

Centre Number	Candidate Number	Name
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UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS  
International General Certificate of Secondary Education

**CO-ORDINATED SCIENCES**

**0654/03**

Paper 3

October/November 2005

**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 in the spaces provided on the Question Paper.  
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.

Answer **all** questions.

The number of marks is given in brackets [ ] at the end of each question or part question.  
A copy of the Periodic Table is printed on page 20.

**For Examiner's Use**

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<b>Total</b>	

If you have been given a label, look at the details. If any details are incorrect or missing, please fill in your correct details in the space given at the top of this page.

Stick your personal label here, if provided.

This document consists of **20** printed pages.



- 1 (a) Red is said to be a *primary colour*, while yellow is said to be a *secondary colour*. Explain what is meant by this statement and name one other primary colour and one other secondary colour.

explanation

.....

.....

primary colour .....

secondary colour ..... [3]

- (b) Below is a list of some waves.

<b>gamma</b>	<b>infra-red</b>	<b>radio</b>	<b>sound</b>
<b>ultrasound</b>	<b>ultraviolet</b>	<b>visible light</b>	

Write down **one** wave from the list that is

- (i) a transverse wave,

..... [1]

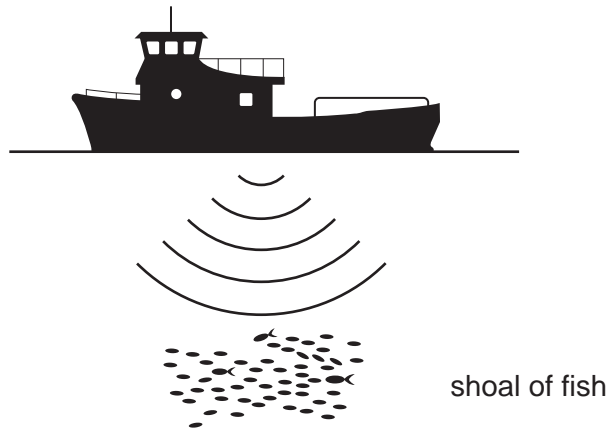
- (ii) a longitudinal wave,

..... [1]

- (iii) emitted by hot objects but cannot be seen by the human eye.

..... [1]

- (c) A fishing boat uses echo sounding to detect a shoal of fish.



Short pulses of high frequency sound are sent out from the boat and the echo from the shoal of fish is detected 0.2 seconds later.

Sound waves travel through water at a speed of 1600 m/s.

- (i) Calculate the distance that the shoal of fish is below the boat.

Show your working and state the formula that you use.

formula used

working

..... [2]

- (ii) The sound waves have a wavelength of 0.2 m.  
Calculate the frequency of the waves.

Show your working and state the formula that you use.

formula used

working

..... [3]

2 (a) Fig. 2.1 shows a vertical section through a human heart.

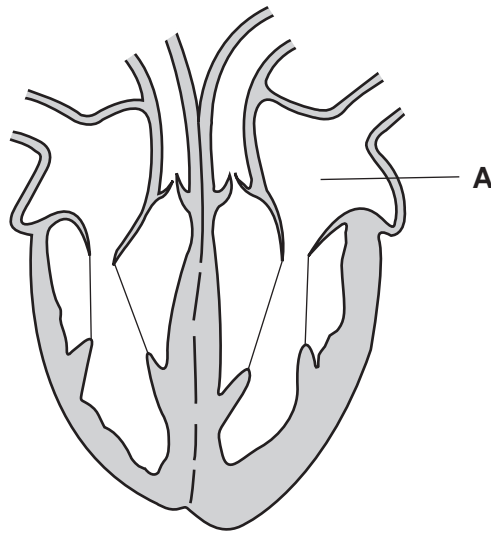


Fig. 2.1

(i) Name the part labelled **A**.

..... [1]

(ii) Using a labelling line and the letter **M**, label the muscular wall of the left ventricle.[1]

(b) The muscular walls of the heart are supplied with oxygen by blood that flows through the coronary arteries.

Explain why a person may suffer a heart attack if one of the coronary arteries becomes blocked.

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

(c) Table 2.1 shows part of a chart that doctors in New Zealand use to estimate the chances of a woman having a heart attack.

**Table 2.1**

percentage of women who are expected to have a heart attack within 5 years								
	age 40		age 50		age 60		age 70	
	no diabetes	with diabetes	no diabetes	with diabetes	no diabetes	with diabetes	no diabetes	with diabetes
non-smokers	1	3	3	7	5	12	7	23
smokers	4	7	6	13	12	22	15	33

(i) Use the information in Table 2.1 to describe how a woman's age affects her chances of having a heart attack, if she does not have diabetes and does not smoke.

.....

.....

.....

..... [2]

(ii) Imagine that you are a doctor. A woman smoker with diabetes asks you how she can improve her chances of living a long and healthy life.

Explain how you would use the **information in Table 2.1** to explain to her why it is very important that she should give up smoking.

.....

.....

.....

.....

..... [3]

(iii) State **one** step that the woman could take, other than giving up smoking, which might reduce her chances of having a heart attack.

..... [1]

- 3 The chemical symbol of the element lithium is shown below.



- (a) (i) State the number of electron shells (energy levels) in a lithium atom.

..... [1]

- (ii) Lithium is obtained as the free element by electrolysis of molten lithium chloride, LiCl.  
Explain briefly how lithium ions, Li<sup>+</sup>, become atoms at the cathode in this process.

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

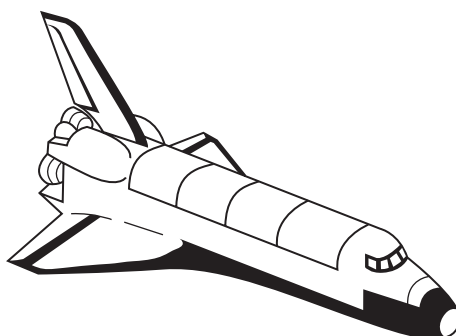
- (b) Lithium reacts with water according to the symbolic equation below.



Explain why fire-fighters must **not** use water to try to extinguish burning lithium.

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

- (c) Lithium hydroxide crystals are used in manned space vehicles to remove carbon dioxide gas from the air exhaled by the astronauts.



The symbolic equation for this reaction is



- (i) The formula and charge of a lithium ion is  $\text{Li}^+$ . Deduce the formula and charge of the carbonate ion.  
Explain your answer.

..... [2]

- (ii) A space vehicle carries a crew of 7 astronauts. Each astronaut exhales 18 moles of carbon dioxide every day.

Calculate the total number of moles of carbon dioxide that the crew will exhale during a mission into space which lasts 10 days.  
Show your working.

..... [2]

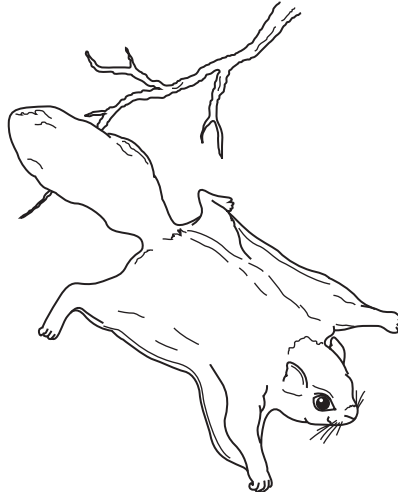
- (iii) Calculate the mass of lithium hydroxide crystals which must be loaded on board the space vehicle to react with all the carbon dioxide exhaled during the mission.  
Show your working.

..... [3]

- (iv) Suggest why lithium hydroxide and not the hydroxide of any of the other Group 1 metals is used on the space vehicle.

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

- 4 Fig. 4.1 shows a flying squirrel. A flying squirrel uses large flaps of skin as a form of parachute to enable it to fall, glide and land safely. The air trapped under these flaps, as the squirrel falls, provides an upward force called air resistance.



**Fig. 4.1**

- (a) (i) As the squirrel starts to fall, it is accelerating.

State the meaning of the term *accelerating*.

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

- (ii) The squirrel weighs 20 N. Suggest a value for the air resistance while the squirrel is accelerating.

air resistance ..... N

Explain your answer.

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

- (iii) At one point as the squirrel falls, the resultant downward force on the squirrel is 10 N. Calculate the acceleration of the squirrel if its mass is 2 kg.

Show your working and state the formula that you use.

formula used

working

..... [2]



(b) Later in its fall, the squirrel reaches a steady speed (terminal velocity) of 3 m/s.

(i) State the value of the air resistance now.

air resistance ..... N

Explain your answer.

..... [2]

(ii) Explain why the value of the air resistance has changed.

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

(iii) The surface area of the squirrel on which the air resistance acts is 0.4 m<sup>2</sup>.  
Use your answer to (b)(i) and the formula

$$\text{pressure} = \frac{\text{force}}{\text{area}}$$

to calculate the pressure on the squirrel.

Show your working.

..... [2]

5 Fig. 5.1 shows a section through a human eye. The eye is focused on a distant object.

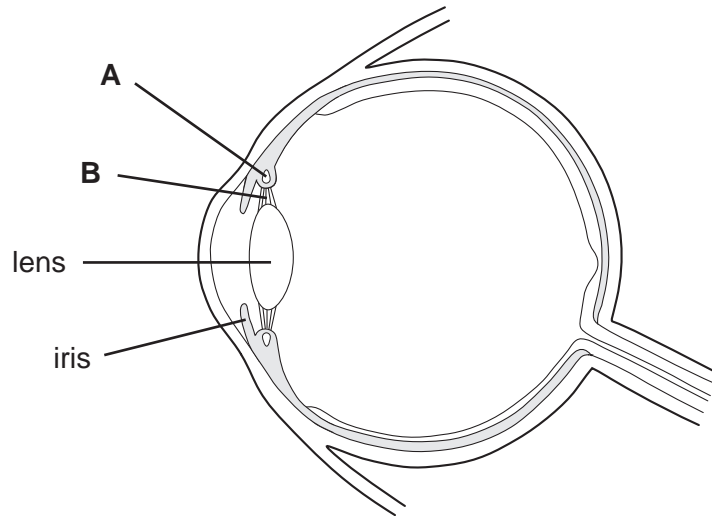


Fig. 5.1

(a) When the eye focuses on a near object, the lens becomes thicker.

(i) Describe the changes that will take place in parts **A** and **B** when the eye focuses on a near object.

A. ....  
.....  
B. ....  
..... [2]

(ii) Explain why the lens needs to become thicker in order to focus on a near object. You may draw a diagram if it helps your answer.

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

- (b) The iris is the coloured part of the eye. It can become wider or narrower to regulate the amount of light that can reach the retina.

The colour of the iris of a rabbit is determined by the rabbit's genes. A rabbit with the genotype **Bb** or **BB** has brown eyes. A rabbit with the genotype **bb** has yellow eyes.

- (i) Use a genetic diagram to explain how two rabbits with brown eyes may have young with yellow eyes.

[3]

Occasionally, a mutation occurs in some of the cells of the iris, which may result in the iris becoming a different colour.

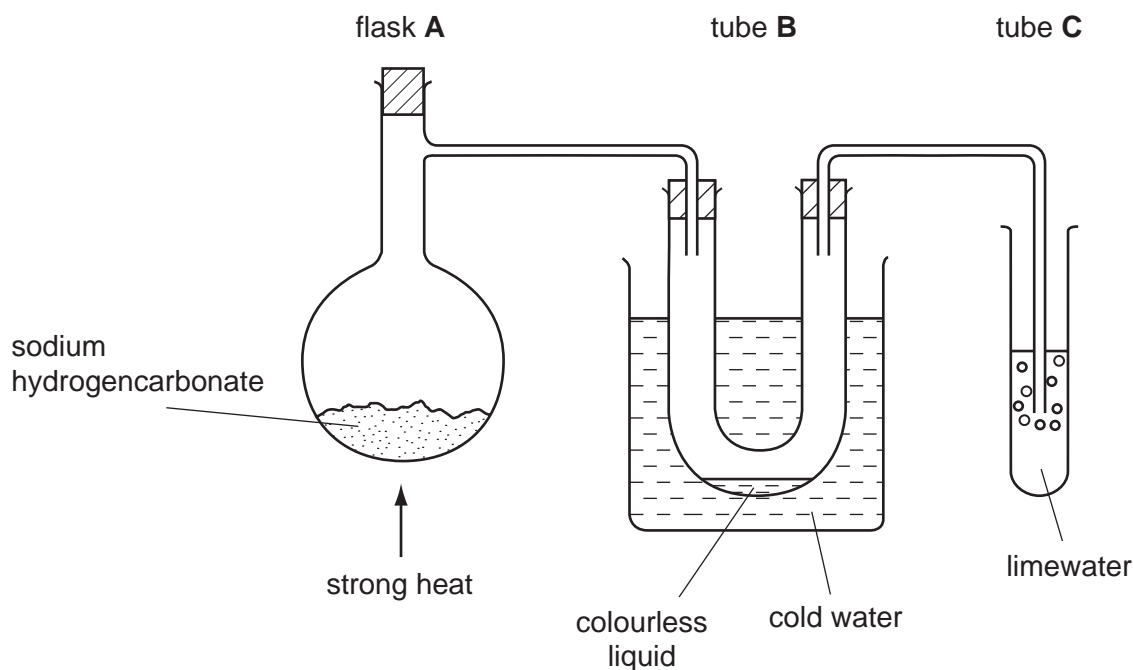
- (ii) Ionising radiation may cause mutation. Explain how it does this.

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

- (iii) Explain why this change in colour of the iris will not be passed on to the rabbit's offspring.

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

- 6 Fig. 6.1 shows the apparatus a student used to investigate the effect of strong heating on sodium hydrogencarbonate,  $\text{NaHCO}_3$ .



**Fig. 6.1**

Table 6.1 shows observations the student made before and after heating the sodium hydrogencarbonate for several minutes.

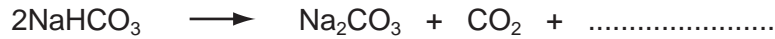
**Table 6.1**

	before heating	after heating
flask <b>A</b>	white solid	white solid
tube <b>B</b>	tube empty	colourless liquid has condensed
tube <b>C</b>	clear liquid	liquid has become cloudy

- (a) State two observations from Table 6.1 which show that a chemical reaction occurs when sodium hydrogencarbonate is heated.

1. ....  
 .....  
 2. ....  
 ..... [2]

(b) An incomplete symbolic equation for the reaction in Fig. 6.1 is shown below.



Use the incomplete equation above to deduce the name of the colourless liquid which condenses in tube B.  
Explain your answer.

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

(c) Sodium carbonate is sometimes added to hard water in order to soften it. The symbolic equation below shows the reaction that occurs when sodium carbonate is added to a sample of hard water.  
In this equation the symbols **(aq)** and **(s)** show whether the substance is an **aqueous** solution or a **solid** respectively.



(i) Name the type of chemical reaction shown above.

..... [1]

(ii) Explain why this reaction softens the water.

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

(d) Sodium carbonate is mixed with silicon(IV) oxide and other oxides to make glass. The mixture has to be heated to a very high temperature in order to melt it and allow the glass to form.  
Explain, in terms of their structures, why compounds like sodium carbonate and silicon(IV) oxide have such high melting points.

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

7 (a) A car has two headlight lamps at the front and two rear light lamps at the back. All four lamps are connected in parallel with each other across a 12V battery.

(i) Draw a circuit diagram to show how the two headlight lamps are connected to the battery. Include a switch in your circuit to control the two headlight lamps.

[3]

(ii) If one lamp fails, the other stays lit. Explain why this happens.

.....

..... [1]

(iii) Each headlight lamp takes a current of 5 A and each rear light lamp takes a current of 1 A. What is the total current taken by these four lamps?

Show your working

..... [2]

(b) Fig. 7.1 shows a speaker for a car radio.

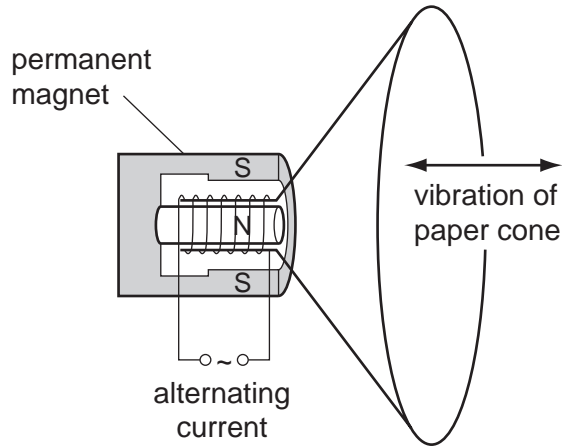


Fig. 7.1

Explain why the cone of the speaker vibrates when an alternating current passes through the coil.

.....

.....

.....

.....

..... [3]

(c) The pressure of the air in car tyres must be correct to give a good grip on the road surface.

(i) Explain in terms of particles why adding more air to a car tyre increases the pressure in the tyre.

.....

.....

..... [2]

(ii) Tyres become warmer during long journeys. Explain in terms of particles why this will result in an increase in tyre pressure.

.....

.....

..... [2]

- 8 A gardener in a country with a cool climate grows peppers in a glasshouse. Fig. 8.1 shows how light intensity affects the rate of growth of the pepper plants.

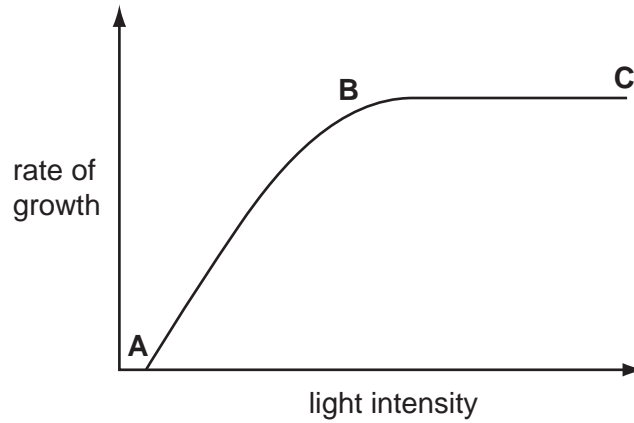


Fig. 8.1

- (a) Explain the reasons for the shape of the graph

between **A** and **B**,

.....  
 .....  
 .....

between **B** and **C**.

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

- (b) The gardener thinks she might be able to increase the growth of her plants by burning a fuel such as methane in the glasshouse.

- (i) Write a **word** equation for the complete combustion of methane.

..... [1]

- (ii) State two reasons why burning methane in the glasshouse might increase the growth of the pepper plants.

1. ....  
 2. .... [2]



(c) Another way of increasing the growth of the plants is to provide them with a fertiliser containing nitrogen.

(i) Suggest **one** compound which can be found in a fertiliser and which provides nitrogen to the plants in a form that they can use.

..... [1]

(ii) Explain why extra nitrogen can increase the growth of plants.

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

(iii) Explain how the careless use of nitrogen-containing fertilisers near to streams and lakes can harm the organisms that live in them.

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

- 9 (a) Table 9.1 shows some information about two elements **X** and **Y**. Both elements are in the third period of the Periodic Table. Complete the table by writing the words **high** or **low** in the empty boxes. Two of the boxes have already been completed.

Table 9.1

element	group number in Periodic Table	melting point	electrical conductivity	pH of element oxide in water
<b>X</b>	2	high		
<b>Y</b>	7	low		

[2]

- (b) A compound from which the metal titanium can be extracted is ilmenite,  $\text{TiFeO}_3$ . In order to obtain titanium, ilmenite is first processed to form titanium chloride. Titanium chloride is then reacted with magnesium. Symbolic equations for these two reactions are shown below.

**reaction 1****reaction 2**

- (i) Name **one** element which has been oxidised in **reaction 1**. Explain your answer.

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

- (ii) Fig. 9.1 shows a diagram of a chlorine atom, showing only the outer electron shell.

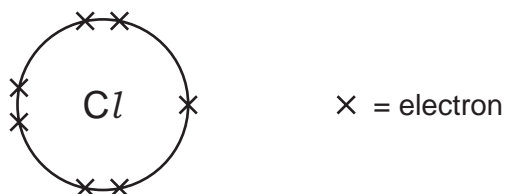


Fig. 9.1

Draw a diagram to show how the outer electrons are arranged in a molecule of chlorine.

[2]

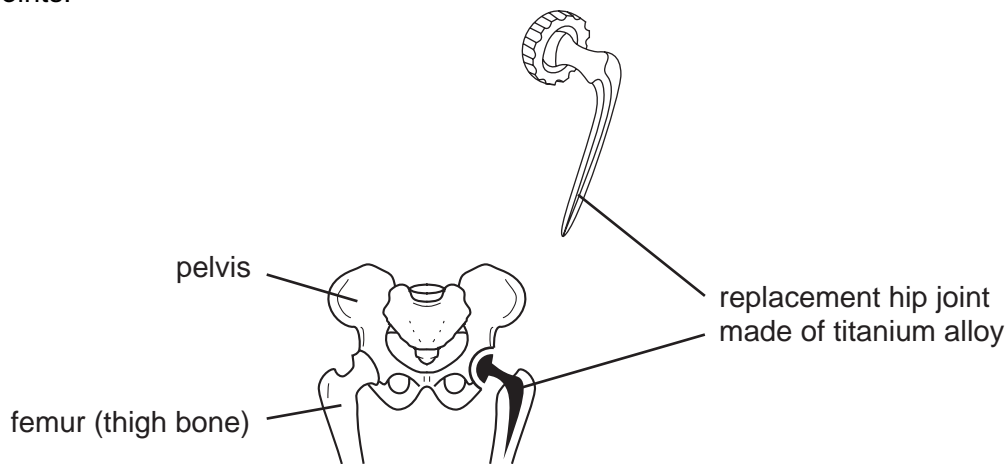
(iii) Describe how the arrangement of the electrons around the magnesium atoms changes during **reaction 2**.

.....

.....

..... [2]

(c) Alloys containing large amounts of titanium are widely used to make replacement hip joints.



Suggest why an alloy of titanium rather than pure titanium is more suitable for making replacement hip joints which have to carry a person's weight.

.....

.....

..... [2]

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