

....[2]

6 Fig. 6.1 shows apparatus called a ripple tank. This is used by students for experiments to investigate water waves.

The electric motor causes the board to vibrate. At a constant speed of rotation, the motor produces waves at a constant rate.

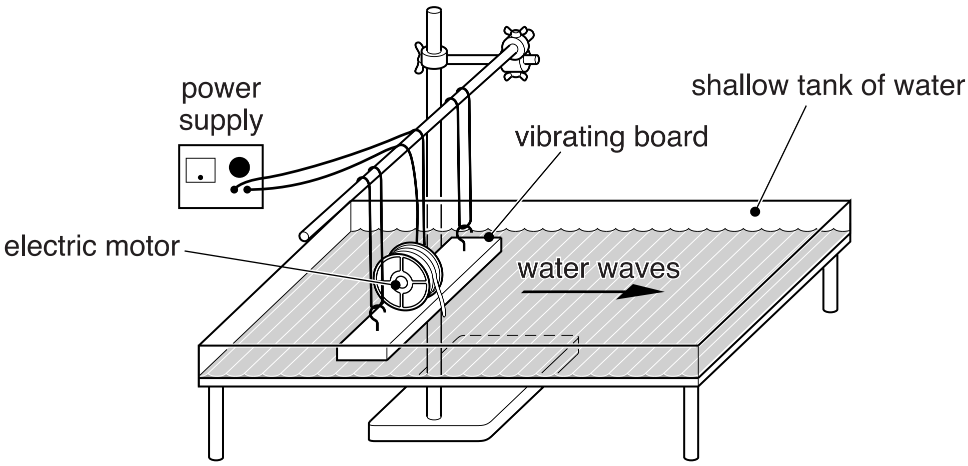


Fig. 6.1

Fig. 6.2 shows a close-up side view of some water waves during an experiment in the tank.

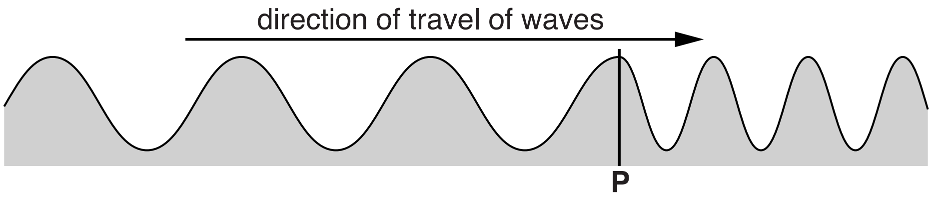


Fig. 6.2

(a) **(i)** Explain why water waves are examples of transverse waves.

....

....[1]

(ii) Give an example of a longitudinal wave.

....[1]

(b) Fig. 6.2 shows a change in the wavelength of the waves as they reach point **P**. The amplitude of the wave does not change.

Name **one** other property of the wave motion that remains the same after passing point **P**.

....[1]

(c) As the speed of the motor is increased, the board vibrates more rapidly.

When the board is vibrating at 10 vibrations per second, the students cannot hear any sound.

When the board is vibrating at 30 vibrations per second, the students can hear a sound with a low pitch.

(i) Explain why the students cannot hear any sound when the board makes 10 vibrations per second.

....

....[1]

(ii) When the board vibrates at 30 vibrations per second, the wavelength of the water waves before they reach point **P**, is 1.0 cm.

Calculate the speed of the waves before they reach point **P**.

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

formula

working

speed of waves = ... unit .... [3]

(iii) Describe how the sound is transmitted from the vibrating board through the air to the students standing at some distance from the ripple tank.

....

....

....[2]

7 **(a)** Petroleum (crude oil) is a mixture of hydrocarbons.

Fig. 7.1 summarises the process which separates the mixture into some of its useful fractions.

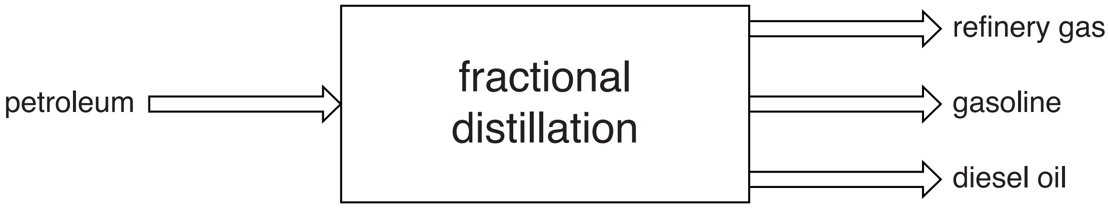


Fig. 7.1

Each of these fractions consists of a mixture of hydrocarbons including alkanes.

Fig. 7.2 shows a model of a molecule of one of the alkanes in refinery gas.

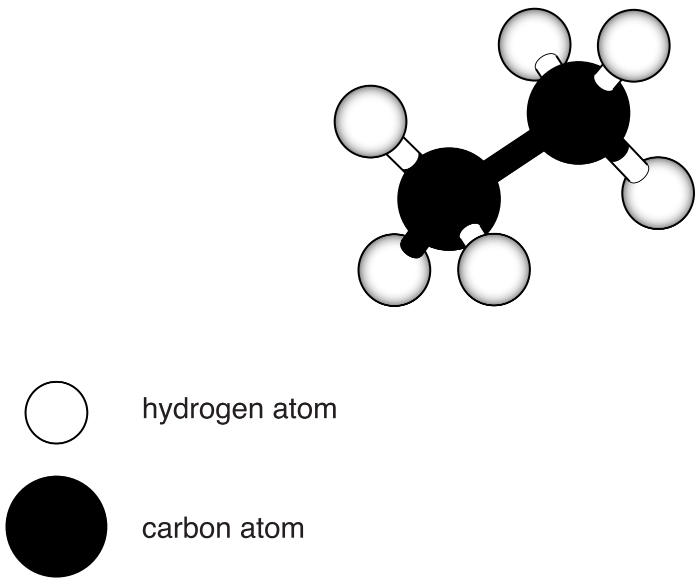


Fig. 7.2

(i) Write the name and molecular formula of this alkane.

....

....[2]

(ii) The petroleum fractions have different boiling point ranges.
This allows them to be separated by fractional distillation.

Describe how boiling point is affected by the size of the molecules and explain your answer.

relationship between boiling point and size of molecules ....

....

explanation ....

....

....[3]

(b) Fig. 7.3 shows the electrolysis of copper chloride solution.

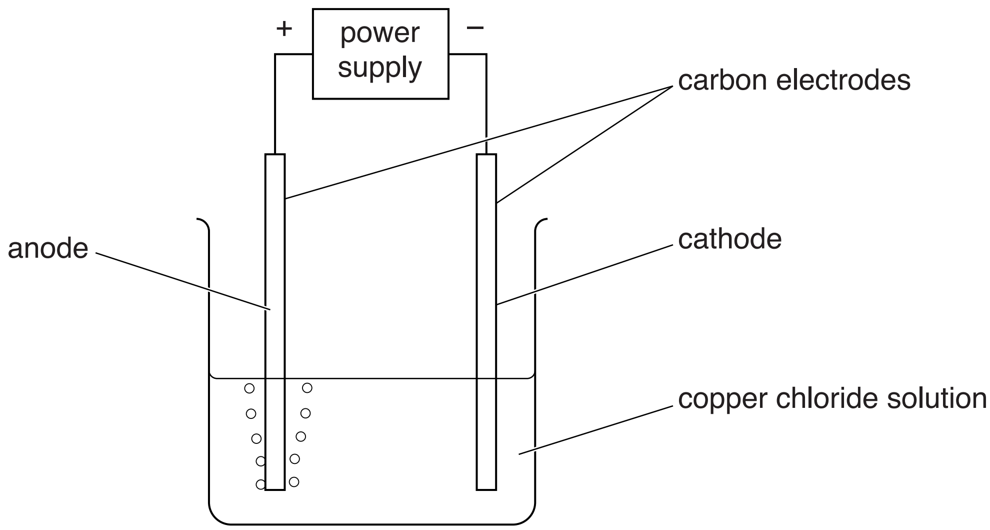


Fig. 7.3

Bubbles of chlorine gas appear at the anode.

By referring to the movement of ions and electrons, explain the formation of this gas.

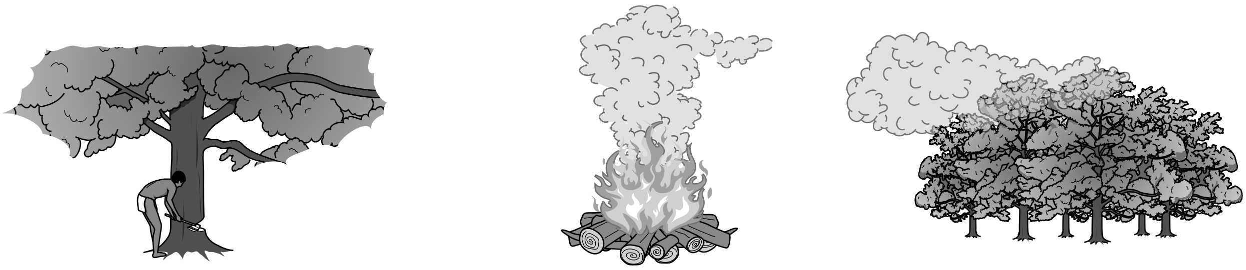
....

....

....

....[2]

8 **(a)** Humans clear forests in some parts of the world so that the land can be used to grow crops. Fig. 8.1 shows the burning of trees to clear forests.



1. trees being felled
2. combustion of wood
3. wind carries smoke to neighbouring trees

Fig. 8.1

When the trees burn, smoke is produced that contains carbon particles. The wind carries the smoke to neighbouring trees. This causes the rate of photosynthesis in these trees to be reduced.

Explain how the following cause the rate of photosynthesis to be reduced.

(i) Particles of carbon landing on the upper surfaces of the leaves.

....

....[1]

(ii) Particles of carbon blocking the stomata in the leaves.

....

....[1]

(b) A few days after the fire finishes, the concentration of oxygen in the atmosphere near the felled trees is measured and compared with the concentration before the fire. It has decreased.

(i) Explain what causes the concentration of oxygen in the atmosphere to decrease in the days after the fire.

....

....

....[2]

(ii) Describe one effect that this decrease in oxygen concentration could have on the remaining living organisms in the area.

....

....[1]

(c) Deforestation causes the carbon dioxide concentration of the Earth's atmosphere to increase.

Describe one consequence of an increase in the carbon dioxide concentration of the Earth's atmosphere.

....

....[1]

(d) Humans also cause the concentration of carbon dioxide in the atmosphere to increase by burning fossil fuels.

Name one other substance produced by the burning of fossil fuels.

....[1]

9 A student is building a model car.

Fig. 9.1 shows a circuit he designs for the electrical equipment he wants in the car.

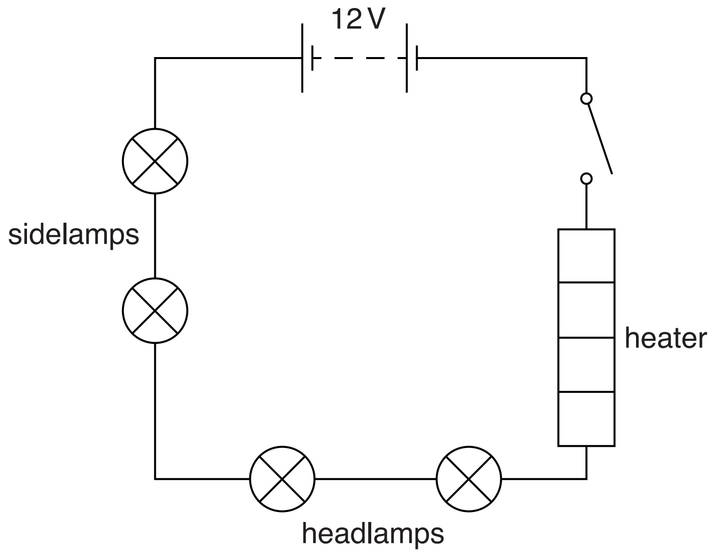


Fig. 9.1

(a) Fig 9.2 shows the lamps and heater he uses for his model. The markings on the lamps and heater are shown below the pictures.

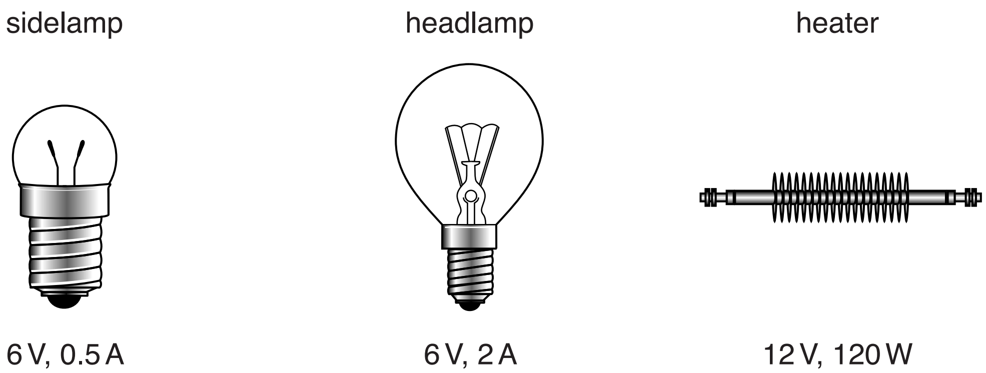


Fig. 9.2

State and explain what is meant by each of these quantities when written on a component.

6 V ....

....

120 W ....

....[4]

(b) When the student switches on the circuit in Fig. 9.1, the lamps glow only very faintly. He has not designed his circuit correctly.

On Fig. 9.3 complete the circuit diagram to show the sidelamps and heater connected so that all the lamps glow brightly.

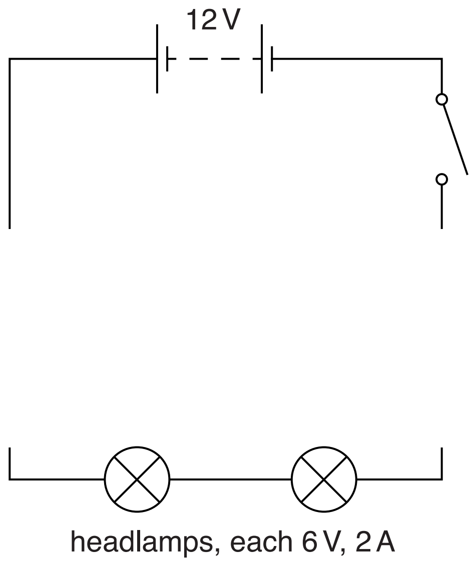


Fig. 9.3

[2]

(c) Calculate the current through the heater when it is working properly at 12 V and 120 W.

State the formula that you use and show your working.

formula

working

current = ... A [2]

(d) The heater is designed to transfer thermal energy to the air to warm the inside of the model car.

Name the method of thermal energy transfer involved when the warm air circulates inside the car.

....[1]

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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	**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 †															

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

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

Key

a
X
b

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

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