Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER			

8569731348

CO-ORDINATED SCIENCES **0654/31**

Paper 3 Theory (Core) **October/November 2023**

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.

1 **(a)** Fig. 1.1 is a diagram of the female reproductive system in humans.

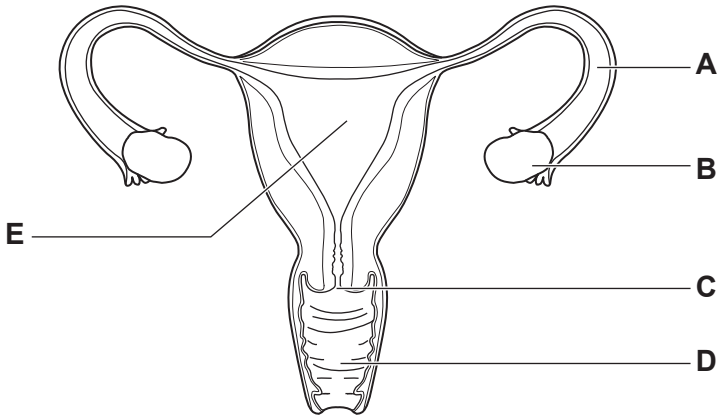

Fig. 1.1

Identify the letters in Fig. 1.1 that represent the part:

that produces female gametes .....

that receives the penis during sexual intercourse .....

where fertilisation occurs. .....

[3]

(b) State the names of the female gametes and the male gametes in humans.

female gametes .....

male gametes .....

[2]

(c) Gametes are cells.

Draw and label the main structures in a simple animal cell in the space provided.

[3]

(d) Circle the correct word or phrase in bold in each sentence to describe early development in humans.

During fertilisation, the nuclei of gametes fuse forming a fertilised cell called **a fetus / a zygote / an embryo**.

This divides to form **a zygote / an embryo / an ovule** which is a ball of cells.

This ball of cells implants into the wall of the **cervix / uterus / vagina**.

[3]

[Total: 11]

2 **(a)** Air is a mixture of gases.

Fig. 2.1 shows two pie charts representing samples of air, **A** and **B**.

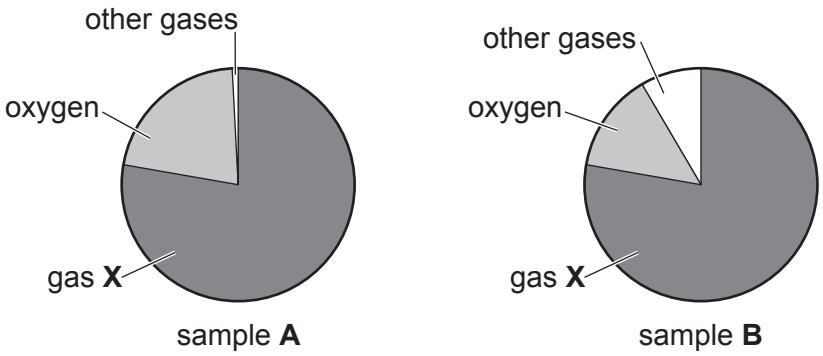

Fig. 2.1

(i) State which sample, **A** or **B**, represents clean air.

Explain your answer.

sample .....

explanation .....

.....

[1]

(ii) Identify gas **X**.

..... [1]

(b) Sulfur dioxide is a common pollutant found in air.

(i) State **one** adverse effect of sulfur dioxide on the health of humans.

.....

..... [1]

(ii) State **one** source of sulfur dioxide in the air.

..... [1]

(iii) State **one** other common pollutant gas found in the air.

..... [1]

(iv) Sulfur dioxide dissolves in rainwater to make acid rain.

Suggest a pH value for acid rain.

pH = ... [1]

(v) Farmers need to treat acidic soil to neutralise the acidity.

State the chemical substance used by farmers to treat soil acidity.

..... [1]

(c) An atom of sulfur has an electronic structure 2, 8, 6.

(i) On Fig. 2.2, complete the electronic structure for this atom of sulfur.

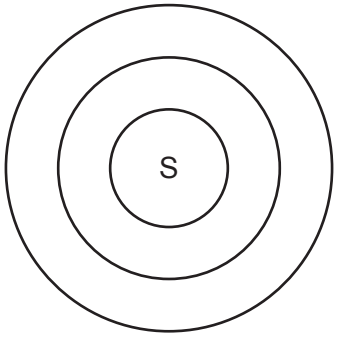

Fig. 2.2

[1]

(ii) Suggest how many electrons this sulfur atom gains to become a sulfide ion S^{2-}.

..... [1]

[Total: 9]

3 Fig. 3.1 shows four forces, **A**, **B**, **C** and **D**, acting on a submarine travelling underwater at a constant depth and at constant speed.

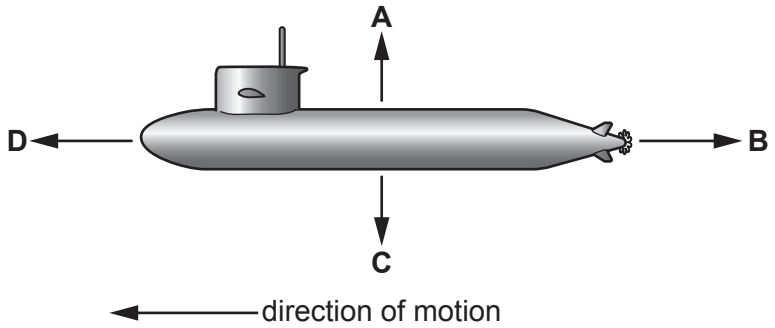

Fig. 3.1

(a) **(i)** State the name of force **C**.

..... [1]

(ii) State how the magnitude of force **B** compares to the magnitude of force **D**.

..... [1]

(b) Sound above the maximum frequency that the healthy human ear can hear is called ultrasound.

The submarine stops moving and then uses ultrasound to determine the depth of the sea floor.

(i) Suggest a value for the frequency of ultrasound.

frequency = ... Hz [1]

(ii) Pulses of ultrasound waves are sent out through the water. The ultrasound pulses reflect off the sea floor and the reflection is detected by the submarine 1.4 s later.

Ultrasound waves move through sea water at a speed of 1600 m / s.

Calculate the total distance travelled by the ultrasound pulse.

distance = ... m [2]

(iii) Use your answer to **(b)(ii)** to calculate the distance between the sea floor and the submarine.

distance = ... m [1]

(c) The submarine is powered by a nuclear reactor.

The nuclear reactor uses the nuclear fission of the isotope uranium-235.

(i) State what is meant by the term isotope.

.....

..... [1]

(ii) Describe what happens to the nucleus of a uranium-235 atom during nuclear fission.

.....

..... [1]

(iii) Suggest **one** advantage of using nuclear fission to generate electricity.

.....

..... [1]

[Total: 9]

4 **(a)** A student records their pulse rate in beats per minute (bpm) during different types of activity.

Fig. 4.1 shows a bar chart of the results.

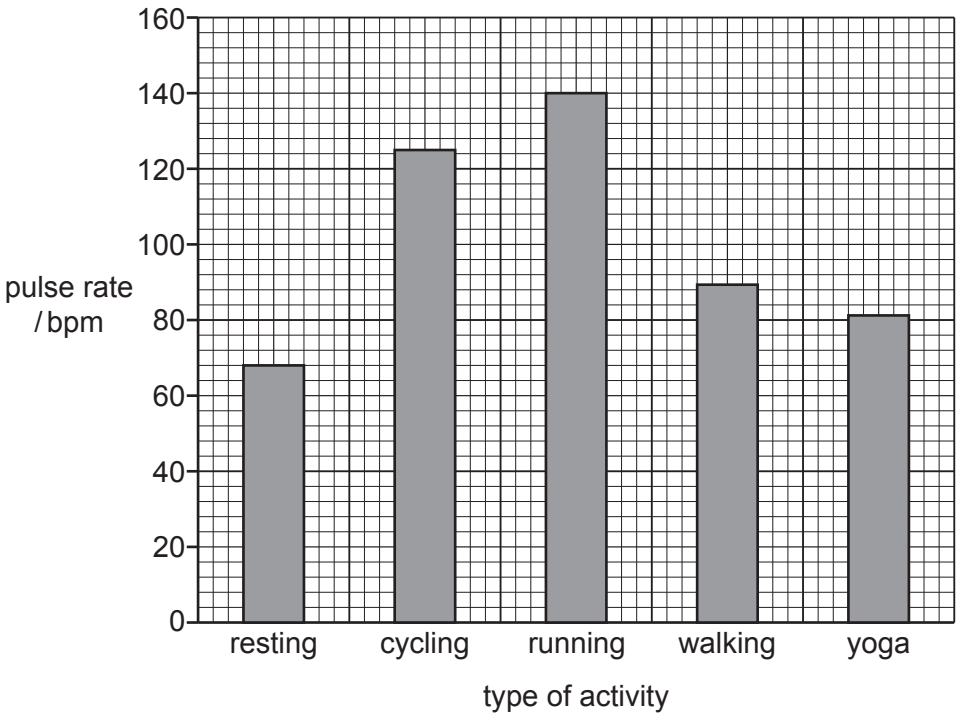

Fig. 4.1

(i) Identify the activity that results in the **smallest** increase in pulse rate from the resting pulse rate.

..... [1]

(ii) Calculate the percentage increase in pulse rate from resting to running shown in Fig. 4.1.

pulse rate during rest ..... bpm

pulse rate during running ..... bpm

percentage increase = ... [2]

(b) The rate of aerobic respiration increases during exercise.

(i) State the **two** reactants in aerobic respiration.

1 .....

2 .....
[2]

(ii) Suggest why the rate of respiration increases during exercise.

.....

.....

.....

..... [2]

(c) A hormone that causes pupils in the eye to widen also affects breathing and pulse rate.

(i) State the name of this hormone.

..... [1]

(ii) State the component of blood that transports hormones.

..... [1]

[Total: 9]

5 Table 5.1 shows five compounds, **A**, **B**, **C**, **D** and **E**, and the formula of each compound.

Table 5.1

compound	formula
A	CO
B	CO_2
C	CH_4
D	C_2H_4
E	C_2H_6

(a) (i) State the compound from Table 5.1 that is an unsaturated hydrocarbon.

..... [1]

(ii) Describe the chemical test that distinguishes between a saturated hydrocarbon and an unsaturated hydrocarbon and state the results for each.

test .....

.....

result for a saturated hydrocarbon .....

.....

result for an unsaturated hydrocarbon .....

.....

[3]

(b) (i) State the **name** of the **two** compounds from Table 5.1 that are possible products of the combustion of compound **E**.

1 .....

2 .....
[2]

(ii) State the name of the compound made when compound **D** reacts with steam.

..... [1]

(iii) State the name of the polymer made using compound **D** as a monomer.

..... [1]

(iv) Draw the structure of compound **E**, C_2H_6.

[2]

(c) State the names of the **two** most common greenhouse gases from Table 5.1.

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

[Total: 11]

6 **(a)** Fig. 6.1 shows an incomplete circuit diagram.

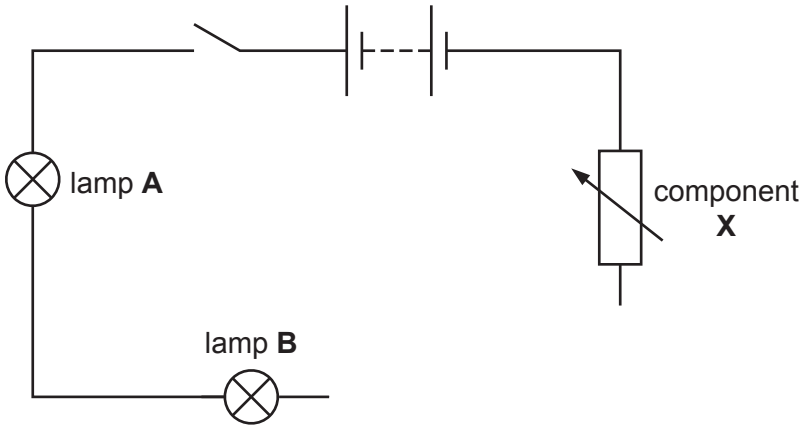

Fig. 6.1

(i) Complete the circuit diagram in Fig. 6.1 by:

- adding an ammeter to measure the current in lamp **A**
- adding a voltmeter to measure the potential difference across lamp **A**.

[3]

(ii) Identify component **X**.

..... [1]

(b) Lamp **A** has a resistance of 6.0 Ω and lamp **B** has a resistance of 4.0 Ω.

The current in lamp **A** is 1.2 A.

(i) Calculate the potential difference across lamp **A**.

potential difference = ... V [2]

(ii) Calculate the combined resistance of the two lamps connected in series.

resistance = ... Ω [1]

(iii) The two lamps are now connected in parallel. Their combined resistance is different.

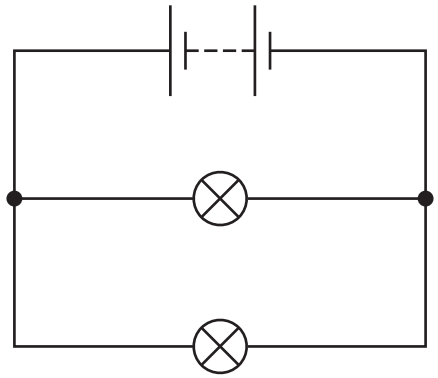

Fig. 6.2

Identify from the list the combined resistance of the two lamps connected in parallel.

Explain your answer.

2.4Ω **4.0Ω** **6.0Ω** **10Ω** **24Ω**

combined resistance .....

explanation .....

.....

[2]

(c) In lighting circuits in houses, lamps are connected in parallel.

State **two** advantages of using lamps connected in parallel rather than in series.

1 .....

.....

2 .....

.....

[2]

[Total: 11]

7 **(a)** Horses are herbivores.

Define the term herbivore.

.....

.....

..... [2]

(b) Fig. 7.1 is a photograph of the lower jaw of a horse.

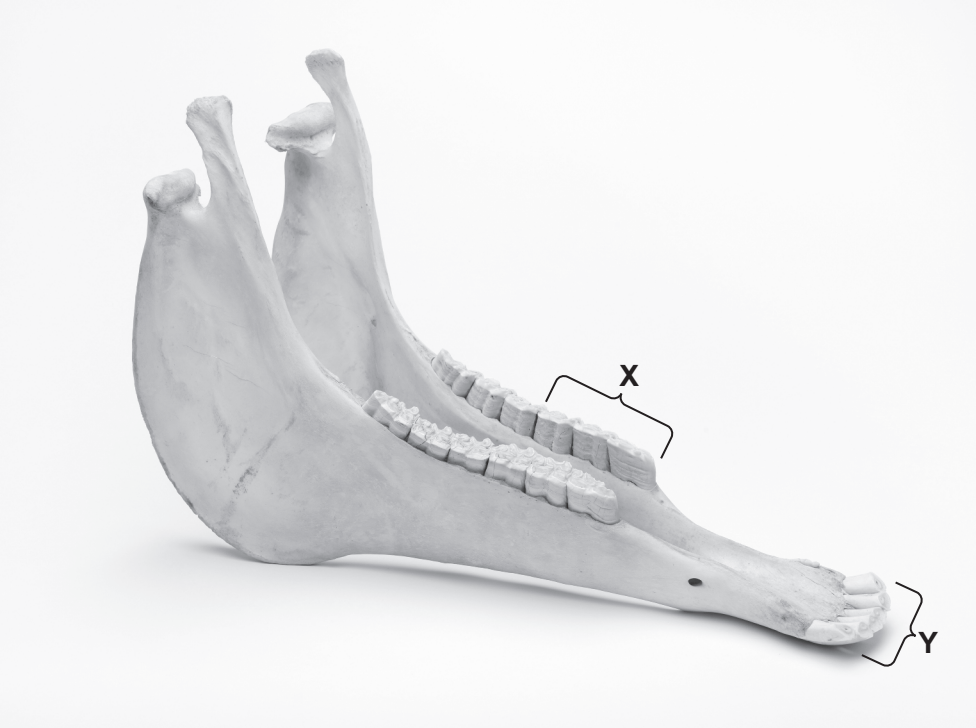

Fig. 7.1

(i) The dental pattern of a horse is similar to that of humans.

Identify the type of teeth labelled **X** and **Y** in Fig. 7.1.

X .....

Y .....
[2]

(ii) Identify the type of teeth found in a human jaw but **not** present in the jaw shown in Fig. 7.1.

..... [1]

(iii) State the name of the type of digestion that takes place using teeth.

..... [1]

(c) The statements describe some processes that occur in the alimentary canal.

Place ticks (✓) to show **all** the statements that describe the process of absorption.

food molecules are broken down so they become soluble	
food molecules become part of cells	
food molecules cross the wall of the small intestine	
food molecules enter the blood	
food molecules are taken in through the mouth	

[2]

(d) Complete these sentences about biological molecules.

Choose words or phrases from the list.

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

amino acids **fatty acids** **glycerol** **glycogen** **starch**

Proteins are made from smaller molecules called ..... .

Glucose is used to make **two** larger molecules called

..... and ..... .

Iodine solution is used to test for the presence of ..... .

[4]

[Total: 12]

8 **(a)** Table 8.1 gives statements about molecules in solids and gases.

Put a tick (✓) next to each statement to show if it refers to a solid or to a gas.

Table 8.1

statement	solid	gas
molecules are closely packed		
molecules are free to move around		
molecules are widely separated		
molecules vibrate about fixed positions		

[2]

(b) Use the list of substances to answer the following questions.

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

carbon chlorine copper ethanol oxygen water

(i) Identify **one** substance which is a compound.

..... [1]

(ii) Identify **two** substances which are solvents.

1 .....

2 .....

[2]

(iii) Identify **one** substance which is a transition element.

..... [1]

(iv) Identify **one** substance which is a halogen.

..... [1]

(v) Identify **one** substance which consists of diatomic molecules.

..... [1]

[Total: 8]

9 **(a)** Train track is made of lengths of steel rails with small gaps between them.

Fig. 9.1 shows some train track.

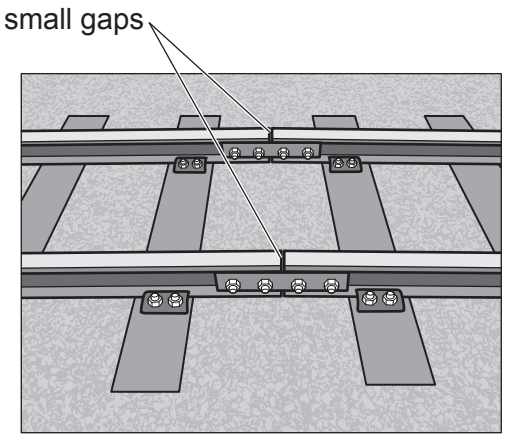

Fig. 9.1

(i) Suggest why gaps are left between the steel rails.

.....

.....

..... [2]

(ii) A steel rail has a volume of $0.13\,m^3$.

The density of steel is $7900\,kg/m^3$.

Calculate the mass of the steel rail.

mass = ... kg [2]

(b) (i) A train travels along the track for 600 s.

The train starts from rest and accelerates to a speed of 12.5 m / s in 200 s.

The train then travels at a constant speed for 300 s before slowing down and stopping after a further 100 s.

Complete the speed–time graph shown in Fig. 9.2 to show the motion of the train.

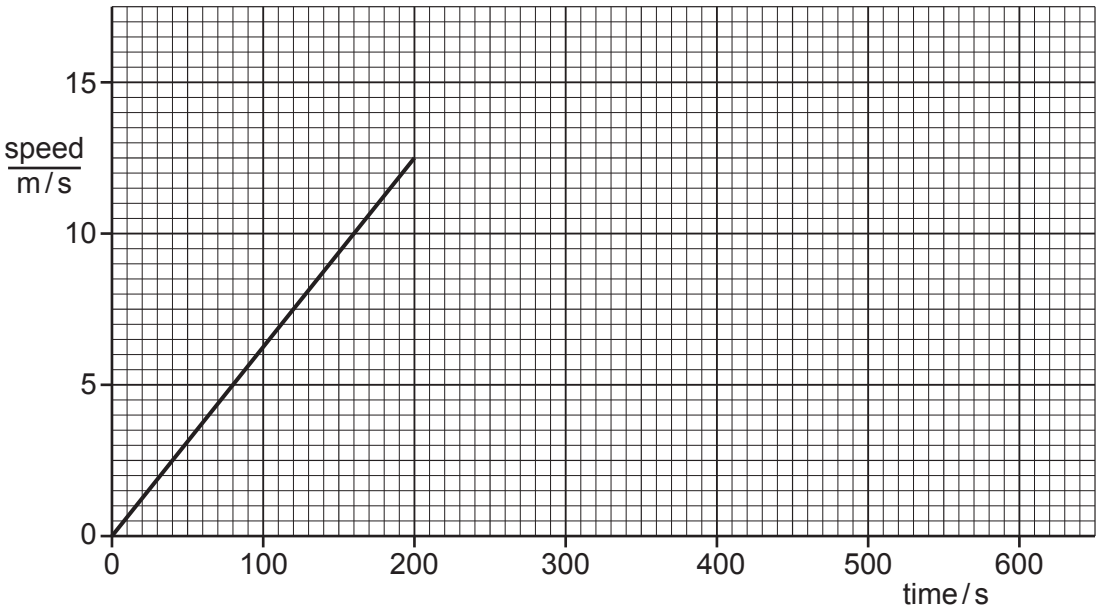

Fig. 9.2

[2]

(ii) During the journey, the train engine transfers 5×10^9 J of energy to the train.

State the work done on the train by the engine.

work done = ... J [1]

(c) Nuclear waste is carried by trains.

Nuclear waste emits ionising radiation.

(i) State **one** harmful effect of ionising radiation on human health.

.....

..... [1]

(ii) Suggest how the nuclear waste is stored safely during the train journey.

.....

..... [1]

(d) The headlamps of a train produce visible light.

Visible light is part of the electromagnetic spectrum.

Fig. 9.3 shows an incomplete electromagnetic spectrum.

Complete Fig. 9.3 to show all the parts of the electromagnetic spectrum.

← increasing frequency						
gamma radiation	X-rays			infrared	microwaves	

Fig. 9.3

[2]

[Total: 11]

10 (a) A student investigates the conditions required for the germination of seeds.

Fig. 10.1 shows the apparatus and conditions.

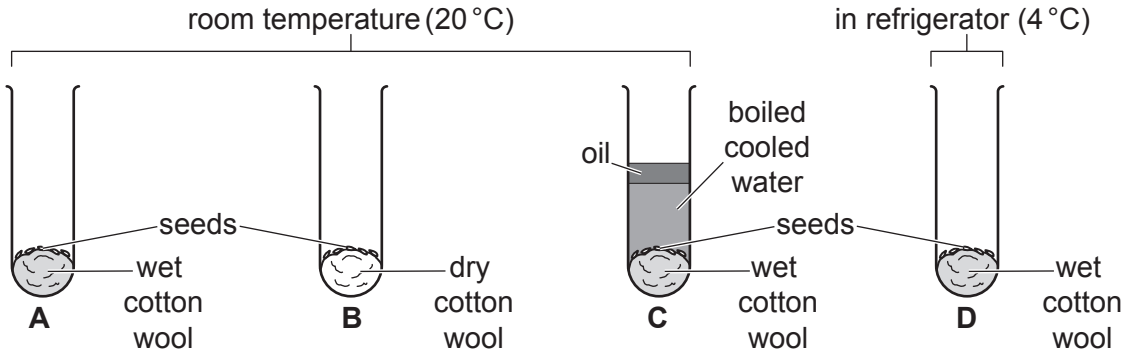

Fig. 10.1

Only the seeds in test-tube **A** germinate.

State why the seeds in test-tubes **B**, **C** and **D** do **not** germinate.

B .....

.....

C .....

.....

D .....

.....

[3]

(b) After germination, the shoots of the new plant grow towards the light.

(i) State the name of this tropic response.

..... [1]

(ii) Explain why plants grow towards light.

.....

.....

..... [2]

(c) Table 10.1 shows some of the names of the different layers of a leaf.

Complete Table 10.1.

Table 10.1

upper surface ↑	
	upper epidermis
	spongy mesophyll
lower surface	lower epidermis

[2]

[Total: 8]

11 **(a)** A student investigates the reaction between magnesium and dilute sulfuric acid.

During the reaction, hydrogen gas and a salt are made.

(i) Complete the word equation for this reaction.

sulfuric acid + ... → ..... + ...

[2]

(ii) The reaction is exothermic.

Describe **two** observations which show that a chemical reaction occurs between magnesium and dilute sulfuric acid.

.....

.....

[2]

(iii) The hydrogen made in the reaction exists as molecules of hydrogen, H_2.

Draw a dot-and-cross diagram to show the bonding in a molecule of hydrogen, H_2.

[2]

(b) The formula of sulfuric acid is H_2SO_4.

(i) State the number of different elements shown in this formula.

..... [1]

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

..... [1]

(c) Magnesium is a metal.

(i) Describe **two** physical properties of metals.

1 .....

2 .....
[2]

(ii) Table 11.1 shows the percentage composition of a magnesium alloy.

Table 11.1

element	percentage by mass in the alloy / %
aluminium	3.0
magnesium	
zinc	1.0

Calculate the mass of magnesium contained in 50 kg of the alloy.

Show your working.

mass of magnesium = ... kg [2]

[Total: 12]

12 (a) A cyclist is riding a bicycle around a circular track.

The length of the track is 400 m.

The cyclist completes five laps of the track.

The time taken for each lap is measured and recorded in Table 12.1.

Table 12.1

lap	time / s
1	35.3
2	34.7
3	37.2
4	35.0
5	34.3

(i) Calculate the average time for **one** lap.

average time for one lap = ... s [1]

(ii) The air in the tyres of the bicycle warms up during the ride.

Describe how the motion of the molecules of the gas in the tyres changes during the ride.

.....

..... [1]

(iii) Select the correct word from the list to complete each sentence.

solids **liquids** **gases**

..... have **no** definite shape or volume.

..... have a definite volume but take the shape of the container.

[1]

(b) Fig. 12.1 shows a cyclist near a road junction.

A car driver at the junction can see the reflection of the cyclist in a plane mirror.

The ray of light shown allows the car driver to see the cyclist approaching the junction.

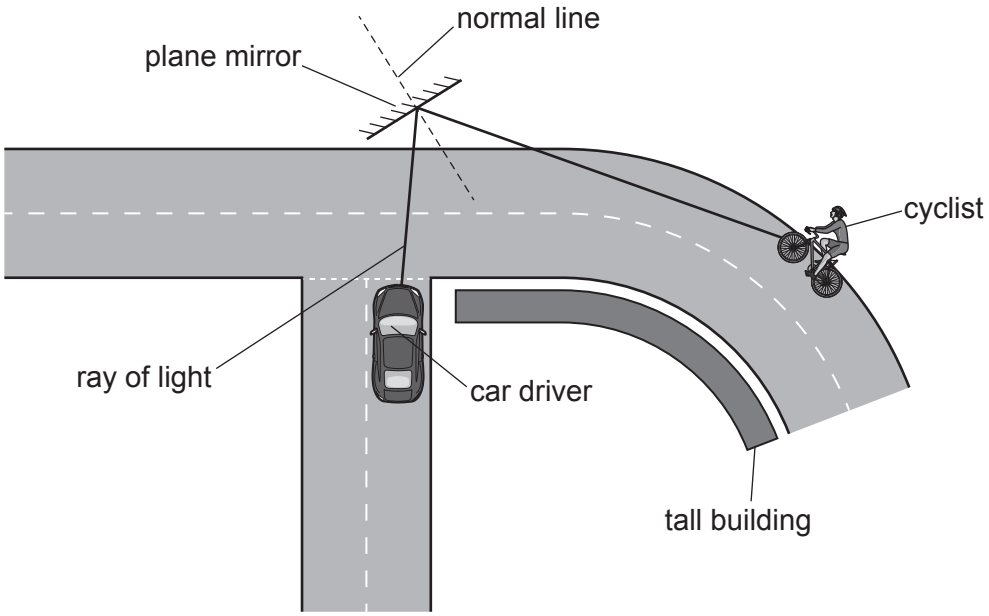

Fig. 12.1

(i) On Fig. 12.1, draw an arrow on the ray of light to show the direction of travel of the ray of light. [1]

(ii) On Fig. 12.1, label the angle of incidence with the letter *i*. [1]

(c) The bicycle is left outside on a sunny day. Energy from the Sun heats the metal frame of the bicycle.

(i) State the method of energy transfer between the Sun and the Earth.

..... [1]

(ii) State the method of energy transfer through the frame of the bicycle.

..... [1]

(iii) Describe a simple way of testing whether the frame of the bicycle is made from steel or from aluminium.

.....

..... [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.).