



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS  
International General Certificate of Secondary Education

CANDIDATE  
NAME

CENTRE  
NUMBER

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**CO-ORDINATED SCIENCES**

**0654/31**

Paper 3 (Extended)

**May/June 2011**

**2 hours**

Candidates answer on the Question Paper.

No Additional Materials are required.

**READ THESE INSTRUCTIONS FIRST**

Write your Centre number, candidate number and name on all the work you hand in.

Write in dark blue or black pen.

You may use a soft pencil for any diagrams, graphs, tables or rough working.

Do not use staples, paper clips, highlighters, glue or correction fluid.

**DO NOT WRITE IN ANY BARCODES.**

Answer **all** questions.

A copy of the Periodic Table is printed on page 24.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
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<b>Total</b>	

This document consists of **22** printed pages and **2** blank pages.



- 1 (a) Fig. 1.1 shows a hot water storage tank in a house. The water is heated by an electric immersion heater at the bottom of the tank.

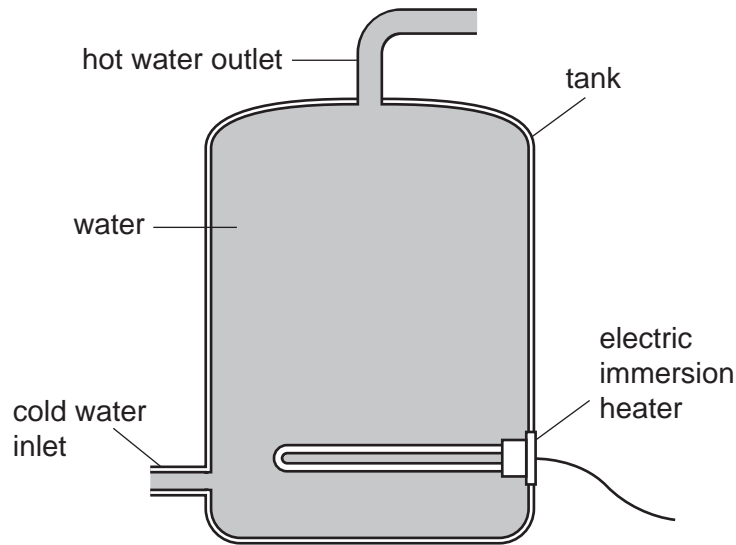


Fig. 1.1

- (i) The heater is placed at the bottom of the tank and heats all the water.

Explain why only some of the water would be heated if the heater is placed at the top of the tank.

.....  
.....  
.....  
..... [2]

- (ii) The heater has a power output of 5 kW. How much energy does the heater deliver in one second?

..... [1]

(iii) It takes 2 hours to heat up 280 000 cm<sup>3</sup> of water from 20 °C to 50 °C. The density of water is 1000 kg/m<sup>3</sup>.

Calculate the specific heating capacity of water.

State the formula that you use and show your working.

formula used

working

..... [4]

(b) Fig. 1.2 shows a circuit breaker. It is designed to switch off the current in a circuit if the current becomes too large.

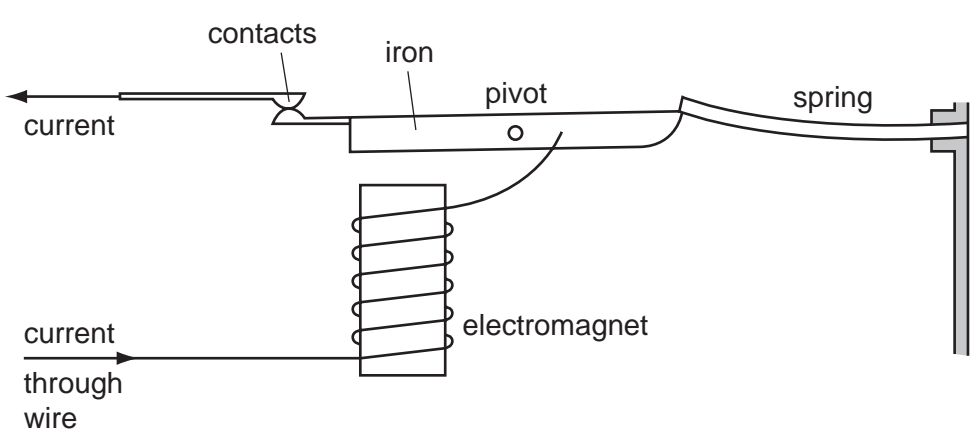


Fig. 1.2

Explain how the circuit breaker switches off the current if the current becomes too large.

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

2 The Earth provides raw materials which are processed into useful products.

(a) Choose products from the list to complete the right hand column of Table 2.1.

aluminium          ceramics          chlorine          glass          steel

Table 2.1

raw material	useful product
rock salt	
sand and metal oxides	

[2]

(b) The way in which the atoms are arranged in a substance is often referred to as its structure.

Substances with different structures are listed below.

argon          copper          glass          sodium chloride

(i) State the substances in the list that have a giant structure.

..... [1]

(ii) State the substances in the list whose atoms are arranged in a disorderly (irregular) manner.

..... [1]

(iii) Decane, C<sub>10</sub>H<sub>22</sub>, is a liquid at room temperature.

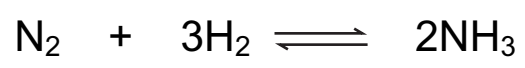
When decane is heated gently, a vapour made of unbroken decane molecules is released. Hydrogen gas and black soot made of carbon are **not** released.

Explain these findings in terms of attractive forces between molecules and chemical bonds within molecules.

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

(c) Nitrogen and hydrogen react together to form ammonia.

The balanced equation for this reaction is



This reaction requires high temperature and pressure, and an iron catalyst which is present in the form of a large number of small pieces.

(i) Suggest the meaning of the symbol  $\rightleftharpoons$  in the equation.

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

(ii) Describe the advantage of using a catalyst broken into a large number of small pieces in this reaction.

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

(iii) The reaction described above involves breaking the bond between the atoms in nitrogen molecules.

Suggest why high temperature and pressure are needed for this reaction to take place.

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

3 Fig. 3.1 shows a sperm cell.



Fig. 3.1

(a) On Fig. 3.1, use label lines to label and name **two** structures that are found in **all** animal cells. [2]

(b) Name the organ in which sperm are produced. .... [1]

(c) An investigation was carried out into the oxygen use and energy use of sperm while they were at rest and while they were swimming.

For each measurement, the researchers calculated the amount of oxygen and the amount of energy used by  $10^9$  sperm.

The results are shown in Table 3.1.

Table 3.1

	oxygen use / units per $10^9$ sperm per hour	energy use / joules per $10^9$ sperm per hour
resting sperm	24	46
swimming sperm	83	164

(i) Suggest why the researchers measured the oxygen use and energy use for  $10^9$  sperm, rather than for a single sperm.

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

(ii) Explain why more oxygen is used when the sperm are using more energy.

.....  
.....  
..... [2]

(iii) Calculate the total power output of a group of  $10^9$  swimming sperm.

State the formula that you use and show your working.

formula

working

..... [3]

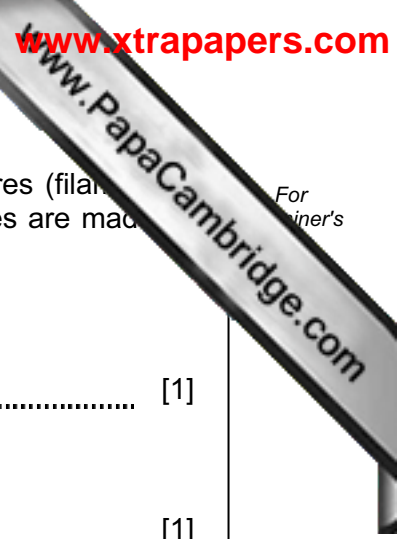
(iv) In order to reach an egg, a human sperm has to swim from the top of the vagina to an oviduct, through a thin layer of liquid.

Explain how the shape of the sperm, shown in Fig. 3.1, reduces the energy required to swim this distance.

.....  
.....  
.....  
..... [2]

(d) Describe what happens immediately after a sperm meets an egg in the oviduct.

.....  
.....  
.....  
..... [2]



4 (a) In older television sets there is a tube which contains three heated wires (filaments). The picture on the screen is produced when emissions from these wires are made to hit the screen.

(i) Name the particles emitted by these hot wires.  
..... [1]

(ii) State the charge on these particles.  
..... [1]

(iii) When a television set is in use, a static charge builds up on the screen. Suggest why this happens.  
.....  
..... [1]

(iv) The heated wire has an electrical resistance.  
State **two** factors which affect the resistance of a piece of wire.  
1 .....  
2 ..... [1]

(b) Television sets contain microprocessors.  
What is a microprocessor?  
.....  
..... [1]



(c) Fig. 4.1 shows the energy transferred each second by a television.

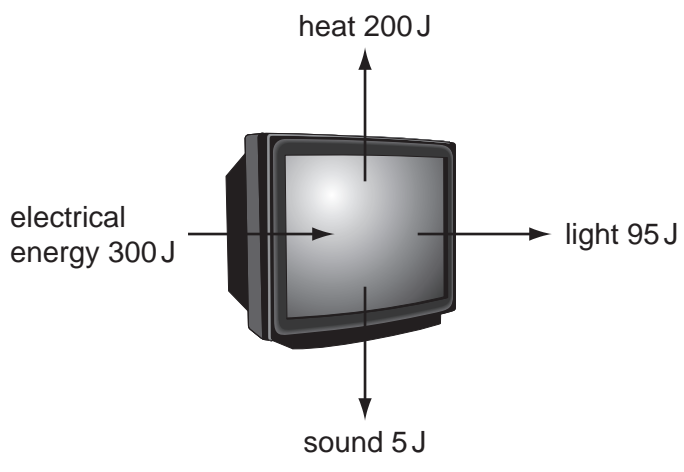


Fig. 4.1

(i) Name the form of energy that is lost as waste energy by the television.  
..... [1]

(ii) State the effect of the waste energy on the air around the television.  
..... [1]

(iii) Calculate the energy efficiency of the television.  
Show your working.  
..... % [2]

5 A student carried out an experiment to find which substances in the environment cause nails made of mild steel to become rusty.

She selected three identical nails and placed them in sealed test-tubes, **A**, **B** and **C**, as shown in Fig. 5.1.

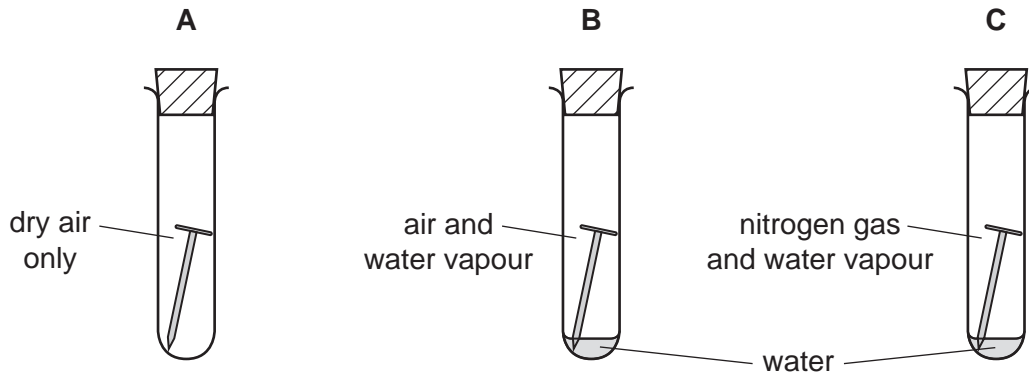


Fig. 5.1

(a) Predict in which tube, **A**, **B** or **C**, the nail became rusty, and explain why the nail did **not** rust in either of the other two tubes.

.....

.....

..... [2]

(b) Fig. 5.2 shows a simplified diagram of two types of atom, **P** and **Q**, in mild steel.

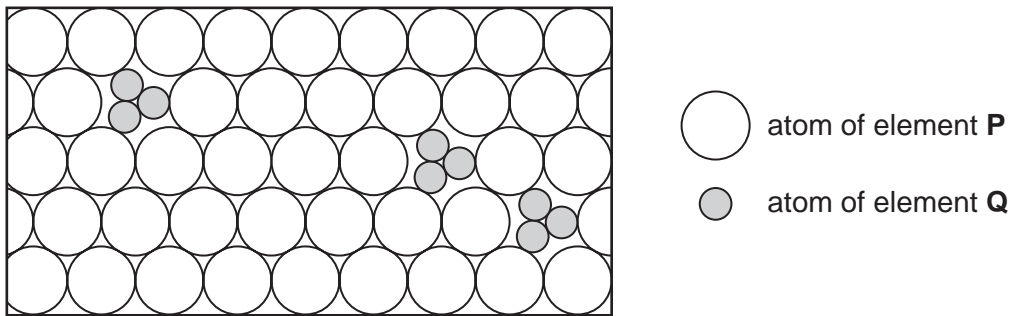


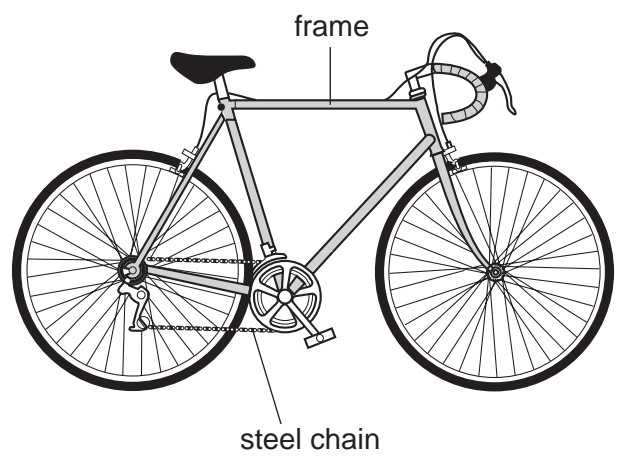
Fig. 5.2

(i) Suggest the name of element **Q**. ..... [1]

(ii) Use Fig. 5.2 to explain why an alloy such as mild steel is less malleable than pure metal such as iron.

.....  
.....  
..... [2]

(c) Steel is used to make both the frames and the chains of bicycles. In order to prevent rusting, the frames are painted and the chains are covered in an oil made of hydrocarbon molecules.



(i) The oil used to protect the bicycle chain contains mainly alkanes. Alkane molecules are described as being saturated.

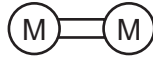
Explain, in terms of chemical bonding, the difference between saturated and unsaturated hydrocarbon molecules.

You may draw a diagram to help your explanation.

.....  
.....  
..... [2]

- (ii) The paint used to protect the bicycle frame from rusting often contains substances made by addition polymerisation of suitable monomers.

Use the simplified diagram of a monomer molecule below to explain what happens in addition polymerisation.



.....

..... [2]



The smell of food cooking can cause a person's salivary glands to secrete saliva.

(a) (i) Name this type of response to a stimulus. .... [1]

(ii) Describe how the information about the smell of the food travels from the nose to the salivary glands.

.....

.....

.....

..... [3]

(b) When food has been taken into a person's mouth, it is chewed by teeth and mixed with saliva.

Describe how the molar teeth help in the digestion of food.

.....

.....

.....

..... [3]

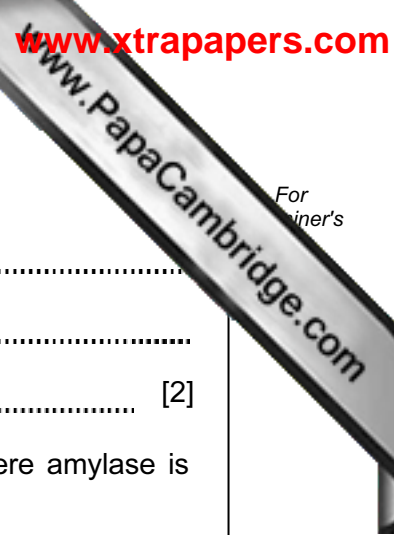
(c) Saliva contains the enzyme amylase.

(i) What is an *enzyme*?

.....

.....

..... [2]



(ii) Describe the function of amylase.

.....  
.....  
..... [2]

(iii) State the parts of the alimentary canal, other than the mouth, where amylase is secreted and where it works.

where amylase is secreted .....

where amylase works ..... [2]

7 (a) Fig. 7.1 shows how radar is used to detect aircraft. Radar uses microwaves of a frequency of about 10000 MHz. Short microwave pulses are sent from the transmitter, reflected from the aircraft and received. The time it takes for the wave pulse to make the journey there and back is measured.

Microwave pulses travel at 300 000 000 m/s.

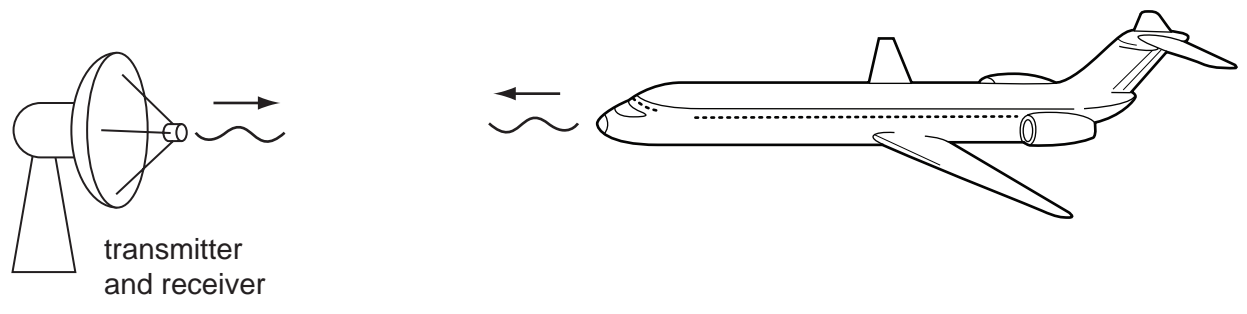


Fig. 7.1

(i) Calculate the wavelength of the microwaves.

State the formula that you use and show your working.

formula used

working

..... [2]

(ii) A radar transmitter sends a microwave pulse which is reflected from the aircraft. The microwave pulse returns to the receiver 0.000 027 s after transmission.

Calculate the distance of the aircraft from the radar transmitter.

State the formula that you use and show your working.

formula used

working

..... [2]

(b) The mass of the aircraft is 140 000 kg.

Calculate the kinetic energy of the aircraft as it travels at 100 m/s.

State the formula that you use and show your working.

formula used

working

..... [2]

(c) As the aircraft lands it is travelling at 85 m/s. It moves along the runway and decelerates at a uniform rate for 40 s until it stops.

(i) Calculate the deceleration of the aircraft along the runway.

State the formula that you use and show your working.

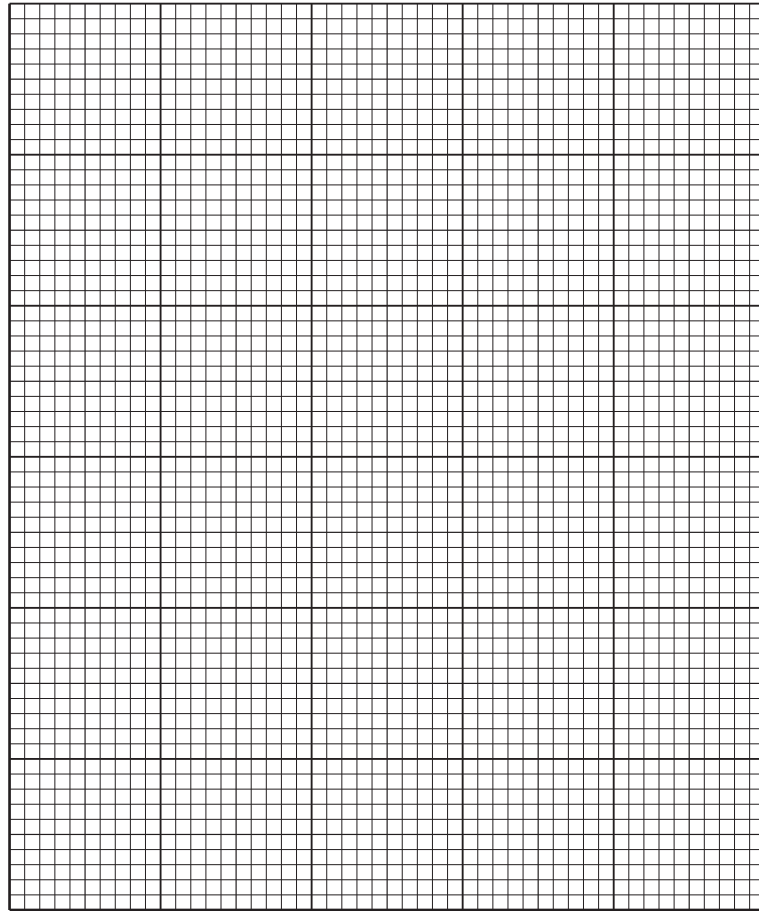
formula used

working

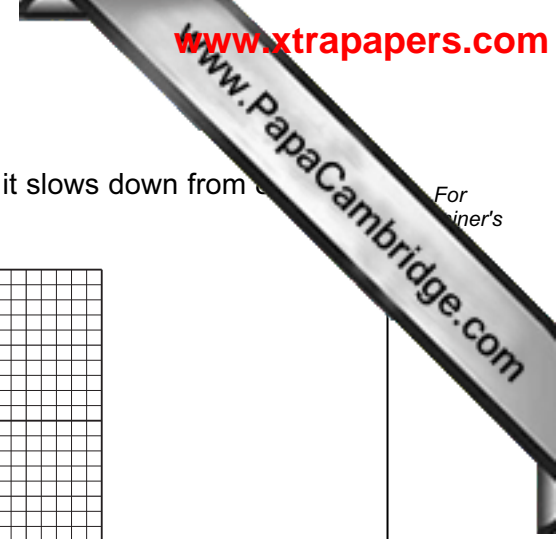
..... [2]



- (ii) On the grid, draw a speed-time graph for the aircraft as it slows down from 800 km/h until it stops.



[3]



8 The chemical formulae for some compounds (minerals) found in rocks are shown below.

$\text{CaMg}(\text{CO}_3)_2$	dolomite
$\text{KAlSi}_3\text{O}_8$	potassium feldspar
$\text{NaAlSi}_3\text{O}_8$	sodium feldspar
$\text{SiO}_2$	quartz

(a) A white powder is known to be either potassium feldspar or sodium feldspar.

Describe how a flame test would enable a chemist to find out which of these minerals it is.

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

(b) Dolomite contains three ions, calcium, magnesium and carbonate.

Calcium and magnesium ions are represented by  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  respectively.

Deduce the electrical charge carried by a carbonate ion.

Explain how you obtained your answer.

..... [2]

(c) When dolomite is strongly heated it undergoes thermal decomposition, giving carbon dioxide gas and leaving a mixture of calcium oxide and magnesium oxide.

The balanced equation for this reaction is



(i) Calculate the number of moles of dolomite in 1.84 g.

Show your working.

..... [3]

(ii) State the number of moles of carbon dioxide which is given off when 1.84 g of dolomite completely decomposes.

..... [1]

(d) When excess dilute hydrochloric acid, HCl, is added to a mixture of calcium oxide and magnesium oxide, a highly exothermic neutralisation reaction occurs.

(i) Name **two** salts which are present in the mixture after the reaction.

1 .....

2 .....

[1]

(ii) Suggest the balanced symbolic equation for the reaction between magnesium oxide and dilute hydrochloric acid.

..... [3]

9 Dung beetles live in places where large herbivores, such as elephants, buffalo or horses, also live. The beetles collect dung produced by the herbivores and make it into a ball, which they roll away and bury.

They lay eggs on the buried ball of dung, so that when their larvae hatch they can feed on the dung. The adults also feed on the dung.

Fig. 9.1 shows a dung beetle rolling a ball of dung.

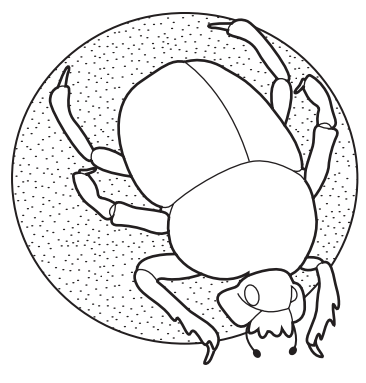


Fig. 9.1

(a) (i) State **one** feature of the dung beetle, visible on Fig. 9.1, that shows it is an arthropod.

..... [1]

(ii) State **one** feature of the dung beetle, visible on Fig. 9.1, that shows it is an insect.

..... [1]

(b) Dung beetles play an important role in the carbon cycle.

Using the information above, suggest how dung beetles can help a carbon atom in animal dung to become part of a carbohydrate molecule within a plant.

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

- (c) (i) Animal dung contains compounds of nitrogen, such as ammonia. When the dung is buried, the ammonia is converted to nitrates by bacteria in the soil.

Explain how this can help plants to grow better.

.....  
.....  
..... [2]

- (ii) If there are plenty of dung beetles on a farmer's land, he may need to add fewer nitrogen-containing fertilisers to the areas where his cattle graze.

Suggest how this could benefit the environment.

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





