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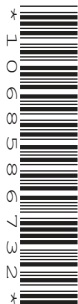
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COMBINED SCIENCE

0653/42

Paper 4 Theory (Extended)

October/November 2023

1 hour 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 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.

1 (a) (i) Fig. 1.1 shows the transfer of pollen from flower **A** to flower **B**.

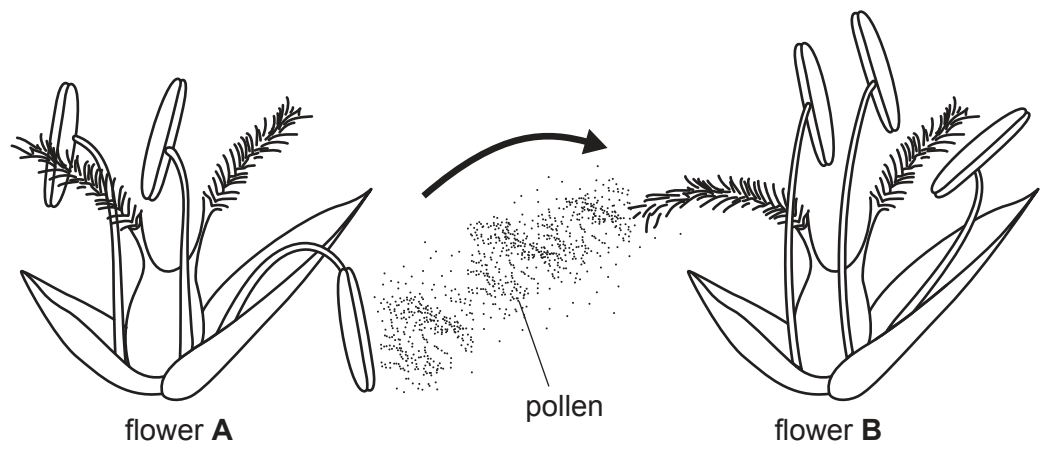


Fig. 1.1

Complete the sentences about Fig. 1.1.

The pollen is transferred from the anthers of flower **A** to the
of flower **B**. The anthers of flower **A** are outside the flower because the agent of
pollination is

[2]

(ii) Fig. 1.2 is a photomicrograph of a pollen grain with air sacs.

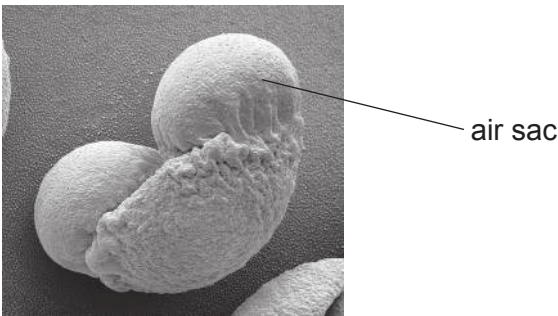


Fig. 1.2

Suggest how air sacs help with the transfer of pollen.

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

- (b) Plants can produce offspring by either sexual reproduction or asexual reproduction.

Sexual reproduction uses gametes. Asexual reproduction does not use gametes.

State **two** other ways sexual reproduction is different from asexual reproduction.

- 1
- 2

[2]

- (c) The male gametes in humans are called sperm.

- (i) Complete Fig. 1.3 to show the pathway of sperm during sexual reproduction.

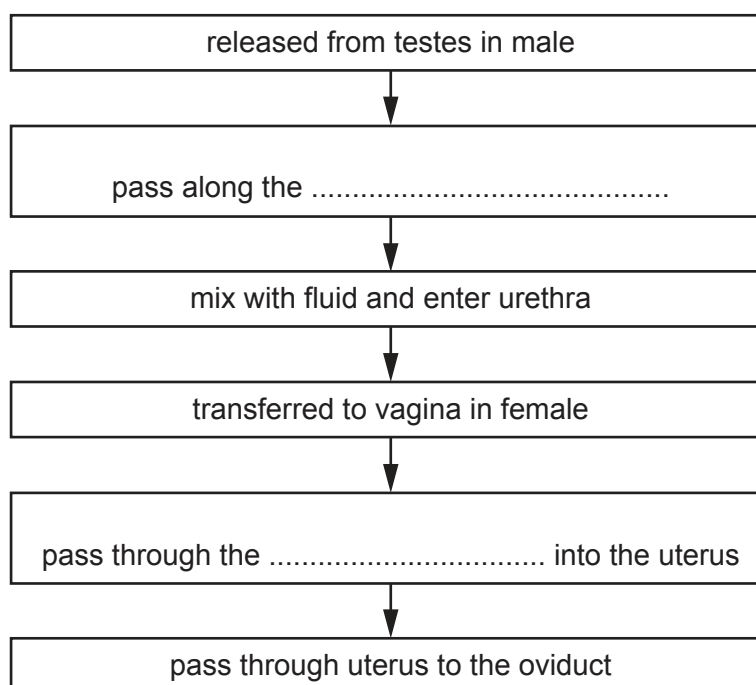


Fig. 1.3

[2]

- (ii) State **two** ways that sperm are adapted for their function.

- 1
- 2

[2]

[Total: 9]

- 2 (a) Magnesium chloride is a soluble salt.

Magnesium chloride is made in the reaction between solid magnesium oxide and a dilute acid. The apparatus used is shown in Fig. 2.1.

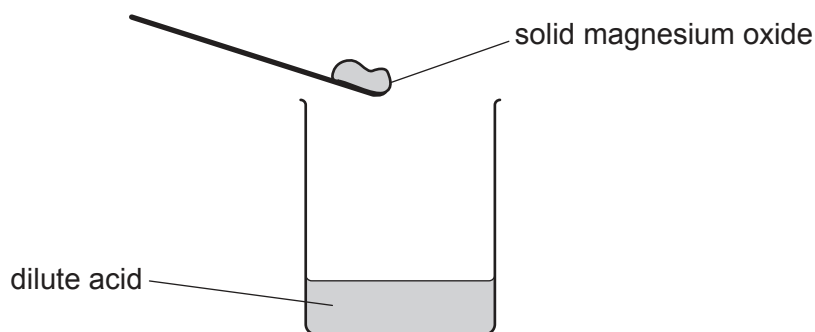


Fig. 2.1

- (i) State the name of the acid that reacts with magnesium oxide to form magnesium chloride.

..... [1]

- (ii) State the name of the other product of the reaction.

..... [1]

- (iii) Magnesium oxide is insoluble in water.

Describe a method to make magnesium chloride crystals from magnesium oxide and dilute acid.

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

- (b) A student dissolves solid magnesium chloride in one beaker containing water at 20°C and solid potassium chloride in a second beaker containing water at 20°C.

The student measures the temperature of the solution in each beaker after the solids dissolve.

Table 2.1 shows some of the results.

Table 2.1

solid	formula	temperature of solution after solid dissolves /°C	type of reaction
magnesium chloride	MgCl_2	26	exothermic
potassium chloride	KCl		endothermic

- (i) Suggest a value for the temperature of the solution after the potassium chloride dissolves.

temperature = °C [1]

- (ii) State why the temperature increases for the exothermic reaction in Table 2.1.

.....
 [1]

- (iii) Explain why magnesium chloride and potassium chloride contain different numbers of chloride ions.

Use the Periodic Table to help you.

.....
 [1]

[Total: 8]

3 Fig. 3.1 shows a truck.

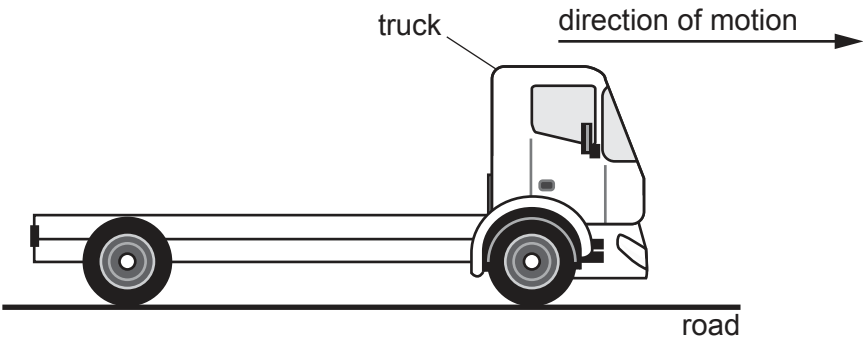


Fig. 3.1

(a) Fig. 3.2 shows a speed–time graph for the motion of the truck on a journey.

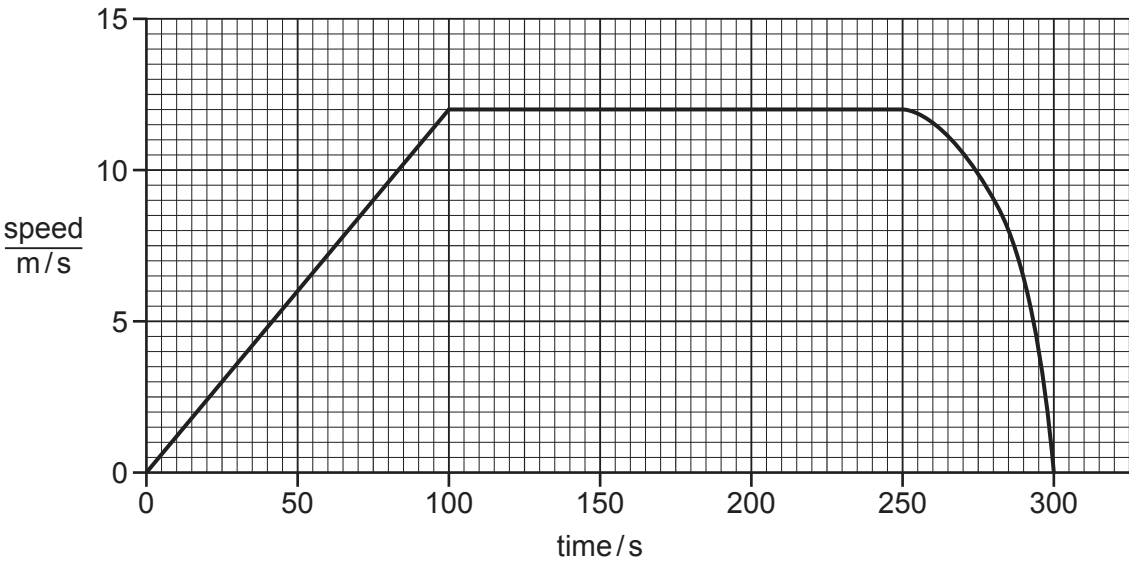


Fig. 3.2

(i) State the time taken by the truck to slow down from maximum speed to a stop.

time = s [1]

(ii) On Fig. 3.2, mark with an **X** a point on the graph when the truck is moving at constant speed. [1]

(iii) Calculate the distance travelled by the truck between $t = 0$ and $t = 100$ s.

distance = m [2]

- (b) A load of mass 2500 kg is lifted from the ground onto the back of the truck.

The load is lifted a vertical height of 0.95 m.

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

- (i) Suggest a value for the minimum force required to lift the load from the ground.

Give a reason for your answer.

minimum force = N

reason

..... [3]

- (ii) Calculate the change in gravitational potential energy (GPE) of the load.

change in GPE = J [2]

- (c) The truck is moving along a level road at a constant speed.

Explain why the truck continues to use fuel.

.....

.....

..... [2]

[Total: 11]

4 (a) Fig. 4.1 shows a food web.

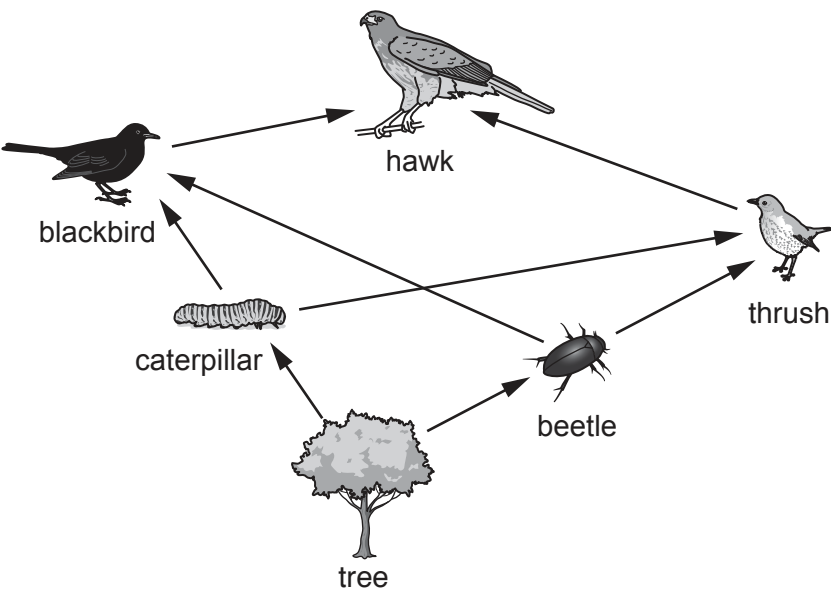


Fig. 4.1

(i) Table 4.1 shows some terms that can be used to describe some of the organisms in Fig. 4.1.

Complete Table 4.1 by placing ticks (✓) in the boxes to show all the terms used to describe each organism.

Table 4.1

organism	carnivore	primary consumer	occupies trophic level 3
blackbird			
caterpillar			
hawk			
thrush			

[3]

(ii) Explain why there are no trophic levels above the hawk.

Use ideas about energy in your answer.

.....

.....

.....

..... [3]

(b) Older trees store more carbon than younger trees.

Scientists record the total number of trees of different species in two forest ecosystems:

- a young forest area where all the trees are less than 20 years old
- a mature forest area where all the trees are over 50 years old.

Fig. 4.2 shows a bar chart of the results.

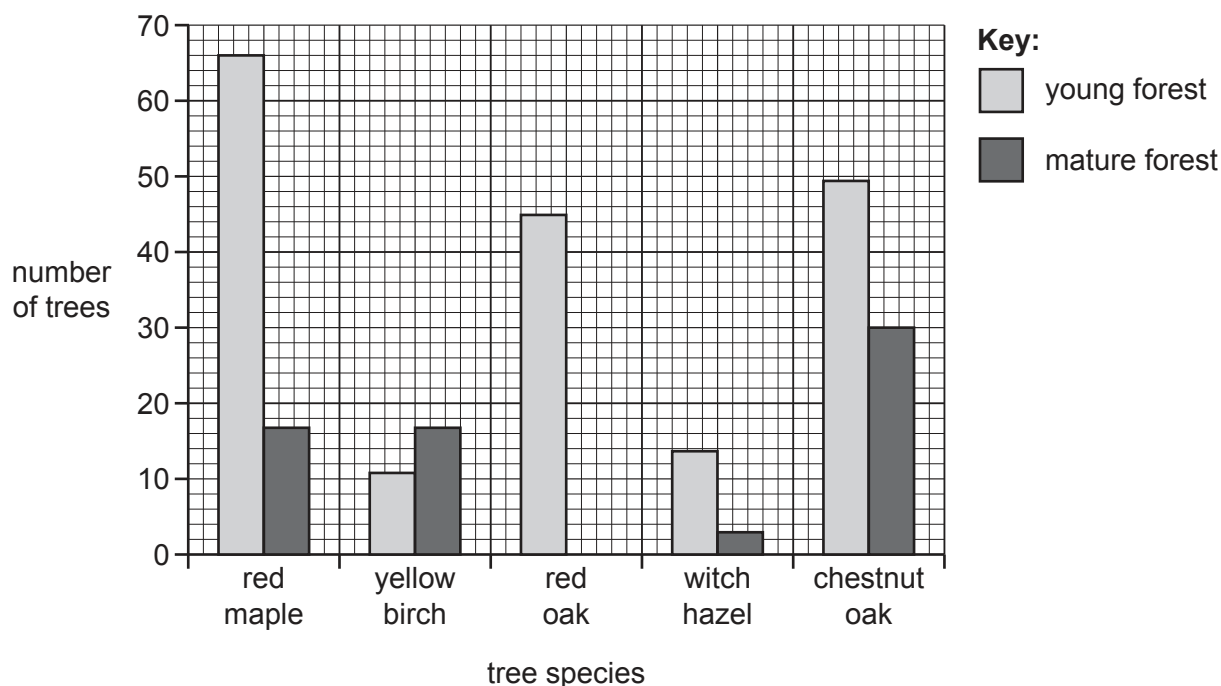


Fig. 4.2

(i) The scientists discover that there is more carbon stored in the young forest area.

Use Fig. 4.2 to explain why.

.....
 [1]

(ii) Identify the tree species in Fig. 4.2 that is **not** found in the mature forest area.

..... [1]

(c) Describe how light energy is used in the production of starch in trees.

.....

 [4]

- 5 A student investigates the reaction of dilute hydrochloric acid with different metals.

The student measures the volume of gas produced during the first 20 s of each reaction using the apparatus shown in Fig. 5.1.

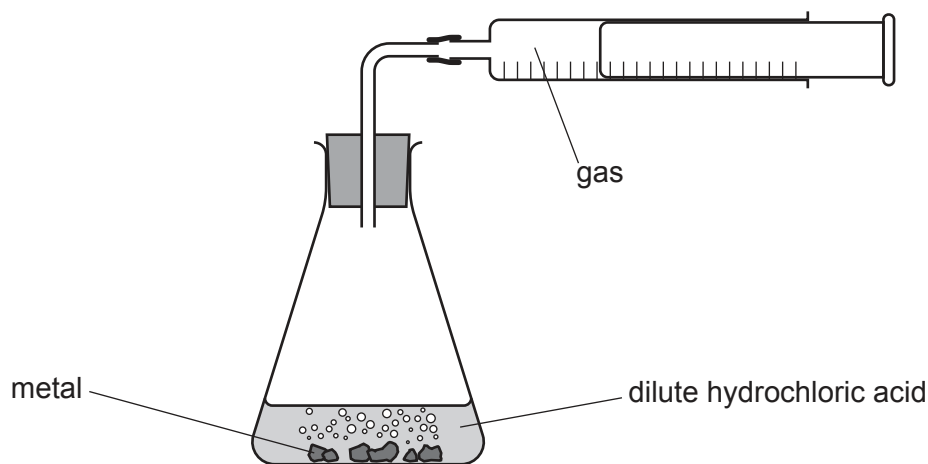


Fig. 5.1

- (a) The results for three metals are shown in Table 5.1.

Table 5.1

metal	volume of gas produced / cm ³
magnesium	38
zinc	30
copper	0

- (i) State which metal listed in Table 5.1 has the greatest tendency to form positive ions.

Give a reason for your answer.

metal

reason

[1]

- (ii) State which metal listed in Table 5.1 is less reactive than hydrogen.

Give a reason for your answer.

metal

reason

[1]

- (iii) The student repeats the experiment using iron.

Predict the volume of gas produced after 20 s.

Give a reason for your answer.

volume cm^3

reason

.....

[2]

- (b) The student repeats the experiment for magnesium using dilute hydrochloric acid at a higher temperature.

All other conditions are kept the same.

- (i) State the effect of using a higher temperature on the volume of gas produced after 20 s.

Explain your answer using ideas about energy and particles.

effect

explanation

.....

.....

[3]

- (ii) At the end of this reaction, some magnesium remains.

The reaction mixture is tested with universal indicator at the start and at the end of the reaction.

Suggest the pH of the reaction mixture at the start and at the end of the reaction.

Explain your answer.

pH at start

pH at end

explanation

.....

[2]

[Total: 9]

6 Fig. 6.1 shows a lighthouse used at night to warn ships of dangerous rocks in the sea.

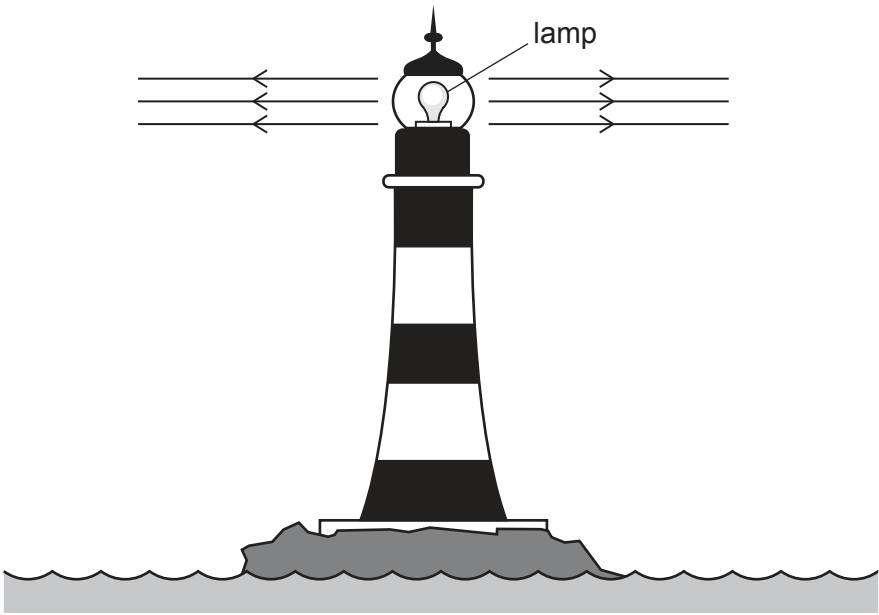


Fig. 6.1

- (a) Light from the lamp in the lighthouse is focused to form two parallel beams using two identical thin converging lenses.

The lamp is centred between the two lenses at point **P**, as shown in Fig. 6.2.



Fig. 6.2

- (i) Complete Fig. 6.2 to show how **six** rays from the lamp at point **P** form the two beams from the lenses. [1]
- (ii) The distance between the lenses is 1.2 m.

State the focal length of each lens.

focal length = m [1]

- (b) Fig. 6.3 shows a large foghorn that is also used to warn ships.



Fig. 6.3

In foggy or cloudy weather, the foghorn makes a loud sound that can be heard over long distances.

- (i) The wavelength of the sound from the foghorn is 75 cm.

Calculate the frequency of the sound.

The speed of sound in air is 330 m/s.

frequency = Hz [3]

- (ii) The foghorn is operated by a high-powered diesel engine.

Suggest why the diesel engine needs to be high powered to produce the loud sound.

Use the word amplitude in your answer.

.....

 [2]

- (c) Radio waves are used in radar systems for ships.

Fig. 6.4 shows an incomplete electromagnetic spectrum.

Write radio waves on Fig. 6.4 in the correct place.

← increasing frequency						
			visible light	infrared		

Fig. 6.4

[1]

[Total: 8]

7 (a) Explain **one** way the structure of an artery is adapted to its function.

.....

.....

..... [2]

(b) The photomicrograph in Fig. 7.1 shows a blockage in a coronary artery.

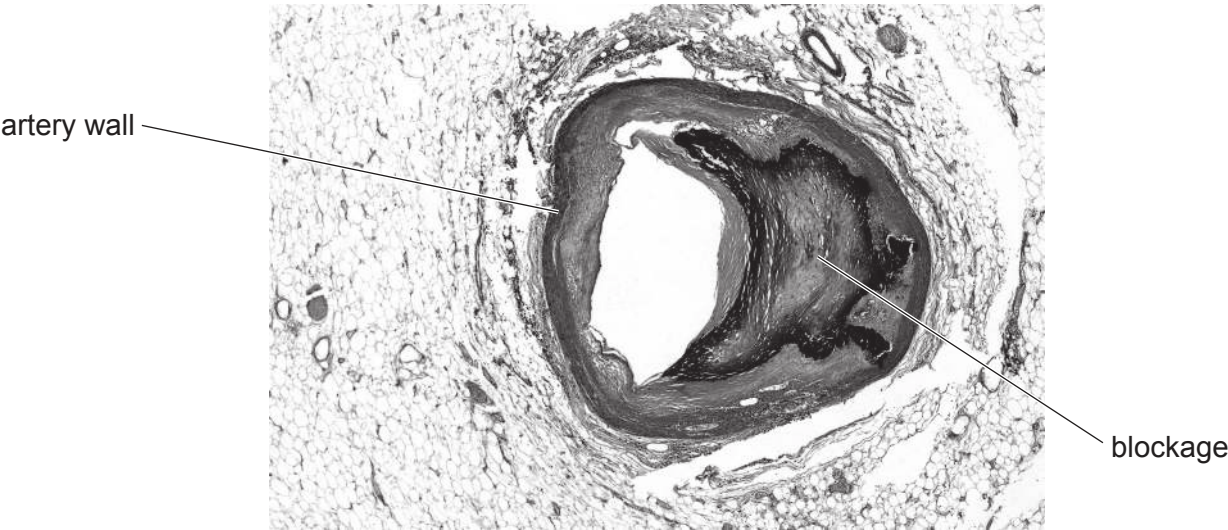


Fig. 7.1

(i) Explain how the blockage reduces the amount of oxygen reaching the wall of the heart.

.....

.....

..... [2]

(ii) State **two** possible risk factors for coronary heart disease.

1

2 [2]

[Total: 6]

- 8 (a) Iron is extracted from hematite in a blast furnace.

The chemical equation for one of the reactions in the blast furnace is shown.



- (i) Complete the balanced chemical equation. [1]

- (ii) State the name of the reducing agent in this reaction.

Give a reason for your answer.

reducing agent

reason

[2]

- (b) Identical iron nails **A** and **B** are placed in separate test-tubes.

Oil is added to the test-tube with iron nail **B**, as shown in Fig. 8.1.

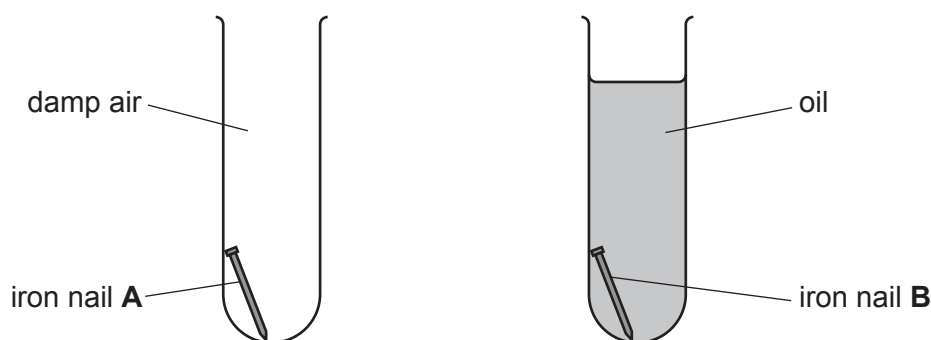


Fig. 8.1

After one week, a layer of rust has formed on iron nail **A**. Iron nail **B** is unchanged.

- (i) Describe how oil prevents iron nail **B** from rusting.

.....

 [2]

- (ii) State **one** other method of rust prevention.

..... [1]

(c) The electronic structure of an oxygen atom is shown in Fig. 8.2.

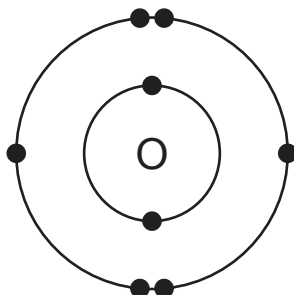


Fig. 8.2

- (i) Describe how the electronic structure of this atom relates to the group of the Periodic Table to which oxygen belongs.

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

- (ii) Complete Fig. 8.3 to show the dot-and-cross diagram of a molecule of oxygen, O_2 .

Show only the outer shell electrons.

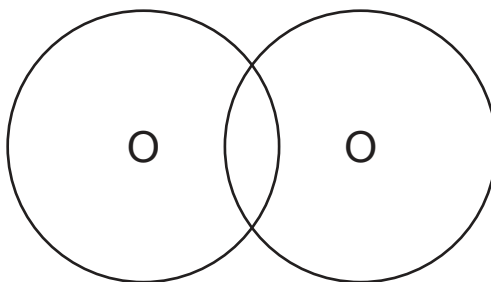


Fig. 8.3

[2]

[Total: 9]

- 9 Fig. 9.1 shows two identical floodlights, **F** and **G**, at a sports ground.

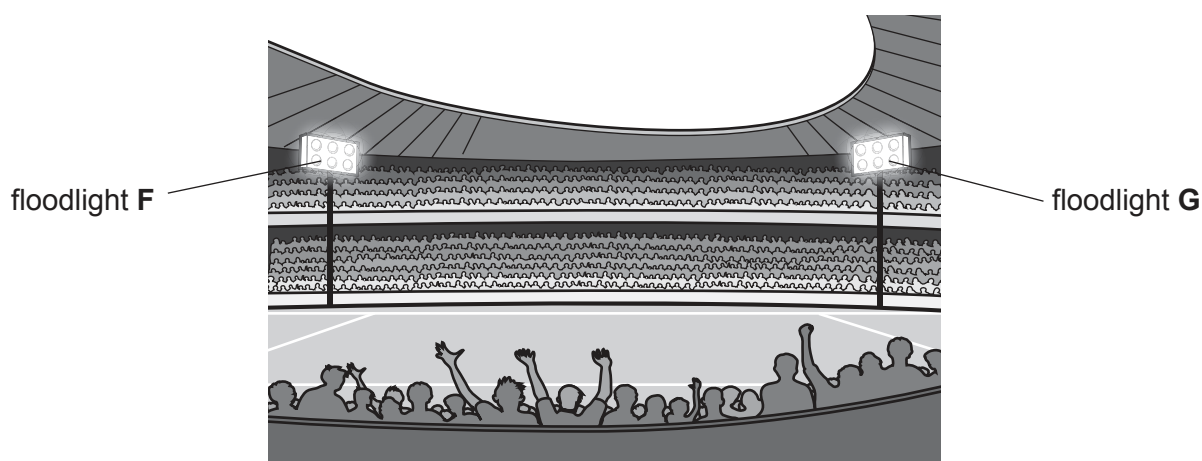


Fig. 9.1

Fig. 9.2 shows a wind turbine used to generate electricity for the two floodlights.

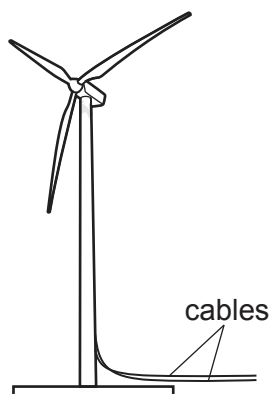


Fig. 9.2

The wind turbine generates an electromotive force (e.m.f.) of 240 V .

There is a current of 18 A in each cable from the wind turbine.

- (a) Calculate the power output from the turbine.

Give the unit of your answer.

power = unit [3]

(b) The two identical floodlights are connected to the wind turbine by cables.

Table 9.1 gives information about the current in each floodlight, and the distance of each floodlight from the wind turbine.

Table 9.1

floodlight	current in floodlight /A	distance from wind turbine /m
F	12.0	200
G	6.0	400

(i) State the type of circuit connection from the wind turbine to the two floodlights.

Give a reason for your answer.

type of circuit connection
reason
..... [2]

(ii) Explain why the current in floodlight **G** is half the current in floodlight **F**.

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

[Total: 8]

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