Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

COMBINED SCIENCE **5129/21**

Paper 2 Theory **October/November 2024**

1 hour 45 minutes

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 80.
- 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 **20** pages. Any blank pages are indicated.

DC (CJ/CGW) 337969/3

[Turn over

1 A toy rocket is launched into the air.

Fig. 1.1 shows how the height of the rocket changes with time.

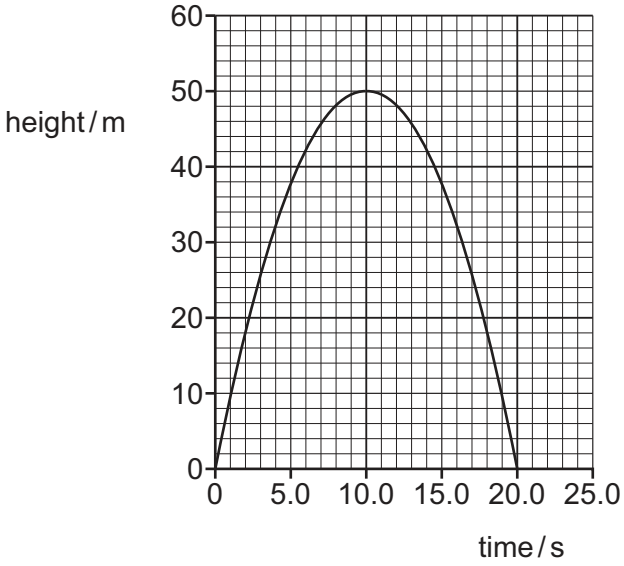


Fig. 1.1

(a) Determine the height of the rocket at time t = 5.0 s.

height of the rocket = ... m [1]

(b) The rocket reaches a height of 50 m at time t = 10.0 s.

Describe the motion of the rocket at t = 10.0 s.

..... [1]

(c) Calculate the average speed of the rocket between t = 5.0 s and t = 10.0 s.

Show your working.

average speed = ... m / s [2]

(d) Explain how the graph shows that the rocket is accelerating between t = 11.0 s and t = 15.0 s.

.....

..... [1]

[Total: 5]

2 The percentage of fat in food changes as it is chemically digested in the digestive system.

Fig. 2.1 shows the percentage of undigested fat left in food as it passes from the mouth to the anus.

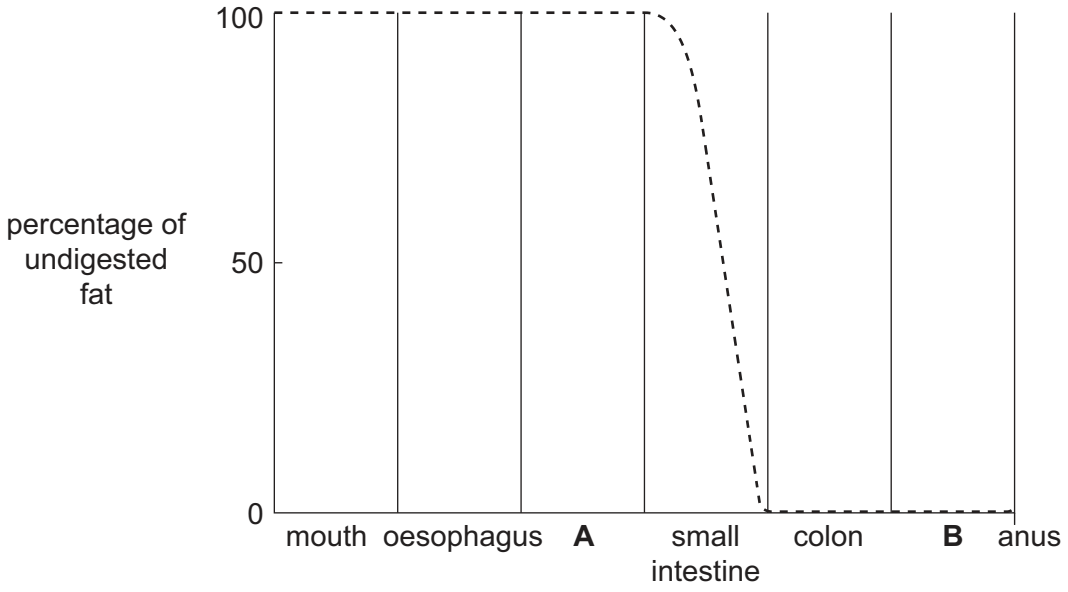


Fig. 2.1

(a) Name the parts of the digestive system labelled **A** and **B** on Fig. 2.1.

A .....

B .....

[2]

(b) Describe and explain the digestion of fat in the digestive system, using the information in Fig. 2.1.

.....

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 6]

3 Phosphorus, P_4, reacts with oxygen, O_2, to form phosphorus(V) oxide, P_4O_{10}.

The equation for the reaction is:

$$P_4 + 5O_2 \rightarrow P_4O_{10}$$

(a) (i) Calculate the relative molecular mass M_r of phosphorus(V) oxide.

The relative atomic masses, A_r, of phosphorus and oxygen are shown.

[A_r: O, 16; P, 31]

M_r = ... [1]

(ii) Complete the following sentence.

62 g of phosphorus reacts with ..... g of oxygen. [1]

(b) Phosphorus(V) oxide is added to distilled water in a conical flask.

Phosphoric acid, H_3PO_4, is produced.

(i) Balance the symbol equation for the reaction.

..... P_4O_{10} + ... $H_2O \rightarrow$ ..... H_3PO_4 [1]

(ii) Suggest the pH of the contents of the conical flask before and after the phosphorus(V) oxide is added.

pH before .....

pH after .....

[2]

(iii) 12 g of phosphoric acid is dissolved in 250 cm^3 of distilled water.

Calculate the concentration of the solution.

[1 dm^3 = 1000 cm^3]

concentration = ... g/dm^3 [1]

[Total: 6]

4 **(a)** The glass block in Fig. 4.1 has a mass of 4.8 g.

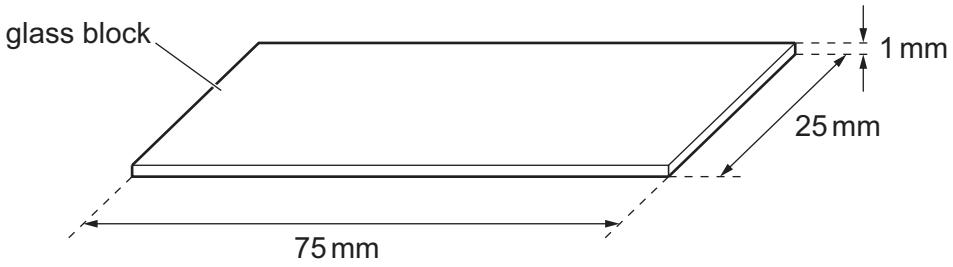


Fig. 4.1 (not to scale)

Calculate the density of the glass block in g / mm^3.

density = ... g / mm^3 [3]

(b) Fig. 4.2 shows a ray of light incident on a different glass block.

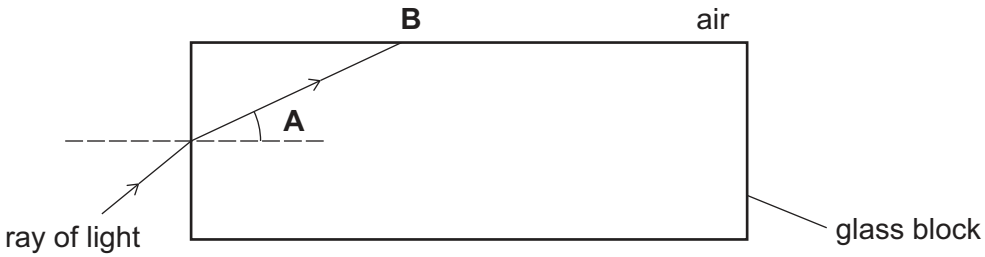


Fig. 4.2

(i) State the name of angle **A**.

..... [1]

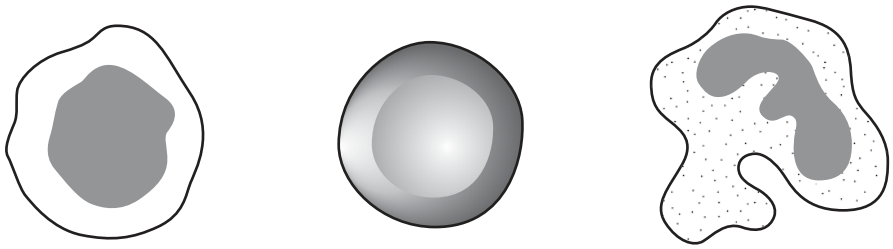
(ii) The side of the block at point **B** is a mirror.

The ray of light reflects at point **B**.

On Fig. 4.2, draw the reflected ray. [1]

[Total: 5]

5 Fig. 5.1 shows three types of cell found in the blood.



X **Y** **Z**

Fig. 5.1 (not to scale)

(a) Table 5.1 shows the functions of these cells.

Complete Table 5.1 by identifying which cell **X**, **Y** or **Z** is responsible for the function.

Each letter can be used once, more than once or not at all.

Table 5.1

function of blood cell	cell
engulfs pathogens	.....
produces antibodies	.....
transports oxygen	.....

[2]

(b) Platelets are another type of cell found in the blood.

When the body is injured, platelets make the blood form a clot.

State **two** functions of a blood clot.

function 1 .....

.....

function 2 .....

.....

[2]

[Total: 4]

6 Draw **three** straight lines from the box on the left to three of the boxes on the right to make three sentences that are correct for starch.

Starch …

… can be detected by Benedict's Test.

… is digested by amylase in the mouth.

… is digested by maltase in the small intestine.

… is made from a product of photosynthesis.

… is transported around plants in the xylem.

… is used as an energy store by plants.

[3]

7 A student reacts solid calcium metal with dilute sulfuric acid.

Hydrogen gas is produced.

(a) (i) Complete the word equation for the reaction.

calcium	+	sulfuric acid	→	....	+	hydrogen

[1]

(ii) Draw a labelled diagram to show how a measuring cylinder is used to measure the volume of hydrogen gas produced.

[2]

(iii) Describe a test and the result of the test that shows that hydrogen gas is produced.

test .....

result .....

[1]

(b) The student changes the rate of the reaction using four different sets of conditions A, B, C and D.

Table 7.1 shows the different conditions.

Table 7.1

conditions	temperature / °C	concentration of dilute sulfuric acid / g / dm^3	state of calcium metal
A	40	20.0	powder
B	20	15.0	lumps
C	20	10.0	lumps
D	40	15.0	powder

List the four different sets of conditions A, B, C and D in order from the lowest rate of reaction produced to the highest rate of reaction produced.

lowest rate ⟶ highest rate

....

[2]

[Total: 6]

8 Fig. 8.1 shows a magnet attached to an iron block.

The magnet and the block are suspended from a spring.

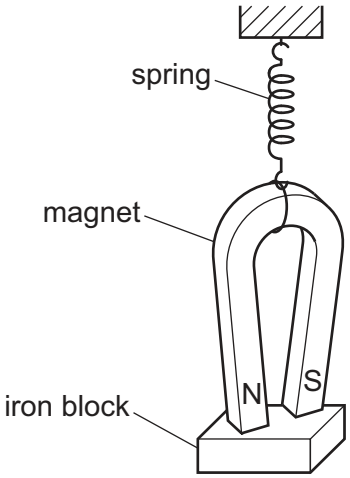


Fig. 8.1

(a) State the name of:

(i) the force of attraction between the magnet and the iron block

..... [1]

(ii) the force in the spring due to the weight of the magnet and the block.

..... [1]

(b) The spring constant k of the spring is 25 N / m.

The extension of the spring is 0.05 m.

Calculate the combined weight of the magnet and the iron block.

combined weight = ... N [2]

(c) Explain how the shape of the spring shows that a force is acting on it.

..... [1]

[Total: 5]

9 Use words or phrases from the list to complete the sentences about transport in plants.

air spaces **diffusion** **epidermal** **evaporates**

flows **mesophyll** **osmosis** **phloem**

stomata **xylem**

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

During transpiration, water ..... from the surface of

..... cells in a leaf.

Water vapour then moves out of the leaf through the ..... by the process of

..... .

In translocation, sucrose and amino acids are moved around a plant in the

..... .

[5]

10 Sodium, Na, reacts with oxygen, O_2, to form sodium oxide, Na_2O.

The equation for the reaction is shown.

$$4Na + O_2 \rightarrow 2Na_2O$$

(a) Explain how the equation shows that sodium is oxidised in this reaction.

.....

..... [1]

(b) Solid sodium oxide is ionically bonded.

Describe ionic bonding.

.....

.....

..... [2]

(c) Sodium is an alkali metal.

State **one** alkali metal that is more reactive than sodium.

..... [1]

(d) Complete Fig. 10.1 to show the outer electrons in a molecule of oxygen.

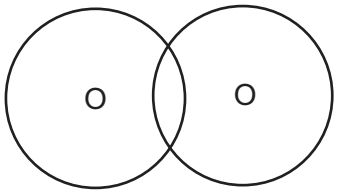


Fig. 10.1

[2]

[Total: 6]

11 (a) Fig. 11.1 shows the crests of a water wave when viewed from above.

Region **A** is shallower than region **B**.

The wave changes direction as it moves from region **A** to region **B**. The frequency of the wave stays the same.

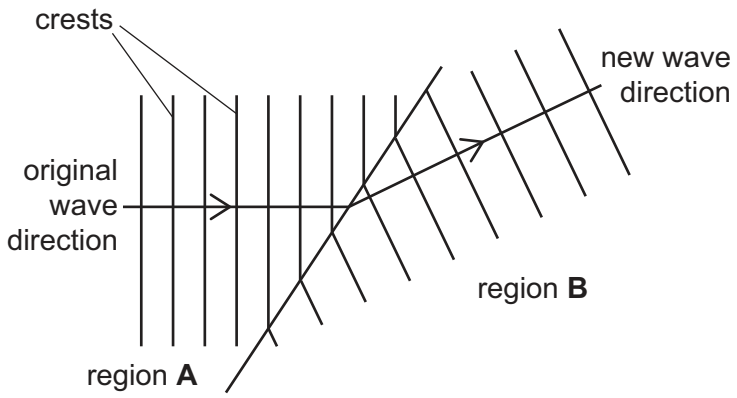


Fig. 11.1

Describe what happens to the wavelength and to the speed of the wave as it moves from region **A** to region **B**.

wavelength .....

.....

speed .....

.....

[2]

(b) Fig. 11.2 shows how the movement of water waves on the sea can be used as an energy resource.

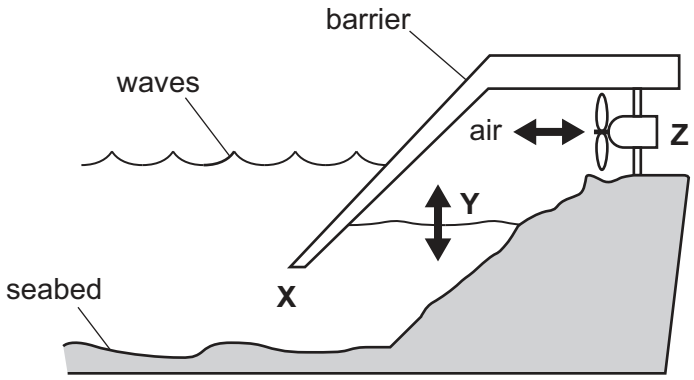


Fig. 11.2

The movement of water below the barrier at **X** causes the wave to rise and fall about the mean position at **Y**.

(i) State the wave term for the maximum height of the wave above its mean position at **Y**.

..... [1]

(ii) Explain how the movement of water at **Y** is used to produce electrical power in the machine at **Z**.

.....

.....

.....

..... [3]

[Total: 6]

12 Fig. 12.1 is an incomplete diagram of a plant cell.

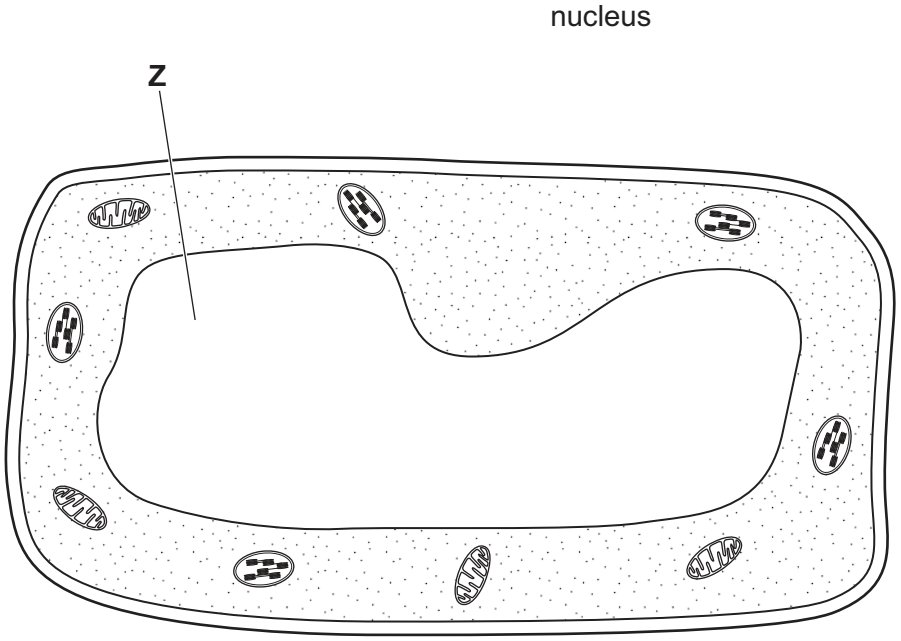


Fig. 12.1

(a) (i) On Fig. 12.1, draw a line to the cytoplasm. Label it **X**. [1]

(ii) On Fig. 12.1, draw a line to a chloroplast. Label it **Y**. [1]

(b) On Fig. 12.1, draw the nucleus and a line to connect the label on the diagram to the structure you have drawn. [1]

(c) Name the structure **Z** on Fig. 12.1 and describe its function.

name .....

function .....

.....

[2]

(d) Describe the function of the mitochondria found in the cell in Fig. 12.1.

.....

.....

.....

..... [2]

[Total: 7]

13 The incomplete combustion of methane, CH_4, produces water, H_2O, and particulates of carbon, C.

The equation is shown.

$$CH_4 + O_2 \rightarrow C + 2H_2O$$

(a) (i) Describe the condition that causes incomplete combustion rather than complete combustion.

.....

..... [1]

(ii) State **one** adverse effect of particulates of carbon on human health.

..... [1]

(b) (i) Draw the displayed formula of methane, CH_4.

[1]

(ii) Name the fossil fuel that consists mainly of methane.

..... [1]

(iii) Methane has a melting temperature of –182.0 °C and a boiling temperature of –161.5 °C.

Name the state of methane at –170.0 °C.

..... [1]

(iv) Methane is a simple covalent compound.

Describe and explain the electrical conductivity of methane.

description .....

explanation .....

.....

[2]

(v) Draw a (ring) around the word that describes methane.

alkane **alkene** **polymer** **unsaturated**

[1]

[Total: 8]

14 (a) Fig. 14.1 represents the distribution of negative charges in an electrical conductor.

A negative charge is represented by a **–**.

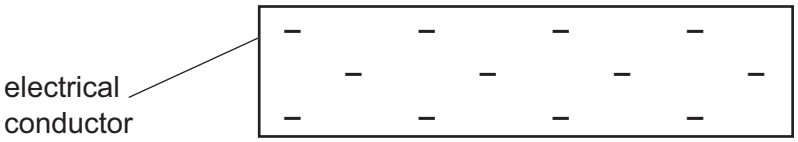


Fig. 14.1

Explain why the charges are spread out across the conductor instead of forming a smaller area of negative charge.

.....

.....

..... [2]

(b) Aircraft must be discharged before they are refuelled.

(i) Determine which **two** statements, when taken together, explain why electrostatic charge builds up on an aircraft while it is flying.

Tick (✓) the boxes by the **two** statements you have chosen.

air is a conductor	☐
air is an insulator	☐
charge is measured in coulombs	☐
friction with air transfers electrons	☐
friction with air transfers protons	☐
there are positive and negative charges	☐

[2]

(ii) Explain why electrostatic charge must be discharged from an aircraft before it is refuelled.

.....

..... [2]

[Total: 6]

15 Fig. 15.1 shows the breathing rates of three female students and three male students before and after running 400 m.

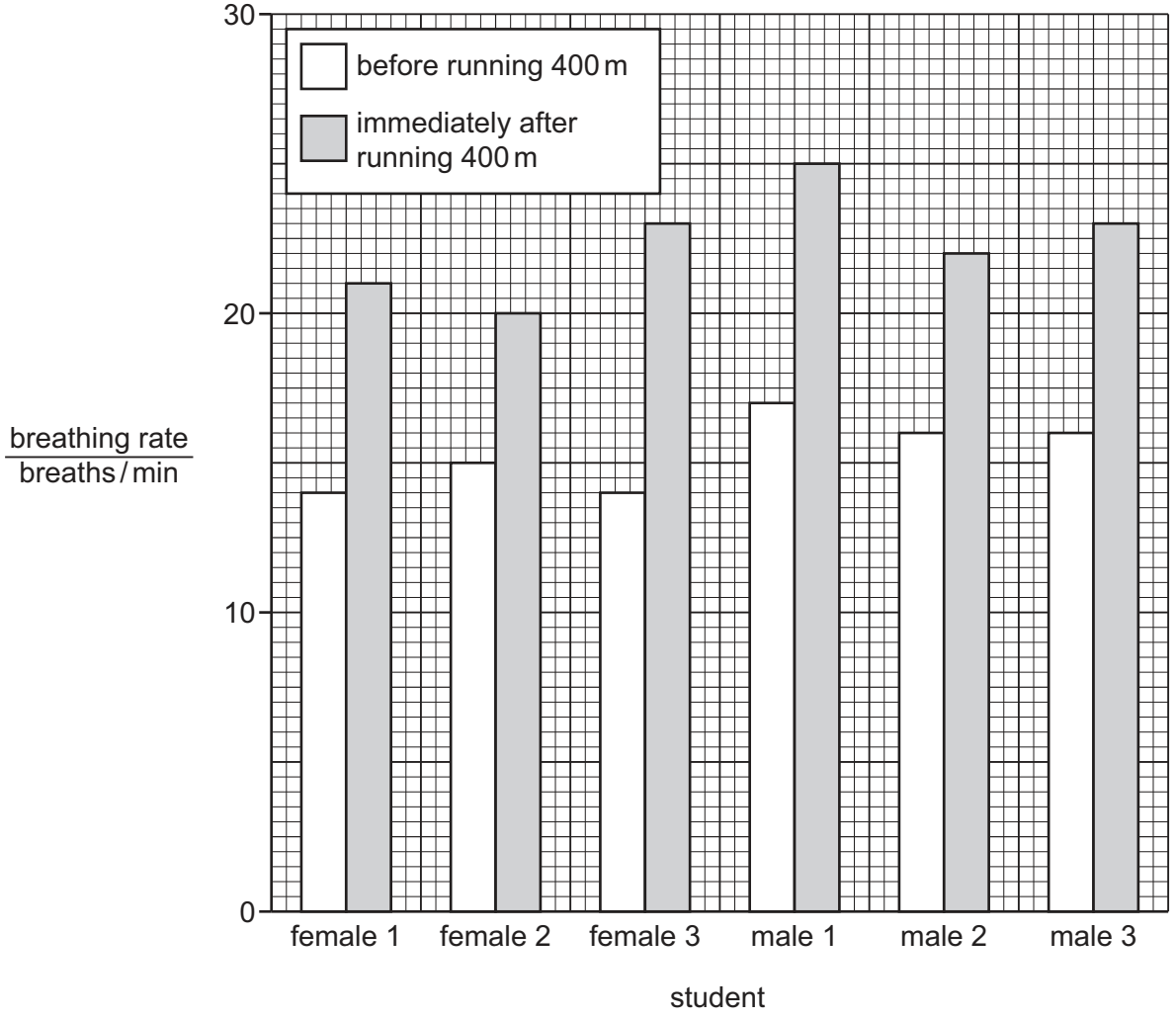


Fig. 15.1

Place a tick (✓) in **two** boxes in Table 15.1 to identify two correct conclusions that can be made from the results shown in Fig. 15.1.

Table 15.1

All the breathing rates of the male students increased more than all the breathing rates of the female students.	
Before running 400 m, all the breathing rates for female students were lower than all the breathing rates for male students.	
The student with the smallest increase in breathing rate was female student 2.	
Male student 1 ran the 400 m faster than any other student.	
Female students 2 and 3 had the same breathing rates before running 400 m.	

[2]

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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 –	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.).