



Cambridge O Level

CANDIDATE
NAME

CENTRE
NUMBER

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COMBINED SCIENCE

5129/21

Paper 2

October/November 2021

2 hours 15 minutes

You must answer on the question paper.

No additional materials are needed.

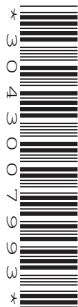
INSTRUCTIONS

- 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 100.
- 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 **24** pages. Any blank pages are indicated.



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- 1 Rock salt is a mixture of sodium chloride and sand.

Sodium chloride is soluble in water. Sand is insoluble in water.

Complete the following sentences about the separation of the rock salt mixture.

Water is added to the mixture to the sodium chloride.

The water is acting as a

The mixture is to remove the sand.

The sodium chloride solution that passes through the filter paper is known as
the

This solution is evaporated to a smaller volume and cooled so that sodium
chloride

[5]

2 The speed–time graph for a car on a theme park ride is shown in Fig. 2.1.

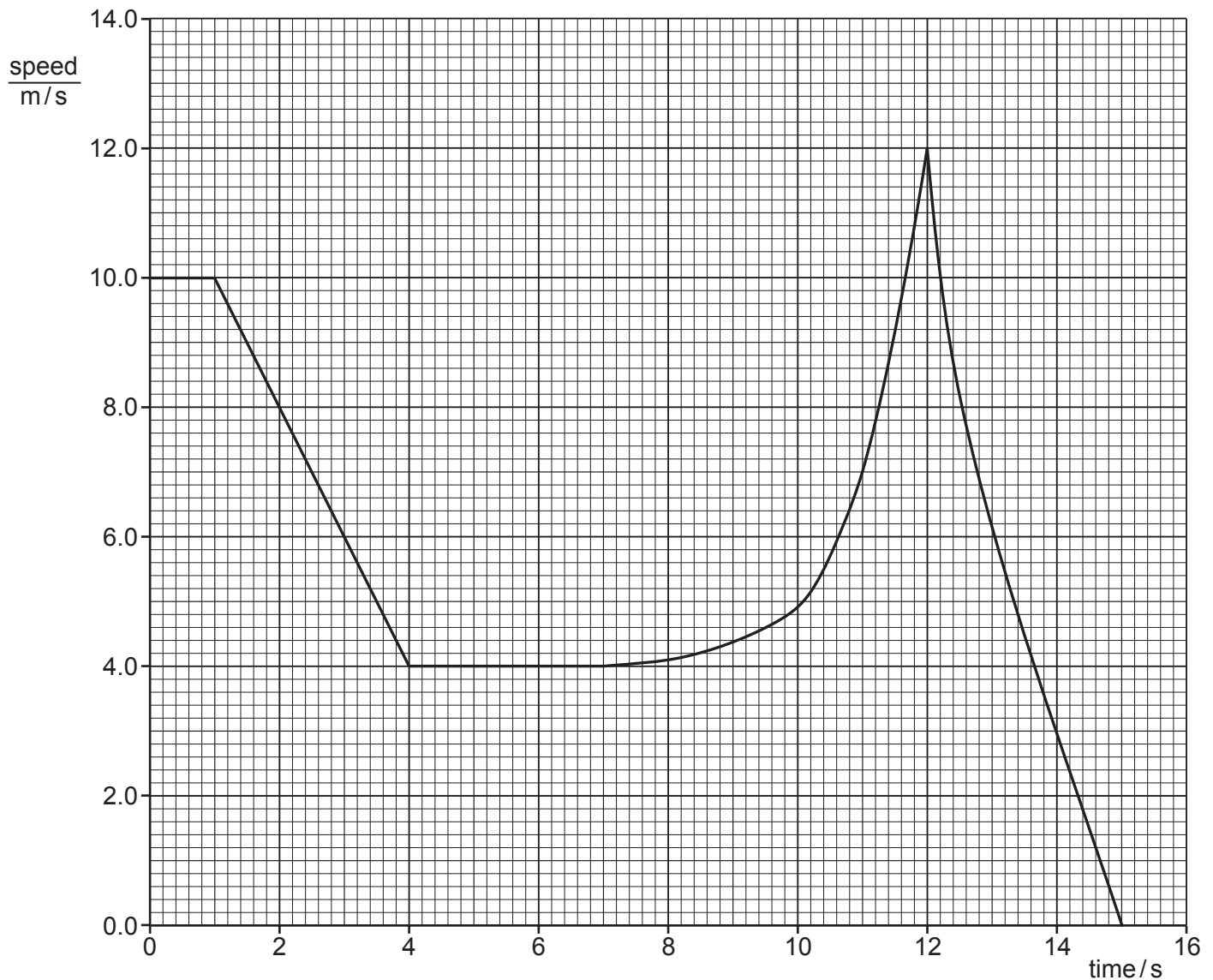


Fig. 2.1

The car has a constant speed of 10 m/s between 0 s and 1.0 s.

(a) Use the data in the graph in Fig. 2.1 to calculate the change in speed between 1.0 s and 4.0 s.

change in speed = m/s [1]

(b) Using the data in the graph in Fig. 2.1, describe the motion of the car after 4.0 s until it stops.

.....

.....

.....

.....

.....

..... [3]

[Total: 4]

- 3 Osmosis and diffusion are both processes by which molecules move.

Compare diffusion with osmosis by stating **one** similarity and **two** differences between these two processes.

similarity

.....

.....

difference 1

.....

.....

difference 2

.....

.....

[3]

- 4 Sulfur is in Group VI of the Periodic Table.

An atom of sulfur is represented by $^{32}_{16}\text{S}$.

- (a) Complete Fig. 4.1 to show the electronic structure of a sulfur atom.

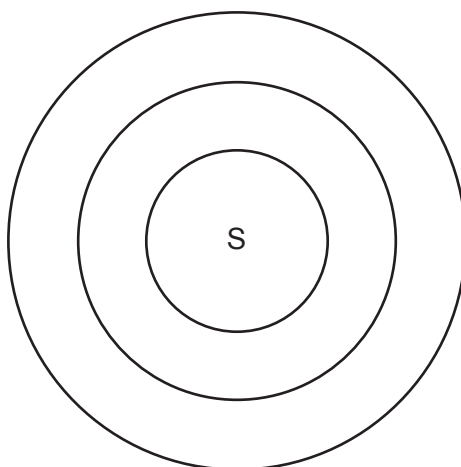


Fig. 4.1

[1]

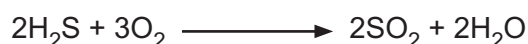
- (b) When sulfur reacts with hydrogen, it forms the compound hydrogen sulfide.

State the type of bonding in hydrogen sulfide.

..... [1]

- (c) Hydrogen sulfide burns in oxygen at 300 °C.

The equation for the reaction is shown.



The relative molecular mass, M_r , of hydrogen sulfide is 34.

[A_r : S, 32; O, 16; H, 1]

- (i) Calculate the relative molecular mass of sulfur dioxide.

..... [1]

- (ii) Complete the following sentences.

68 g of hydrogen sulfide produces g of sulfur dioxide and g of water.

3.4 g of hydrogen sulfide produces g of sulfur dioxide. [3]

- (d) An aqueous solution of hydrogen sulfide turns universal indicator orange.

Suggest the pH of the solution. [1]

[Total: 7]

- 5 Fig. 5.1 shows a simple pendulum.

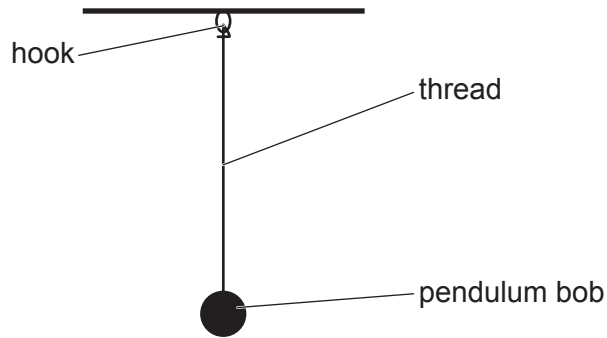


Fig. 5.1

The pendulum bob is free to swing from side to side.

- (a) Describe a procedure to measure accurately the period of the pendulum.

.....

.....

.....

.....

..... [4]

- (b) Some lengths of parts of the pendulum in Fig. 5.1 and some instruments used to measure lengths are shown in Fig. 5.2.

Draw a straight line from each length to the most suitable instrument to use for measuring it.

length	instrument
diameter of bob	micrometer
length of thread	metre rule with cm divisions
width of thread	vernier caliper

[2]

Fig. 5.2

[Total: 6]

6 The electronic structure of sodium is 2,8,1.

The electronic structure of phosphorus is 2,8,5.

(a) State how the electronic structures show that sodium and phosphorus are in the same period of the Periodic Table.

..... [1]

(b) Describe the relationship between the group number and the electronic structure of an atom.

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

(c) State the general name of the elements in the group to which sodium belongs.

..... [1]

(d) (i) Describe how the character of the elements changes across a period from left to right.

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

(ii) The oxides of sodium and phosphorus are both soluble in water.

State the name of the type of oxide of:

sodium oxide

phosphorus oxide.

[2]

(e) Phosphorus gains three electrons to form a P^{3-} ion.

The ion has a noble gas electronic structure.

Explain the significance of the noble gas electronic structure.

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

[Total: 7]

7 Students investigated the effect of light intensity on the size of leaves.

They studied two species of plant, **C** and **D**.

Leaves from each species were grown in three different light intensities and the surface areas measured.

The results are shown in Fig. 7.1.

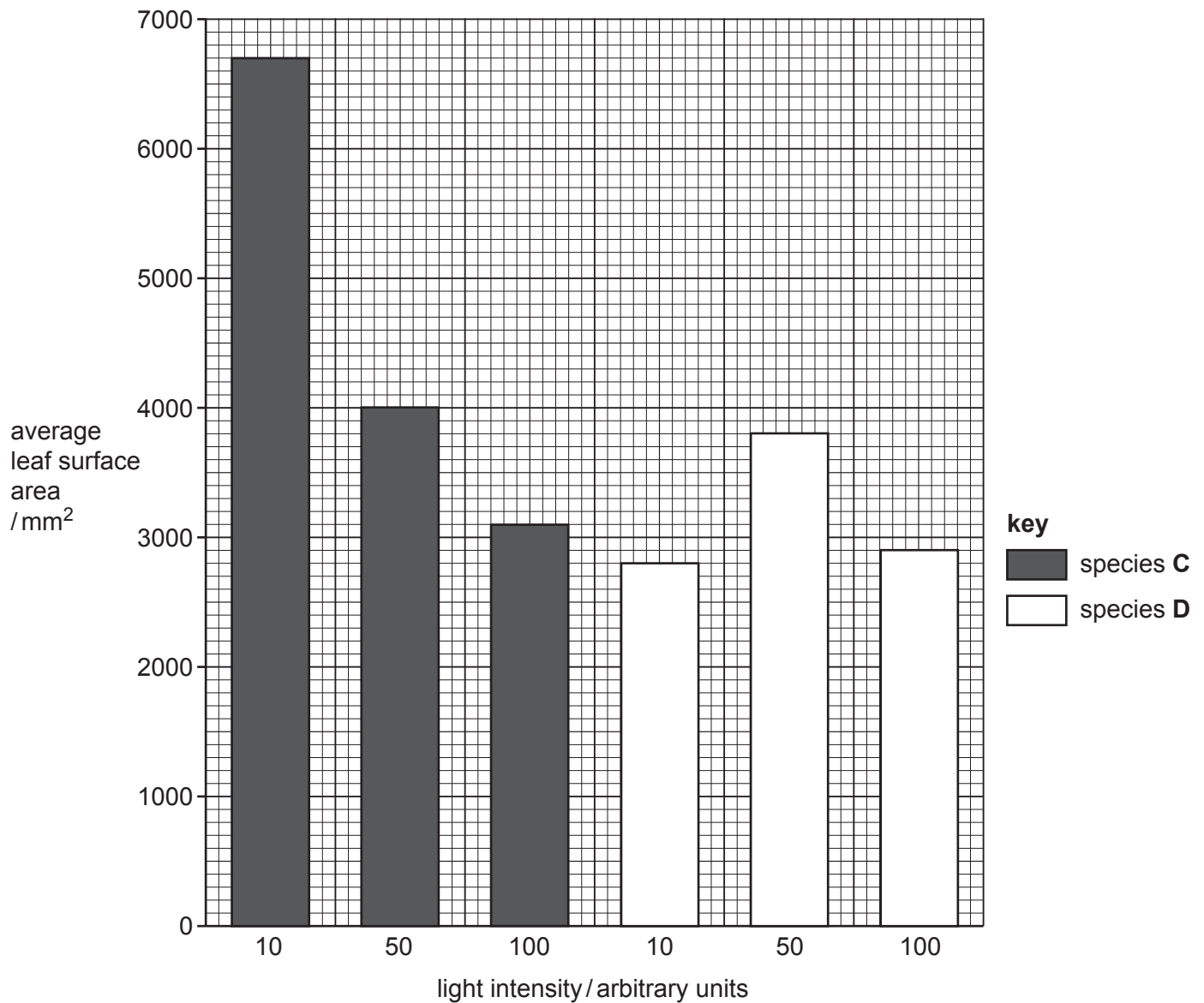


Fig. 7.1

- (a) (i) State the average leaf surface area of a leaf from species **C** when it is grown in a light intensity of 100 arbitrary units.

average leaf surface area = mm² [1]

- (ii) State the light intensity that produced an average leaf surface area of 2800mm² in species **D**.

light intensity = arbitrary units [1]

- (iii) Describe how light intensity affects the average leaf surface area of leaves in species **C** and in species **D**, as shown in Fig. 7.1.

species **C**

.....

.....

species **D**

.....

.....

[3]

- (b) Suggest why the average leaf surface area of the leaves in species **C** changes as the light intensity changes.

.....

.....

.....

..... [2]

[Total: 7]

8 Fig. 8.1 shows a tower crane.

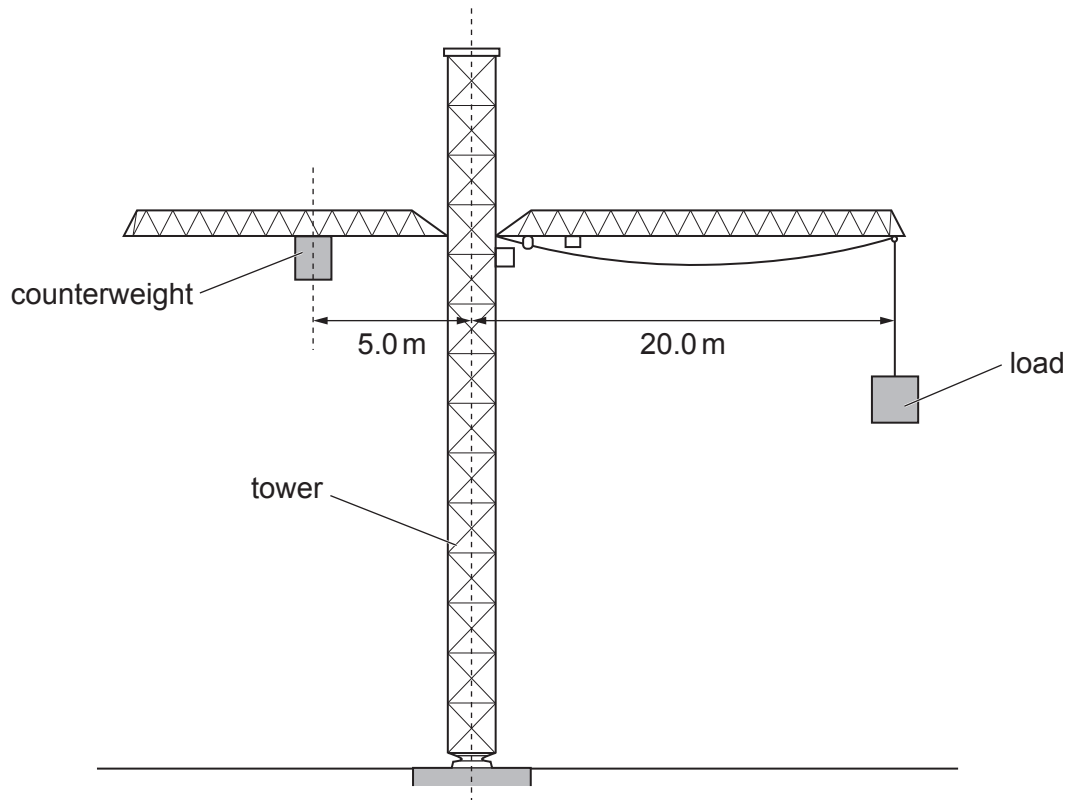


Fig. 8.1

The crane is used to lift a load. The vertical line through the centre of the tower is the pivot.

A counterweight of 250 000 N is used to balance the load.

(a) State how the principle of moments applies to this crane.

.....
 [2]

(b) Calculate the moment of the counterweight when it is 5.0 m from the centre of the tower.

moment = Nm [2]

(c) The crane is used to lift a load of 125 000 N at a distance of 20.0 m from the tower.

The counterweight is moved further away from the tower.

Calculate the distance between the counterweight and the tower that balances the load.

distance = m [2]

[Total: 6]

- 9 Fig. 9.1 shows the alimentary canal and associated organs.

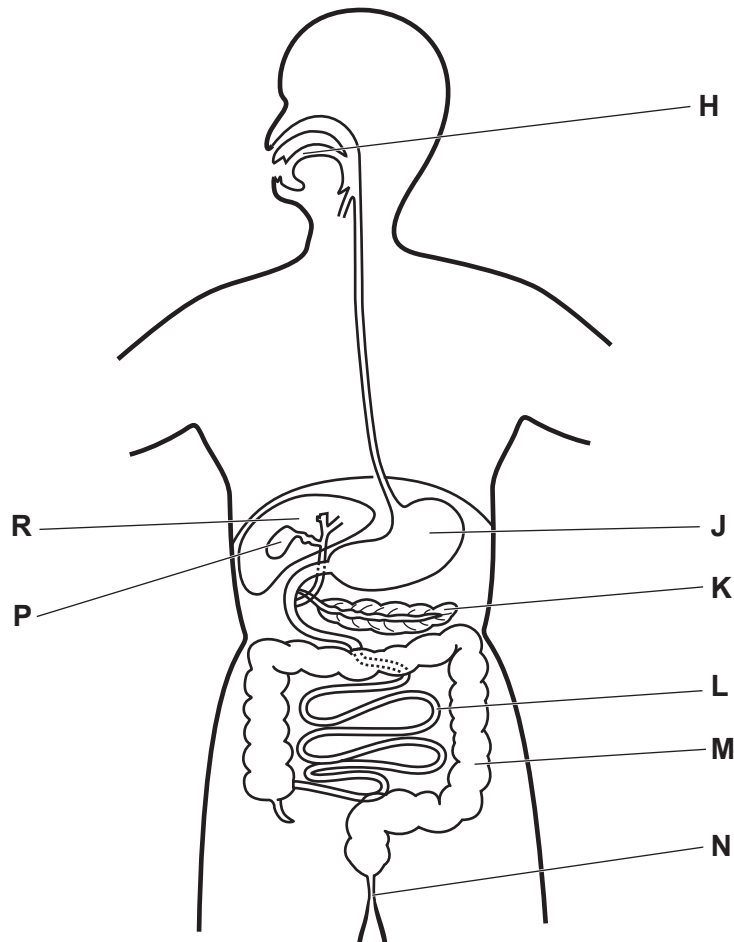


Fig. 9.1

- (a) Table 9.1 lists some processes that take place in the digestive system.

Complete Table 9.1 by writing an appropriate letter from Fig. 9.1 to indicate where the process takes place.

Table 9.1

process	letter on Fig. 9.1
absorption	
digestion	
egestion	
ingestion	

[4]

- (b) State the name of **one** enzyme which acts on food in the alimentary canal and state the name of the substrate it acts on.

name of enzyme

name of substrate

[2]

[Total: 6]

[Turn over

10 Oxygen and nitrogen are components of clean air.

(a) State the approximate percentages of oxygen and nitrogen in clean air.

oxygen

nitrogen

[2]

(b) State one industrial use of nitrogen.

..... [1]

(c) Nitrogen and oxygen react together in a car engine to produce oxides of nitrogen.

State **one** adverse effect that oxides of nitrogen have on the environment.

.....

..... [1]

(d) Lithium burns in both oxygen and nitrogen forming lithium oxide, Li_2O , and lithium nitride.

(i) Deduce the balanced equation for the reaction between lithium, Li, and oxygen, O_2 .

..... [1]

(ii) The lithium ion has the formula Li^+ .

The nitride ion has the formula, N^{3-} .

Deduce the formula of lithium nitride.

..... [1]

[Total: 6]

11 Fig. 11.1 shows a liquid-in-glass thermometer.

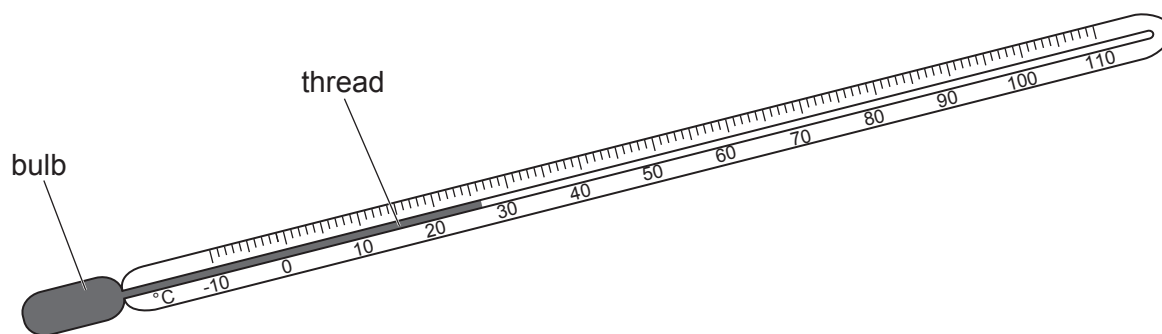


Fig. 11.1

(a) On Fig. 11.1, draw arrows to show on the scale of the thermometer:

- the temperature in Celsius at which water freezes. Label this arrow **F**
- the temperature in Celsius at which water boils. Label this arrow **B**.

[2]

(b) (i) Determine the temperature shown on the thermometer.

temperature = °C [1]

(ii) A student places the thermometer in a beaker of hot water.

Explain how the hot water causes the reading on the thermometer to increase.

.....

 [2]

(c) Suggest how the sensitivity of a thermometer can be increased.

.....
 [1]

[Total: 6]

12 Table 12.1 contains some processes that occur during respiration.

Place ticks (✓) in Table 12.1 to show if each process:

- occurs in aerobic respiration **only**
- occurs in anaerobic respiration in muscle cells **only**
- occurs in **both** types of respiration.

Table 12.1

process	occurs only in aerobic respiration	occurs only in anaerobic respiration in muscle cells	occurs in both aerobic respiration and anaerobic respiration in muscle cells
carbon dioxide is released			
energy is released			
glucose is used			
oxygen is used			
water is produced			

[5]

13 Some reactions of ethene are shown in Fig. 13.1.

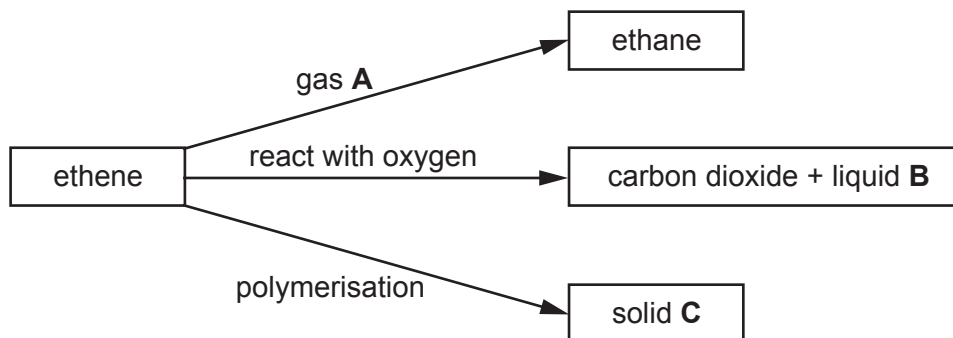


Fig. 13.1

(a) Identify:

gas **A**

liquid **B**

solid **C**.

[3]

(b) (i) Explain why ethene is described as an unsaturated hydrocarbon.

.....

..... [1]

(ii) Name the reagent used to distinguish between unsaturated hydrocarbons and saturated hydrocarbons.

..... [1]

(c) Energy is produced when ethane reacts with oxygen.

State the name given to reactions that produce energy.

..... [1]

(d) Draw the structure of ethane.

[1]

[Total: 7]

- 14 A sodium lamp can be used as a source of visible light radiation.

Fig. 14.1 represents some of the visible light radiation given out by a sodium lamp.

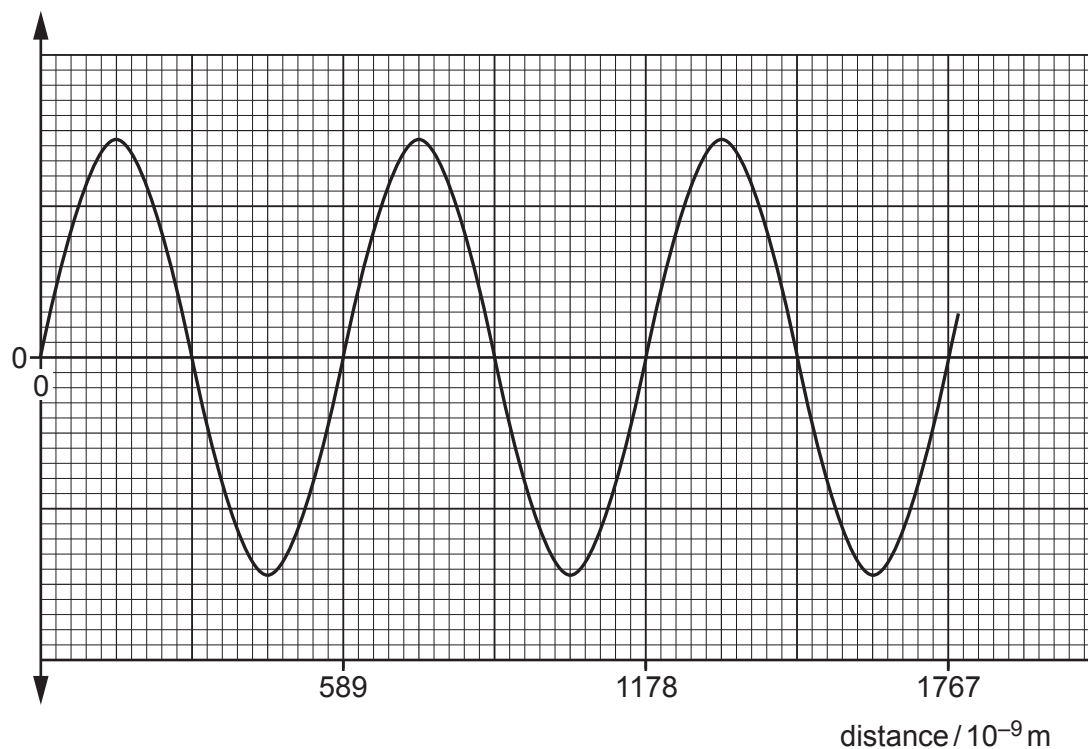


Fig. 14.1

The scale shown for distance on the graph is unusual.

- (a) (i) On Fig. 14.1, draw an arrow to show the amplitude of the radiation.

Label this arrow **A**.

[1]

- (ii) Use Fig. 14.1 to determine the wavelength of this radiation.

wavelength = $\times 10^{-9}\text{m}$ [1]

- (b) Fig. 14.2 shows three types of radiation that make up part of the electromagnetic spectrum.

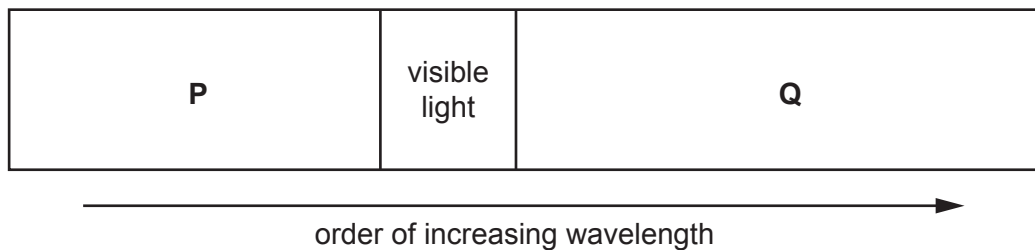


Fig. 14.2

State the name of the radiations **P** and **Q**.

P

Q

[2]

- (c) The speed of the radiation shown in Fig. 14.1 is $3.0 \times 10^8 \text{ m/s}$.

Use your answer to **(a)(ii)** to determine the frequency of this radiation.

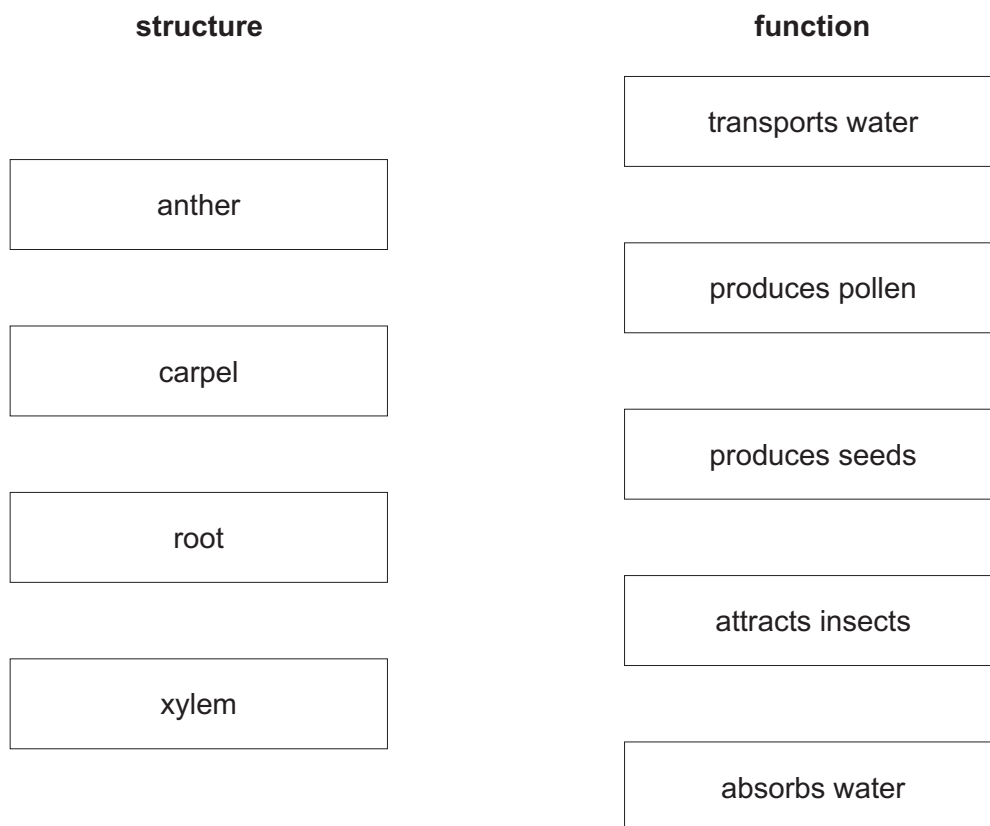
Give your answer to 2 significant figures and use standard notation.

frequency = Hz [3]

[Total: 7]

15 Plant structures carry out specific functions.

On Fig. 15.1, draw a straight line from each structure to its function.



[4]

Fig. 15.1**16** Some reactions of four metals W, X, Y and Z are listed.

The letters do not represent the symbols of the elements.

W can be extracted from its oxide by heating with metal X.

Y reacts with steam and dilute hydrochloric acid.

Z reacts with dilute hydrochloric acid but not with steam.

Z displaces both X and W from an aqueous solution of their sulfates.

Deduce the order of reactivity of the metals.

most reactive

.....

.....

least reactive

[2]

17 Fig. 17.1 represents an electrical device which changes an input voltage to an output voltage.

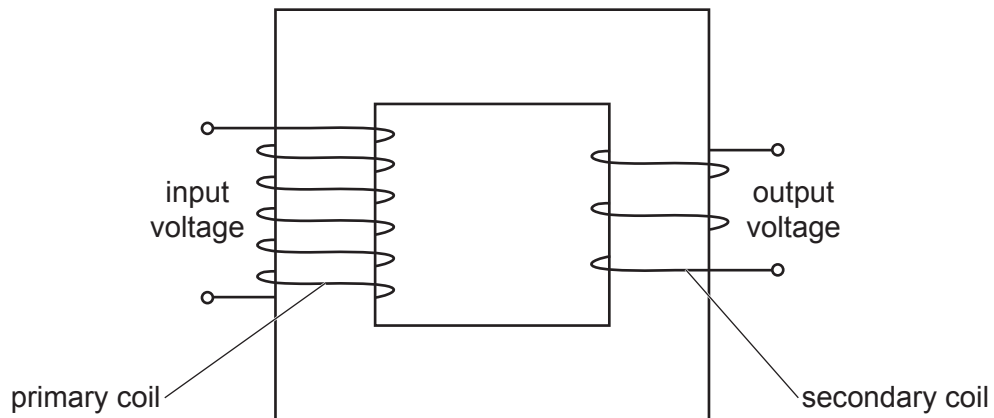


Fig. 17.1

(a) Identify the device shown in Fig. 17.1.

..... [1]

(b) There is an alternating current in the primary coil.

Explain how the device changes the voltage from input to output.

.....
.....
.....
.....
..... [3]

[Total: 4]

18 Fig. 18.1 shows sections through three different types of blood vessels.

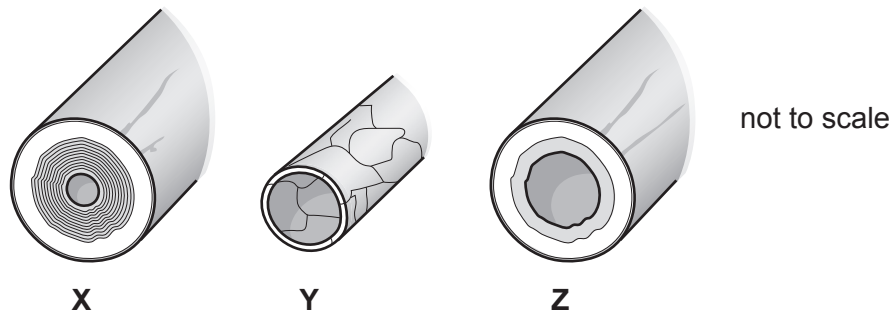


Fig. 18.1

(a) Name the type of blood vessel represented by Y.

..... [1]

(b) Draw straight lines from the box on the left to **three** boxes on the right to complete three correct sentences about veins.

Veins ...

... carry blood away from the heart.

... carry blood at high pressure.

... contain valves.

... have thicker walls than arteries.

... have a wider lumen than arteries.

... usually carry deoxygenated blood.

[3]

[Total: 4]

19 There are many methods of birth control.

Complete these sentences about birth control.

A surgical method of birth control in a man is to cut the

One mechanical method of birth control in a woman is to place a
over the cervix.

A mechanical method of birth control in a man is to place a over the
penis.

A hormonal method of birth control is when a person takes a

[4]

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The Periodic Table of Elements

Group																	
I	II	1 H hydrogen 1										III	IV	V	VI	VII	VIII
3 Li lithium 7	4 Be beryllium 9	Key atomic number atomic symbol name relative atomic mass										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	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 —

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
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 —

actinoids

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).