Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER			

8044033097

CO-ORDINATED SCIENCES **0654/31**

Paper 3 (Extended) **May/June 2014**

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 an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.
A copy of the Periodic Table is printed on page 32.

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.

This document consists of **32** printed pages.

1 **(a)** Complete the following sentences about chemical bonding choosing words from the list below.

Each word may be used once, more than once or not at all.

electrons	**ions**	**lost**	**molecules**
neutralised	**nucleons**	**shared**	**transferred**

When a covalent bond forms, ... are .....

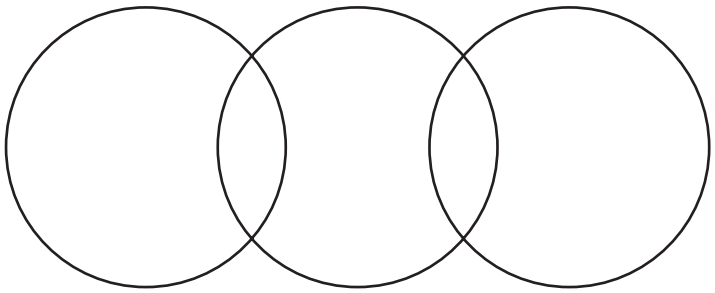
between atoms.

When an ionic bond forms, ... are .....

between atoms. [2]

(b) Complete the dot-and-cross diagram of one molecule of carbon dioxide.

The diagram should show the chemical symbols of the elements and the arrangement of only the outer electrons of the atoms.



[3]

(c) A metal displacement reaction may occur when a metal is placed into an aqueous solution of a salt of a different metal.

Metals **L**, **M** and **N** are added to solutions of the nitrates of the same three metals. Table 1.1 shows whether or not a displacement reaction occurs.

Table 1.1

	metal **L**	metal **M**	metal **N**
metal **L** nitrate solution		**no** reaction	reaction
metal **M** nitrate solution	reaction		reaction
metal **N** nitrate solution	**no** reaction	**no** reaction	

(i) Use the results in Table 1.1 to place the three metals, **L**, **M** and **N**, into order according to their relative reactivity starting with the most reactive.

.....(most reactive)

.....

..... [1]

(ii) Explain your answer to **(i)**.

.....

.....

.....

.....

..... [3]

(iii) A metal displacement reaction occurs when magnesium is placed into a solution of silver nitrate.

This reaction may be represented by the ionic equation

$$Mg(s) + 2Ag^{+}(aq) \longrightarrow Mg^{2+}(aq) + 2Ag(s)$$

Using the idea of electron transfer, explain why this is an example of a redox reaction.

.....

.....

..... [2]

2 Fig. 2.1 shows an insect-pollinated flower cut through lengthways.

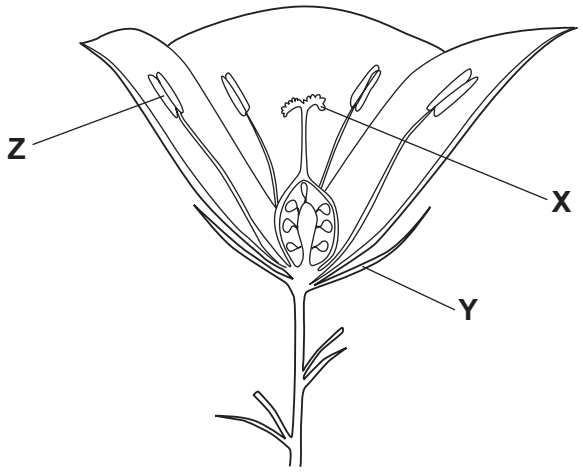


Fig. 2.1

(a) Name the structures labelled **X** and **Y**.

X .....

Y ..... [2]

(b) State the function of the part labelled **Z**.

.....

..... [1]

(c) Name the part of the flower in which the seeds will develop if the flower is pollinated.

..... [1]

(d) State **two** ways, shown in Fig. 2.1, in which this flower is adapted for pollination by insects.

1 .....

2 ..... [2]

(e) Grass flowers are usually pollinated by the wind.

State **two** ways in which the structure of a grass flower would be different from the flower in Fig. 2.1.

1 .....

2 ..... [2]

(f) A scientist did a genetic experiment in which she crossed flowers from two different plants, **A** and **B**, of the same species.

This is the procedure that she used.

- The immature stamens were removed from a flower of plant **A**.
- This flower was then covered with a plastic bag.
- When the flowers on both plants were mature, a small paintbrush was used to transfer pollen from plant **B** to plant **A**.
- The plastic bag was put back to cover the flower of plant **A** again.
- The flower inside the plastic bag produced seeds, which were then allowed to germinate and grow.

In this procedure, suggest why

(i) the stamens were removed from the flowers of plant **A**,

..... [1]

(ii) the flower of plant **A** was kept covered by a plastic bag.

..... [1]

3 Fig. 3.1 shows information about two trucks, **X** and **Y**, coming to rest under the action of the same braking force.

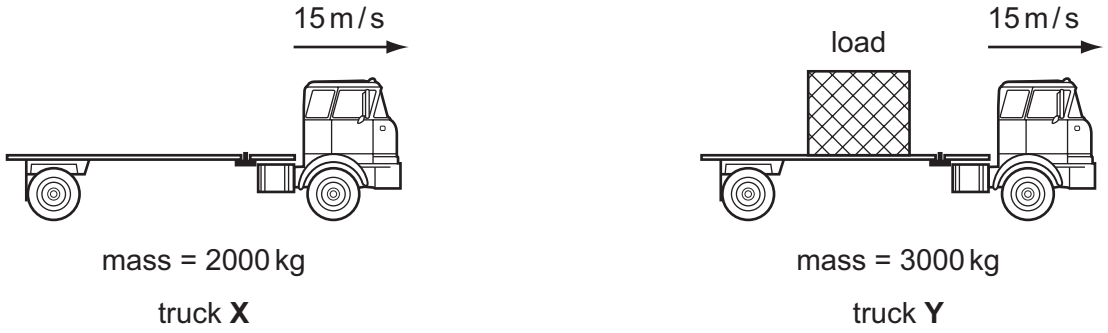


Fig. 3.1

The mass of truck **X** is 2000 kg and the mass of truck **Y** and its load is 3000 kg.

Fig. 3.2 shows the speed / time graph for the two trucks.

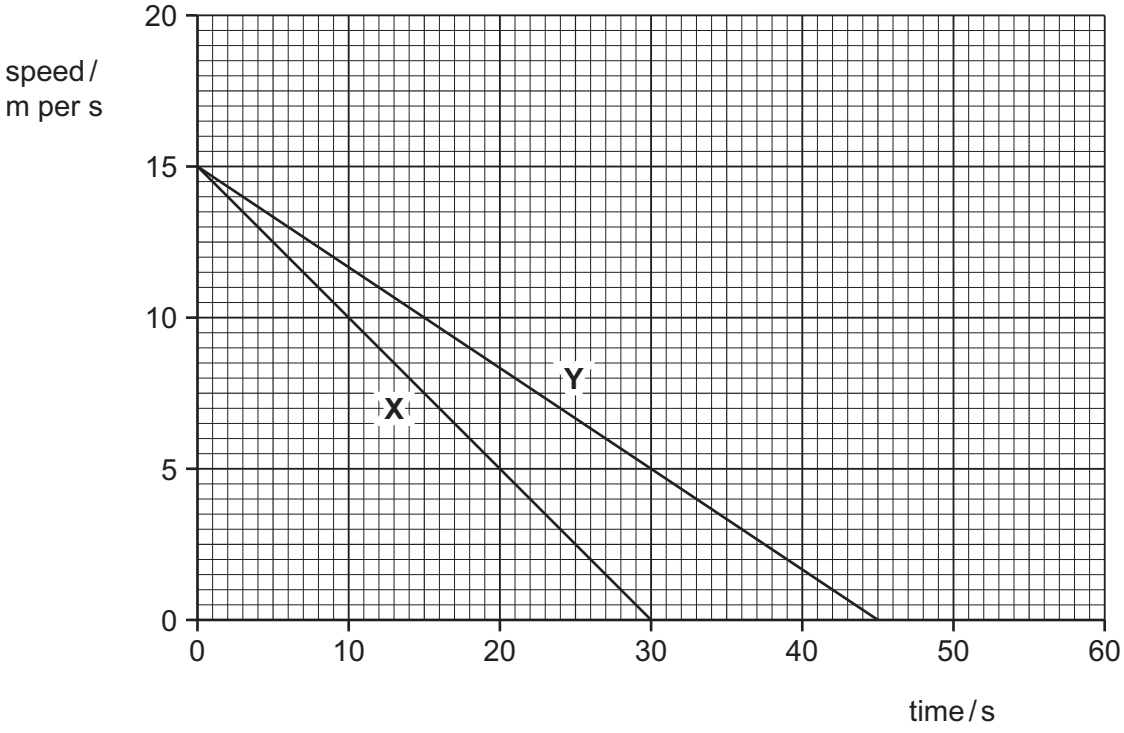


Fig. 3.2

(a) (i) Explain how Fig. 3.2 shows that truck **X** has the greater deceleration.

.....

..... [1]

(ii) Calculate the deceleration of truck **Y**.

Show your working.

deceleration = ... m/s^2 [2]

(iii) The deceleration of truck **X** is $0.5\,m/s^2$.

Calculate the braking force on truck **X**.

State the formula that you use and show your working. State the units of your answer.

formula

working

force = ... unit ..... [2]

(b) The density of the metal used to make the load carried by truck **Y** is 2700 kg / m^3. The mass of the load is 1000 kg.

Calculate the volume of the load.

State the formula that you use and show your working. State the unit of your answer.

formula

working

volume = ... unit ..... [3]

(c) The metal block needs 1820 kJ of thermal energy to raise its temperature by 2 °C.

Calculate the specific heat capacity of the metal in the block.

State the formula that you use and show your working.

formula

working

specific heat capacity = ... kJ / (kg °C) [3]

Please turn over for Question 4.

4 Fuels react with oxygen in combustion reactions. During these reactions, heat energy is released.

(a) (i) Name and state a use for a gaseous fuel.

name .....

use ..... [2]

(ii) State the word used to describe chemical reactions that release heat energy.

..... [1]

(b) When some fuels are burned, the mixture of combustion products contains sulfur dioxide and oxides of nitrogen.

State **two** harmful effects of these gases in the environment.

1 .....

.....

2 .....

..... [2]

(c) Charcoal is a solid fuel that contains mainly the element carbon.

Large pieces of charcoal burn slowly. Charcoal in the form of a fine powder burns very quickly.

(i) Explain, in terms of the collision theory of rate of reaction, why charcoal powder burns more quickly than large pieces of charcoal.

.....

.....

..... [2]

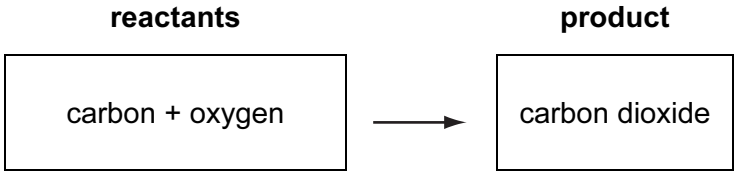


Fig. 4.1

(ii) The reactants and the product for the complete combustion of carbon are shown in Fig. 4.1.

Predict and explain whether the product contains a greater, smaller or the same total amount of chemical potential energy compared to the reactants.

prediction .....

explanation .....

.....

..... [2]

5 **(a)** In a domestic lighting circuit, lamps are connected in parallel.

Explain why the lamps are **not** connected in series.

.....

.....

..... [2]

(b) **(i)** Explain why a balloon rubbed with a woollen cloth gains a negative electric charge.

.....

.....

..... [2]

Fig. 5.1 shows two similarly charged balloons, suspended close together.

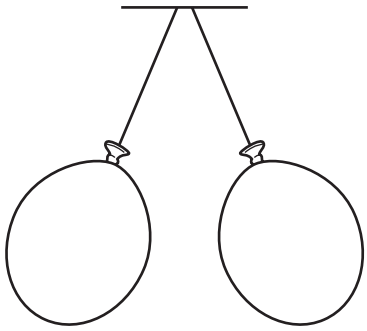


Fig. 5.1

(ii) Explain why the two balloons move apart.

.....

..... [1]

(c) Describe how a circuit breaker protects a worker using an electric drill.

.....

..... [1]

(d) Explain why energy losses in overhead electricity transmission cables are lower when the voltage is high.

.....

.....

..... [2]

6 Fig. 6.1 shows part of a food web in African grassland (savannah).

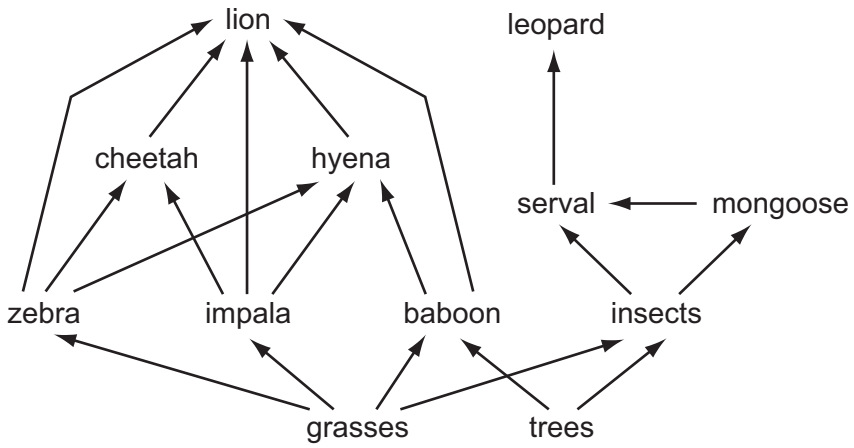


Fig. 6.1

(a) The savannah is an ecosystem. Define an *ecosystem*.

.....

.....

..... [2]

(b) Use the information in Fig. 6.1 to write down a food chain containing five organisms.

[2]

(c) **(i)** Explain why food chains rarely have more than five trophic levels.

.....

..... [1]

(ii) With reference to Fig. 6.1, explain why there are fewer lions than zebras.

.....

..... [1]

(d) The food web in Fig. 6.1 does not show any decomposers.

(i) Define the term *decomposer*.

.....

..... [1]

(ii) Name **one** type of organism that is a decomposer.

..... [1]

(iii) State on which organisms in Fig. 6.1 the decomposers would feed on.

.....

..... [1]

(iv) Explain why decomposers are important for the grasses and trees in the ecosystem.

.....

..... [1]

7 **(a)** Fig. 7.1 shows a chlorine atom that has a nucleon number (mass number) of 35.

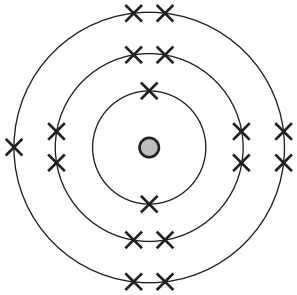


Fig. 7.1

Two types of particle are found in the nucleus of this atom.

Complete Table 7.1 with the names and numbers of these particles in the nucleus of this chlorine atom.

Table 7.1

name of particle	number in the nucleus

[2]

(b) **(i)** Explain why chlorine is added to water that will be used for drinking.

.....

..... [1]

(ii) Suggest the **word** chemical equation for the reaction that occurs when chlorine is mixed with sodium iodide solution.

..... [1]

(c) Fig. 7.2 shows a simplified diagram of the electrolysis of sodium chloride solution, used to produce chlorine in industry.

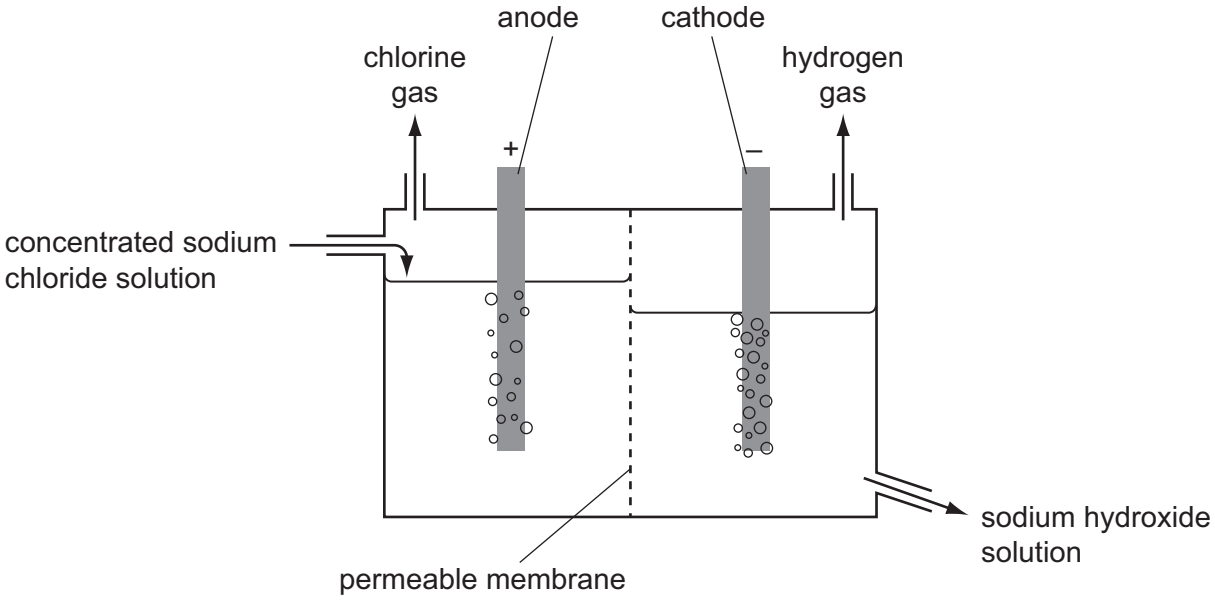


Fig. 7.2

The balanced equation for the overall chemical change that occurs in the process shown in Fig. 7.2 is

$$2NaCl + 2H_2O \rightarrow 2NaOH + Cl_2 + H_2$$

(i) Show that the relative formula mass of sodium chloride is 58.5.

[1]

(ii) Calculate the number of moles in 234 g of sodium chloride.

Show your working.

number of moles = ... [1]

(iii) Calculate the volume of chlorine molecules produced at room temperature and pressure, when 234 g of sodium chloride are electrolysed.
(1 mole of chlorine molecules has a volume of 24 dm^3 at room temperature and pressure.)

Show your working.

volume = ... [2]

(iv) Explain why chlorine is given off at the anode in this process.

Your answer should refer to

- the movement of ions, atoms and electrons,
- the reactions involving ions, atoms and electrons.

.....

.....

.....

..... [3]

8 **(a)** Electricity can be generated by burning fossil fuels in a power station.

Describe how the energy released from the fossil fuel is used to produce electrical energy.

.....

.....

.....

..... [3]

(b) In some power stations highly radioactive isotopes are formed when energy is released. Workers at these power stations are monitored to check their exposure to radiation.

(i) State **one** way in which a worker's exposure to radiation can be monitored.

.....

..... [1]

(ii) State **one** effect of ionising radiation on the human body.

.....

..... [1]

(c) Gamma radiation is one form of ionising radiation. Gamma radiation is part of the electromagnetic spectrum.

State the part of the electromagnetic spectrum which is used for

terrestrial television communications, ...

mobile telephone (cell phone) communications,

.....

television remote control. .....

[1]

(d) Fig. 8.1 and Fig. 8.2 show a perspective view and an end view of a simple a.c. generator.

Fig. 8.2 also shows the magnetic field lines between the poles of the magnet.

perspective view of generator

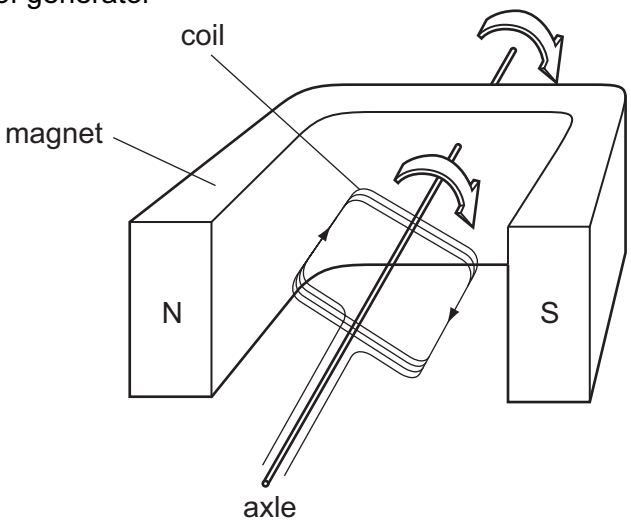


Fig. 8.1

end view of generator

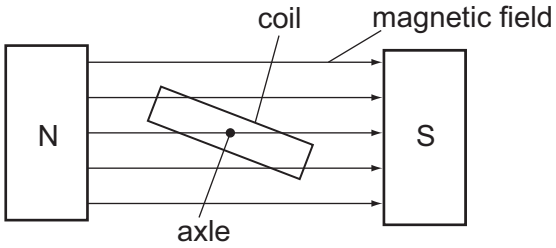
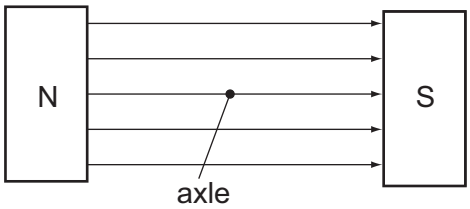


Fig. 8.2

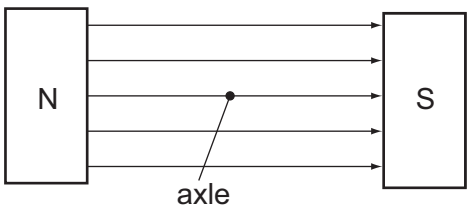
Complete the diagrams to show the positions of the coil when the current produced is

(i) zero,



[1]

(ii) maximum.



[1]

(e) On the grid in Fig. 8.3, sketch a graph of voltage against time for **two** rotations of the coil in this simple a.c generator.

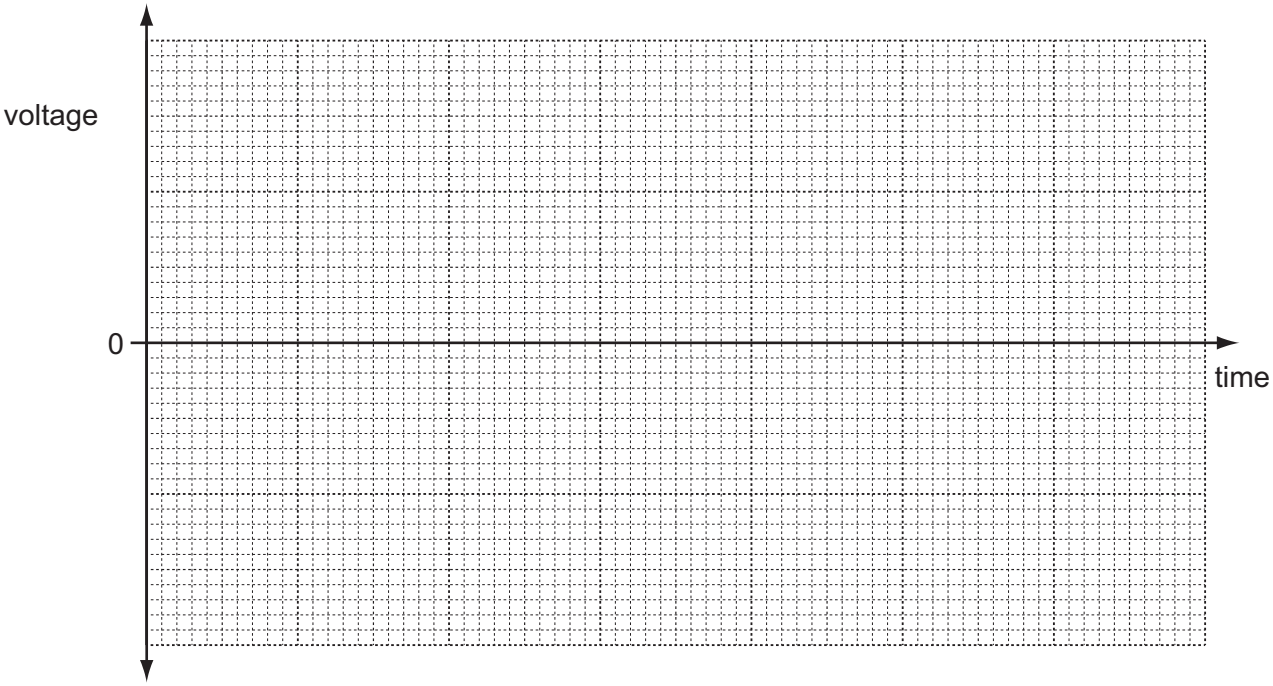


Fig. 8.3

[3]

9 Some washing powders contain enzymes that digest fats. These enzymes help in the removal of greasy stains in clothing.

(a) Name the type of enzyme that digests fats.

.....[1]

(b) The graph in Fig. 9.1 shows the effect of temperature on the activity of two different fat-digesting enzymes from different washing powders.

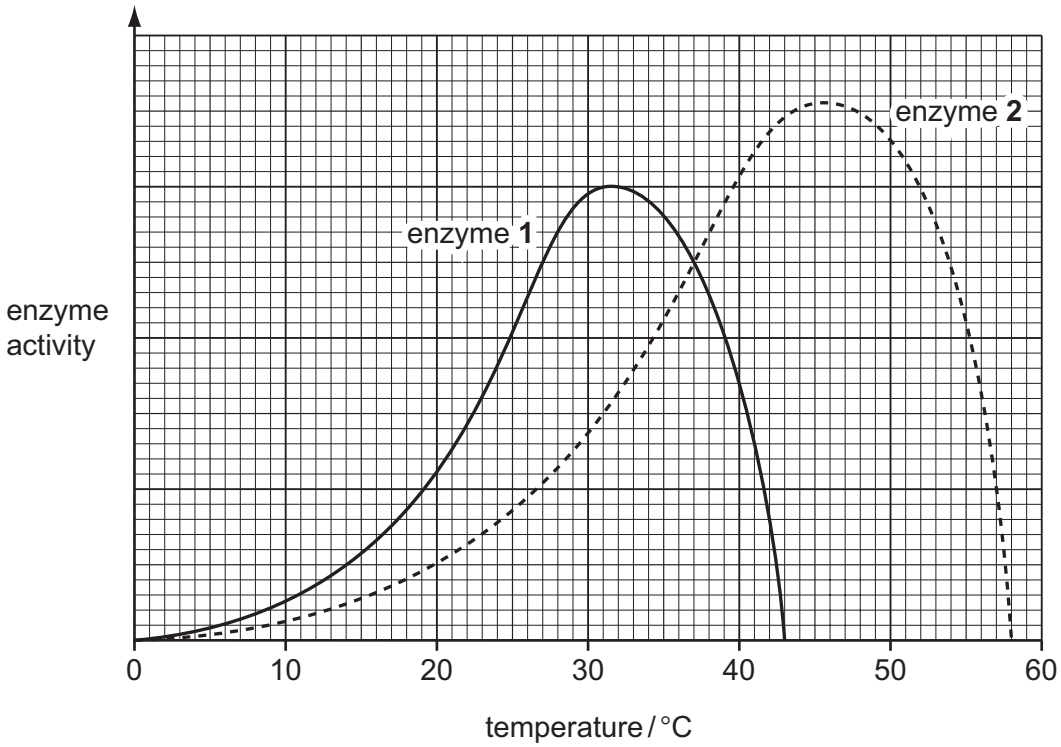


Fig. 9.1

(i) State the temperature at which both enzymes are working, and have the same activity.

temperature ..... °C [1]

(ii) Explain why both enzymes work very slowly at 10 °C.

.....

.....

.....[2]

(iii) Explain why the enzymes do not work at all above 60 °C.

.....

.....[1]

(c) Most washing machines have a standard programme that washes clothes at 40 °C. Some machines also have an 'ECO' programme that washes at 30 °C.

(i) Explain why the 'ECO' programme is thought to be better for the environment than the standard programme.

.....

.....

..... [2]

(ii) Suggest which of the two enzymes in Fig. 9.1 should be used in a washing powder designed for use in a washing machine with an 'ECO' programme.

Explain your answer.

enzyme .....

explanation .....

.....

..... [2]

(d) Enzymes are proteins.

Describe a test that you could do on a solution of washing powder to see if it contained protein.

.....

.....

..... [2]

10 (a) Thunder and lightning happen at the same time. An observer sees the flash of lightning before he hears the thunder.

(i) Explain why the observer sees the lightning before he hears the thunder.

.....

..... [1]

(ii) Describe how the sound of the thunder is transmitted to the observer through the air.

.....

..... [1]

(iii) An observer in a space station orbiting in a vacuum sees the lightning but does not hear the thunder.

Explain why.

.....

..... [1]

(b) Ultrasound waves are sound waves with a very high frequency. These waves cannot be heard by human beings.

(i) State the approximate range of frequencies audible to humans.

..... Hz to ..... Hz [1]

(ii) Devices which emit ultrasound waves can be used to keep small animals such as cats away from gardens.

The ultrasound waves emitted by a device take 0.05 s to travel from the device to a cat. The speed of the ultrasound waves is 330 m / s.

Calculate the distance between the ultrasound device and the cat.

State the formula that you use and show your working.

formula

working

distance = ... m [2]

(iii) An ultrasound device emits waves with a wavelength of 0.011 m.

Calculate the frequency of these waves.

State any formula that you use and show your working.

formula

working

frequency = ... Hz [2]

(c) A student builds a simple circuit including a buzzer. Fig. 10.1 shows the circuit diagram for the circuit.

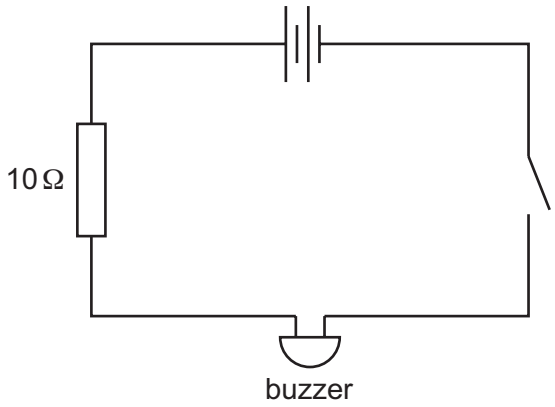


Fig. 10.1

When the student closes the switch, the buzzer does not emit a sound. The teacher tells the student that he needs a greater current to make the buzzer work.

Redraw the circuit diagram to show **two** ways in which the student could increase the current flowing through the buzzer.

[2]

11 Fig. 11.1 shows the human heart, as seen from the front.

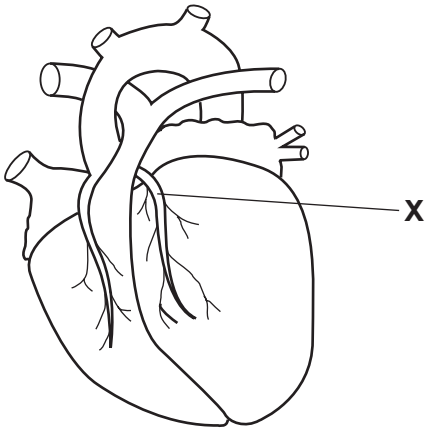


Fig. 11.1

(a) State the main type of tissue in the heart.

.....[1]

(b) (i) Name the blood vessel labelled **X**.

.....[1]

(ii) Describe and explain the effect on the heart tissue if this blood vessel **X** becomes blocked.

.....

.....

.....[2]

(c) Table 11.1 shows the rates of heart disease in men and women in two different countries.

Table 11.1

	country **A**		country **B**	
	men	women	men	women
deaths from heart disease per year per 100 000 people	105	55	80	50

(i) Using information from Table 11.1, describe the differences between the rates of heart disease in the two countries.

.....

.....

..... [2]

(ii) Suggest **two** ways in which someone could change their lifestyle to reduce their chances of suffering from heart disease.

1 .....

2 ..... [2]

(iii) Apart from differences in lifestyle, suggest **one** other possible reason for the difference in rates of heart disease in countries **A** and **B**.

.....

..... [1]

12 (a) The elements are often described as being either metals or non-metals.

(i) Describe **two** differences in the **physical** properties of a typical metal and a typical non-metal.

1 .....

.....

2 .....

..... [2]

(ii) The element radium has a proton number of 88.

Predict and explain briefly whether radium is a metallic or non-metallic element.

You may wish to refer to the Periodic Table on page 32.

.....

..... [1]

Question 12 continues on page 30.

(b) Oxides are compounds of oxygen with other elements.

A student made four mixtures, **W**, **X**, **Y** and **Z**, by shaking four oxides in water. He measured the pH values of the mixtures, and his results are shown in Table 12.1.

Table 12.1

mixture	pH
W	3
X	2
Y	12
Z	7

(i) State and explain which mixture was the most acidic.

mixture .....

explanation .....

..... [1]

(ii) State and explain in which mixture the oxide had **not** changed the pH of the water.

mixture .....

explanation .....

..... [1]

(iii) State and explain which mixture had been made using the oxide of a metallic element.

mixture .....

explanation .....

..... [1]

(c) Rust is a type of iron oxide.

Fig. 12.1 shows four test-tubes, **1**, **2**, **3** and **4**, that a student set up to investigate the rusting of iron.

Each test-tube contained an iron nail and different combinations of a liquid and a gas.

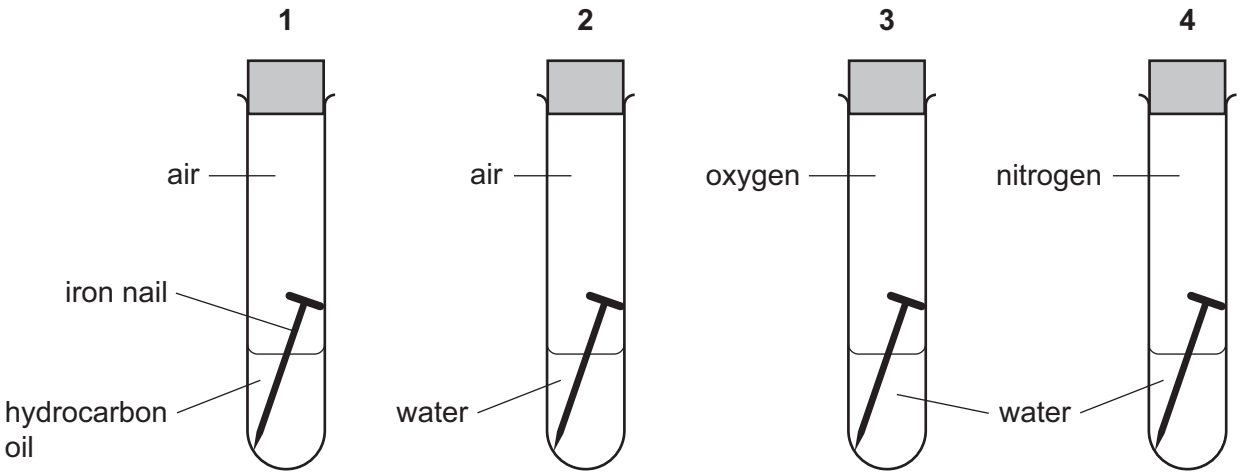


Fig. 12.1

The test-tubes and their contents were left for a week and then observed. Table 12.2 shows the observations the student made.

Table 12.2

test-tube	observation
1	no rust
2	rust formed
3	rust formed
4	no rust

Explain how the results in each test-tube lead to a conclusion about what is needed for rust to form.

.....

.....

.....

.....

.....

.....

..... [3]

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.).