



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)

October/November 2010

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 28.

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	
1	
2	
3	
4	
5	
6	
7	
8	
9	
Total	

This document consists of **26** printed pages and **2** blank pages.



- 1 Fig. 1.1 shows the apparatus a student used to study the rate of reaction between 1.0 g of powdered metal and dilute hydrochloric acid.

For
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Use

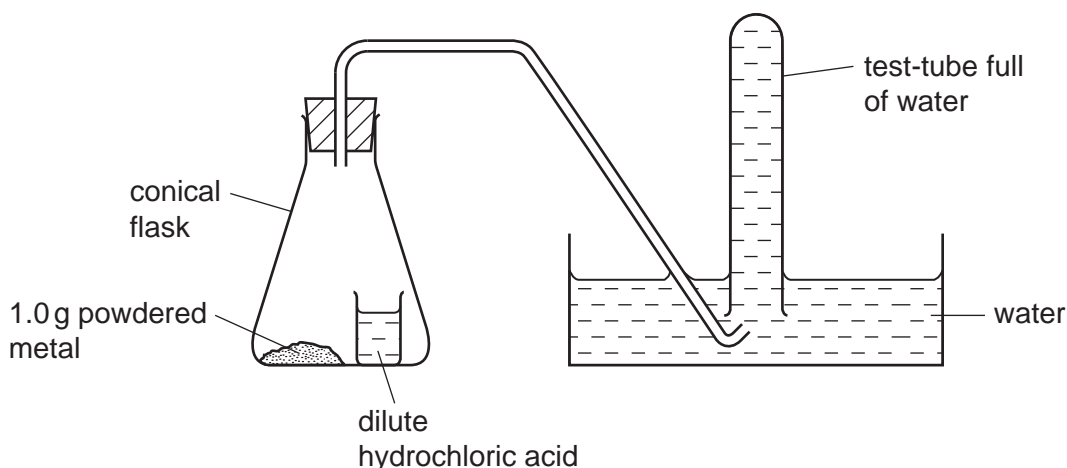


Fig. 1.1

When the student tilted the conical flask, the acid mixed with the powdered metal. If a reaction occurred, any gas which was produced collected in the test-tube, pushing the water out. The student measured the time taken for the test-tube to fill with gas.

- (a) (i) Name the gas produced when metals react with dilute hydrochloric acid.

..... [1]

- (ii) State the formula of the *ion* which is present in relatively high concentrations in all acids.

..... [1]

- (b) The student used the apparatus and method described above to compare the rates of reaction between dilute hydrochloric acid and three powdered metals, X, Y and Z.

The results the student obtained are shown in Table 1.1.

Table 1.1

metal	mass of metal /g	time for gas to fill the test-tube / seconds
X	1.0	154
Y	1.0	28
Z	1.0	76

- (i) The student was careful to ensure that the only variable (factor) which differed between the experiments was the type of metal.

State **two** variables, other than the mass and surface area of the metals, which the student must keep the same in each experiment.

1

2 [2]

- (ii) Explain how the results show that the rate of reaction was the lowest when metal X was used.

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

- (iii) The student repeated the experiment with metal Y but this time he used a single piece of metal which had a mass of 1.0 g.

State how the rate of reaction would differ from the experiment in which 1.0 g of powdered metal was used.

Explain your answer in terms of the collisions between atoms in the surface of the metal and ions in the solution.

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

(c) When magnesium reacts with dilute hydrochloric acid, HCl , one of the products is magnesium chloride, MgCl_2 .

For
Examiner's
Use

(i) Construct a balanced symbolic equation for this reaction.

..... [2]

(ii) Magnesium chloride is a compound which causes hardness in water.

Describe briefly how the process of *ion exchange* is used to soften hard water. You may draw a simple diagram if it helps you to answer this question.

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

Please turn over for Question 2.

2 Fig. 2.1 shows a mobile phone (cell phone).



mobile phone
containing a battery

Fig. 2.1

(a) Energy is stored inside the mobile phone in a battery.

Describe the energy changes taking place when the battery is being charged.

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

(b) The quality of digital signals is maintained far better than that of analogue signals.

Explain why.

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

- (c) The strength of phone cases can be tested by dropping the phones onto different surfaces from a height of 2 m.

A phone of mass 80 g is dropped onto a concrete path. The case breaks when it hits the concrete. When an identical mobile phone is dropped onto a soft carpet from the same height, the case does not break.

- (i) State the momentum of each phone after it has landed on the surface.

..... [1]

- (ii) As a phone was about to hit the concrete path, its momentum was 1.2 kg m/s. It took 0.03 s to stop.

The force it experienced as it hit is given by the formula

$$\text{force} = \frac{\text{change in momentum}}{\text{time taken to stop}}$$

Calculate this force.

Show your working.

..... [2]

- (iii) The phones that hit the concrete and the soft carpet had the same change in momentum. Suggest why the phone dropped onto the soft carpet did not break.

.....

 [2]

3 Fig. 3.1 shows a generalised reflex arc.

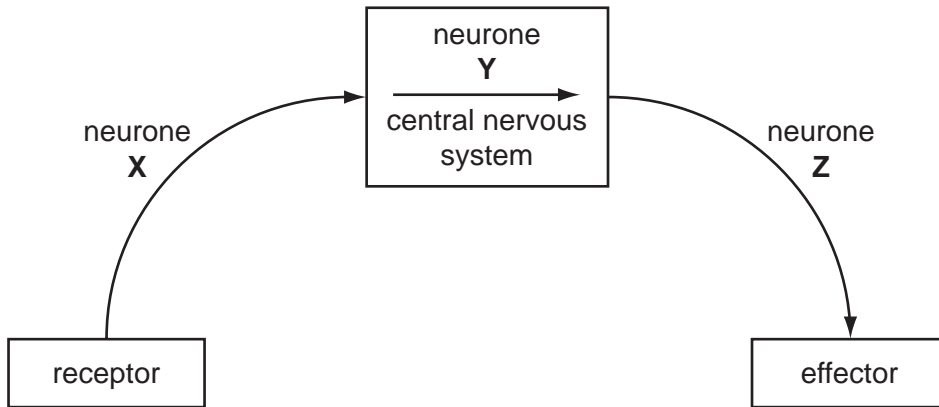


Fig. 3.1

(a) (i) Name the neurones labelled X, Y and Z.

X

Y

Z

[3]

(ii) Name **one** part of the central nervous system in which neurone Y might be found.

.....

[1]

(b) A student hears a sudden, loud bang. Receptors in his ear respond to the sound by generating electrical impulses in neurone X. These impulses travel along the reflex arc, eventually reaching an effector.

Suggest what the effector could be in this reflex, and how it would respond.

effector

response

[2]

(c) Another reflex action involves the secretion of saliva into the mouth in response to the smell of food.

(i) Describe the role of saliva in the digestion of food.

.....

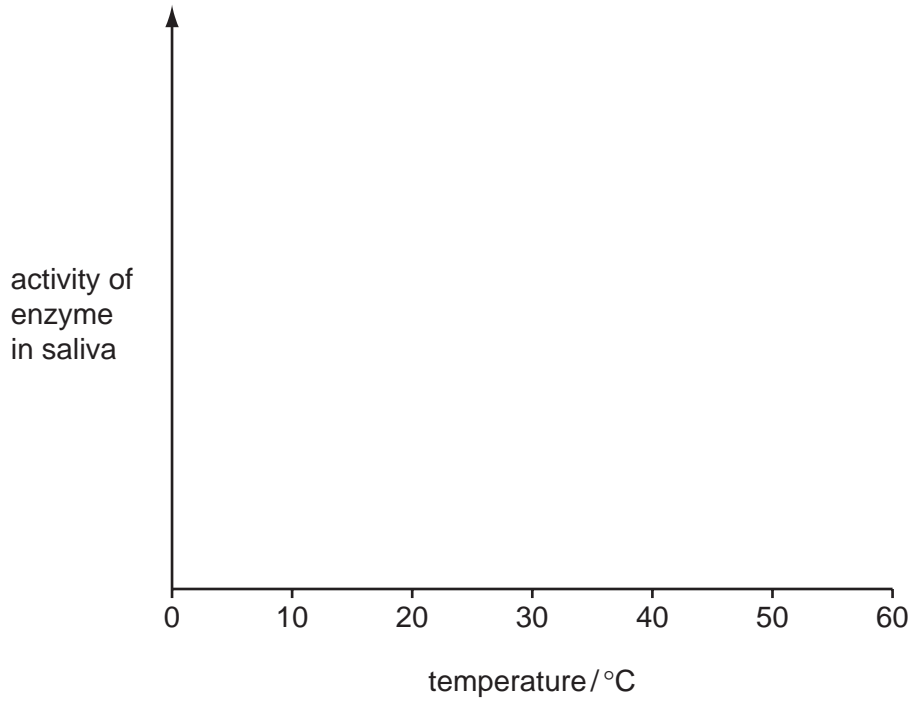
[2]

(ii) Explain why it is necessary for most types of food that we eat to be digested.

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

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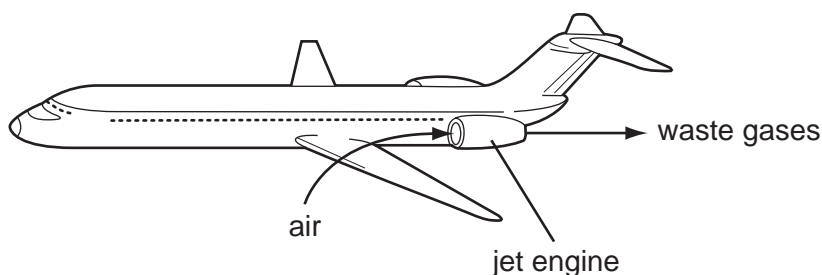
(iii) On the axes below, sketch a curve to show how the activity of enzyme from human saliva would vary with temperature.



[2]

- 4 In jet engines, hydrocarbon molecules from the jet fuel mix with air and burn. This releases a large amount of energy and produces a mixture of waste gases. These waste gases pass out through the back of the jet engine into the atmosphere.

For
Examiner's
Use



- (a) Fig. 4.1 shows a molecule of octane, which is a typical hydrocarbon molecule in jet fuel.

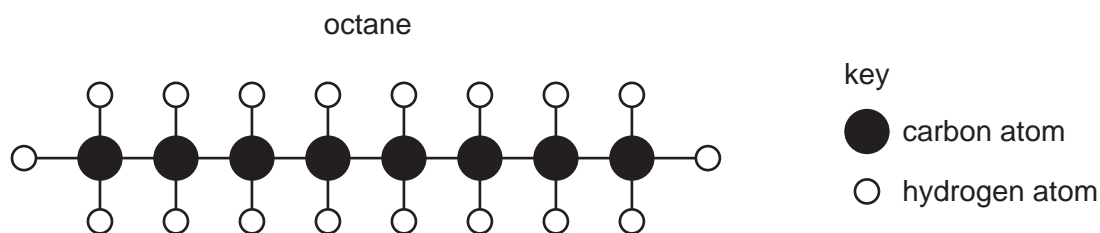
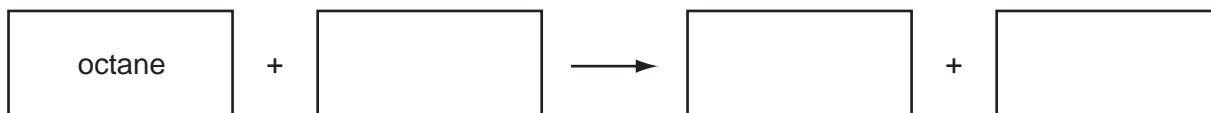


Fig. 4.1

- (i) State the chemical formula of octane.

..... [1]

- (ii) Complete the word equation below for the complete combustion of octane.



[2]

- (b) The mixture of waste gases coming from the jet engine contains a large amount of the free element nitrogen, N_2 , which exists naturally in the air. The atoms in a nitrogen molecule are held together by a triple covalent bond as shown in the displayed formula below.

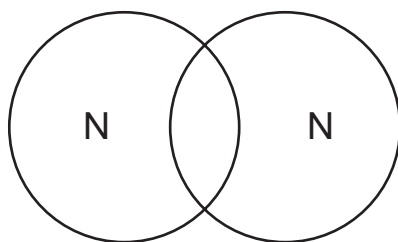


- (i) State the number of outer electrons in a single nitrogen atom.

..... [1]

- (ii) Complete the bonding diagram below to show how the outer electrons are arranged around the atoms in a nitrogen molecule.

*For
Examiner's
Use*



[2]

- (iii) The temperature inside the jet engine is very high.

Suggest why most of the nitrogen molecules which pass through the engine do **not** break up into individual atoms.

.....

.....

..... [2]

(c) Table 4.1 shows information about some metallic materials.

For
Examiner's
Use

Table 4.1

material	strength	density
mild steel	very high	very high
aluminium	low	low
duralumin (an aluminium alloy)	very high	low

(i) Duralumin is used in the manufacture of aircraft.

Explain why the properties of this material make it suitable for this purpose.

.....

.....

.....

.....

..... [2]

(ii) A sample of duralumin has a mass of 50.00g and contains 1.73 moles of aluminium.

Calculate the percentage by mass of aluminium in this sample of duralumin.

Show your working.

..... [3]

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Please turn over for Question 5.

5 A student investigated the relationship between the potential difference across a lamp and the current passing through it.

For
Examiner's
Use

(a) Fig. 5.1 shows her results.

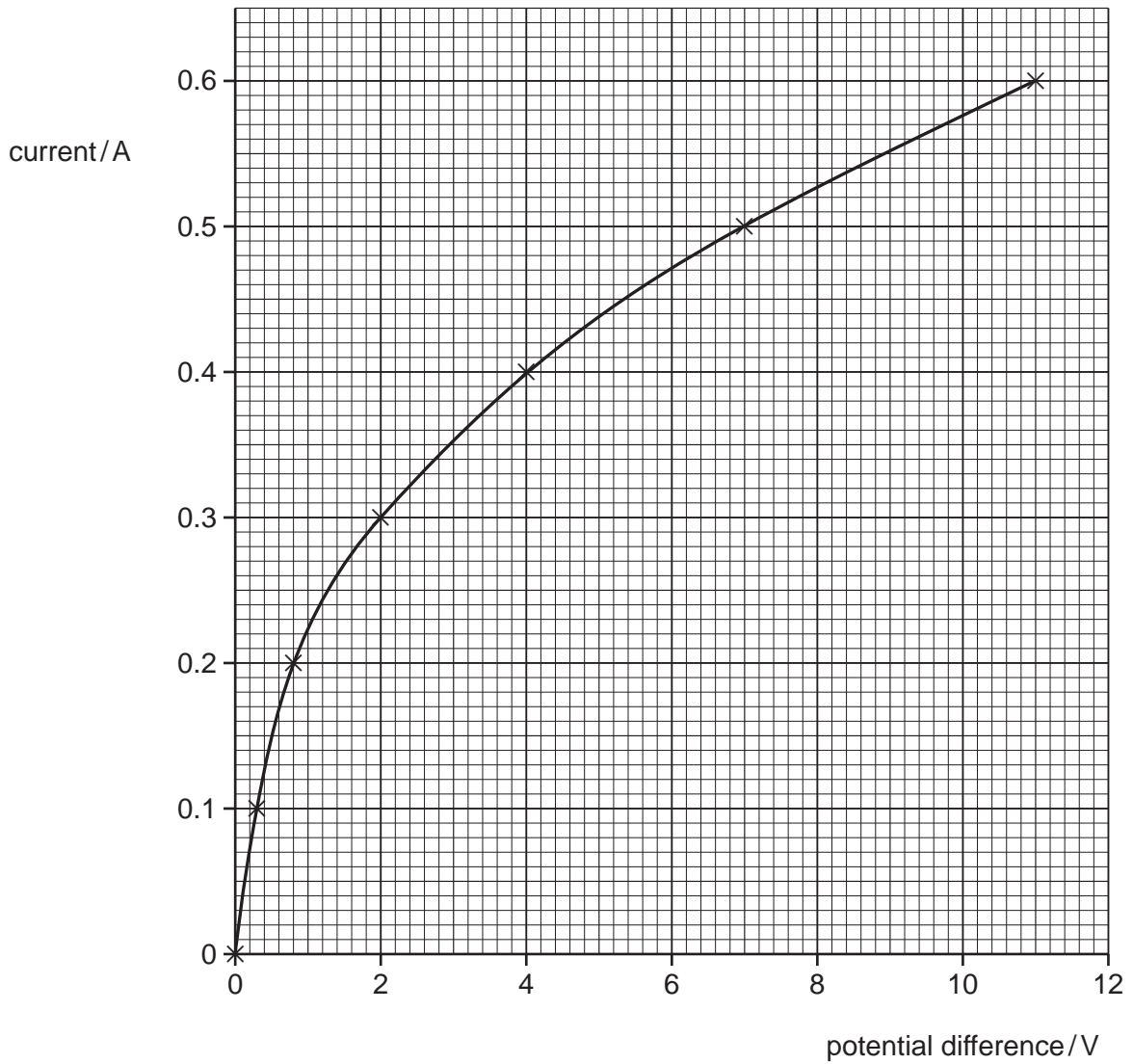


Fig. 5.1

(i) What is the current when the potential difference is 6 V?

..... [1]

(ii) Calculate the resistance of the lamp when the potential difference is 6 V.

State the formula that you use and show your working.

formula used

working

..... [2]

(b) A student was given two bar magnets and a bar of soft iron. She carried out the following experiments.

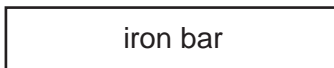
(i) She brought the magnets close together with like poles facing.



State what she observed.

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

(ii) She brought the soft iron bar towards one of the magnets.



State what she observed.

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

For
Examiner's
Use

- (c) Fig. 5.2 shows a strip of aluminium foil hung between the poles of a magnet. When the current is switched on, the foil experiences a force as shown.

For
Examiner's
Use

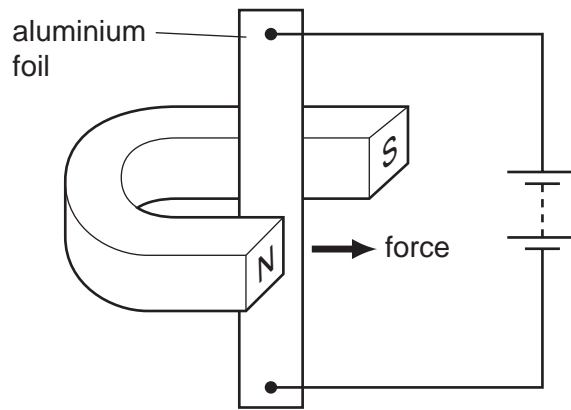


Fig. 5.2

- (i) Explain why a force is produced.

.....

 [2]

- (ii) State **two** changes which would increase the size of the force acting on the aluminium foil.

1
 2 [2]

(d) A transformer used in a television set has 100 turns on the primary coil.

The potential difference across the primary coil is 240 V and the potential difference across the secondary coil is 35 000 V.

Calculate the number of turns on the secondary coil.

Use the formula $V_p/V_s = N_p/N_s$.

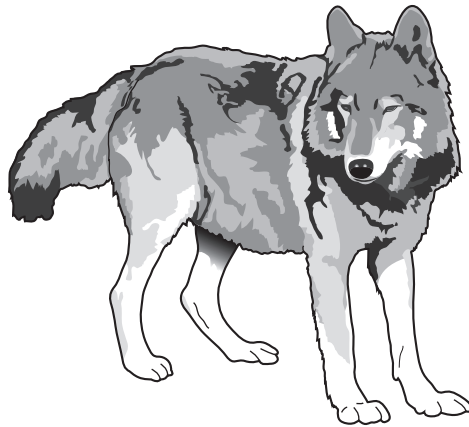
Show your working.

For
Examiner's
Use

..... [2]

- 6 The gray wolf, *Canis lupus*, is a predator. In Wisconsin, Canada, the wolves' diet consists mainly of white-tailed deer, beavers, snowshoe hares and mice.

For
Examiner's
Use



(a) White-tailed deer eat grasses and other plants.

(i) Construct a food chain including white-tailed deer and wolves.

[1]

(ii) Sketch a pyramid of biomass for the food chain you have constructed in (i). Label the trophic levels in your pyramid.

[3]

(iii) With reference to your answers in (i) and (ii), suggest why wolves are rarer than white-tailed deer.

.....

.....

.....

[2]

- (b) People used to shoot gray wolves. In 1978, a conservation programme for gray wolves began in Wisconsin and people were no longer allowed to shoot them. The main causes of death of wolves are disease, starvation and accidents such as collisions with vehicles.

For
Examiner's
Use

Fig. 6.1 shows the size of the gray wolf population in Wisconsin between 1986 and 2010. It also shows the predicted wolf population if the conservation programme is successful.

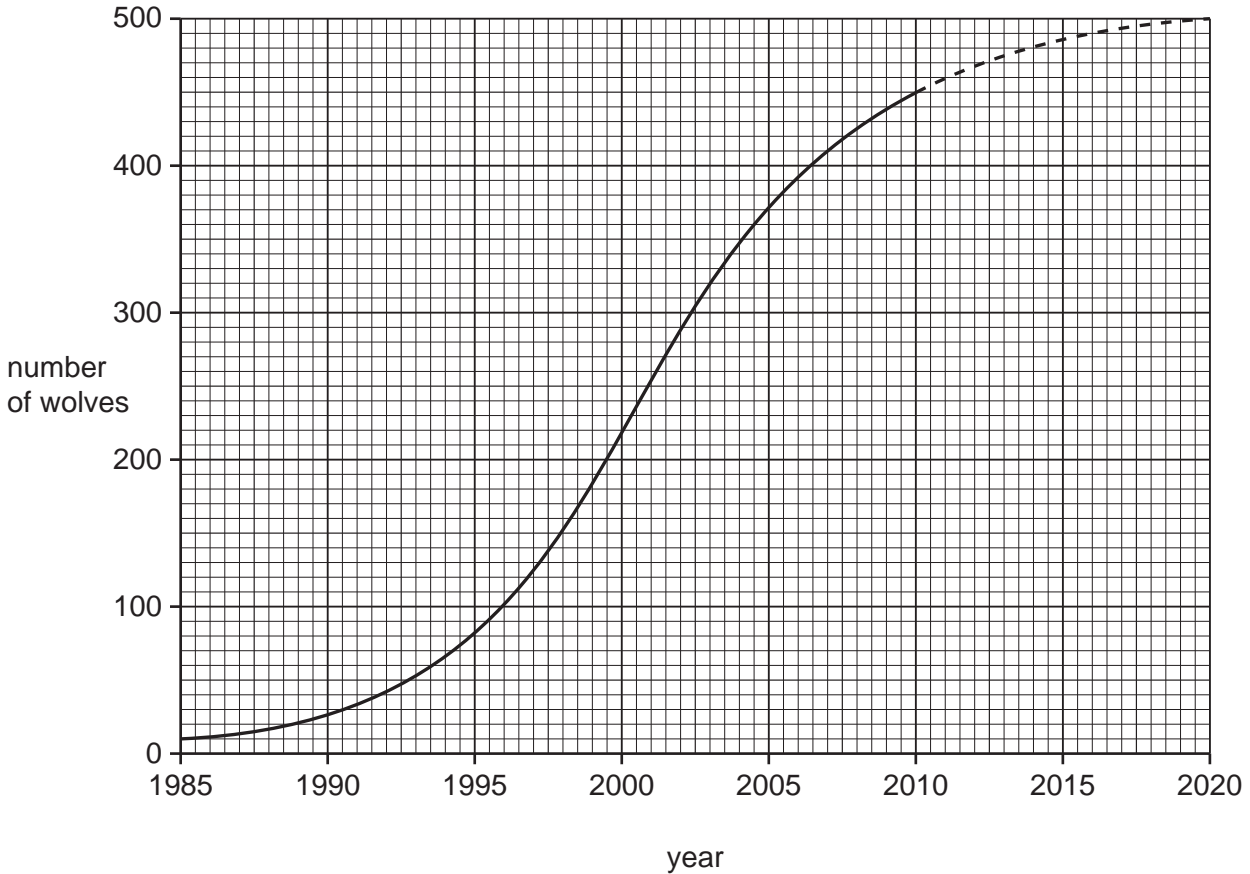


Fig. 6.1

- (i) Suggest why the population of gray wolves in Wisconsin is not expected to increase beyond about 500 individuals, even if they are no longer killed by humans.

.....

 [2]

- (ii) Some people in Wisconsin are opposed to the wolf conservation programme. Explain why it is important to conserve species such as the gray wolf.

.....

 [2]

7 Copper metal reacts with oxygen gas to form copper oxide.

(a) Table 7.1 shows information about two different types of copper oxide.

For
Examiner's
Use

Table 7.1

name	colour	chemical formula
copper(II) oxide	black	CuO
copper(I) oxide	red	Cu ₂ O

(i) Copper is a transition metal.

State **one** property, shown in Table 7.1, which is typical of transition metals.

..... [1]

(ii) The formula of the oxide ion is O²⁻.

Use the formula of copper(I) oxide to deduce the charge of the copper ion in this compound.

Show your working.

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

- (b) Fig. 7.1 shows apparatus and materials needed for the electrolysis of aqueous solutions of ionic compounds, using graphite electrodes.

For
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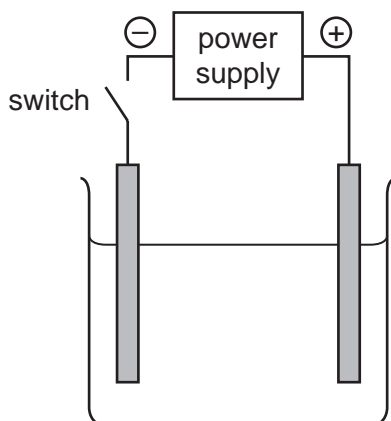


Fig. 7.1

Table 7.2 shows the observations made when solutions of three compounds, **W**, **X** and **Y**, were each electrolysed.

Table 7.2

compound in solution	observation at the cathode	observation at the anode
W	bubbles of gas	bubbles of gas which bleach damp litmus paper
X	orange / pink solid layer forms	bubbles of gas which bleach damp litmus paper
Y	bubbles of gas	orange solution produced

- (i) On Fig 7.1, clearly label the **anode** and the **electrolyte**. [2]
- (ii) Suggest the name of compound **X**. [1]
- (iii) Name the gas produced at the cathode when compound **W** is electrolysed. [1]
.....
- (iv) Explain which compound, **W**, **X** or **Y**, could be potassium bromide.
compound [2]
.....
.....
.....

8 (a) Explain why plants need light for photosynthesis.

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

(b) A student fixed a piece of black paper over a leaf, which was still attached to the plant. He left the plant in the sun for two days.

He then removed the leaf from the plant and tested it for starch, after removing the black paper.

(i) Describe how the student should test the leaf for starch.

.....
.....
.....
.....
.....
..... [4]

(ii) Fig. 8.1 shows the leaf before and after he did the starch test.

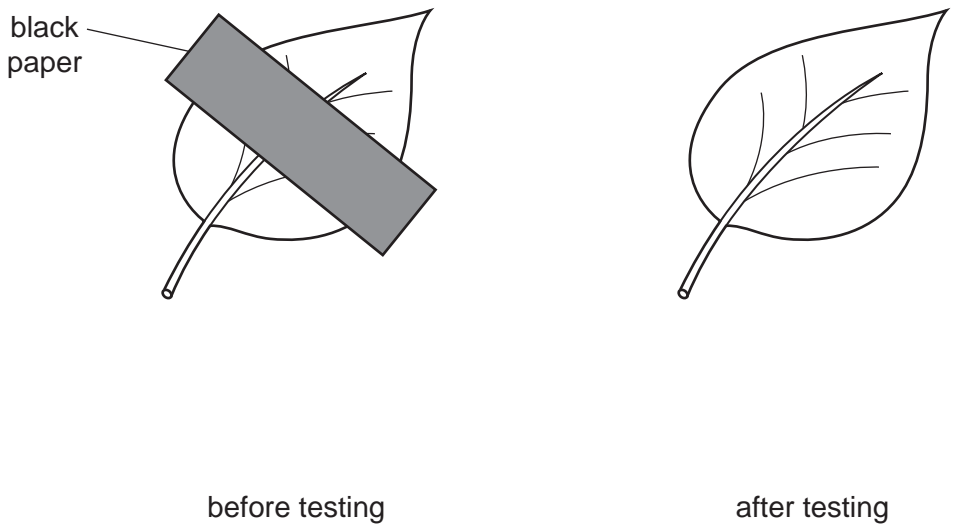


Fig. 8.1

Complete the diagram of the leaf after testing in Fig. 8.1, using labels to show the colours of each part. Do **not** colour the diagram. [2]

- (c) In daylight, plant leaves take in carbon dioxide and give out oxygen. In darkness, they take in oxygen and give out carbon dioxide.

For
Examiner's
Use

Explain why this happens.

.....

.....

.....

.....

.....

.....

..... [3]

- 9 Fig. 9.1 shows a rock that is falling from the top of a cliff into the river below.

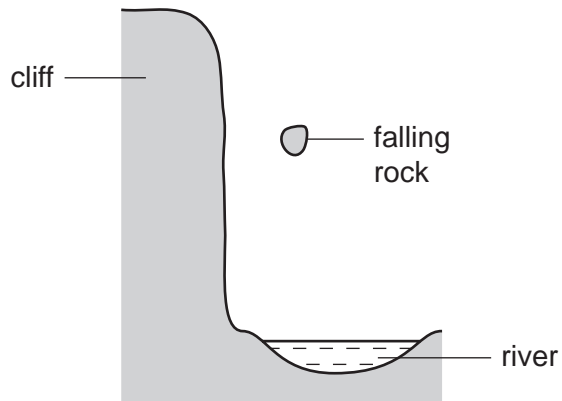


Fig. 9.1

- (a) The rock accelerates downwards at 9.8 m/s^2 . The mass of the rock is 2000 g.

Calculate the weight of the rock.

State the formula that you use and show your working.

formula used

working

..... [2]

For
Examiner's
Use

(b) Fig. 9.2 is a speed-time graph for the motion of the rock. This graph ignores the effect of air resistance on the rock.

For
Examiner's
Use

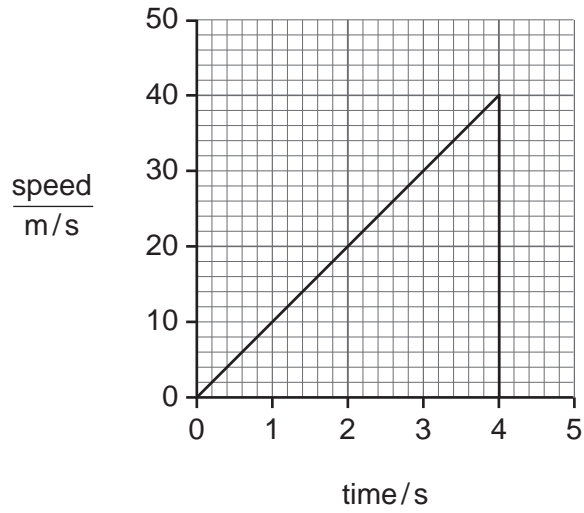


Fig. 9.2

(i) Calculate the kinetic energy of the rock as it hits the water.

State the formula that you use and show your working.

formula used

working

..... [3]

(ii) Calculate the height of the cliff.

Show your working.

..... [2]

(c) The rock has an irregular shape. It has a mass of 2000 g and a volume of 700 cm³.

(i) Calculate the density of the rock.

State the formula that you use and show your working.

formula used

working

..... [2]

(ii) Describe how you could find the volume of an irregularly shaped object such as a rock. You should state the apparatus you would use and the measurements you would need to make.

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

For
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Use

(d) The rock contains radioactive substances emitting high levels of ionising radiation.

(i) State how the radioactivity could be detected.

..... [1]

(ii) Explain why it would be dangerous for a person to handle this rock without proper protection.

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

DATA SHEET
The Periodic Table of the Elements

		Group																														
I	II	III	IV	V	VI	VII	0																									
7 Li Lithium 3	9 Be Beryllium 4	1 H Hydrogen 1					4 He Helium 2																									
23 Na Sodium 11	24 Mg Magnesium 12	5 B Boron 5	6 C Carbon 6	7 N Nitrogen 7	8 O Oxygen 8	9 F Fluorine 9	10 Ne Neon 10																									
39 K Potassium 19	40 Ca Calcium 20	13 Al Aluminium 13	14 Si Silicon 14	15 P Phosphorus 15	16 S Sulfur 16	17 Cl Chlorine 17	18 Ar Argon 18																									
85 Rb Rubidium 37	88 Sr Strontium 38	56 Fe Iron 26	57 Ga Gallium 31	58 Zn Zinc 30	59 Co Cobalt 27	60 Ni Nickel 28	61 Cu Copper 29	62 Zn Zinc 30	63 Ga Gallium 31	64 Cd Cadmium 48	65 Hg Mercury 80	66 Tl Thallium 81	67 Pb Lead 82	68 Bi Bismuth 83	69 Po Polonium 84	70 At Astatine 85	71 Rn Radon 86															
133 Cs Caesium 55	137 Ba Barium 56	91 Zr Zirconium 40	92 Nb Niobium 41	93 Mo Molybdenum 42	94 Tc Technetium 43	95 Ru Ruthenium 44	96 Rh Rhodium 45	97 Pd Palladium 46	98 Ag Silver 47	99 Au Gold 79	100 Pt Platinum 78	101 Ir Iridium 77	102 Os Osmium 76	103 Re Rhenium 75	104 W Tungsten 74	105 Ta Tantalum 73	106 Hf Hafnium 72	107 La Lanthanum 57	108 Ce Cerium 58	109 Pr Praseodymium 59	110 Nd Neodymium 60	111 Pm Promethium 61	112 Sm Samarium 62	113 Eu Europium 63	114 Gd Gadolinium 64	115 Tb Terbium 65	116 Dy Dysprosium 66	117 Ho Holmium 67	118 Er Erbium 68	119 Tm Thulium 69	120 Yb Ytterbium 70	121 Lu Lutetium 71
226 Ra Radium 88	227 Ac Actinium 89	140 Ce Cerium 58	141 Pr Praseodymium 59	142 Nd Neodymium 60	143 Pm Promethium 61	144 Sm Samarium 62	145 Eu Europium 63	146 Gd Gadolinium 64	147 Tb Terbium 65	148 Dy Dysprosium 66	149 Ho Holmium 67	150 Er Erbium 68	151 Tm Thulium 69	152 Yb Ytterbium 70	153 Lu Lutetium 71	232 Th Thorium 90	233 Pa Protactinium 91	234 U Uranium 92	235 Np Neptunium 93	236 Pu Plutonium 94	237 Am Americium 95	238 Cm Curium 96	239 Bk Berkelium 97	240 Cf Californium 98	241 Es Einsteinium 99	242 Fm Fermium 100	243 Md Mendelevium 101	244 No Nobelium 102	245 Lr Lawrencium 103			

*58-71 Lanthanoid series
†90-103 Actinoid series

a	X
b	

Key

a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

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

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