Cambridge IGCSE

Cambridge Assessment International Education
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

0321747687

CO-ORDINATED SCIENCES **0654/43**

Paper 4 Theory (Extended) **May/June 2019**

2 hours

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 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 32.

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 **31** printed pages and **1** blank page.

Cambridge Assessment International Education

[Turn over

1 **(a)** Fig. 1.1 is a graph showing the effect of pH on an enzyme's activity at 20 °C.

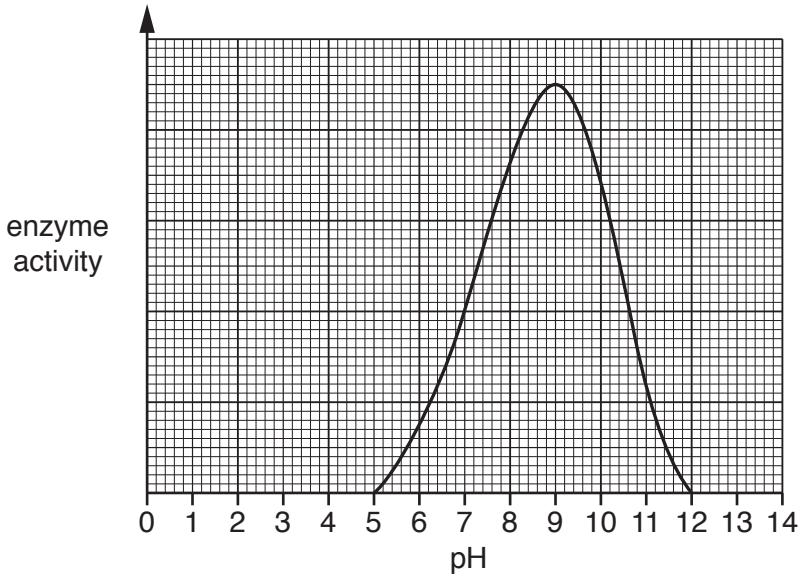


Fig. 1.1

(i) State the optimum pH of this enzyme.

..... [1]

(ii) Explain why this enzyme is inactive at pH 12.

.....

.....

.....

.....

..... [3]

(b) The investigation was repeated at a temperature of 30 °C.

There was an increase in enzyme activity recorded across the pH range.

Explain why there is an **increase** in enzyme activity at 30 °C.

.....

.....

.....

.....

..... [3]

(c) Enzymes are proteins.

(i) List the chemical elements that make up proteins.

..... [1]

(ii) State the test for the protein and the positive result.

test .....

positive result .....
[2]

[Total: 10]

2 Fig. 2.1 shows industrial processes carried out to make some useful materials from petroleum.

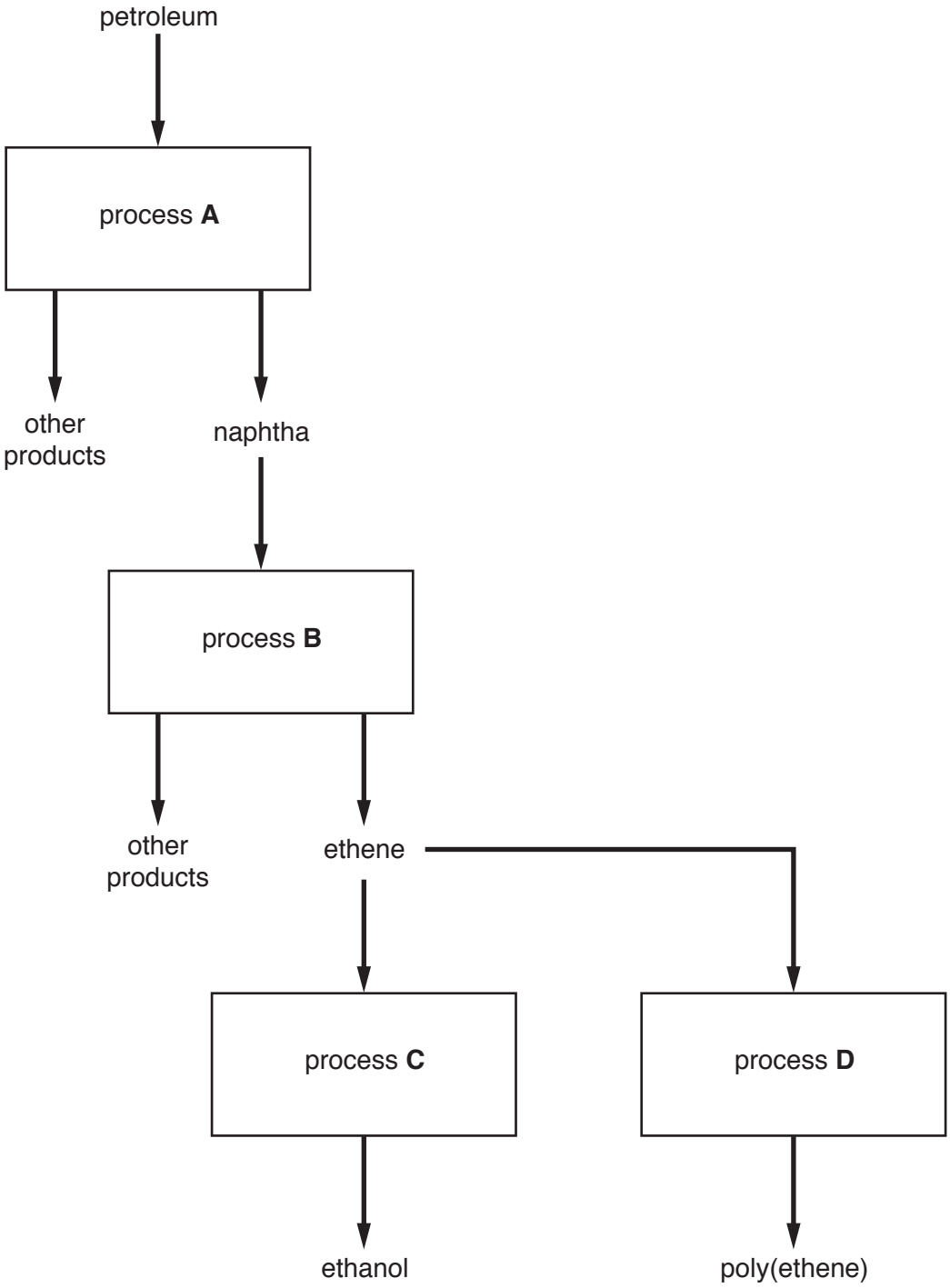


Fig. 2.1

(a) Use words and phrases from the list below to name the processes **A** to **D** in Fig. 2.1.

Each word or phrase may be used once, more than once or not at all.

Process **C** has been named for you.

addition polymerisation **catalytic addition** **condensation polymerisation**

cracking **dehydration** **electrolysis**

fractional distillation **oxidation** **reduction**

process **A** .....

process **B** .....

process **C** catalytic addition .....

process **D** ..... [3]

(b) In process **A** petroleum is separated into mixtures of hydrocarbons, such as naphtha.

State the physical property of naphtha that enables it to be separated from the other hydrocarbon mixtures in process **A**.

..... [1]

(c) In process **B**, larger molecules are changed into smaller molecules.

The energy level diagram for this reaction is shown in Fig. 2.2.

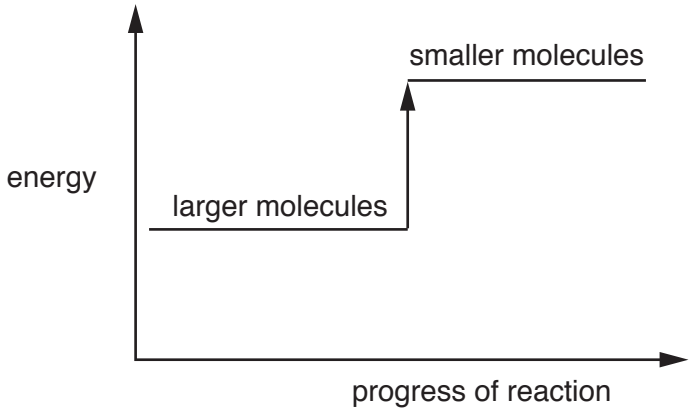


Fig 2.2

State the type of chemical reaction that causes the type of energy change shown in Fig. 2.2.

Explain your answer in terms of bond breaking and bond making.

type of reaction .....

explanation .....

.....

..... [3]

(d) In process **C** ethene reacts with steam to produce ethanol, C_2H_5OH. A catalyst is used to increase the rate of reaction.

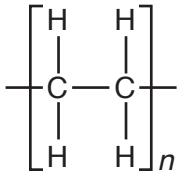
State **two** other conditions necessary for this reaction.

1 .....

2 .....
[2]

(e) **(i)** In process **D** poly(ethene) is formed.

The structure of poly(ethene) is shown.



(*n* is a large number)

Describe the formation of poly(ethene) using the terms *monomer* and *polymer*.

.....

.....

.....

..... [2]

(ii) Ethene is reactive and reacts with bromine.

Poly(ethene) is less reactive and does not react with bromine.

Explain this difference.

.....

..... [1]

[Total: 12]

3 **(a)** Fig. 3.1 shows the forces acting on an aircraft.

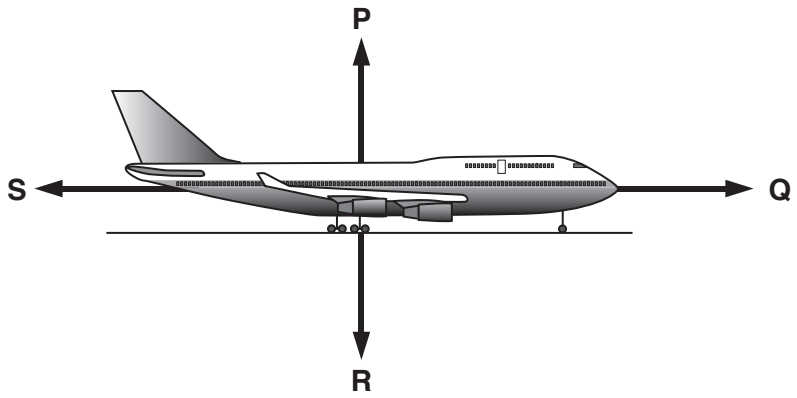


Fig. 3.1

Four forces **P**, **Q**, **R** and **S** are shown.

(i) Compare the sizes of forces **Q** and **S** when the aircraft is accelerating.

.....

..... [1]

(ii) State which force is the weight of the aircraft.

..... [1]

(iii) Complete the sentence below to describe the relationship between the mass and the weight of an object.

Weight is the effect of a ..... field on a mass. [1]

(b) Fig. 3.2 is the speed-time graph for an aircraft during take-off.

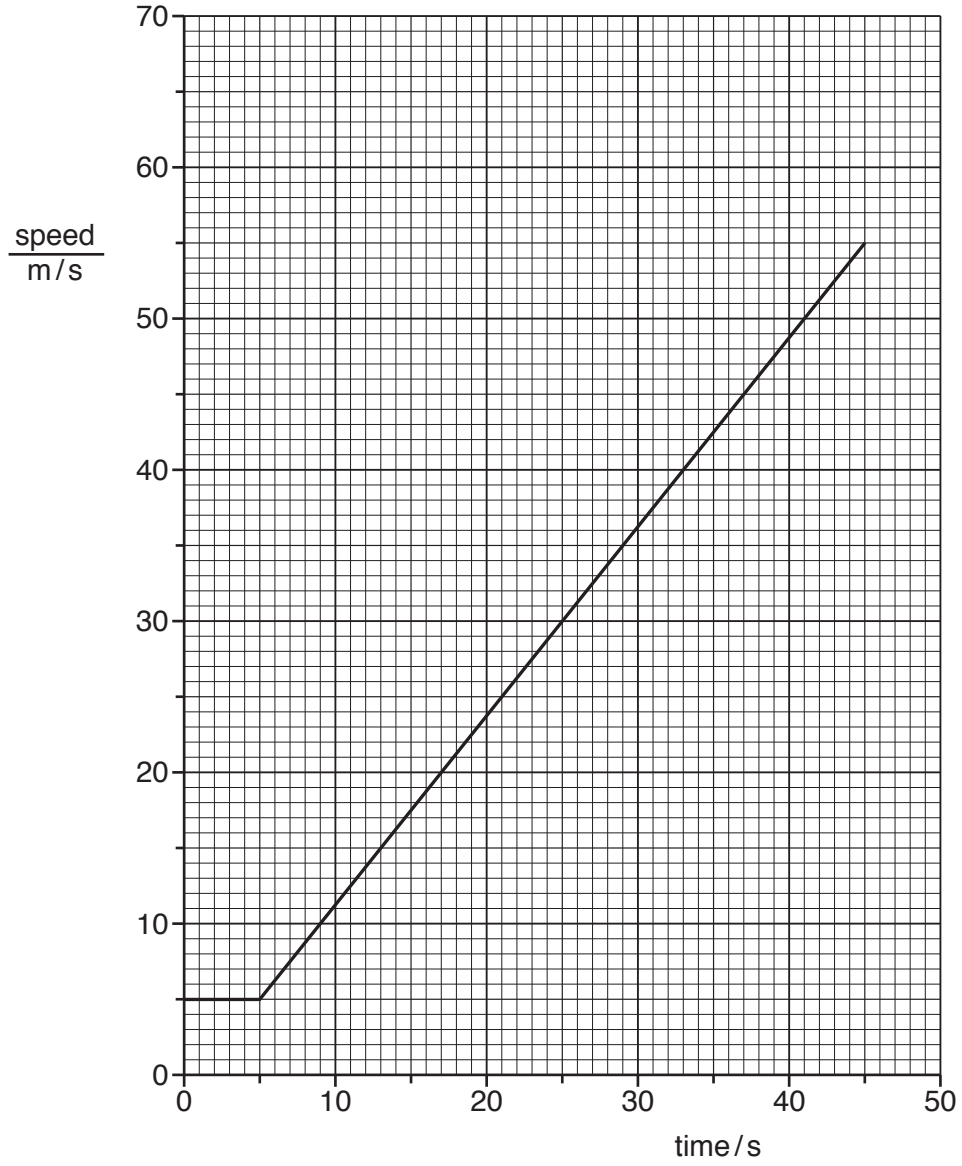


Fig. 3.2

Calculate the acceleration between 5 s and 45 s.

Show your working. State the units of your answer.

acceleration = ... units ..... [3]

(c) State the **two** types of energy gained as the aircraft continues to accelerate and gain height after take-off.

1 ..... energy

2 ..... energy
[1]

(d) The aircraft engines are noisy. Sound waves from the engines pass through the air as a series of compressions and rarefactions.

(i) State what is meant by a *compression*.

.....

..... [1]

(ii) Describe the wavelength of a sound wave in terms of compressions.

.....

..... [1]

[Total: 9]

[Turn over

4 **(a)** Fig. 4.1 is a diagram of a food web.

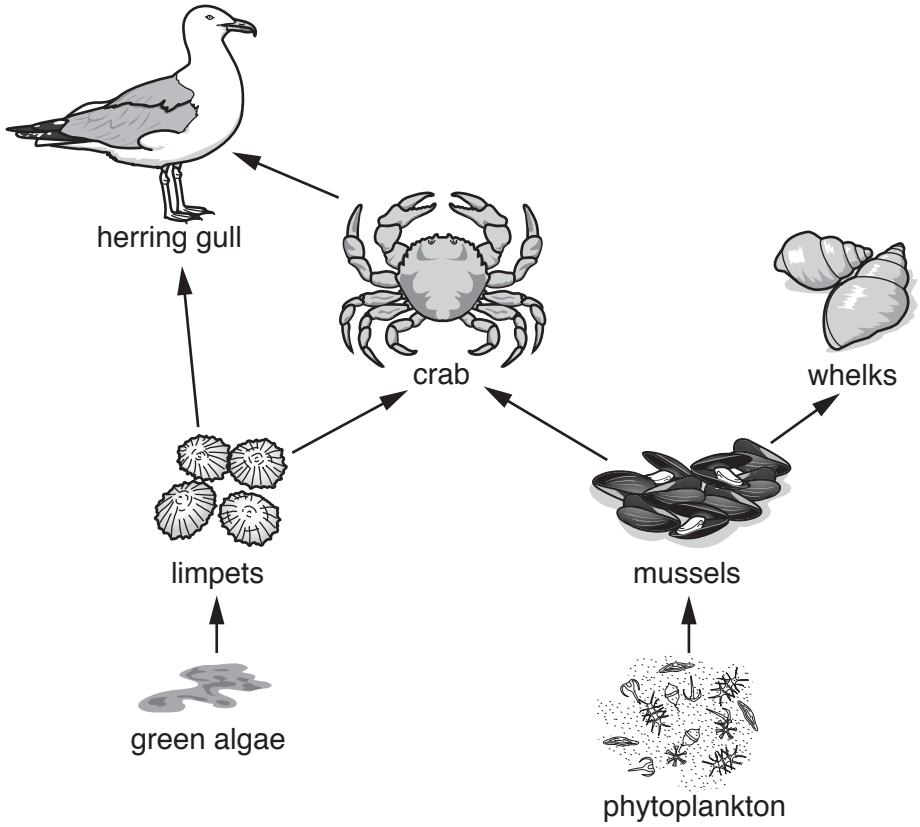


Fig. 4.1

Use the food web in Fig. 4.1 to answer these questions.

(i) State the number of trophic levels in this food web.

..... [1]

(ii) Name **one** organism that occupies the **first** trophic level.

..... [1]

(iii) Construct a food chain that includes one **tertiary** consumer.

..... [2]

(b) A disease causes a decrease in the population of mussels.

Explain the effect of a decrease in **mussel** population on the **limpet** population.

.....

.....

.....

..... [2]

(c) Organisms in the food web respire.

Complete the sentence to define the term *respiration*.

Respiration is the ..... reactions in cells that break

down ..... molecules and release

..... for metabolism. [2]

[Total: 8]

5 **(a)** A teacher investigates the rate at which carbon dioxide is produced when dilute hydrochloric acid reacts with excess calcium carbonate powder.

She uses the apparatus shown in Fig. 5.1.

The temperature of the acid is 20 °C.

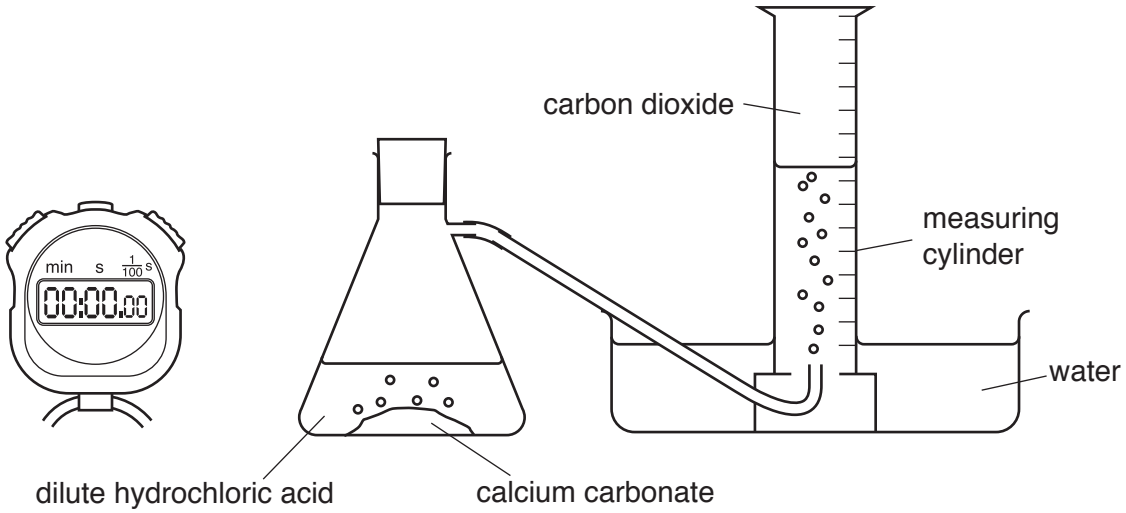


Fig. 5.1

She measures the volume of carbon dioxide collected in the measuring cylinder every minute for 10 minutes.

Fig. 5.2 shows a graph of her results.

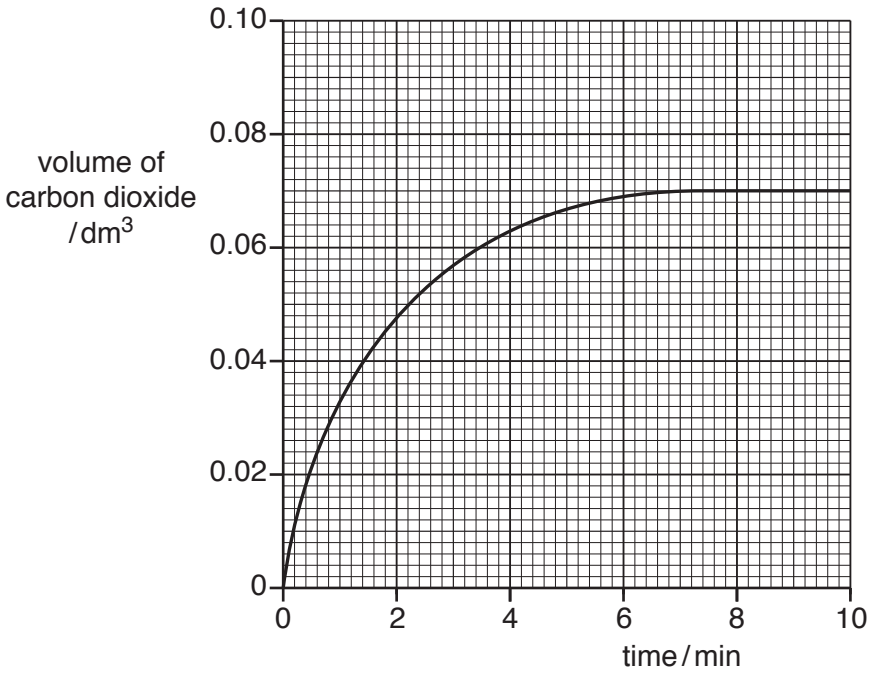


Fig. 5.2

(i) Use ideas about colliding particles to explain the shape of the graph.

.....

.....

..... [3]

(ii) The teacher repeats the experiment, adding dilute hydrochloric acid at 30 °C to excess calcium carbonate powder.

Sketch the graph she obtains on Fig. 5.2. [2]

(b) The symbol equation for the reaction between calcium carbonate and dilute hydrochloric acid is shown.

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$$

(i) State the volume of gas produced in 10 minutes when dilute hydrochloric acid at 20 °C is added to excess calcium carbonate powder.

…….. dm^3 [1]

(ii) Use your answer to **(b)(i)** to calculate the volume of dilute hydrochloric acid added to the excess calcium carbonate.

Complete steps 1 to 3. Show your working.

The concentration of the dilute hydrochloric acid is 0.50 mol / dm^3.

The volume of 1 mole of any gas is 24 dm^3 at room temperature and pressure.

Step 1

Calculate the number of moles of carbon dioxide produced.

number of moles = ...

Step 2

Calculate the number of moles of HCl reacting.

number of moles = ...

Step 3

Calculate the volume of dilute acid added.

volume = ... dm^3
[3]

(c) State the ratio of the number of molecules in 1 mole of carbon dioxide to the number of molecules in 1 mole of water.

..... [1]

[Total: 10]

6 **(a)** Fig 6.1 shows a penguin walking on the ice in Antarctica.

Fig. 6.1

The penguin has a weight of 25 N and its feet have a total area of 22 cm^2.

Calculate the pressure in N/m^2 exerted by the penguin on the ice when it is standing on both feet.

Show your working.

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

(b) The penguin observes a fish swimming in a pool.

Fig. 6.2 shows a ray of light going from the fish to the penguin. The ray is refracted at the surface.

The angles of incidence and refraction are shown.

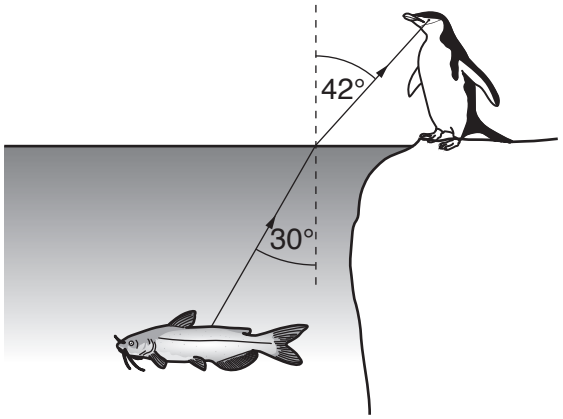


Fig. 6.2

Calculate the refractive index of water.

Show your working.

refractive index = ... [2]

(c) The penguin jumps into the pool of water and produces water waves.

A 3-metre section of the pool is shown in Fig. 6.3.

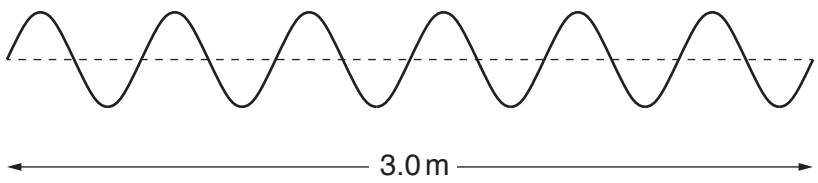


Fig. 6.3

(i) Show that the wavelength of the waves is 0.5 m.

[1]

(ii) The speed of the waves produced in the pool is 1.5 m/s.

Calculate the frequency of the waves.

Show your working.

frequency = ... Hz [2]

(d) In the Antarctic, harmful ultraviolet radiation reaches the Earth's surface.

(i) State **one** danger to living things of being exposed to large quantities of ionising radiation.

..... [1]

(ii) α-particles and β-particles are both types of ionising radiation.

State **two** differences between an α-particle and a β-particle.

1 .....

.....

2 .....

.....

[2]

(iii) An isotope of an unknown element decays by β-emission to produce an isotope of silicon, which has a nucleon number of 28.

Identify the unknown element and give its full nuclide notation.

A periodic table is shown on page 32.

..... [2]

[Total: 13]

7 A student investigates the need for chlorophyll in photosynthesis.

He uses a variegated leaf.

Fig. 7.1 shows a variegated leaf.

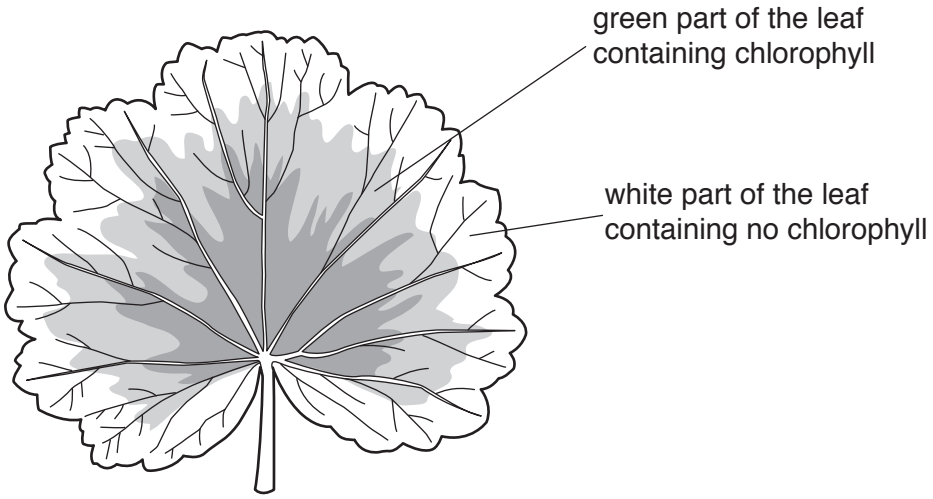


Fig. 7.1

The student prepares the leaf by boiling it in ethanol. He then tests the leaf for the presence of starch using iodine solution.

Table 7.1 shows his results.

Table 7.1

part of leaf	colour when tested with iodine solution
green part	blue-black
white part	orange-brown

(a) Explain the result for the green part of the leaf.

.....

.....

.....

.....

..... [3]

(b) Name the mineral ion needed to make chlorophyll.

..... [1]

(c) Starch is one carbohydrate found in plants.

Describe how carbohydrates are transported around the plant.

.....

.....

.....

.....

..... [3]

(d) Water is one of the raw materials needed for photosynthesis.

State the chemical formula of **one other** raw material needed for photosynthesis.

..... [1]

(e) State the term used for the property of water molecules that enables them to be drawn up the xylem during transpiration.

..... [1]

[Total: 9]

8 Fig. 8.1 shows part of Group I of the Periodic Table.

3 Li lithium 7
11 Na sodium 23
19 K potassium 39
37 Rb rubidium 85

Fig. 8.1

(a) **(i)** State the electronic structure of a sodium atom.

..... [1]

(ii) Describe how the electronic structure of sodium is related to its group number.

.....

..... [1]

(b) A teacher adds Universal Indicator solution to water in a large bowl.

She places a piece of sodium onto the surface of the water.

Fig. 8.2 shows the apparatus she uses.

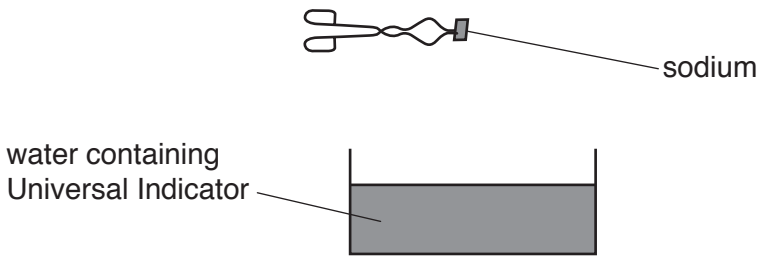


Fig. 8.2

Students notice that gas forms around the sodium and the indicator changes colour.

(i) The teacher informs her students that hydrogen and sodium hydroxide are formed by the reaction.

State and explain the change in colour of the indicator.

change in colour .....

explanation .....

.....

[2]

(ii) Suggest **one** similarity and **one** difference between rubidium and sodium in their reaction with water containing Universal Indicator.

Explain your answers.

similarity .....

explanation .....

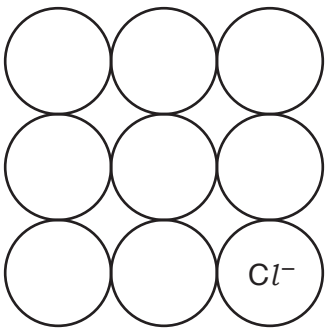
difference .....

explanation .....

[3]

(c) Fig. 8.3 shows an incomplete diagram of part of the structure of a sodium chloride crystal.

Complete the diagram by showing the arrangement of sodium ions, Na^+, and chloride ions, Cl^-.



(ions are not drawn to scale)

Fig. 8.3

[2]

[Total: 9]

9 Fig. 9.1 shows a potato being baked in the oven of an electric cooker.

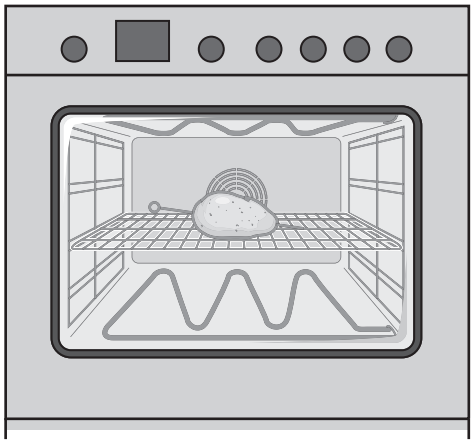


Fig. 9.1

(a) The potato has a steel skewer (a long metal pin) pushed through it.

When heated the metal skewer expands.

Explain in terms of the motion and arrangement of molecules why a solid expands less than a gas when heated.

.....

.....

.....

..... [2]

(b) A thermocouple is used to measure the temperature inside the oven.

Describe the structure of a thermocouple.

.....

..... [1]

(c) The cooker has one electrically heated hotplate. The hotplate uses a current of 2.0 A when used with a mains voltage of 230 V.

(i) Calculate the resistance of the hotplate.

Show your working.

resistance = ... Ω [2]

(ii) Calculate the energy supplied to the hotplate in 1200 seconds.

Show your working.

energy = ... J [2]

(iii) Some water is heated in a saucepan and turns to steam.

Describe the differences between water and steam in terms of the forces and distances between the molecules and the motion of the molecules.

.....

.....

.....

..... [3]

[Total: 10]

[Turn over

10 (a) Fig. 10.1 shows the circulatory system of a fish and a human.

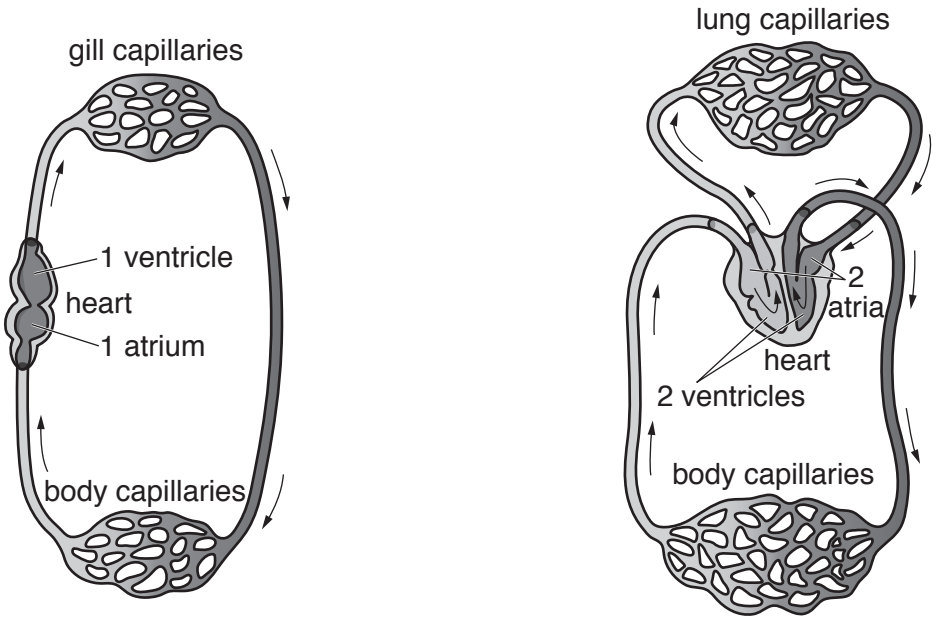


Fig. 10.1

(i) Use Fig. 10.1 to describe **three** ways the circulatory system of a human is different from the circulatory system of a fish.

1 .....

.....

2 .....

.....

3 .....

.....

[3]

(ii) State the name of the structure in the human heart that separates the left ventricle from the right ventricle.

.....[1]

(b) Gills are the gas exchange surface in fish.

Suggest **two** features that gills have that allow efficient gas exchange.

1 .....

2 .....

[2]

(c) The human circulatory system contains arterioles.

Arterioles are used in the regulation of body temperature.

Describe the role of arterioles in **reducing** body temperature.

.....

.....

.....

.....

..... [3]

[Total: 9]

11 Fig. 11.1 shows a blast furnace used to extract iron from iron oxide.

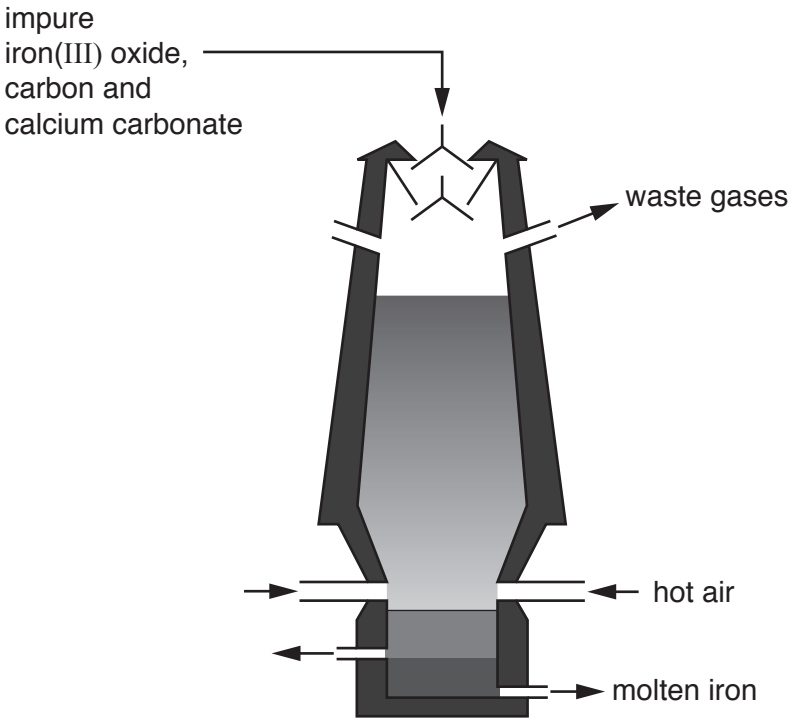


Fig. 11.1

(a) State the substance that reacts with oxygen in the blast furnace.

..... [1]

(b) **(i)** Identify the reducing agent that is formed in the blast furnace.

..... [1]

(ii) Iron(III) oxide consists of iron ions, Fe^{3+}, and oxide ions, O^{2-}.

Use ideas about atoms, ions and electron transfer to explain how iron (III) oxide is reduced to iron.

.....

.....

..... [2]

(c) Complete the sentences, using words from the list below, to describe how acidic impurities are removed in the blast furnace.

Each word or phrase may be used once, more than once or not at all.

air	**calcium carbonate**	**calcium oxide**	**carbon**
carbon dioxide	**iron**	**silicon dioxide**	**slag**

Calcium carbonate decomposes to ..... and

..... at the high temperature in the blast furnace.

Acidic impurities such as ..... react with

..... to form molten ..... .

[3]

(d) **(i)** Explain why a blast furnace cannot be used to extract aluminium from aluminium oxide.

.....

..... [1]

(ii) Explain why aluminium appears to be resistant to corrosion.

.....

..... [1]

[Total: 9]

12 (a) Fig. 12.1 shows a gardener using a leaf-blower.

Fig. 12.1

Fig. 12.2 shows the energy input and outputs for the leaf-blower.

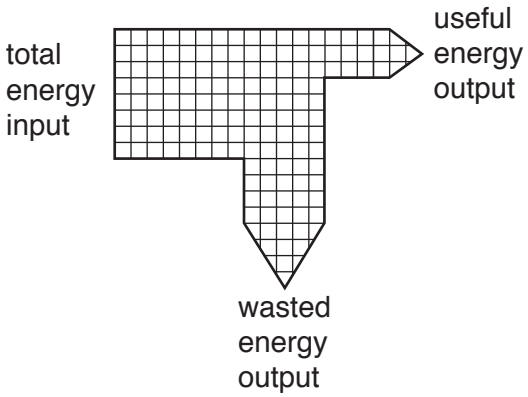


Fig. 12.2

Calculate the efficiency of the leaf-blower as a percentage.

Show your working.

efficiency = ... % [2]

(b) When used the leaf-blower takes a current of 3.0 A.

Calculate the charge that flows through the leaf-blower when it is used for 180 seconds.

Show your working.

charge = ... C [1]

(c) The leaf-blower contains a small electric motor powered by a battery.

Fig. 12.3 shows a simple electric motor powered by a battery.

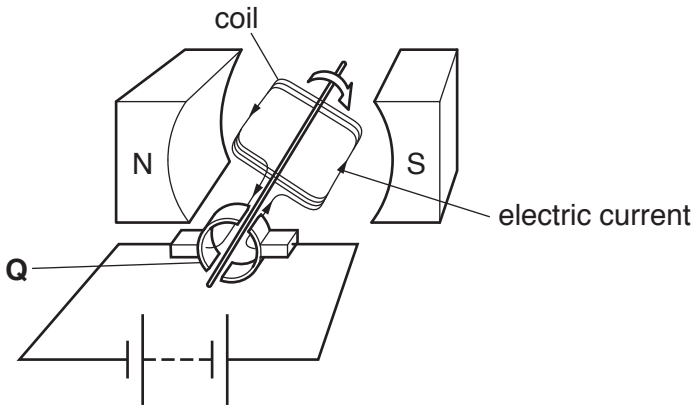


Fig. 12.3

(i) State the name of the component labelled **Q** on Fig. 12.3.

name of component **Q** ..... [1]

(ii) Draw an arrow on Fig. 12.3 to show the direction of the magnetic field. [1]

(iii) Explain why the coil moves when an electric current passes through it.

.....

.....

.....

..... [3]

[Total: 8]

13 A student investigates the effect of temperature on the movement of red dye through water.

She adds one drop of red dye to the centre of the water in a Petri dish.

She measures the time taken for the dye to move to the edge of the Petri dish.

She repeats this with water at different temperatures.

Fig. 13.1 shows the apparatus used.

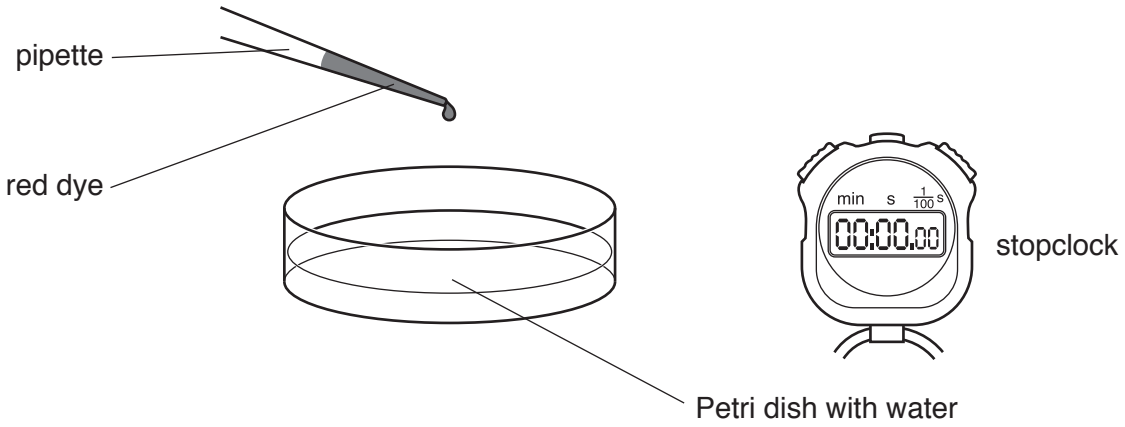


Fig. 13.1

Table 13.1 shows her results.

Table 13.1

temperature / °C	time taken for dye to move to the edge / s
5	321
40	98
80	55

(a) Use the results in Table 13.1 to describe the relationship between temperature and the time taken for the dye to move to the edge.

.....

..... [1]

(b) Explain, in terms of particles, the movement of the red dye through the water.

.....

.....

.....

.....

..... [3]

[Total: 4]

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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.).