Cambridge Assessment International Education

Cambridge IGCSE™ (9–1)

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

6583211856

CO-ORDINATED SCIENCES **0973/31**

Paper 3 Theory (Core) **May/June 2024**

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 **28** pages. Any blank pages are indicated.

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1 **(a)** Fig. 1.1 shows the parts of a human tooth.

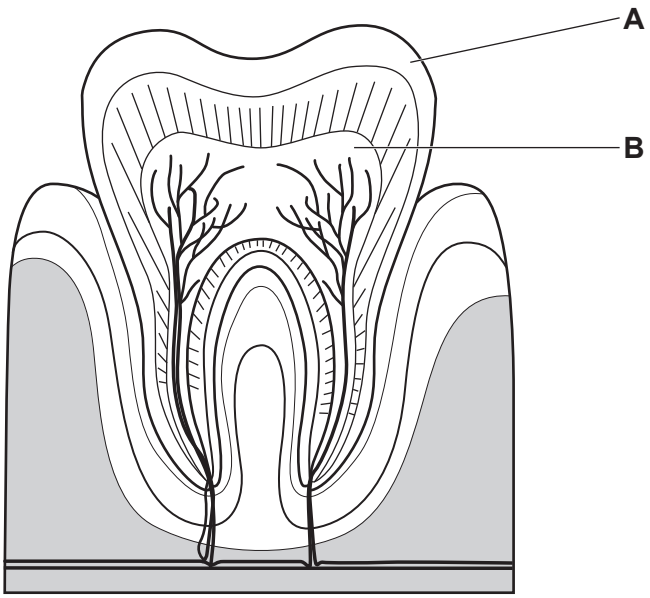

Fig. 1.1

(i) State the names of the parts labelled **A** and **B** in Fig. 1.1.

A .....

B .....
[2]

(ii) State the type of digestion that teeth are responsible for.

..... [1]

(b) Cavities are holes in the teeth caused by poor care of teeth.

A survey records the average number of cavities that 12-year-old school students have in one school.

Every five years, the survey is repeated with another group of 12-year-olds in the same school.

Fig. 1.2 shows a bar chart of the results.

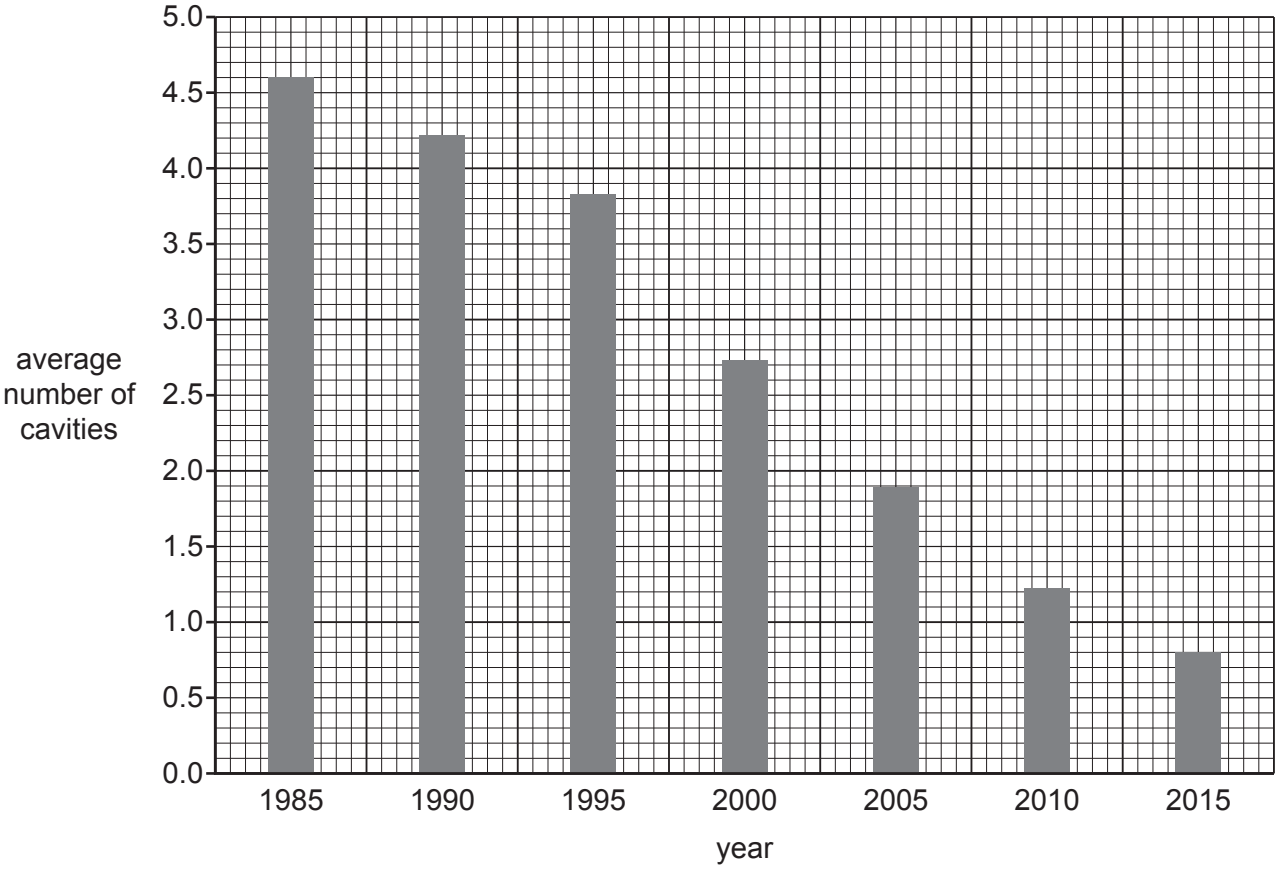

Fig. 1.2

(i) Calculate the percentage decrease in the average number of cavities between **1985** and **2015** in Fig. 1.2.

average number of cavities in 1985 .....

average number of cavities in 2015 .....

percentage decrease = ...% [2]

(ii) Suggest **three** reasons for the trend seen in Fig. 1.2.

1 .....

.....

2 .....

.....

3 .....

.....

[3]

(c) The mouth has a good supply of blood.

List **two** main components of blood.

1 .....

2 .....

[2]

[Total: 10]

2 **(a)** A list of metals is shown.

aluminium
copper
iron
lead
magnesium
platinum
sodium

Identify from the list the metal that is:

(i) found in Group I of the Periodic Table.

..... [1]

(ii) extracted from the ore bauxite.

..... [1]

(iii) the main metal in the alloy steel.

..... [1]

(iv) used as inert electrodes in electrolysis.

..... [1]

(b) Table 2.1 gives some information about the rate of reaction of four metals with cold water and with dilute hydrochloric acid.

Table 2.1

metal	rate of reaction with cold water	rate of reaction with dilute hydrochloric acid
copper	no reaction	no reaction
iron	no reaction	reacts slowly
magnesium	reacts very slowly	reacts very quickly
zinc	no reaction	reacts quickly

(i) Deduce the order of reactivity of the four metals from the most reactive to the least reactive.

most reactive .....

.....

.....

least reactive .....

[2]

(ii) Only magnesium in Table 2.1 reacts with cold water.

Suggest **one** other metal, **not** from Table 2.1, that reacts quickly with cold water.

..... [1]

(iii) In an experiment, magnesium reacts with dilute hydrochloric acid as shown in Fig. 2.1.

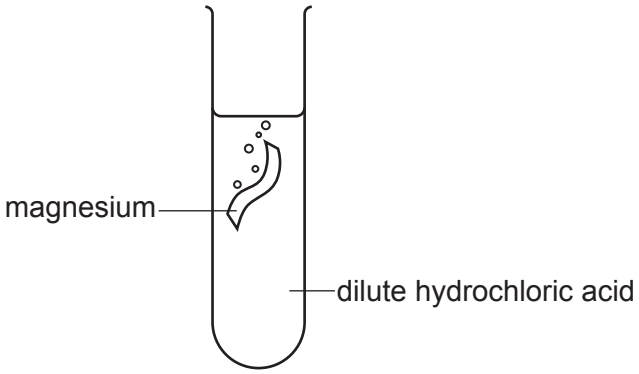

Fig. 2.1

State **two** ways of changing the **dilute hydrochloric acid** to make the reaction faster.

1 .....

2 .....
[2]

(iv) The word equation for the reaction between magnesium and dilute hydrochloric acid is shown.

magnesium + hydrochloric acid → magnesium chloride + hydrogen

Complete the balanced symbol equation for this reaction.

$$Mg + ...HCl \rightarrow MgCl_2 + H_2$$

[1]

[Total: 10]

3 **(a)** A torch (flashlight) contains two cells, a lamp and a switch connected in series.

Fig. 3.1 shows an incomplete circuit diagram for the torch.

(i) Complete the circuit diagram in Fig. 3.1 for the torch using electrical symbols.

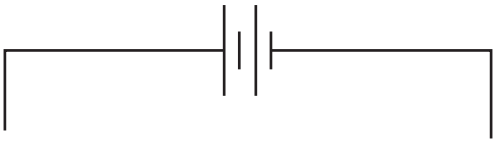

Fig. 3.1

[2]

(ii) A voltmeter is connected to measure the potential difference across the lamp.

Add a voltmeter to your circuit diagram in Fig. 3.1 using the correct electrical symbol. [2]

(iii) Fig. 3.2 shows a cell and lamp used in the torch.

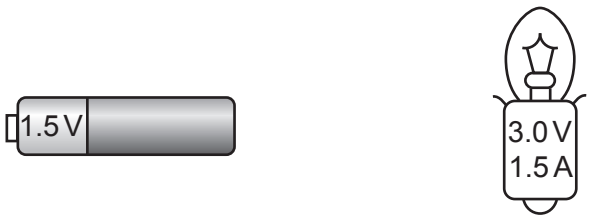

Fig. 3.2

Use information from Fig. 3.2 to explain why two cells are used to light the lamp.

.....

..... [1]

(iv) Use information from Fig. 3.2 to calculate the resistance of the lamp when lit.

resistance = ... Ω [2]

(v) The cell provides an electromotive force (e.m.f.) to the circuit.

Complete the sentence.

The e.m.f. of an electrical source of energy is measured in ..... . [1]

(b) Fig. 3.3 shows a single ray of light from the torch shining on a mirror.

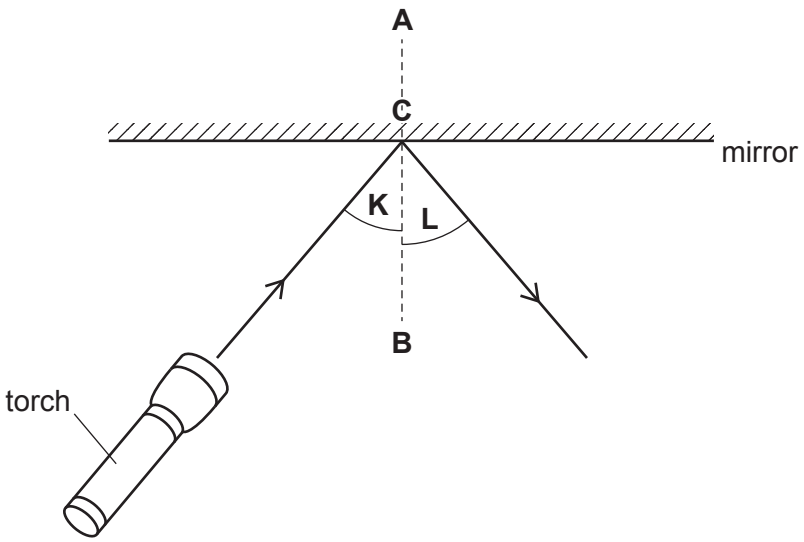

Fig. 3.3

(i) State the relationship between angle **K** and angle **L**.

.....

..... [1]

(ii) State the name of the dotted line **AB**.

..... [1]

(iii) State what happens to the ray of light at point **C**.

..... [1]

[Total: 11]

4 **(a)** Fig. 4.1 shows a food web from a rainforest environment.

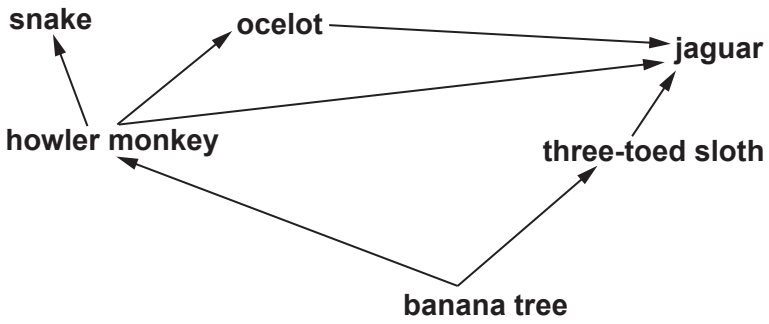

Fig. 4.1

(i) Construct a food chain from Fig. 4.1 that includes the snake.

..... [2]

(ii) Use Fig. 4.1 to identify **one**:

herbivore .....

tertiary consumer. .....

[2]

(iii) Removal of banana trees can cause the extinction of three-toed sloths.

List **two** other undesirable effects of deforestation.

1 .....

.....

2 .....

.....

[2]

(b) Banana trees are producers that make their own carbohydrates.

State the **two** raw materials that producers need to make their own carbohydrates.

1 .....

2 .....

[2]

(c) A student makes a statement:

'All carnivores are consumers but **not** all consumers are carnivores.'

Explain this statement.

.....

.....

.....

..... [2]

(d) State the name of the type of organism that gets its energy from dead organic matter.

..... [1]

[Total: 11]

5 **(a)** Ice is a solid. Water is a liquid. Steam is a gas.

Fig. 5.1 shows the different arrangement of the particles in ice, water and steam.

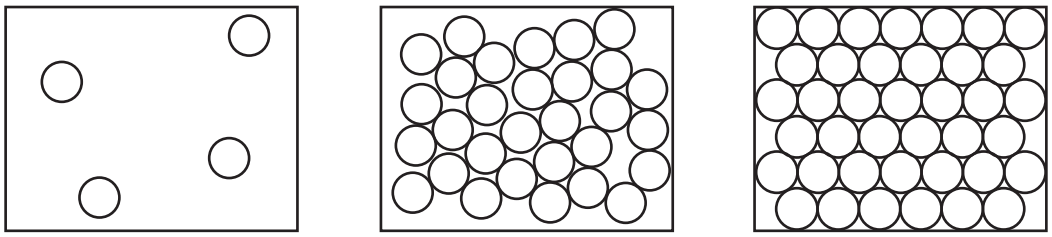

Fig. 5.1

State and explain which diagram, **A**, **B** or **C**, shows the arrangement of particles in ice, water or steam.

ice is diagram .....

explanation .....

.....

water is diagram .....

explanation .....

.....

steam is diagram .....

explanation .....

.....

[3]

(b) A few drops of water are left in a cup in a warm room.

After a few hours, no water is left in the cup.

State the name of the process that has occurred.

..... [1]

(c) Water is neutral.

State the pH number of pure water.

pH = ... [1]

(d) State why chlorine is added to water to make it safe to drink.

.....

..... [1]

(e) The electronic structures for oxygen and hydrogen are shown in Fig. 5.2.

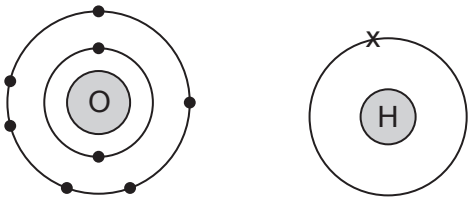

Fig. 5.2

Complete the dot-and-cross diagram in Fig. 5.3 to show the arrangement of electrons in a molecule of water.

Show the outer-shell electrons only.

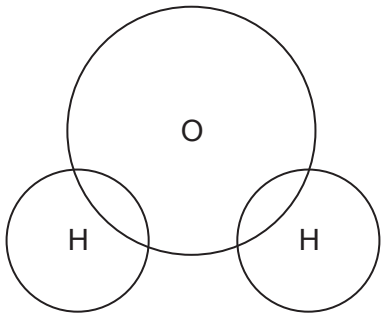

Fig. 5.3

[2]

(f) Sodium chloride is a solute. Water is a solvent.

Define the terms solute and solvent.

solute .....

.....

solvent .....

.....

[2]

[Total: 10]

6 **(a)** A train travels between two stations **X** and **Y**.

Fig. 6.1 shows a speed–time graph for the journey.

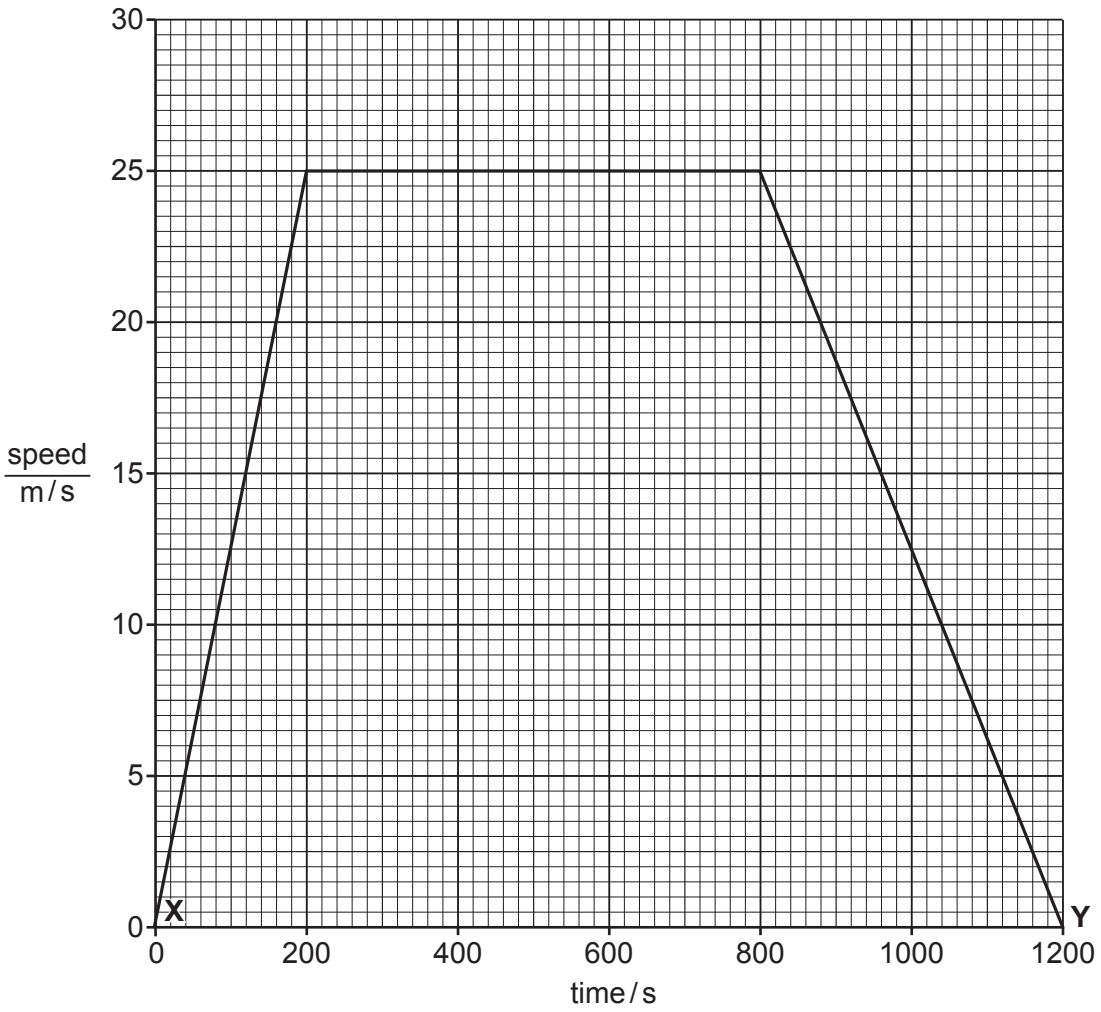

Fig. 6.1

(i) State the time taken for the journey from station **X** to station **Y**.

time = ... s [1]

(ii) On Fig. 6.1, mark with the letter **C** a point on the graph when the train is travelling at a constant speed. [1]

(iii) Calculate the distance travelled by the train between station **X** and station **Y**.

distance = ... m [3]

(b) Fig. 6.2 shows some railway track.

Railway track is made of lengths of steel rails with small gaps between them.

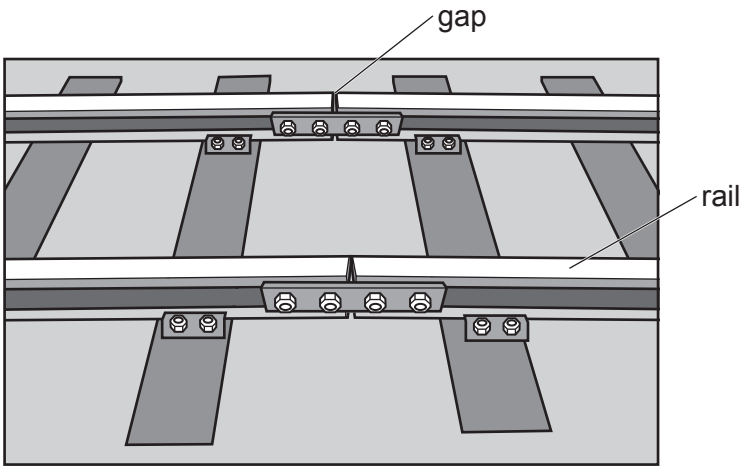

Fig. 6.2

(i) Explain why leaving gaps in the rails avoids damage to the track in hot weather.

.....

..... [1]

(ii) A length of steel rail has a weight of 10 270 N.

The density of steel is 7870 kg / m^3.

Calculate the volume of steel used to make the steel rail.

The gravitational force *g* on unit mass is 10 N / kg.

volume = ... m^3 [3]

[Total: 9]

7 **(a)** Fig. 7.1 shows a cross-section through human skin.

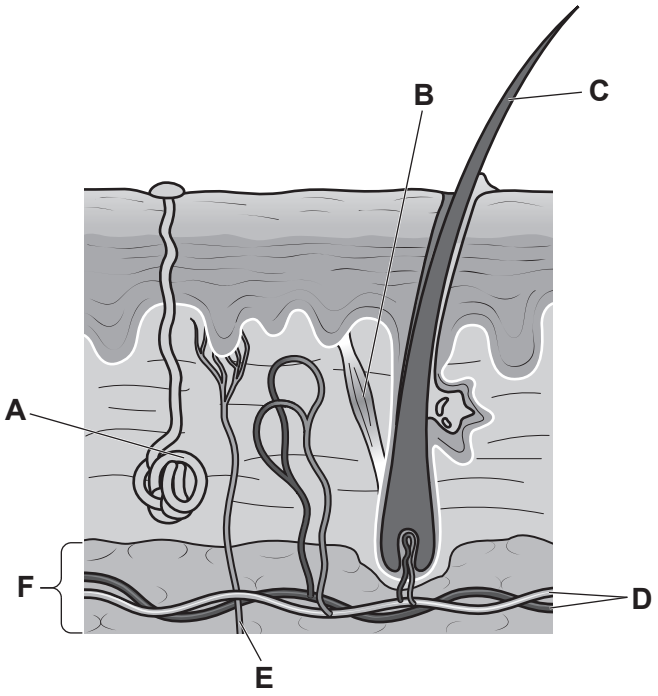

Fig. 7.1

(i) Table 7.1 shows some information about two of the parts labelled in Fig. 7.1.

Complete Table 7.1.

Table 7.1

letter in Fig. 7.1	name	role in maintenance of internal body temperature
		produces sweat
		contracts to erect hair

[4]

(ii) A human has a fat layer in the skin of 3 cm.

A whale has a fat layer in the skin of 50 cm.

Explain why whales are better adapted to a cold environment.

.....

.....

.....

..... [2]

(b) Tick (✓) **two** boxes to show the role of the **brain** in the maintenance of internal body temperature.

has receptors that detect changes in blood temperature	
contracts to trap air to increase body temperature	
coordinates response to changes in temperature	
acts as insulation to decrease body temperature	
shivers to increase body temperature	
sweats to decrease body temperature	

[2]

(c) State the word that is used to describe the maintenance of a constant internal environment.

..... [1]

[Total: 9]

8 **(a)** Petroleum is separated into different fractions.

Table 8.1 shows the percentage composition of a 500 kg sample of petroleum.

Table 8.1

fraction	percentage
X	10
gasoline (petrol)	30
naphtha	30
diesel oil	26
bitumen	4

(i) Identify fraction **X**.

..... [1]

(ii) Most of the fractions are used as fuels.

State **one** other use for the naphtha fraction.

..... [1]

(iii) State the name of the process used to separate petroleum into different fractions.

..... [1]

(iv) Calculate the mass of diesel oil obtained from the 500 kg sample of petroleum.

mass of diesel oil = ... kg [1]

(v) State the **two** chemical elements present in the molecules of the fractions in Table 8.1.

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

(b) (i) Petroleum is a fossil fuel.

State the name of **one** other fossil fuel.

..... [1]

(ii) When fossil fuels are burned, carbon dioxide is made.

Carbon dioxide is a greenhouse gas.

State the name of **one** other greenhouse gas.

..... [1]

(iii) Burning fossil fuels is a chemical change.

State **two differences** between a chemical change and a physical change.

1 .....

.....

2 .....

.....

[2]

[Total: 10]

9 **(a)** Fig. 9.1 shows four forces acting on a submarine.

The submarine is moving underwater from right to left.

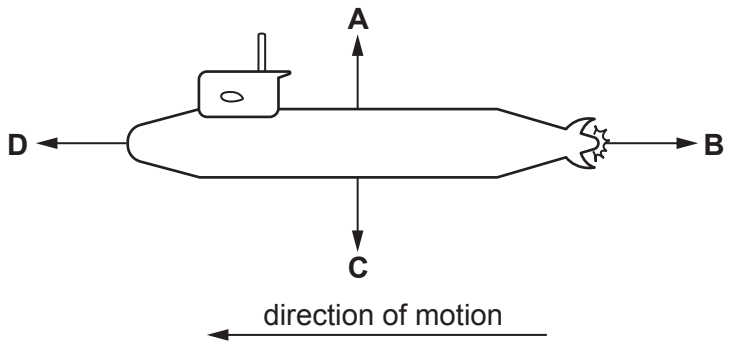

Fig. 9.1

(i) State which force **A**, **B**, **C** or **D** is the weight of the submarine.

..... [1]

(ii) Force **B** has the same magnitude as force **D**.

Describe the motion of the submarine.

.....

..... [1]

(b) The submarine is powered by a small nuclear reactor.

In the nuclear reactor, energy is released by the nuclear fission of an isotope of uranium.

(i) Describe what happens to an atom during nuclear fission.

.....

.....

..... [2]

(ii) Ionising radiation is released in the reactor during nuclear fission.

Suggest why the nuclear reactor is surrounded by a thick layer made of lead.

.....

..... [1]

(c) Ultrasound waves have a frequency higher than the maximum audible frequency for a human.

(i) The submarine uses ultrasound waves to calculate the depth of the water below the submarine.

A pulse of ultrasound is sent through the water and reaches the sea floor after 0.8 s.

Ultrasound waves travel through seawater at a speed of 1550 m / s.

Calculate the distance of the sea floor below the submarine.

distance = ... m [2]

(ii) Ultrasound waves are not part of the electromagnetic spectrum.

State the name of **one** region of the electromagnetic spectrum and give **one** use for waves in this region.

name .....

use .....
[2]

[Total: 9]

10 **(a)** Fig. 10.1 shows the activity of some bacterial enzymes at different temperatures.

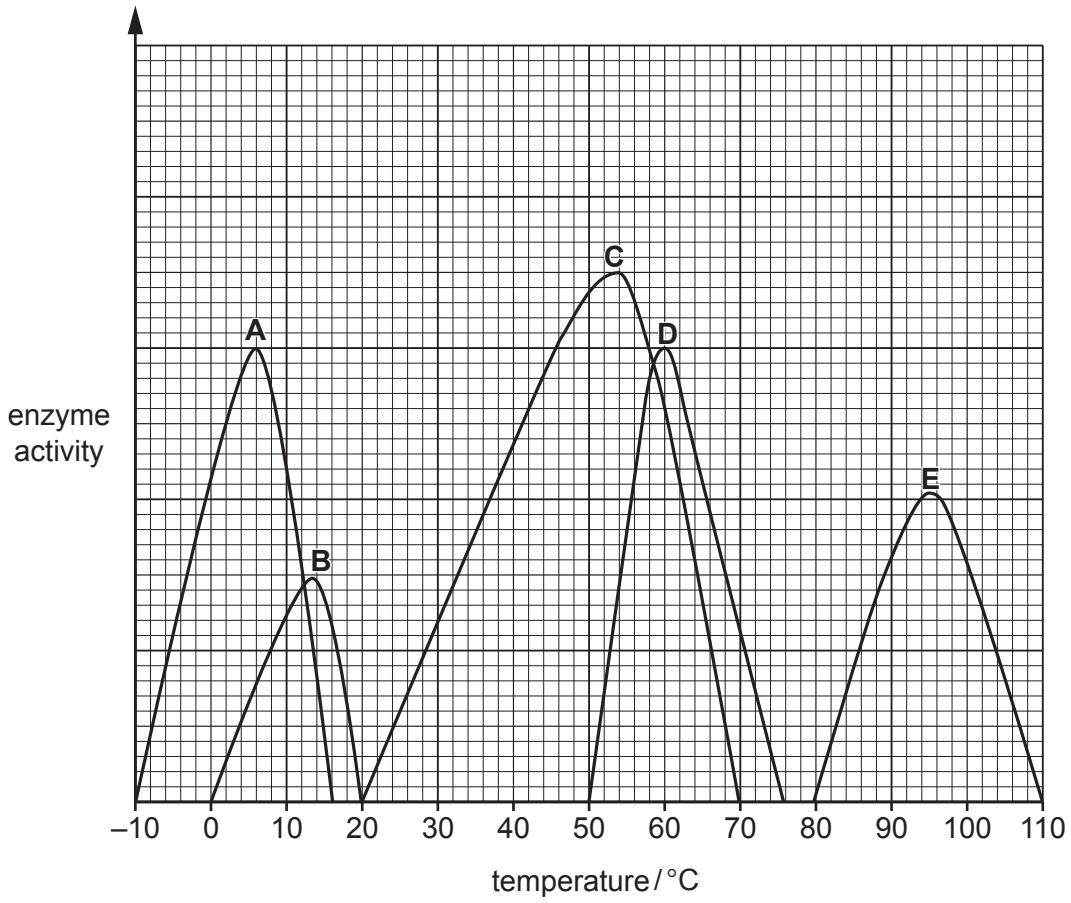

Fig. 10.1

Complete the sentences to describe the results in Fig. 10.1.

The only two enzymes active at 60 °C are enzymes ..... and .....

The greatest activity for enzyme **E** is at ..... °C.

The enzyme active over the greatest range of temperatures is enzyme ..... [4]

(b) State **one** factor, other than temperature, that affects enzyme activity.

..... [1]

(c) Enzymes are proteins.

Circle the elements that all proteins are made from.

carbon **calcium** **hydrogen**

oxygen **nitrogen**

[1]

(d) State the name of the solution used to test for the presence of protein.

..... [1]

(e) The boxes on the left show some biological molecules.

The boxes on the right show the smaller molecules they are made from.

Draw lines to link each biological molecule to **all** the smaller molecules they are made from.

fats and oils	amino acids
glycogen	fatty acids
protein	glucose
	glycerol

[3]

[Total: 10]

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11 **(a)** A calcium atom has a proton number of 20 and a nucleon number of 40.

Deduce the number of protons, neutrons and electrons in this atom of calcium.

number of protons .....

number of neutrons .....

number of electrons .....

[3]

(b) When calcium atoms react, they change into calcium ions, Ca^{2+}.

Describe how calcium atoms change into calcium ions.

.....

.....

..... [2]

(c) Lime is produced from limestone, calcium carbonate, by thermal decomposition.

(i) State the chemical name for lime.

..... [1]

(ii) State the name of the gas formed in this thermal decomposition reaction.

..... [1]

(iii) Explain why farmers spread limestone onto soil that is used for growing crops.

.....

..... [1]

(d) The main compound in limestone is calcium carbonate, $CaCO_3$.

(i) State the number of different elements in calcium carbonate.

..... [1]

(ii) State the total number of atoms shown in the formula $CaCO_3$.

..... [1]

[Total: 10]

12 **(a)** The driver of a car fills the fuel tank with gasoline (petrol).

As the gasoline flows into the fuel tank, the gasoline becomes charged.

(i) State the force that causes the gasoline to become charged.

..... [1]

(ii) State the name and the charge on the particles transferred when the gasoline becomes charged.

name .....

charge .....
[2]

(b) Some of the gasoline spills onto the hand of the driver.

The gasoline evaporates and the driver's hand cools down.

Explain this cooling effect.

Use ideas about molecules in your answer.

.....

.....

.....

..... [2]

(c) **(i)** During a journey in the car, the car engine transfers 5.8×10^7 J of useful energy to the car.

State the work done on the car by the car engine.

State the unit of your answer.

work done = ... unit ..... [2]

(ii) During the journey, the air in the tyres of the car warms up.

Describe what happens to the motion of the air particles in the tyres as the air warms up.

.....

..... [1]

(d) The windscreen wipers on the car are powered by an electric motor.

The turning effect on the current-carrying coil in the electric motor can be increased by increasing the magnetic field strength.

(i) State **one** other way to increase the turning effect on the coil.

..... [1]

(ii) The moment of a force is a measure of its turning effect.

Complete the sentence to describe how to calculate the moment of a force.

The moment of a force is calculated by multiplying the ..... by the perpendicular distance from the ..... . [2]

[Total: 11]

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 –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

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.).