UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER | | | | | |

CANDIDATE NUMBER | | | | |

0573530616

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.

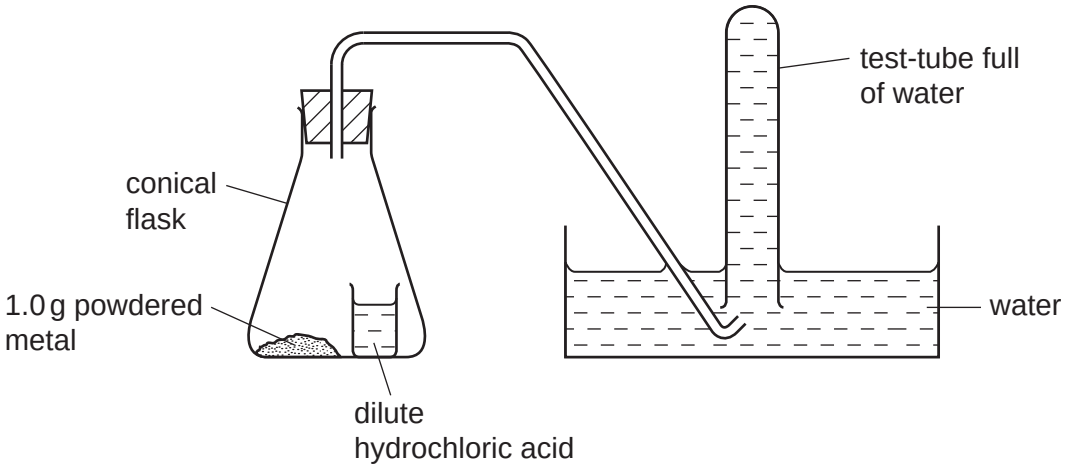

Fig. 1.1

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

For Examiner's Use

(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]

[Turn over

For Examiner's Use

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

(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]

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Please turn over for Question 2.

For Examiner's Use

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]

For Examiner's Use

(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]

For Examiner's Use

3 Fig. 3.1 shows a generalised reflex arc.

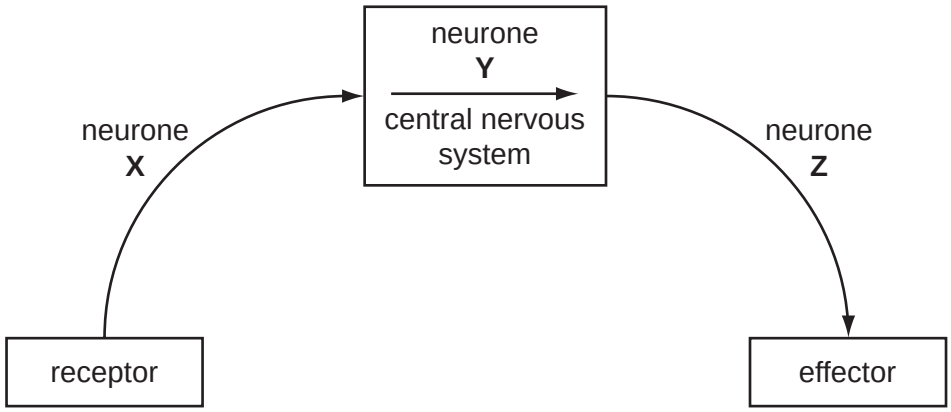


Fig. 3.1

(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]

For Examiner's Use

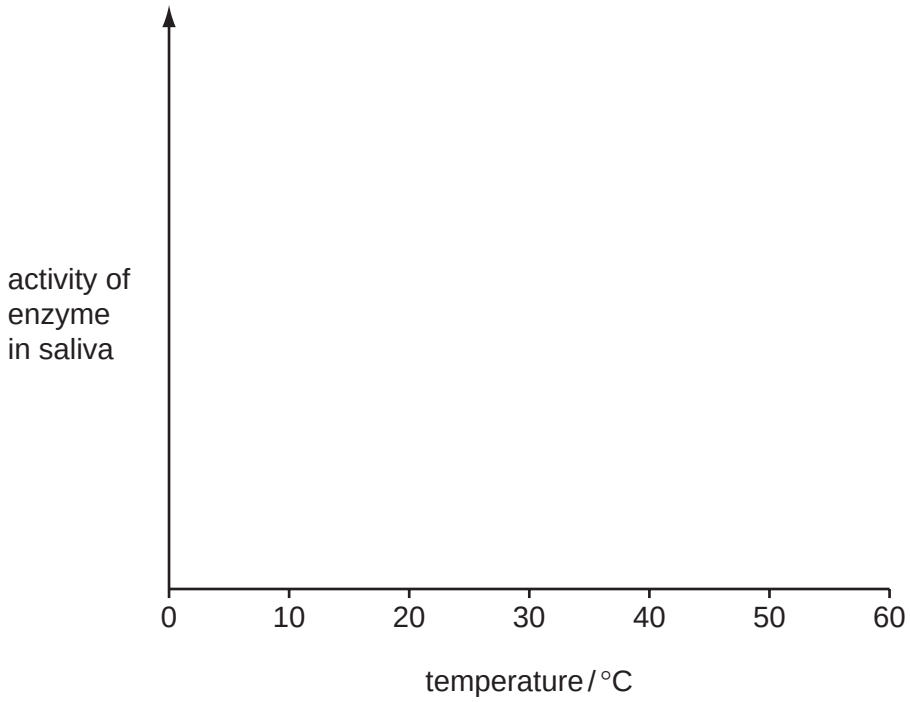
(ii) Explain why it is necessary for most types of food that we eat to be digested.

.....

.....

..... [2]

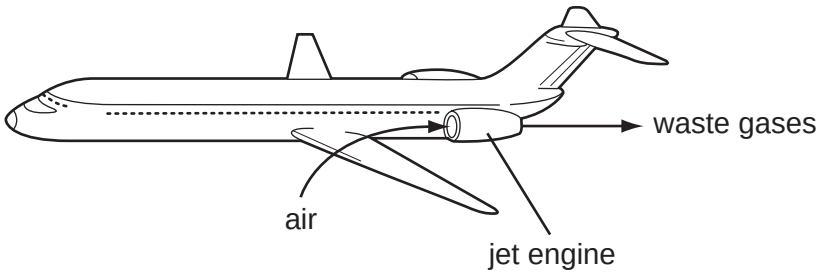
(iii) On the axes below, sketch a curve to show how the activity of enzyme from human saliva would vary with temperature.



[2]

For Examiner's Use

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.



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

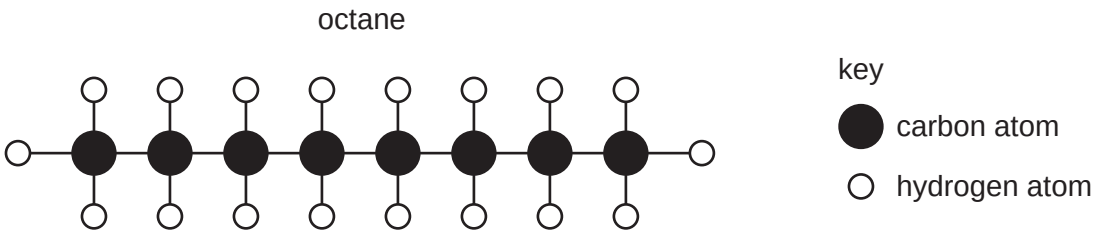


Fig. 4.1

(i) State the chemical formula of octane.

..... [1]

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

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.

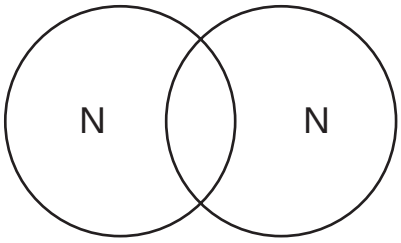
$$N \equiv N$$

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

..... [1]

For Examiner's Use

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



[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]

For Examiner's Use

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

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 50.00 g 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.

For Examiner's Use

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

(a) Fig. 5.1 shows her results.

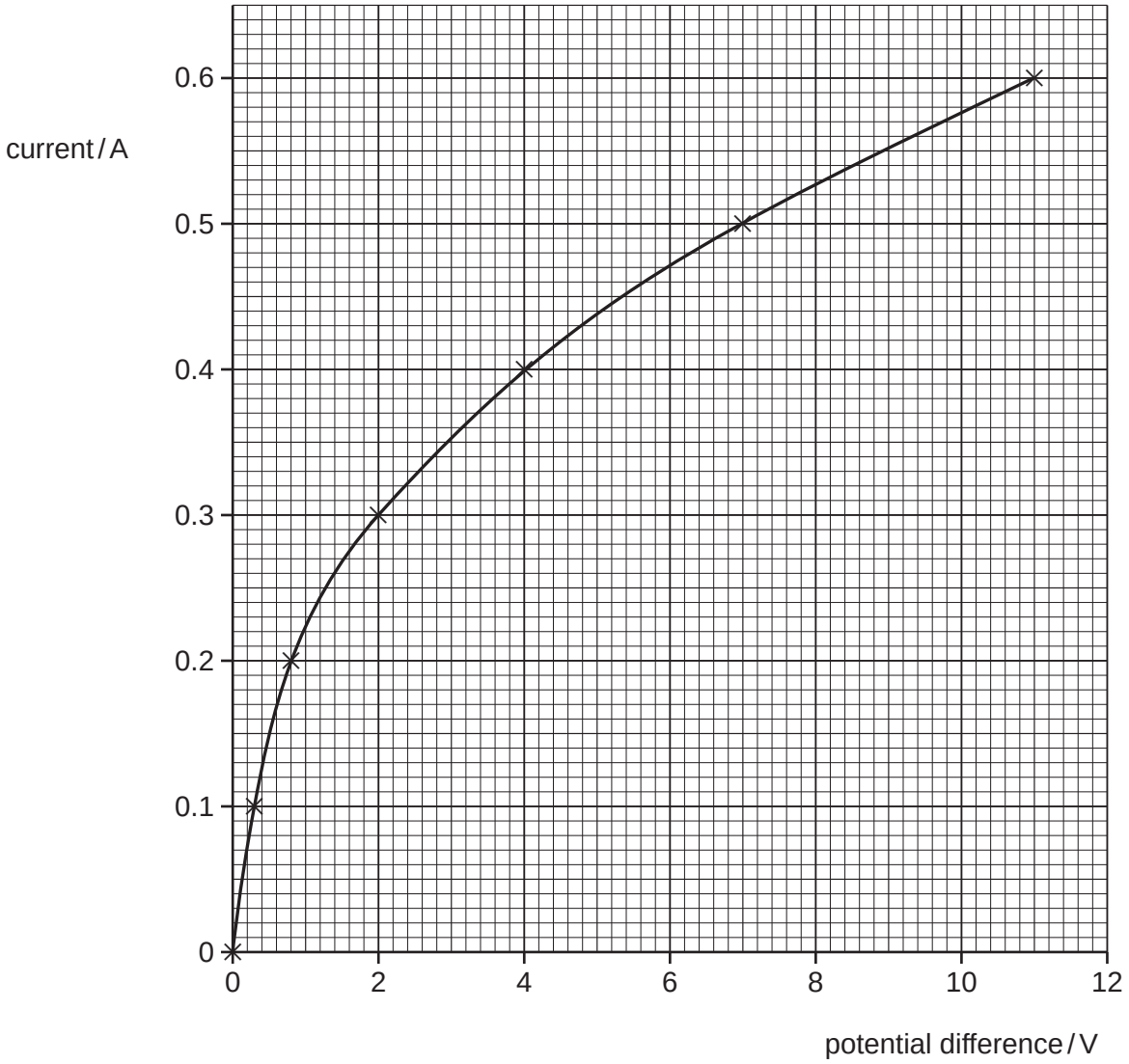


Fig. 5.1

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

..... [1]

For Examiner's Use

(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]

(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.

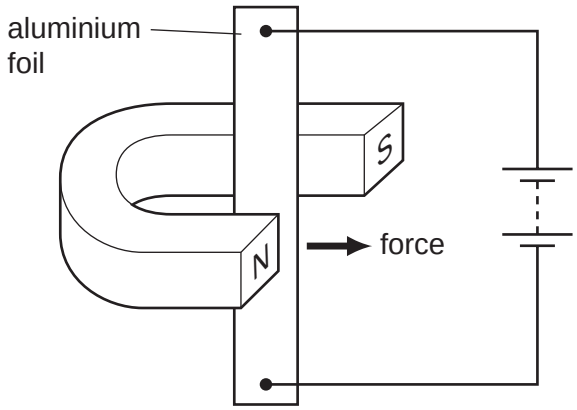


Fig. 5.2

(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.

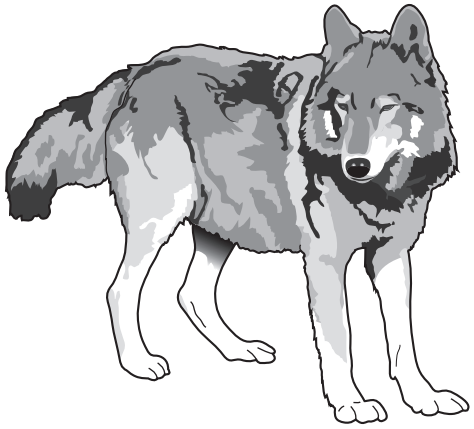
.....

[2]

For Examiner's Use

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]

For Examiner's Use

(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.

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.

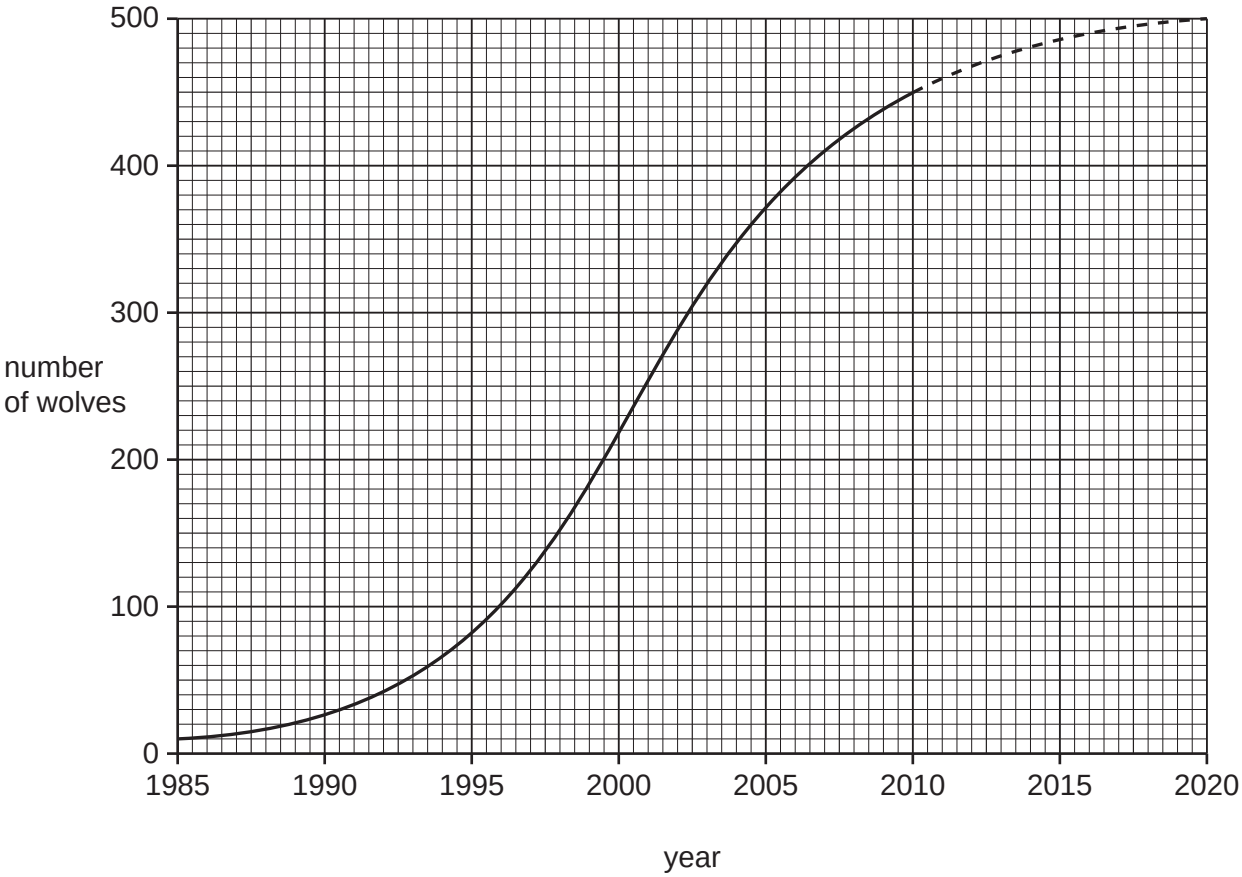


Fig. 6.1

(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]

For Examiner's Use

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

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

Table 7.1

name	colour	chemical formula
copper(II) oxide	black	CuO
copper(I) oxide	red	Cu_2O

(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 O^{2-}.

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.

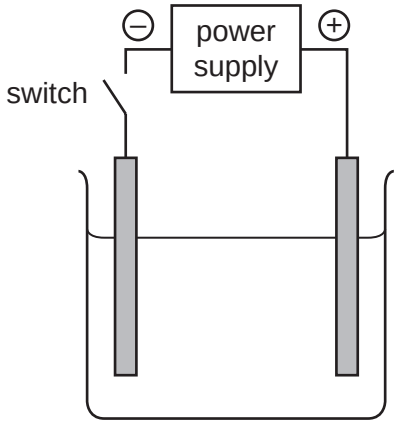


Fig. 7.1

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]

For Examiner's Use

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.

.....

.....

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..... [4]

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

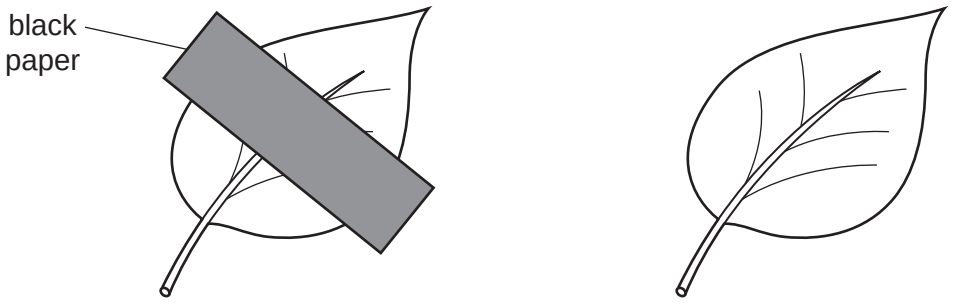

Fig. 8.1

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.

.....

.....

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.....

.....

..... [3]

For Examiner's Use

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

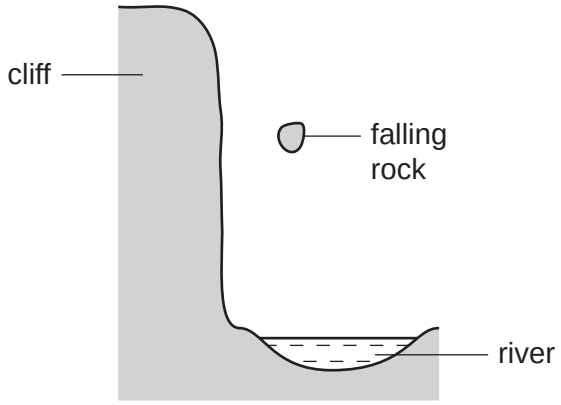

Fig. 9.1

(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]

(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

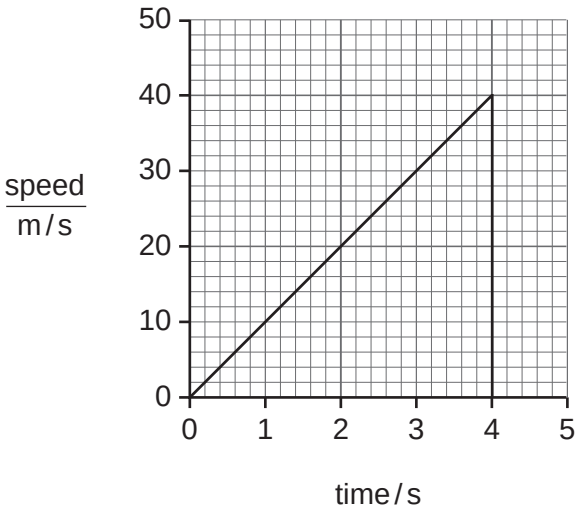

Fig. 9.2

(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]

For Examiner's Use

(c) The rock has an irregular shape. It has a mass of 2000 g and a volume of 700 cm^3.

(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]

(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
							1 H Hydrogen 1										4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57 *	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86
Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89 †															

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

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	Pa Protactinium 91	238 U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103

Key: a X b

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

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).