Cambridge Assessment International Education

Cambridge IGCSE™ (9–1)

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

0412468692

CO-ORDINATED SCIENCES **0973/41**

Paper 4 Theory (Extended) **May/June 2020**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 120.
- The number of marks for each question or part question is shown in brackets [ ].
- The Periodic Table is printed in the question paper.

This document has **32** pages. Blank pages are indicated.

1 A student investigates the effect of temperature on the rate of photosynthesis in elodea (an aquatic plant).

Fig. 1.1 shows the apparatus used.

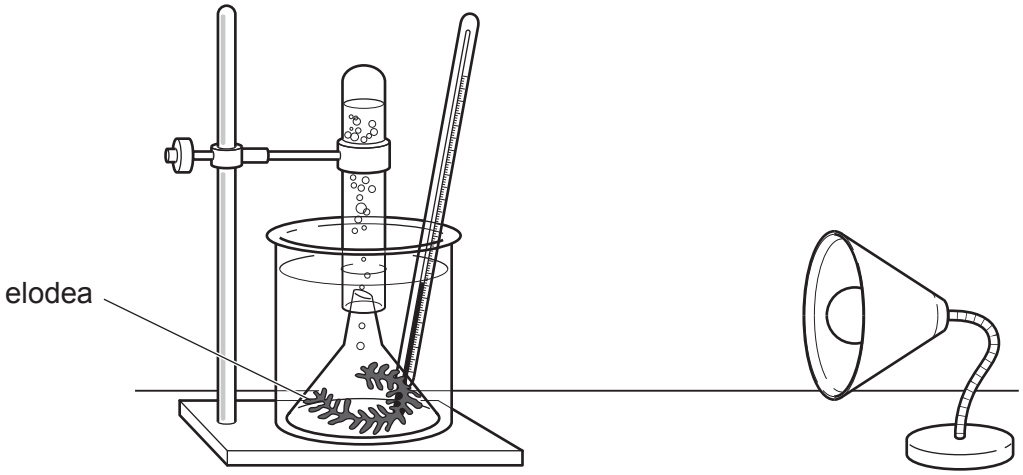

Fig. 1.1

The student counts the number of bubbles of gas released in one minute.

They repeat this with water at different temperatures.

Fig. 1.2 is a graph of their results.

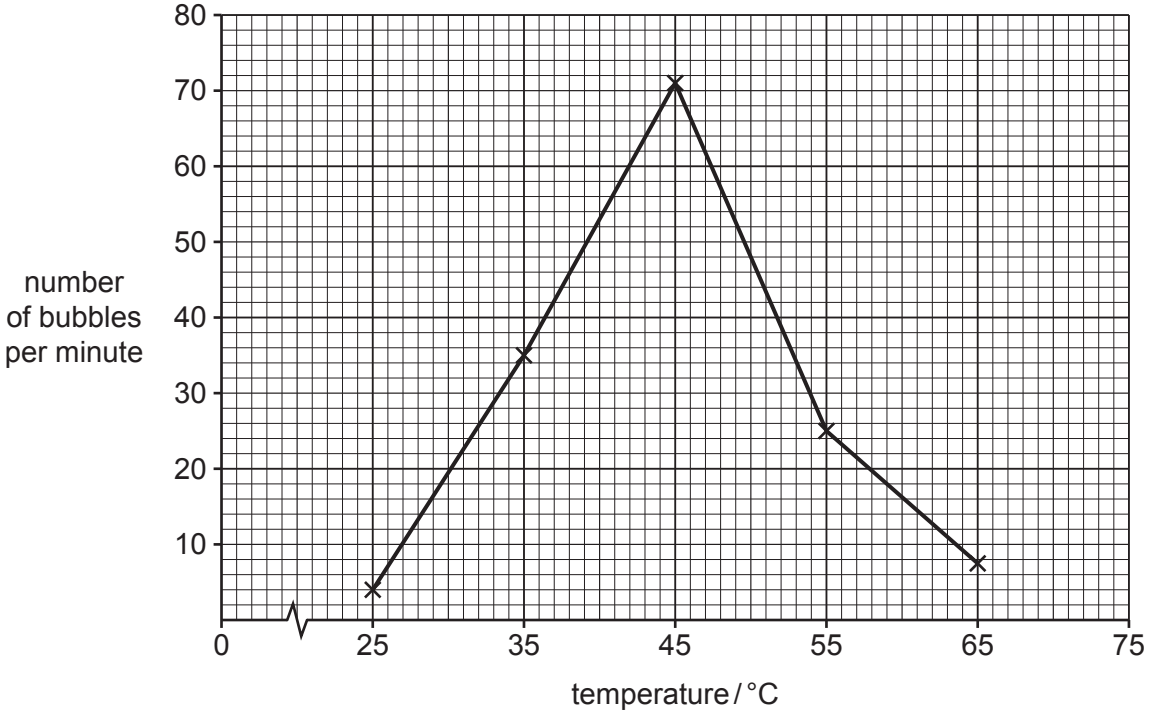

Fig. 1.2

(a) **(i)** Name the gas released by the elodea.

..... [1]

(ii) Describe the results shown in Fig. 1.2.

Include data from Fig. 1.2 in your answer.

.....

.....

.....

..... [2]

(b) Photosynthesis is an enzyme-controlled reaction.

Explain the results between **55**–**65** °C.

.....

.....

.....

.....

.....

..... [3]

(c) Most photosynthesis occurs in the leaves.

Some of the carbohydrates produced are stored in the roots.

(i) Name a carbohydrate stored in the roots of plants.

..... [1]

(ii) Describe how carbohydrates are transported from the leaves to the roots.

.....

.....

.....

.....

..... [2]

[Total: 9]

2 **(a)** Table 2.1 shows some information about the structure of atoms.

Complete Table 2.1. [2]

Table 2.1

particle	charge	relative mass
electron	.....	.....
neutron	.....	1
proton	+1	.....

(b) There are two isotopes of bromine.

One isotope is called bromine-79 and the other is called bromine-81.

(i) Table 2.2 shows some information about one atom of each isotope of bromine.

Complete Table 2.2. [2]

Table 2.2

	symbol	number of protons	number of neutrons	number of electrons
bromine-79	$^{79}_{35}Br$	35	44	35
bromine-81	.....	.....	.....	.....

(ii) The two isotopes of bromine have the same chemical properties.

Explain why.

.....

..... [1]

(c) Sodium is a metal. Bromine is a non-metal.

Sodium reacts with bromine to form sodium bromide.

Sodium bromide is an **ionic** compound.

(i) Describe how **metallic** elements and **non-metallic** elements form ionic bonds.

.....

.....

.....

..... [3]

(ii) Explain why bromine, Br_2, has a low melting point.

.....

.....

..... [2]

[Total: 10]

3 **(a)** An elephant of mass 3800 kg is moving at 0.4 m / s.

Calculate the kinetic energy of the elephant.

kinetic energy = ... J [2]

(b) The elephant stands with all four feet on the ground. The area of each foot is 0.06 m^2.

The gravitational field strength is 10 N / kg.

Calculate the pressure exerted by the elephant on the ground.

pressure = ... N/m^2 [3]

(c) Infrasound is a very low frequency sound wave which is below the lowest frequency that a human is able to hear.

Elephants communicate with each other using infrasound.

Suggest a possible frequency for infrasound.

Explain your answer.

frequency ..... Hz

explanation .....

..... [1]

(d) Fig. 3.1 represents the infrasound wave travelling through the air as a series of compressions and rarefactions.

Fig. 3.1

(i) On Fig. 3.1 label one compression with the letter **C**. [1]

(ii) On Fig. 3.1 use a double headed arrow (⟷) to indicate one wavelength. [1]

(iii) Describe the difference between a compression and a rarefaction in terms of particles in air.

.....

..... [1]

[Total: 9]

4 **(a)** Cystic fibrosis is an inherited disease.

- The allele for developing cystic fibrosis is recessive, **b**.
- The allele for **not** developing cystic fibrosis is dominant, **B**.

People with a heterozygous genotype are described as carriers of the disease. They can pass the allele to their offspring but do not show the symptoms of cystic fibrosis.

Fig. 4.1 is a pedigree diagram showing the inheritance of cystic fibrosis.

Each person is represented by a letter.

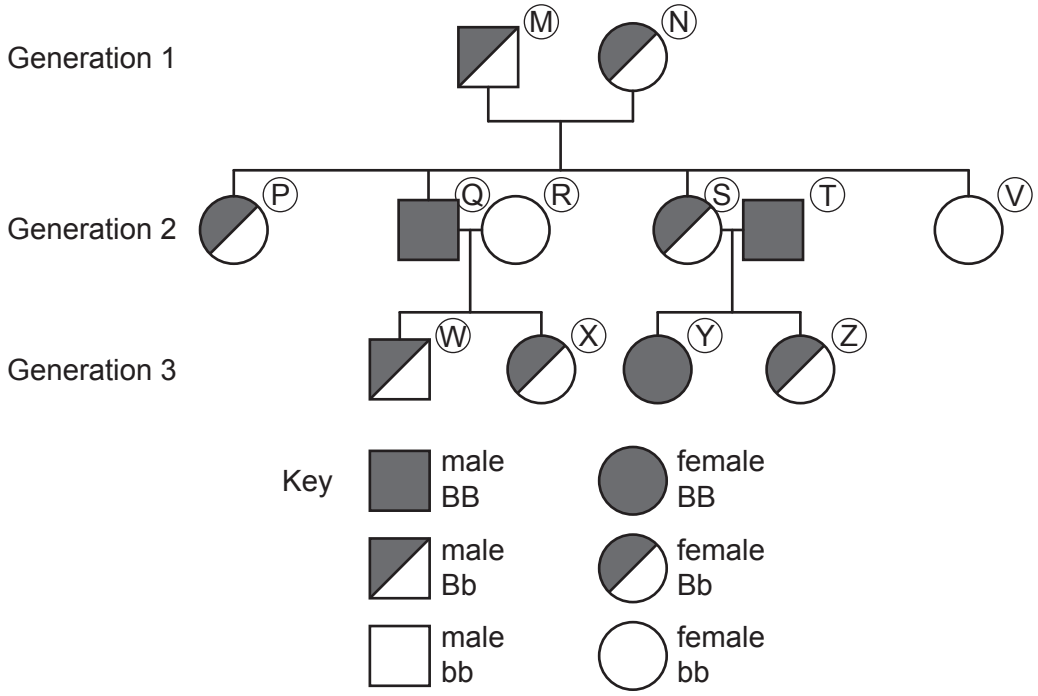

Fig. 4.1

(i) State the total number of people that are carriers of cystic fibrosis in Fig. 4.1.

..... [1]

(ii) Identify the letter of **one** person who has cystic fibrosis.

..... [1]

(b) Generation 3 had offspring of their own.

The boxes on the left of Fig. 4.2 show the genotypes of the genetic cross.

The boxes on the right of Fig. 4.2 show the genotypes of the offspring.

(i) On Fig. 4.2, draw **one** line from each genetic cross to its offspring genotypes.

Use the space provided for your working.

genetic cross	offspring genotypes
cross 1: Bb × Bb	BB, Bb
cross 2: BB × Bb	BB, Bb, bb
cross 3: Bb × bb	bb
cross 4: bb × bb	Bb, bb

Fig. 4.2

[3]

(ii) Name the type of **breeding** shown in genetic cross 4 in Fig. 4.2.

..... [1]

(c) Explain why cystic fibrosis is an example of discontinuous variation.

.....

.....

.....

..... [2]

(d) One of the symptoms of cystic fibrosis is the excess production of thick sticky mucus in the airways of the lungs.

Cilia find it difficult to remove the excess mucus.

Explain the effects of this on the gas exchange system.

.....

.....

.....

.....

.....

..... [3]

[Total: 11]

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5 Fig. 5.1 shows the electrolysis of dilute sulfuric acid.

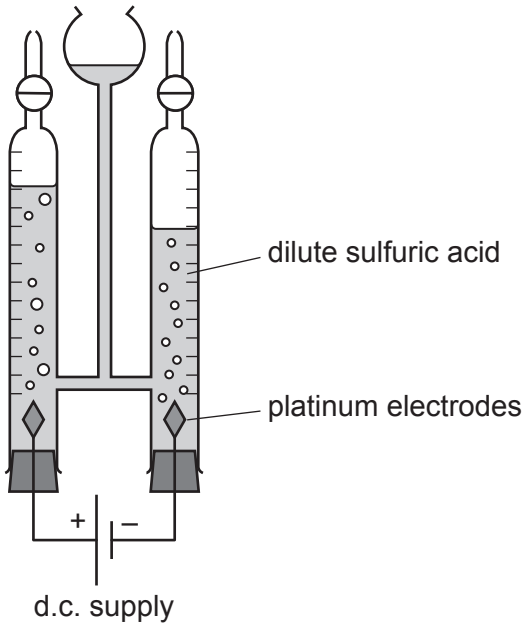

Fig. 5.1

(a) Hydrogen gas, H_2, is made at the cathode.

(i) State the name of the gas made at the anode.

..... [1]

(ii) Write the ionic half-equation for the formation of hydrogen gas.

..... [2]

(b) Hydrogen gas is also made by the electrolysis of concentrated aqueous sodium chloride.

Chlorine gas is made at the anode in this process.

The ionic half-equation for the reaction is shown.

$$2Cl^- - 2e^- \longrightarrow Cl_2$$

(i) State if this reaction is oxidation or reduction.

Explain your answer.

.....

..... [1]

(ii) Describe the test for chlorine gas and its positive result.

test .....

result ..... [2]

(iii) The total volume of chlorine gas produced at 25 °C in an electrolysis experiment is 4.8 cm^3.

Calculate the number of moles of chlorine gas in 4.8 cm^3.

The molar gas volume is 24 dm^3.

number of moles = ... [2]

(c) Chlorine reacts with aqueous sodium iodide, NaI.

State the **formulae** of the products made in this reaction.

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

[Total: 9]

6 **(a)** Describe how thermal energy passes through copper by conduction.

.....

.....

.....

..... [2]

(b) Copper boils at 2562 °C. Describe two differences between boiling and evaporation.

1 .....

.....

2 .....

.....

[2]

(c) Equal volumes of air, copper and water are heated from 10 °C to 90 °C.

State which of these materials will expand:

most .....

least. .....

[1]

(d) A copper wire of length 0.5 m has a resistance of 0.02 Ω.

Determine the resistance of another copper wire of length 0.25 m that has twice the cross-sectional area.

resistance = ... Ω [2]

(e) Two wires are connected in parallel.

One wire has a resistance of 0.40 Ω.

The other wire has a resistance of 0.60 Ω.

Calculate the combined resistance of the two wires connected together in parallel.

resistance = ... Ω [2]

(f) Copper wire is used in the coil of a generator.

Fig. 6.1 shows a simple a.c. generator.

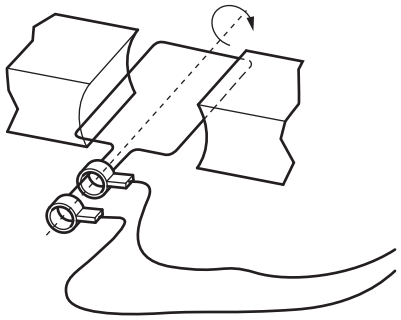

Fig. 6.1

(i) On Fig. 6.1 label the coil with the letter **C**. [1]

(ii) An electromotive force (e.m.f.) is induced in the rotating coil.

State two factors that would increase the magnitude of the induced e.m.f.

1 .....

2 .....
[2]

[Total: 12]

7 **(a)** Fig. 7.1 is a diagram of a fetus inside a uterus.

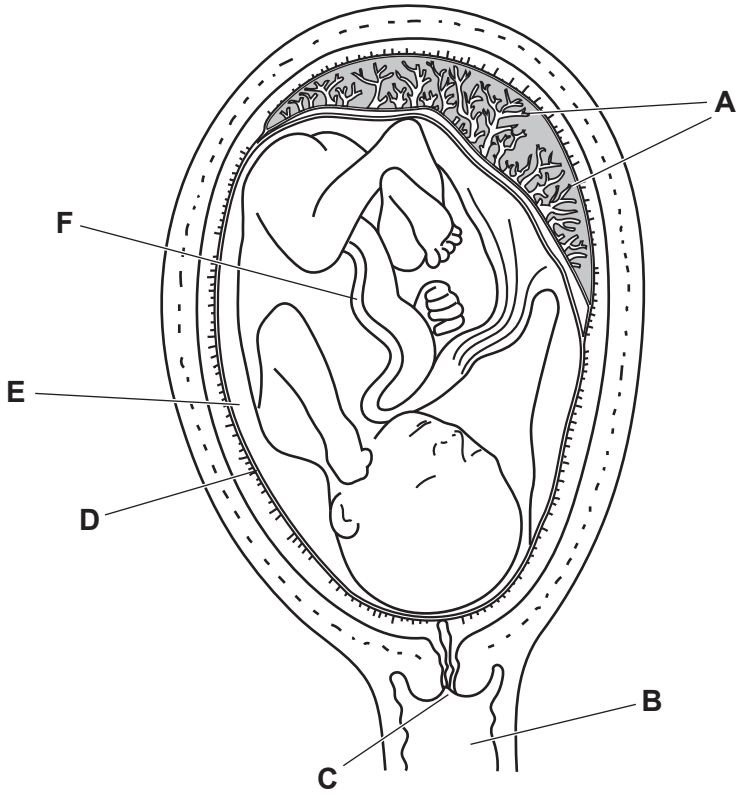

Fig. 7.1

Table 7.1 shows the functions of some parts shown in Fig. 7.1.

Table 7.1

name of part	letter in Fig. 7.1	function
	F	carries nutrient rich blood to fetus
		contains amniotic fluid
amniotic fluid		protects baby from mechanical damage
		site of exchange between the blood of the fetus and the mother

(i) Complete Table 7.1. [4]

(ii) Name **one** gas that is transferred from the blood of the fetus to the mother's blood.

..... [1]

(b) Pregnancy can occur after fertilisation.

(i) Name the **two** types of gametes involved in fertilisation in humans.

..... [1]

(ii) Name the process that is involved in the production of gametes.

..... [1]

(iii) Describe two differences between the nuclei in gametes and those in body cells.

1 .....

.....

2 .....

.....
[2]

[Total: 9]

8 Calcium carbonate, $CaCO_3$, reacts with dilute hydrochloric acid.

Calcium chloride, $CaCl_2$, carbon dioxide and water are made.

(a) Write the balanced symbol equation for this reaction.

..... [2]

(b) The hydrochloric acid used in the experiment is made by dissolving 0.75 moles of hydrogen chloride in 500 cm^3 of water.

Calculate the **concentration** of the hydrochloric acid in mol/dm^3.

concentration = ... mol/dm^3 [2]

(c) The rate of this reaction can be changed by changing the concentration of the acid.

Explain the effect of changing the concentration of the acid on the rate of the reaction.

Use ideas about particles.

.....

.....

.....

.....

..... [3]

(d) The reaction between calcium carbonate and hydrochloric acid is exothermic.

(i) State the meaning of an *exothermic* reaction.

.....

..... [1]

(ii) Fig. 8.1 shows an energy level diagram for an exothermic reaction.

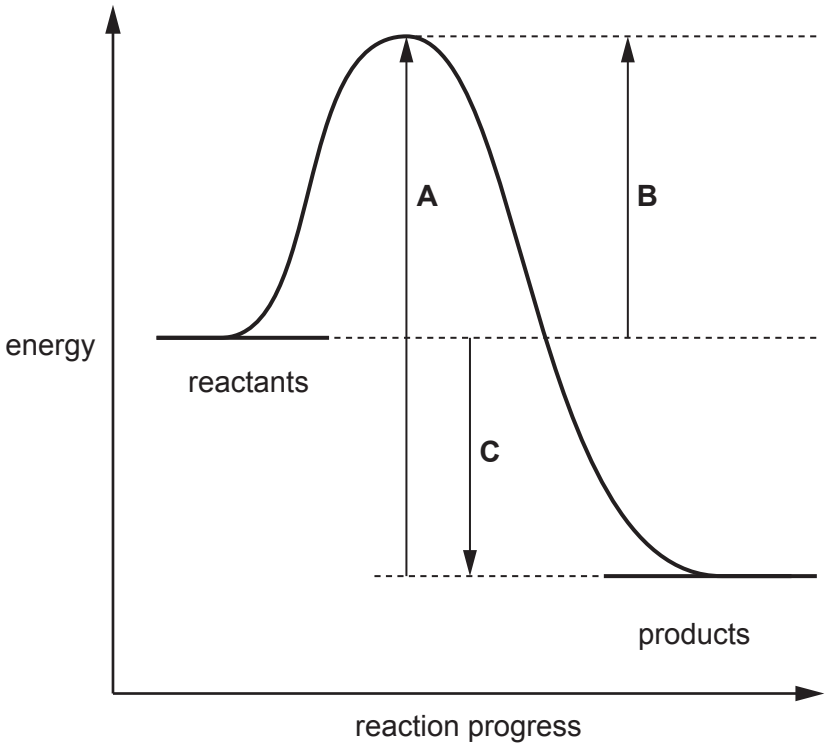

Fig. 8.1

State which arrow, **A**, **B** or **C**, shows the activation energy for the reaction.

..... [1]

[Total: 9]

9 **(a)** Visible light and γ-radiation are both used in hospitals. They are both examples of electromagnetic waves. γ-radiation travels at a speed of 3.0×10^8 m/s in a vacuum.

(i) State the speed at which visible light travels in a vacuum.

speed = ... m/s [1]

(ii) γ-radiation has a wavelength of 8×10^{-12} m.

Calculate the frequency of γ-radiation.

State the unit of your answer.

frequency = ... unit ..... [3]

(b) Doctors use visible light and optical fibres to see inside the human body.

Visible light passes along optical fibres by total internal reflection.

(i) Fig. 9.1 shows a ray of light passing into an optical fibre.

On Fig. 9.1 continue the ray of light to show its path through the optical fibre.

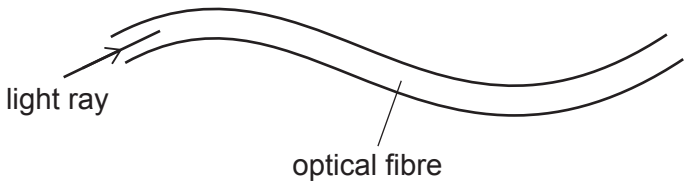

Fig. 9.1

[1]

(ii) Explain why total internal reflection occurs.

.....

..... [1]

(c) Doctors use an isotope of iodine, I-123, to examine the thyroid gland of a patient.

Small quantities of I-123 are absorbed by the thyroid gland.

I-123 emits γ-radiation which is detected outside the body.

I-123 has a half-life of 13 hours.

(i) Give two reasons why I-123 is suitable for use inside the body.

1 .....

.....

2 .....

.....

[2]

(ii) A sample of I-123 contains 8×10^{14} atoms.

Sometime later 6×10^{14} atoms have decayed.

Calculate the time needed for this number of atoms to decay.

time = ... hours [2]

[Total: 10]

[Turn over

10 (a) Plant shoots respond to stimuli such as light.

Fig. 10.1 shows the growth response of a shoot to light.

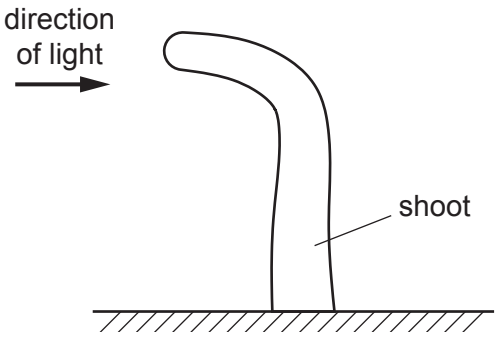

Fig. 10.1

(i) Name the response shown in Fig. 10.1.

..... [1]

(ii) Draw an **X** on Fig. 10.1 to show the area with the greatest cell elongation. [1]

(iii) Name the hormone that controls cell elongation.

..... [1]

(b) Fig. 10.2 shows a plant shoot with the tip removed.

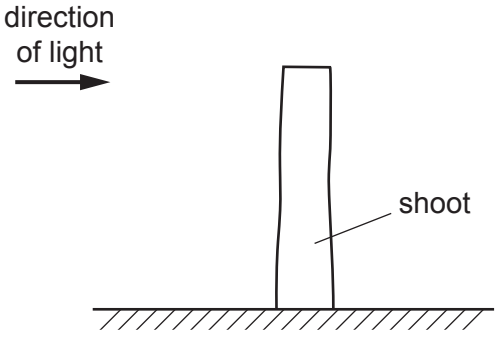

Fig. 10.2

State why the shoot in Fig. 10.2 did **not** bend.

.....

..... [1]

(c) Explain why plants need magnesium ions for photosynthesis and healthy growth.

Use ideas about energy in your answer.

.....

.....

.....

.....

.....

..... [3]

(d) Growth is one of the characteristics of living things.

(i) Complete the definition of the term *growth*.

Growth is a ..... increase in size and dry .....

by an increase in cell number or cell size or both. [2]

(ii) State the name of two other characteristics of living things.

1 .....

2 .....
[2]

[Total: 11]

11 Petroleum is separated into useful chemicals by fractional distillation.

Fig. 11.1 shows a fractionating column.

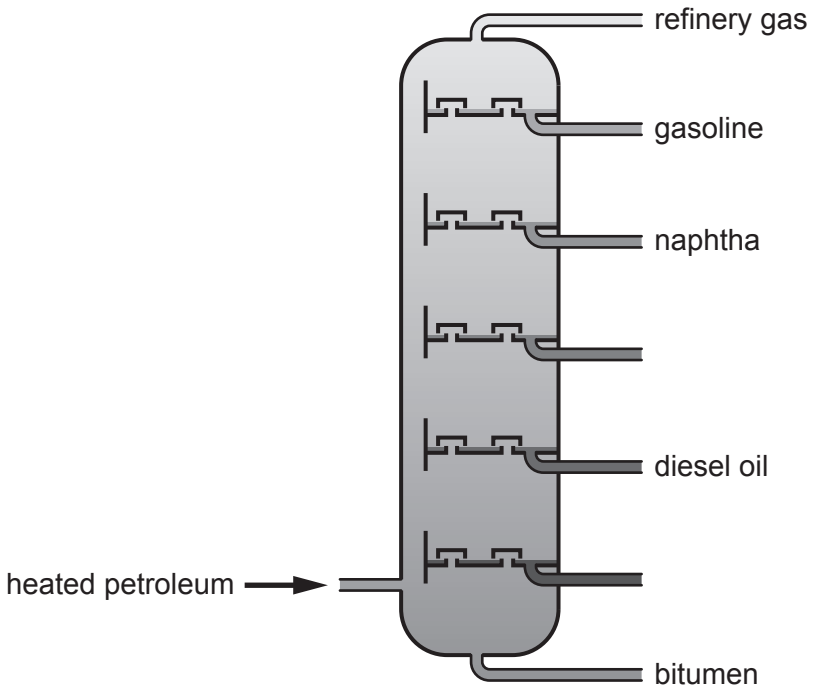

Fig. 11.1

(a) Table 11.1 shows the uses of some of the fractions.

Complete Table 11.1. [3]

Table 11.1

fraction	use
bitumen	.....
diesel oil	fuel in diesel engines
naphtha	feedstock for making chemicals
gasoline	.....
refinery gas	.....

(b) Butane is a hydrocarbon found in refinery gas.

(i) State **two** properties of butane gas.

.....

..... [2]

(ii) Butane is a type of hydrocarbon called an alkane.

Complete Fig. 11.2 to show the structure of a butane molecule.

Show all of the atoms and all of the covalent bonds.

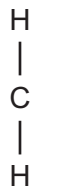

Fig. 11.2

[2]

(iii) The alkanes are a homologous series.

Describe what is meant by a *homologous series*.

.....

.....

..... [2]

(c) Ethene, C_2H_4, is an alkene made by the cracking of large alkane molecules.

Ethene reacts with steam to make ethanol, C_2H_5OH.

$$C_2H_4 + H_2O \rightarrow C_2H_5OH$$

(i) State one other method of making ethanol.

..... [1]

(ii) In an experiment 5.6 g of ethene reacts with excess steam.

Calculate the maximum mass of ethanol that can be made.

maximum mass of ethanol = ... g [2]

[Total: 12]

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12 (a) Fig. 12.1 shows an aircraft being refuelled using a plastic pipe.

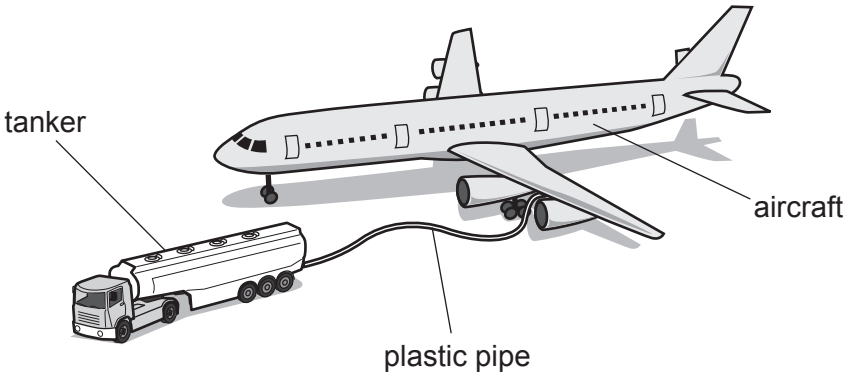

Fig. 12.1

As the fuel flows through the pipe, the fuel and pipe become electrically charged.

Explain why the fuel becomes negatively charged and the pipe becomes positively charged.

.....

.....

..... [2]

(b) Fig. 12.2 is the speed-time graph for the aircraft during take-off.

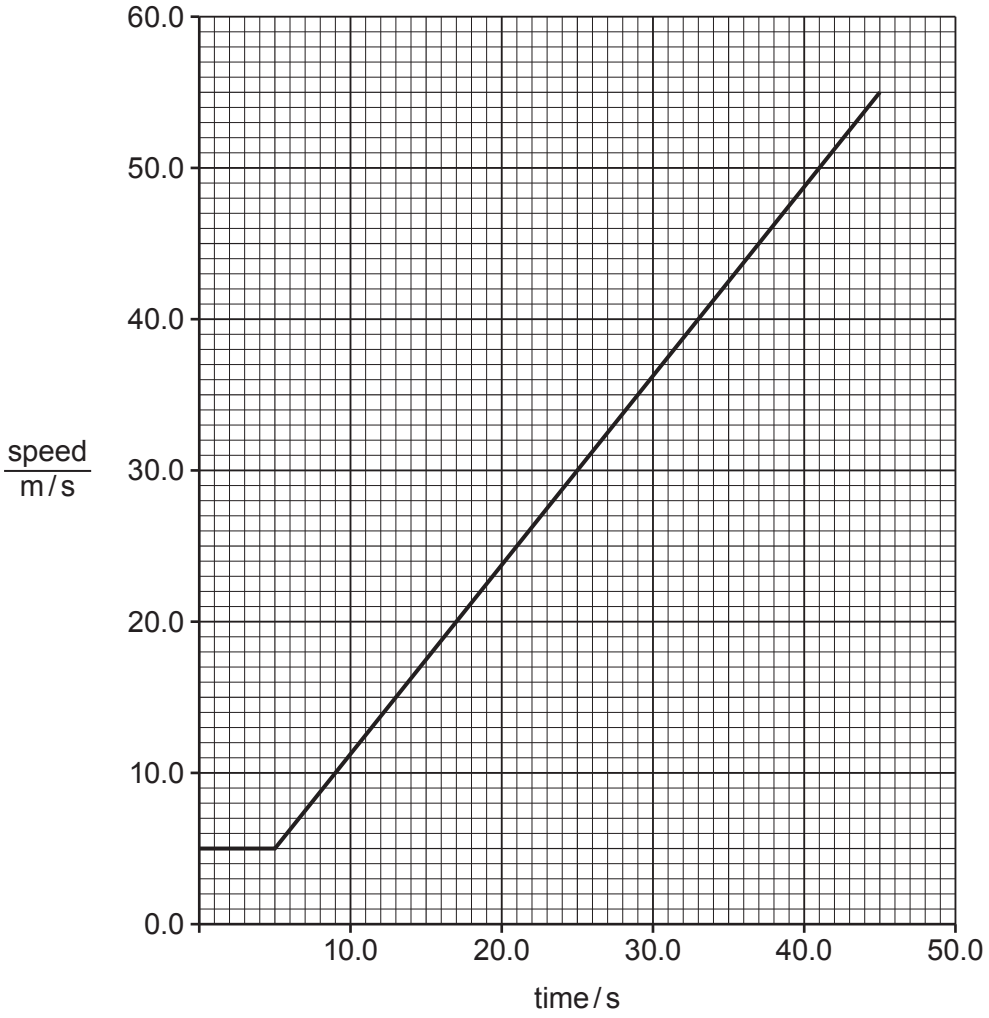

Fig. 12.2

(i) Calculate the acceleration at 25 seconds.

acceleration = ... m/s^2 [2]

(ii) State how the graph shows that the acceleration of the aircraft is constant between 5.0 s and 45.0 s.

.....

..... [1]

(c) (i) During the flight the pressure inside the aircraft cabin decreases but the temperature is kept constant.

Use ideas about gas molecules to describe the change in pressure in terms of the arrangement and motion of molecules.

.....

.....

.....

..... [2]

(ii) The aircraft flies at a high altitude. Some water on the outside of the aircraft body turns to ice.

Describe in terms of molecular motion and arrangement how ice differs from liquid water.

.....

.....

..... [2]

[Total: 9]

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The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

Key

atomic number
atomic symbol
name
relative atomic mass

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

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