Cambridge Assessment International Education

Cambridge IGCSE™ (9–1)

CANDIDATE NAME

CENTRE NUMBER | | | | | |

CANDIDATE NUMBER | | | | |

2336163556

CO-ORDINATED SCIENCES **0973/31**

Paper 3 Theory (Core) **May/June 2022**

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.

DC (EF) 311735

1 **(a)** An athlete monitors her pulse rate during different types of activity.

Fig. 1.1 shows the results.

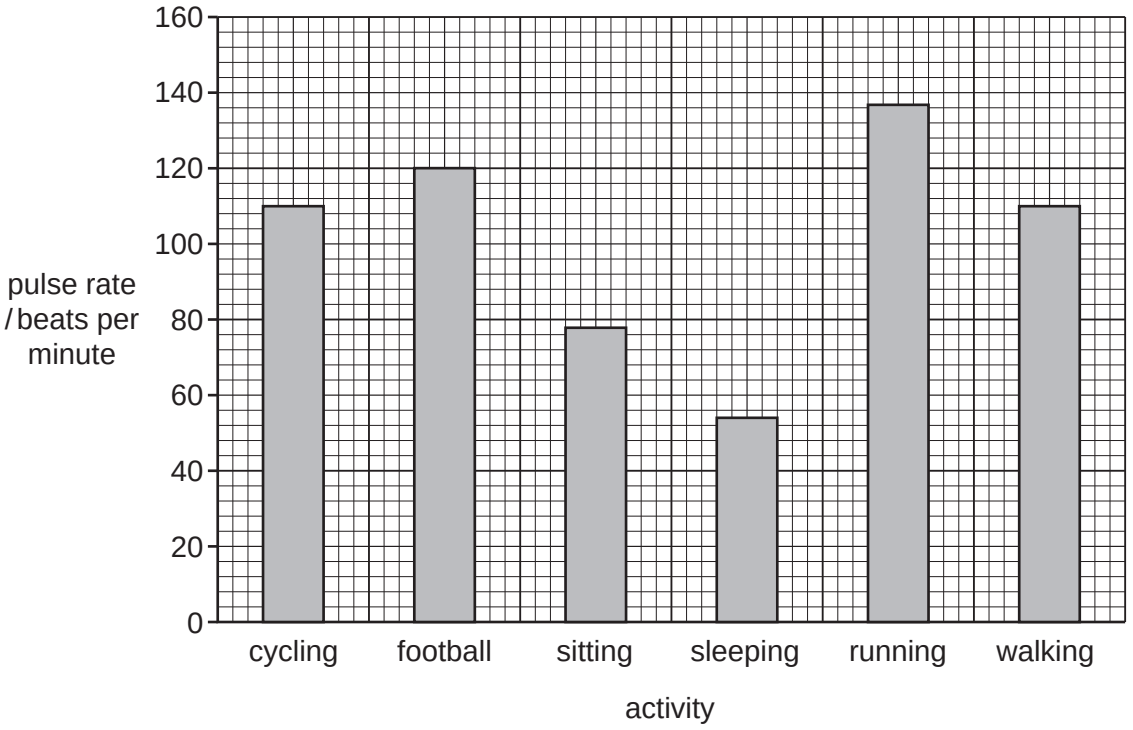

Fig. 1.1

Use Fig. 1.1 to complete these sentences.

The activity with the highest pulse rate is ..... .

Two activities have the same pulse rate. They are

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

The athlete's pulse rate was 54 beats per minute when the activity

is ..... .

[3]

(b) Fig. 1.2 is a diagram of the heart.

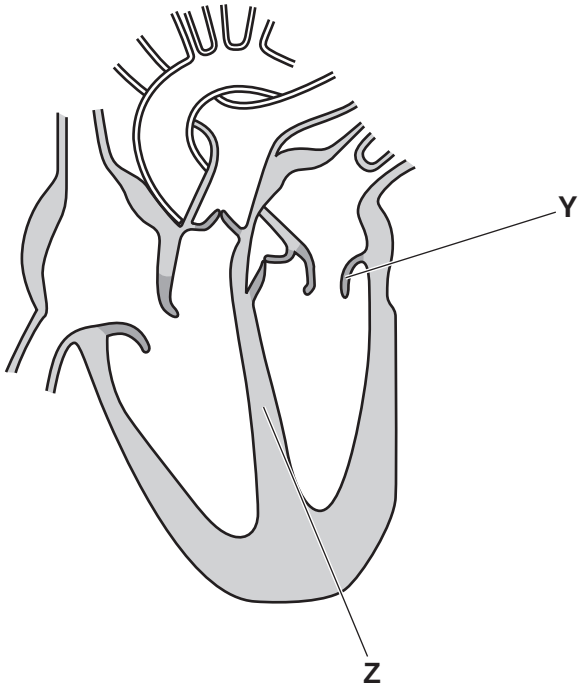

Fig. 1.2

(i) Draw an **X** on Fig. 1.2 to identify the position of one ventricle. [1]

(ii) State the function of the part labelled **Y** in Fig. 1.2.

.....

..... [1]

(iii) Identify the part labelled **Z** in Fig. 1.2.

..... [1]

(iv) Name the type of tissue the wall of the heart is made from.

..... [1]

(v) State the function of the heart.

.....

..... [1]

(c) Name **one** of the main blood vessels to **or** from the:

lungs .....

kidney. .....
[2]

[Total: 10]

2 **(a)** Petroleum is a fossil fuel.

Name two other fossil fuels.

1 .....

2 .....
[2]

(b) Complete the sentences using words or phrases from the list.

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

bitumen **chromatography** **filtration** **fractional distillation**

gases **hydrocarbons** **naphtha** **refinery gas** **solids**

Petroleum is a mixture of ..... .

The fractions in petroleum are separated using ..... .

The fraction used as a feedstock for making chemicals is the

..... fraction. [3]

(c) Octane, C_8H_{18}, is a hydrocarbon fuel.

(i) State the number of different **elements** in one molecule of octane.

..... [1]

(ii) State the total number of **atoms** in one molecule of octane.

..... [1]

(iii) When fuels burn, the reaction produces a temperature increase.

State the name given to all reactions that produce a temperature increase.

..... [1]

(iv) State the chemical test for carbon dioxide and the observation for a positive result.

test .....

observation .....
[2]

[Total: 10]

3 A student uses her laptop computer.

(a) The laptop screen acts as a plane mirror.

Fig. 3.1 shows a ray of light reflected by the laptop screen.

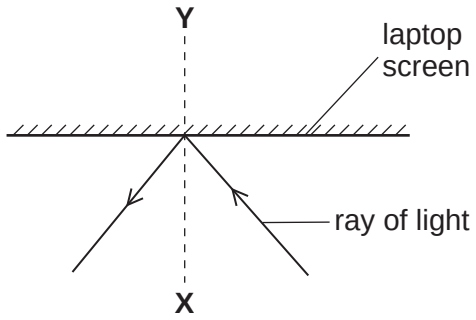

Fig. 3.1

(i) Name the line labelled **XY**.

..... [1]

(ii) Label the angle of incidence with the letter ***i***. [1]

(iii) The angle of incidence is 40°.

State the angle of reflection.

..... ° [1]

(b) The laptop contains two speakers each with a resistance of 8 Ω.

(i) The current in one speaker is 3 A.

Calculate the potential difference (p.d.) across this speaker.

p.d. = ... V [2]

(ii) The two speakers are connected in parallel.

The combined resistance of the two speakers is one of the following values.

4 Ω 8 Ω 16 Ω 64 Ω

State the correct value of the combined resistance.

Explain your answer.

resistance = ... Ω

explanation .....

.....

[2]

(iii) Fig. 3.2 shows circuit symbols for four electrical components found in the laptop.

Identify the four electrical components.

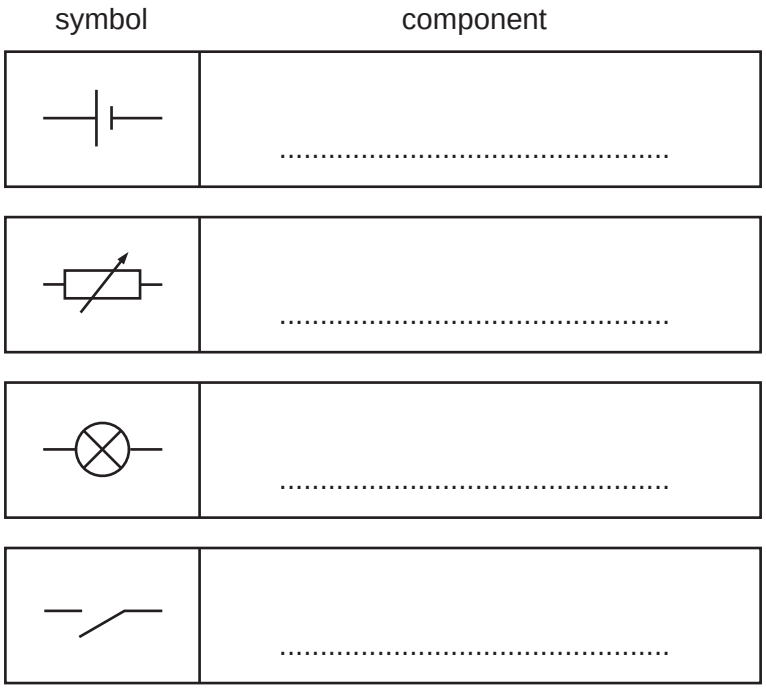

Fig. 3.2

[2]

(c) Fig. 3.3 shows the laptop being closed.

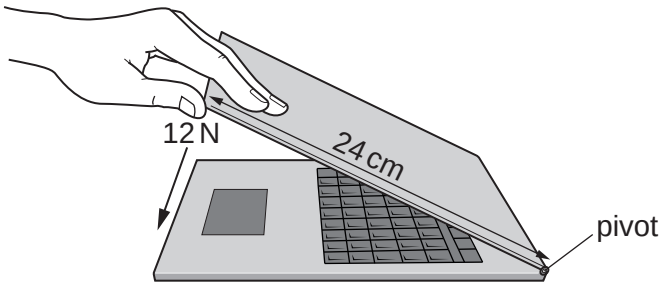

Fig. 3.3

Calculate the moment of the force about the pivot in Nm.

moment = ... Nm [3]

[Total: 12]

4 **(a)** The inheritance of smooth or wrinkled skin in pea plants is controlled by a single gene.

- The allele for smooth skin is **R**.
- The allele for wrinkled skin is **r**.

Fig. 4.1 is a photograph of two peas.

- Pea **A** has wrinkled skin.
- Pea **B** has smooth skin.

pea **A** pea **B**

Fig. 4.1

(i) Table 4.1 shows the genotypes and genotype descriptions of the peas shown in Fig. 4.1.

Complete Table 4.1.

Table 4.1

pea	genotype	description of genotype
A		homozygous recessive
B	**Rr**	

[2]

(ii) A scientist crossed two pea plants and observed the results.

Complete the genetic diagram in Fig. 4.2 to identify the parental gametes.

		parental gametes	
		.....	.....
parental gametes	.....	**RR**	**Rr**
	.....	**Rr**	**rr**

Fig. 4.2

[2]

(iii) State the ratio of smooth peas to wrinkled peas from Fig. 4.2.

smooth ..... : wrinkled ..... [1]

(b) Fertilisation in **plants** occurs when the nuclei of the male and female gametes fuse.

Name these two gametes.

1 .....

2 .....
[2]

(c) State the name of the female gamete in humans.

..... [1]

(d) Table 4.2 contains one term and two definitions linked to inheritance.

Complete Table 4.2.

Table 4.2

term	definition
.....	A thread-like structure of DNA, carrying genetic information in the form of genes.
gene	....
.....	A version of a gene.

[4]

[Total: 12]

5 **(a)** Aluminium is a metal.

Two physical properties of metals are that they are good thermal conductors and good electrical conductors.

State two other **physical properties** of metals.

1 .....

2 .....
[2]

(b) Duralumin is an alloy of 95% aluminium and 5% copper.

(i) Calculate the mass of aluminium used in 1000 kg of duralumin.

mass = ... kg [1]

(ii) State why aluminium alloys are used in aircraft parts.

.....

..... [1]

(c) Aluminium is extracted from its ore by electrolysis.

(i) State the name of the ore of aluminium used.

..... [1]

(ii) Define electrolysis.

.....

.....

..... [2]

(iii) Aluminium cannot be extracted from its ore by heating with carbon.

Name **one** metal which can be extracted from its ore by heating with carbon.

..... [1]

(d) Aluminium ores must be conserved.

(i) State **why** aluminium ores must be conserved.

.....

..... [1]

(ii) Suggest **how** aluminium ores may be conserved.

.....

..... [1]

[Total: 10]

6 Many types of radiation are used in hospitals.

(a) Fig. 6.1 shows an infrared thermometer used to measure body temperature.

Fig. 6.1

(i) Place infrared radiation in the correct place in the incomplete electromagnetic spectrum shown in Fig. 6.2.

← increasing frequency						
	X-rays	ultraviolet				radio waves

Fig. 6.2

[1]

(ii) Electromagnetic radiation is used in hospitals.

On Fig. 6.3, draw one straight line from each radiation to its correct medical use.

One line has been drawn for you.

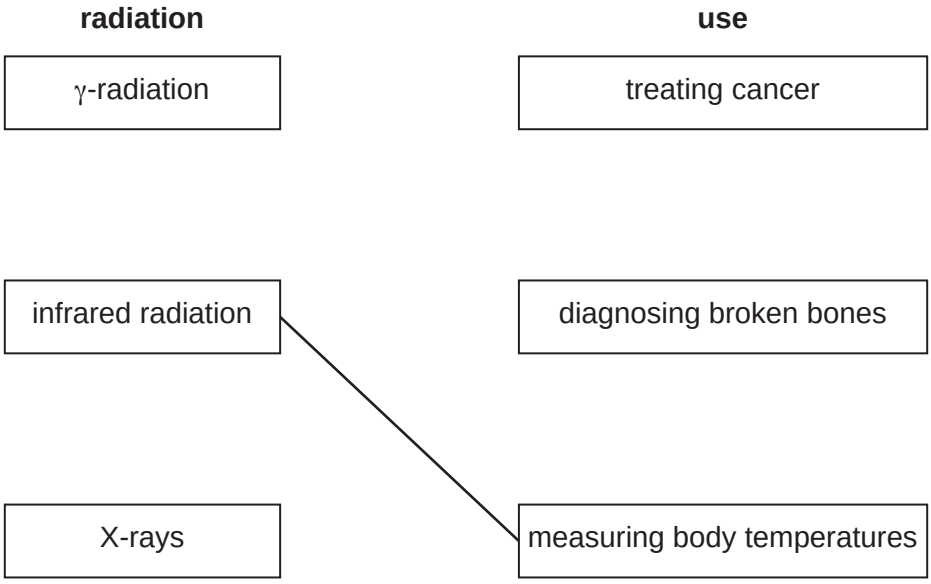

Fig. 6.3

[1]

(b) Ionising radiation from radioactive sources is used in hospitals.

(i) Place α-radiation, β-radiation and γ-radiation in order of their relative ionising effect.

greatest ionising effect .....

.....

least ionising effect .....

[1]

(ii) State **one** harmful effect of ionising radiation on the human body.

.....

..... [1]

(c) The isotope iodine-131 is used in hospitals.

(i) State the meaning of the term isotope.

.....

..... [1]

(ii) The half-life of iodine-131 is 8 days.

A sample of iodine-131 is left for 16 days.

The mass of iodine-131 remaining is 0.05 g.

Calculate the mass of iodine-131 in the sample at the start.

mass = ... g [2]

(d) In the hospital, the audible frequency range of a patient's hearing is measured.

The result is a range from 100 Hz to 15 000 Hz.

State how this compares to the average range of audible frequencies for a healthy human ear.

.....

.....

..... [2]

(e) A power station supplies electricity to the hospital. The power station uses petroleum as a fuel.

Complete Fig. 6.4 to show the energy transformations that occur in the power station.

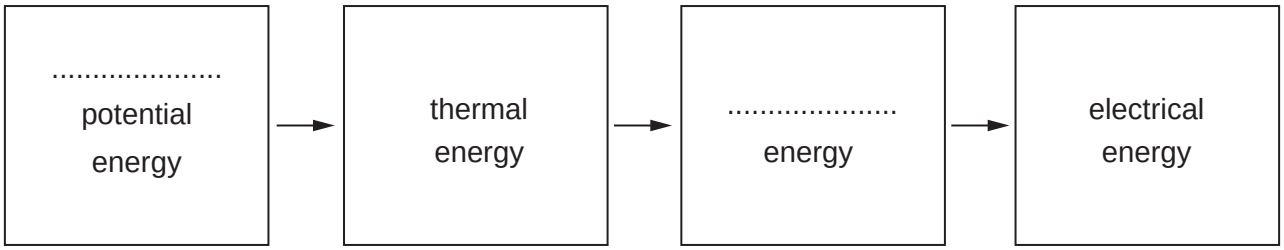

Fig. 6.4

[2]

[Total: 11]

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7 Fig. 7.1 is a diagram of the male reproductive system.

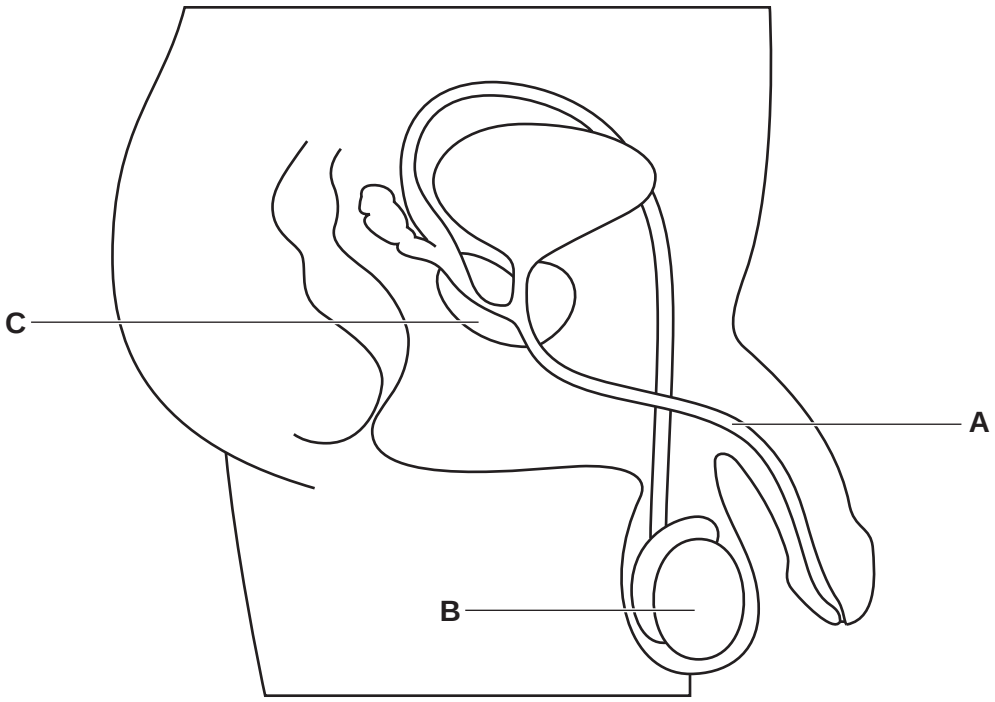

Fig. 7.1

(a) The boxes on the left show the letters of some of the parts in Fig. 7.1.

The boxes on the right show the functions of these parts.

Draw lines to link each letter to its correct function.

part in Fig. 7.1	function
A	production of male gametes
B	secretes fluid for sperm to swim in
C	transfers sperm to urethra
	transfers urine and semen

[3]

(b) Sperm need a high rate of respiration for movement.

State the word equation for aerobic respiration.

..... [2]

(c) Sperm is an example of a type of animal cell.

The list shows some components of cells.

Circle **two** components that you would expect to find in a sperm cell.

cell membrane **cell wall** **chloroplast**

cytoplasm **vacuole**

[1]

(d) State the name of the cell that is formed when gametes fuse.

..... [1]

(e) Name the part of the cell that contains the genetic material.

..... [1]

[Total: 8]

8 **(a)** Table 8.1 shows the names of eight gases.

Table 8.1

name of gas
ammonia
carbon monoxide
chlorine
helium
hydrogen
methane
nitrogen
oxygen

(i) One of the gases in Table 8.1 has molecules with the formula Cl_2.

State the name of this gas.

..... [1]

(ii) State the name of the gas from Table 8.1 that is a product of the **incomplete** combustion of carbon-containing substances.

..... [1]

(iii) State the name of the gas from Table 8.1 that is 78% of clean air.

..... [1]

(iv) State the name of the gas from Table 8.1 that is a greenhouse gas.

..... [1]

(v) State the name of the gas from Table 8.1 that is a noble gas.

..... [1]

(b) Fig. 8.1 shows apparatus a student uses to investigate the rate of reaction between calcium carbonate and dilute hydrochloric acid.

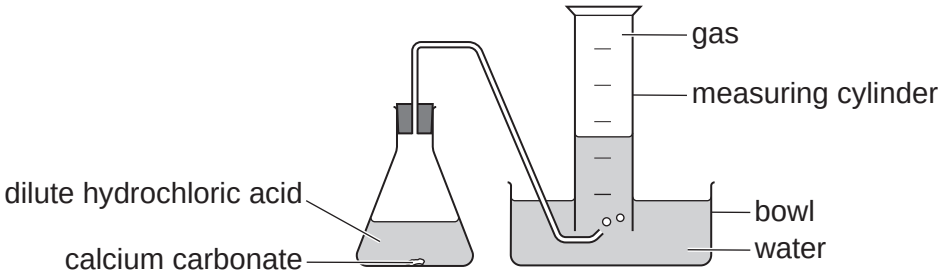

Fig. 8.1

The student adds a single piece of calcium carbonate to the dilute hydrochloric acid.

(i) State the name of the gas collected in the measuring cylinder.

..... [1]

(ii) Predict how the pH of the water changes as the gas bubbles through it.

Explain your answer.

pH change .....

explanation .....

.....
[2]

(iii) The student repeats the experiment using the same mass of calcium carbonate and the same volume of dilute hydrochloric acid.

Suggest two changes the student can make to their experiment to **increase** the rate of reaction.

1 .....

2 .....
[2]

[Total: 10]

9 **(a)** Fig. 9.1 shows a wind surfer on a surfboard, driven by the wind, sailing at a constant speed across the water.

Four forces **J**, **K**, **L** and **M** acting on the surfboard are shown.

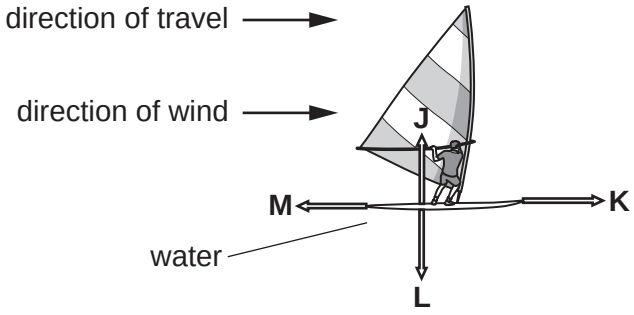

Fig. 9.1

(i) Explain why force **K** and force **M** must be equal and opposite.

.....

..... [1]

(ii) Identify force **L**.

..... [1]

(iii) Work is done by the wind to move the surfboard across the water.

State the two quantities needed to calculate the work done by the wind.

1 .....

2 .....

[2]

(b) Fig. 9.2 represents a water wave.

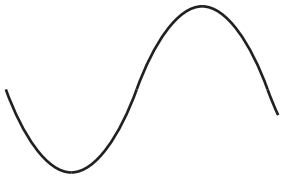

Fig. 9.2

(i) On Fig. 9.2, label the amplitude of the wave with a double headed arrow (↔ or ↕). [1]

(ii) The waves have a frequency of 0.1 Hz.

Explain what is meant by a frequency of 0.1 Hz.

.....

..... [1]

(c) Water molecules in the sea are able to form water vapour above the sea.

During this process, the more energetic molecules escape from the surface of the sea.

(i) Suggest the effect this will have on the **energy** of the water molecules remaining in the sea water.

.....

..... [1]

(ii) Suggest the effect this will have on the **temperature** of the sea water.

.....

..... [1]

(d) Some sea water has a volume of 5.0 m^3 and a mass of 5120 kg.

Calculate the density of the sea water.

density = ... kg / m^3 [2]

[Total: 10]

10 **(a)** Water is lost from leaves by transpiration. This causes a loss in mass.

A student records the mass of leaves from a plant.

He places the leaves under a heat lamp.

He records the mass of the leaves every 24 hours for 5 days.

The results are shown in Table 10.1.

Table 10.1

day	mass of leaves / g
1	115
2	100
3	85
4	65
5	58

(i) Calculate the total decrease in mass between day 1 and day 5.

..... g [1]

(ii) The investigation is repeated at a **lower** temperature.

The statements show some predictions.

Tick (✓) **one** box to show the correct prediction.

The decrease in mass will be less than in the first investigation.	
The decrease in mass will be more than in the first investigation.	
The mass will increase not decrease.	
The decrease in mass will be the same as in the first investigation.	

[1]

(b) State the process by which water is lost from the surfaces of the mesophyll cells during transpiration.

..... [1]

(c) State the name of the part of the leaf where water exits the plant.

..... [1]

(d) A plant obtains water from the soil.

Describe how water enters the plant and is transported to the mesophyll cells in the leaves.

.....

.....

.....

.....

..... [3]

(e) One use of water in a plant is for photosynthesis.

(i) State **one** other use of water in a plant.

..... [1]

(ii) State two other requirements of photosynthesis.

1 .....

2 .....
[2]

[Total: 10]

11 **(a)** Fig. 11.1 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. 11.1

(i) State the electronic structure of a potassium atom.

..... [1]

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

.....

..... [1]

(iii) The proton number of a potassium atom is 19.

The nucleon number of this potassium atom is 39.

State the numbers of electrons and neutrons in this potassium atom.

electrons .....

neutrons .....

[2]

(iv) Complete Table 11.1 to show the charges and approximate relative masses of an electron and a neutron.

Table 11.1

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

[2]

(b) Potassium, K, is an element. Potassium hydroxide, KOH, is a compound.

Explain the difference between an element and a compound.

element .....

.....

compound .....

.....

[2]

(c) Balance the symbol equation for the reaction between potassium and water.

$$.....K + ...H_2O \rightarrow .....KOH + H_2$$

[2]

[Total: 10]

12 **(a)** Fig. 12.1 shows a large snow tractor used in Antarctica.

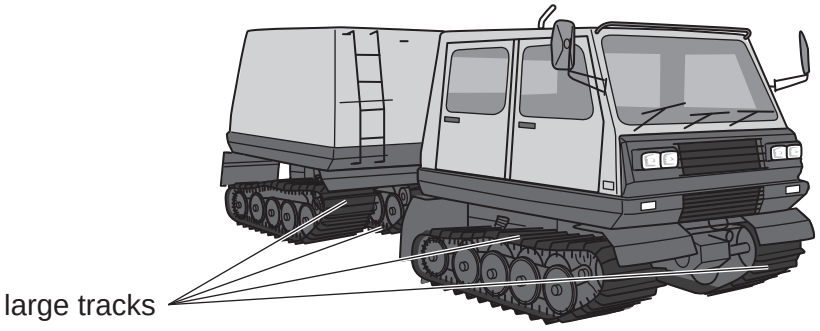

Fig. 12.1

The snow tractor has large continuous tracks.

These tracks allow the snow tractor to move across the snow without sinking.

Explain why a tractor with normal wheels would sink into the snow.

.....

.....

..... [2]

(b) When gasoline (petrol) burns in the engine of the snow tractor, carbon dioxide gas and water vapour are produced.

State which of the diagrams, **X**, **Y** or **Z** in Fig. 12.2, shows the arrangement of gaseous carbon dioxide molecules.

Give a reason for your answer.

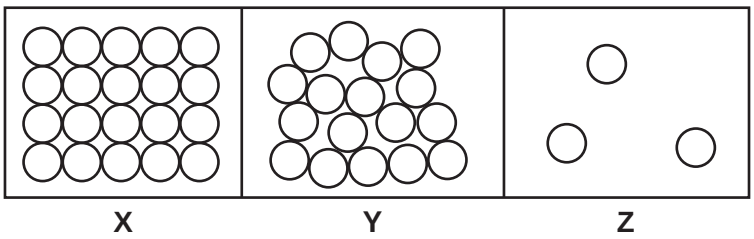

Fig. 12.2

diagram .....

reason .....

.....

[1]

(c) (i) The snow tractor accelerates.

State the form of energy gained as the tractor accelerates.

..... [1]

(ii) The snow tractor moves up a hill at constant speed.

State the form of energy gained as the tractor moves up the hill.

..... [1]

(d) Fig. 12.3 shows a distance-time graph for the snow tractor moving at constant speed.

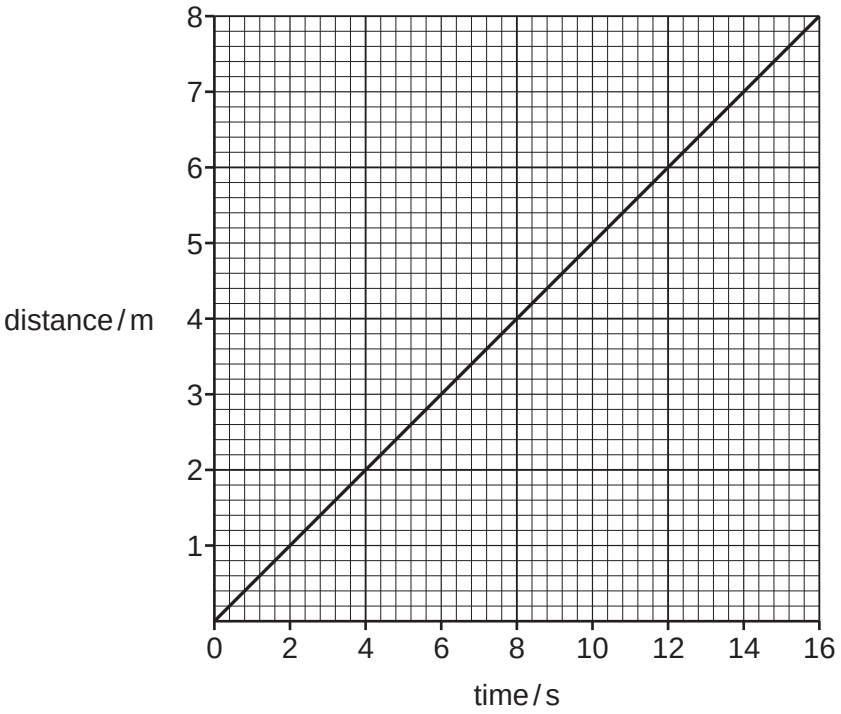

Fig. 12.3

Calculate this constant speed.

speed = ... m / s [2]

[Total: 7]

The Periodic Table of Elements

Group I	Group II						Group III	Group IV	Group V	Group VI	Group VII	Group 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.).