Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

8460102567

CO-ORDINATED SCIENCES **0654/31**

Paper 3 (Extended) **October/November 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 soft pencil for any diagrams, graphs, tables or rough working.
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 **30** printed pages and **2** blank pages.

CAMBRIDGE International Examinations

1 The method used to extract metals from their compounds depends on the reactivity of the metal.

Magnesium is more reactive than iron. Most magnesium is produced industrially using electrolysis.

(a) Name the industrial apparatus used to extract iron.

.....[1]

(b) State the name or give the chemical formula of the main compound from which iron is extracted.

.....[1]

(c) Molten iron produced by the apparatus in **(a)** contains sulfur as an impurity.

Sulfur is removed from the molten iron by adding magnesium powder to form magnesium sulfide.

Fig. 1.1 shows diagrams of a magnesium atom and a sulfur atom.

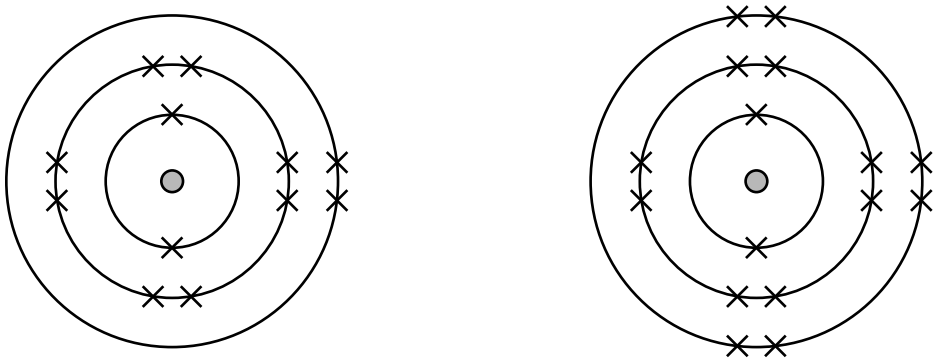


Fig. 1.1

Describe the changes to the electron configurations of these atoms when magnesium sulfide is formed.

.....

.....

.....[2]

(d) Suggest the balanced equation for the formation of magnesium sulfide.

.....[1]

(e) Magnesium sulfide has a very high melting point.

Suggest why magnesium sulfide has a very high melting point.

.....

.....

.....

.....[2]

2 Fig. 2.1 shows the chromosomes from the nucleus of a single cell of a human male.

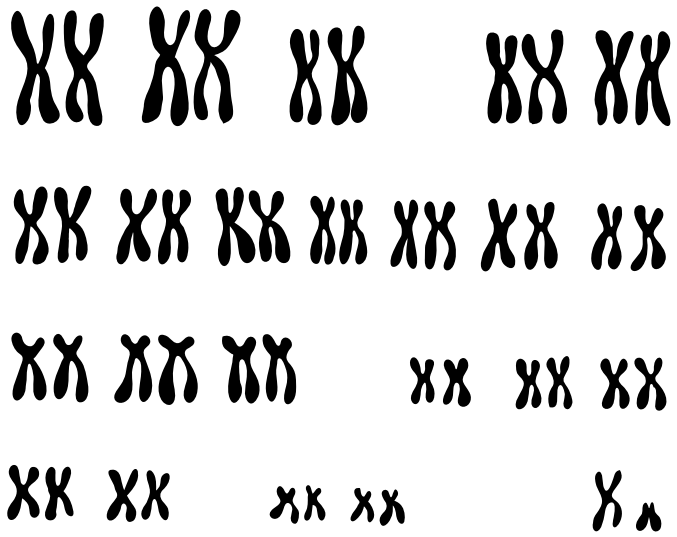


Fig. 2.1

(a) Fig. 2.1 shows two sets of chromosomes. State the term used to describe a cell with two sets of chromosomes.

.....[1]

(b) **(i)** Complete the genetic diagram below to explain why, in a human population, equal numbers of male and female babies should be expected.

parents

phenotypes	female	male
sex chromosomes	XX	XY
gametes	◯ and ◯	◯ and ◯

chromosomes and phenotypes of offspring

male gametes

female gametes	◯	◯
◯		
◯		

ratio of male to female .....

[4]

(ii) In fact, in all human populations, slightly more male babies are born than female babies.

Suggest a possible explanation for this.

.....

.....[1]

(c) In sea turtles, the sexes of the offspring are not determined by chromosomes. Instead, sex depends on the temperature at which the eggs are incubated. Fig. 2.2 shows this effect.

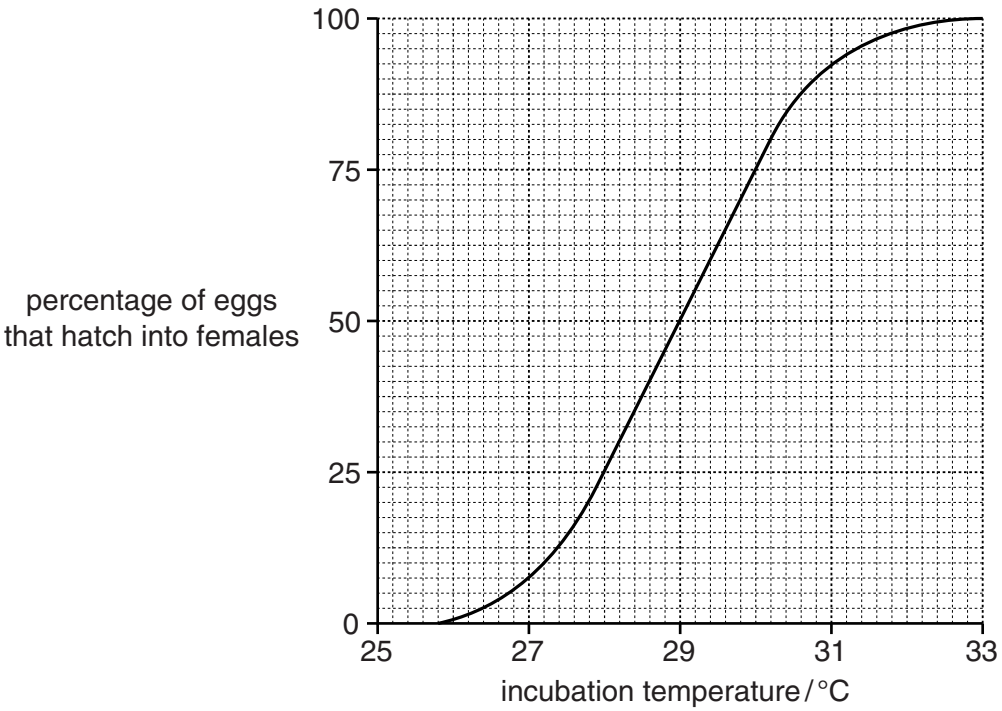


Fig. 2.2

(i) Describe the effect of temperature on the percentage of eggs that hatch into females.

.....

.....[1]

(ii) State the temperature at which equal numbers of male and female offspring are produced.

.....[1]

(iii) Suggest why the temperature affects the percentage of eggs that hatch into females.

.....

.....[1]

(iv) Use the information in Fig. 2.2 to predict how global warming might affect the sea turtle population. Explain your answer.

.....

.....

.....[2]

3 **(a)** A car has two headlamps and two rear lamps. All four lamps are connected in parallel with each other across a 12V battery.

(i) Each headlamp takes a current of 4A and each rear lamp takes a current of 0.4A.

State the total current taken by all four lamps.

current = ... A [1]

(ii) Calculate the resistance of **one** of the headlamps.

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

formula

working

resistance = ... unit ..... [3]

(b) One of the headlamps of the car has a power rating of 55W.

Calculate the power of the headlamp, when the current passing through it is 4A and the voltage across it is 12V.

State the formula that you use and show your working.

formula

working

power = ... W [2]

(c) As the car drives along, the temperature of the air in the tyres increases.

Use the idea of particles to explain why this will result in an increase in tyre pressure.

.....

.....

.....

.....[3]

4 **(a)** Define the term *translocation*.

.....

.....

.....[2]

(b) Fig. 4.1 shows xylem vessels from the stem of a plant as seen in longitudinal section.

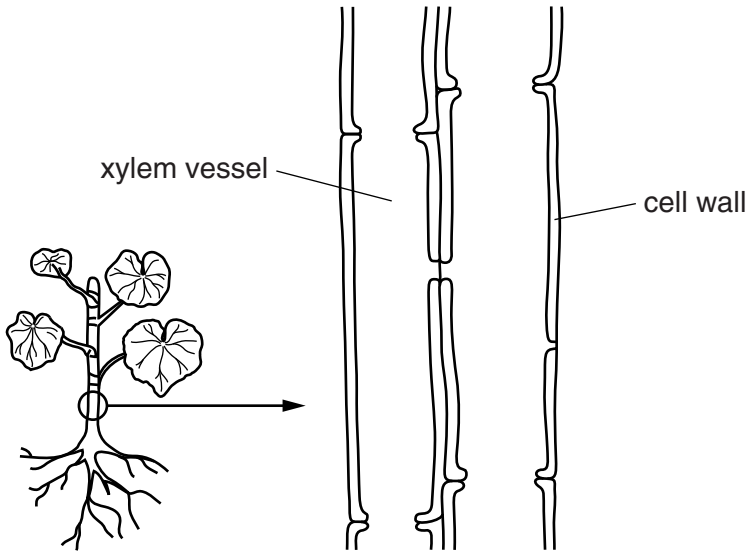


Fig. 4.1

On Fig. 4.1,

(i) draw an arrow to show the direction in which water flows through the xylem vessels, [1]

(ii) mark with the letter **X** the point at which the water potential is lowest. [1]

(c) Describe the mechanism by which water flows through the xylem.

.....

.....

.....

.....[3]

(d) Name **one** other substance, apart from water, that is transported through xylem vessels.

.....[1]

Please turn over for Question 5.

5 A student investigates the reactions between dilute hydrochloric acid and five substances.

Fig. 5.1 shows the five substances contained in test-tubes **A** to **E**.

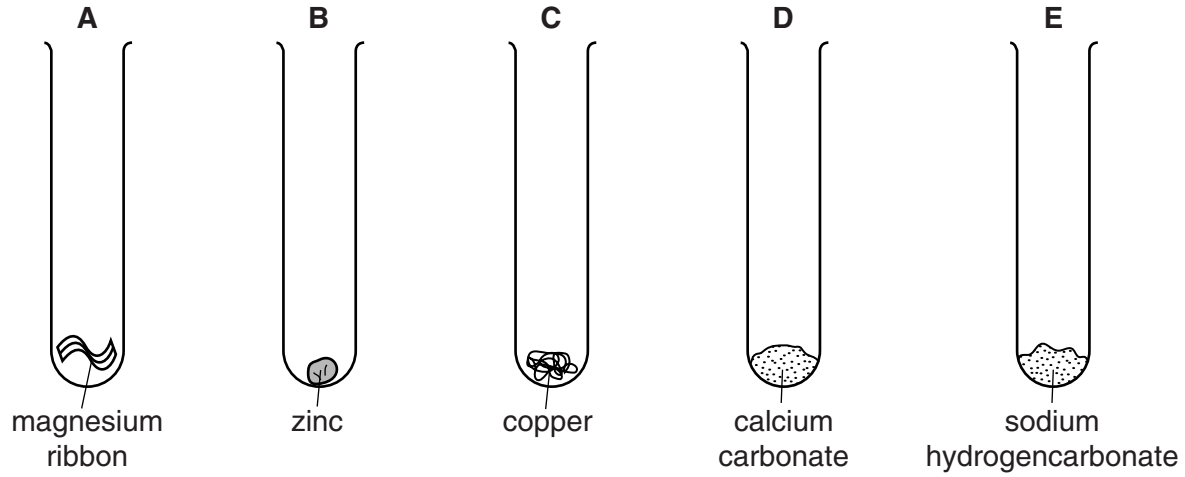


Fig. 5.1

She adds dilute hydrochloric acid to each tube.

Her observations and temperature measurements are shown in Table 5.1.

Table 5.1

test-tube	observations	temperature of the reactants before reaction/°C	temperature of the mixture in the test-tube after a short time/°C
A	gas given off quickly	18	45
B	gas given off slowly	18	19
C	no gas produced	18	
D	gas given off quickly	18	20
E	gas given off quickly	18	11

(a) (i) Name the gas given off when dilute hydrochloric acid is added to test-tubes **A** and **B**.

.....[1]

(ii) The pH of the dilute hydrochloric acid before reacting is 2.

Predict the pH of the solution in test-tube **D** after reaction.

Explain your answer.

prediction .....

explanation .....

.....

.....[2]

(b) Temperature changes are observed in many chemical reactions.

(i) Suggest the temperature of the mixture in test-tube **C** after a short time.

Write your answer in Table 5.1. [1]

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

.....

.....[1]

(iii) Temperature changes show that the chemical potential energy of the reactants is different from that of the products.

State the letter of the test-tube in which the chemical potential energy of the products is **greater** than that of the reactants. Explain your answer.

test-tube .....

explanation .....

.....

.....[3]

(c) Suggest **two** possible reasons why the rate of production of gas in test-tube **A** is different from that in test-tube **B**.

1 .....

.....

2 .....

.....[2]

6 **(a)** Infra-red waves are part of the electromagnetic spectrum.

State **two** properties that are the same for all electromagnetic waves.

1 .....

2 .....[2]

(b) Infra-red waves can pass through optical fibres.

(i) Fig. 6.1 shows a length of optical fibre.

An infra-red ray goes in at one end and emerges at the other end.

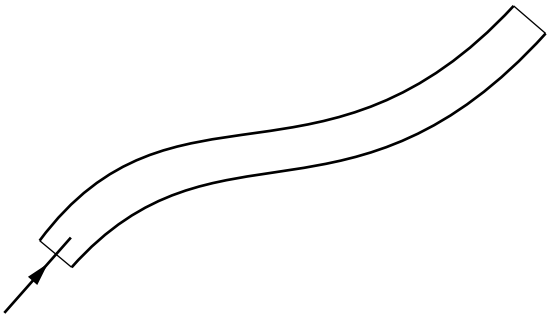


Fig. 6.1

On Fig. 6.1, use a ruler to draw the path of the ray along the optical fibre. [1]

(ii) State **one** use of optical fibres in medicine.

.....[1]

(c) Infra-red waves transfer energy.

Fig. 6.2 shows an experiment.

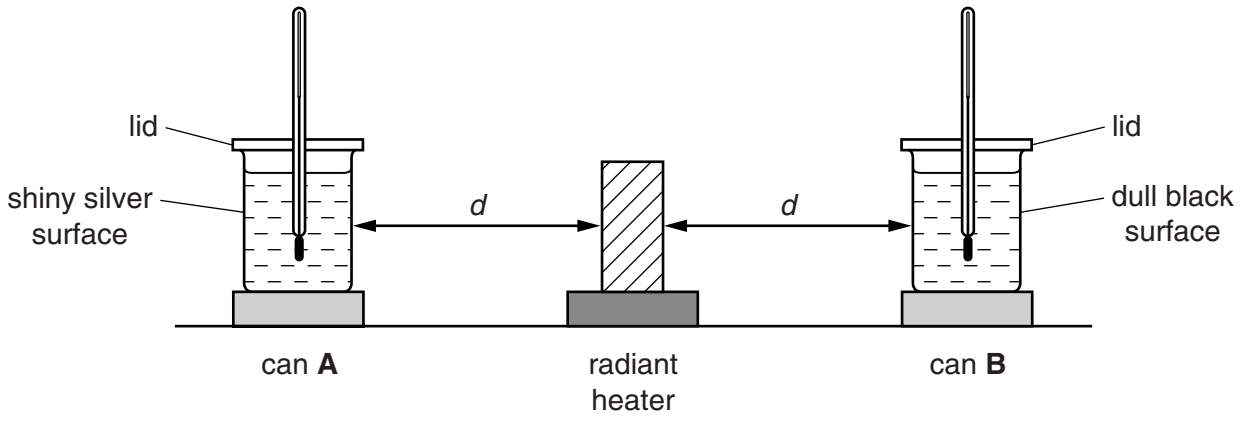


Fig. 6.2

Two similar cans, **A** and **B** contain equal amounts of water which start off at the same temperature.

Can **A** has a shiny silver surface and can **B** has a dull black surface.

A thermometer is placed into each can. The cans stand on cork mats and are placed at the same distance *d* from a radiant heater emitting infra-red radiation.

The temperature of the water is measured every minute for twelve minutes.

Fig. 6.3 shows how the temperature of the water changes for the two cans.

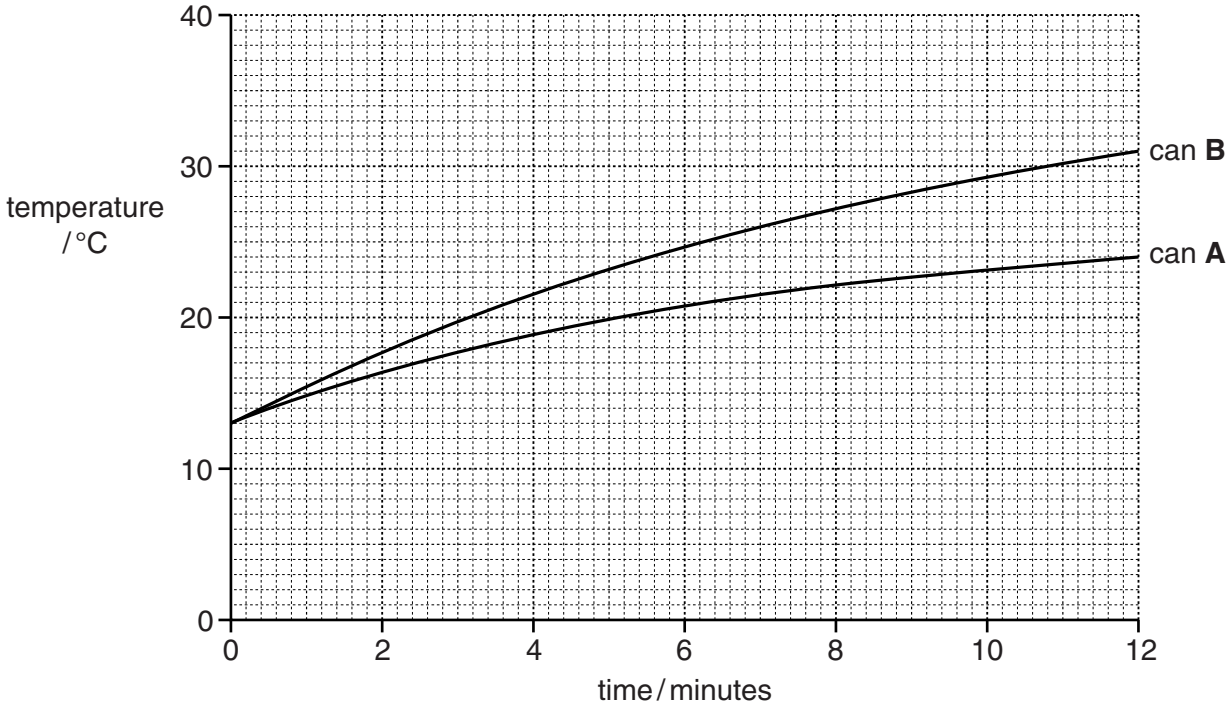


Fig. 6.3

(i) Explain why the two cans

have lids,

.....

are placed on cork mats.

.....
[2]

(ii) Explain why the temperature changes differ for the two cans.

.....

.....[1]

(d) A large hot meteorite falls into a lake, warming the water without causing the water to evaporate or boil.

(i) Describe the difference between evaporation and boiling.

.....

.....

.....

.....[2]

(ii) The meteorite is made of iron and has a mass of 32 000 kg.

It has a temperature 1520 °C before it enters the lake. After it enters the lake its temperature falls to 20 °C.

Calculate the thermal energy transfer, in kJ, from the hot meteorite to the water.

The specific heat capacity of iron is 450 J / kg °C.

State the formula that you use and show your working.

formula

working

..... kJ [3]

7 Fig. 7.1 shows the concentration of lactic acid in a muscle cell of an athlete before, during and after he has taken part in a 100 m sprint race.

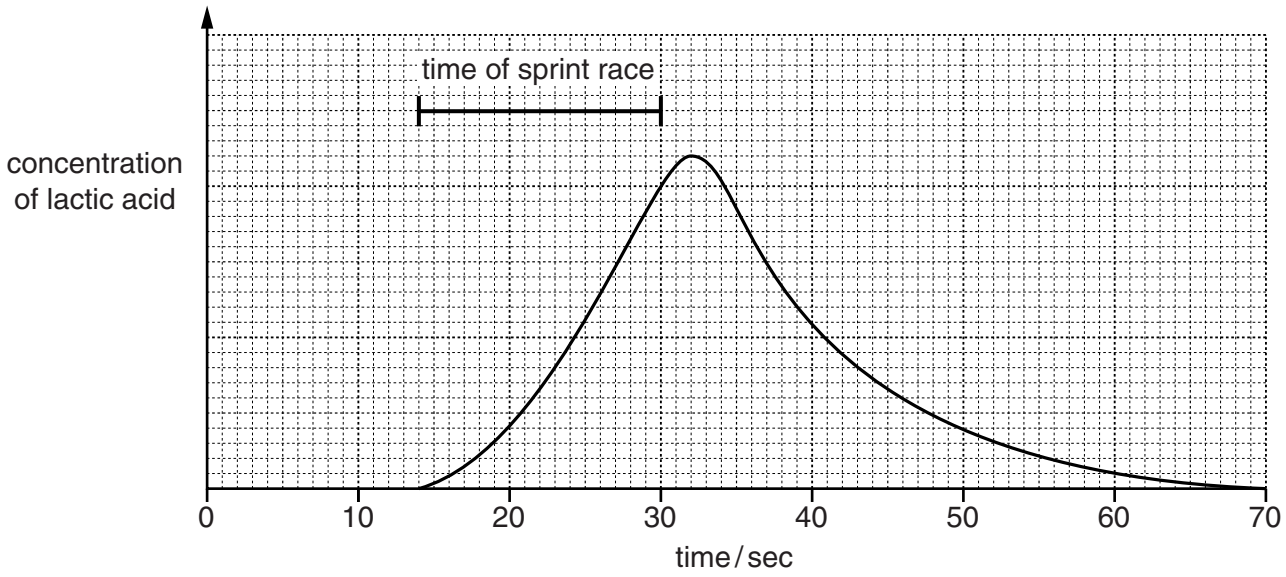


Fig. 7.1

(a) (i) Name the process that produces lactic acid.

.....[2]

(ii) Give the **word** equation for this process.

.....[1]

(b) State the time in Fig. 7.1 at which the lactic acid concentration is highest.

.....[1]

[Turn over

(c) During a sprint, the blood flow to the muscles increases. Suggest and explain the effect of this increased blood flow on

(i) the rate of lactic acid production,

.....

.....

.....[2]

(ii) the rate at which lactic acid is removed from the muscle cell.

.....

.....

.....[2]

(d) After the sprint, the athlete is 'out of breath' (breathing rapidly and deeply). Explain why the athlete breathes rapidly and deeply.

.....

.....

.....[2]

(e) Training increases the number of red blood cells in an athlete's body. Suggest how this affects the amount of lactic acid produced when an athlete is sprinting. Explain your answer.

.....

.....[1]

8 **(a)** A spillage of a radioactive substance occurs in a store for radioactive materials. The activity due to normal background radiation is 100 counts per minute. After the spillage, the activity in the store rises to 900 counts per minute.

(i) State the meaning of the term *background radiation*.

.....

.....[1]

(ii) Write down the increase in activity produced by the spilled material.

..... counts per minute [1]

(iii) The half-life of the material spilled is 20 days.

The radioactive store can only be safely entered again when the total activity falls to 200 counts per minute.

Calculate how many days it will take before the store can be safely entered.

Show how you worked out your answer.

.....

.....

..... days [3]

(iv) The spilled radioactive material contains a small quantity of californium-253.

Write down the numbers of protons, neutrons and electrons found in an atom of californium-253.

number of protons .....

number of neutrons .....

number of electrons ..... [1]

(v) Californium-253 emits α- and β- radiations. Describe the changes in the composition of the nucleus of a californium-253 atom when it emits

an α-particle, ...

.....

.....

a β-particle. .....

.....

.....

[2]

(b) Fig. 8.1 shows how electricity produced in a nuclear power station is transferred from the power station to the consumer.

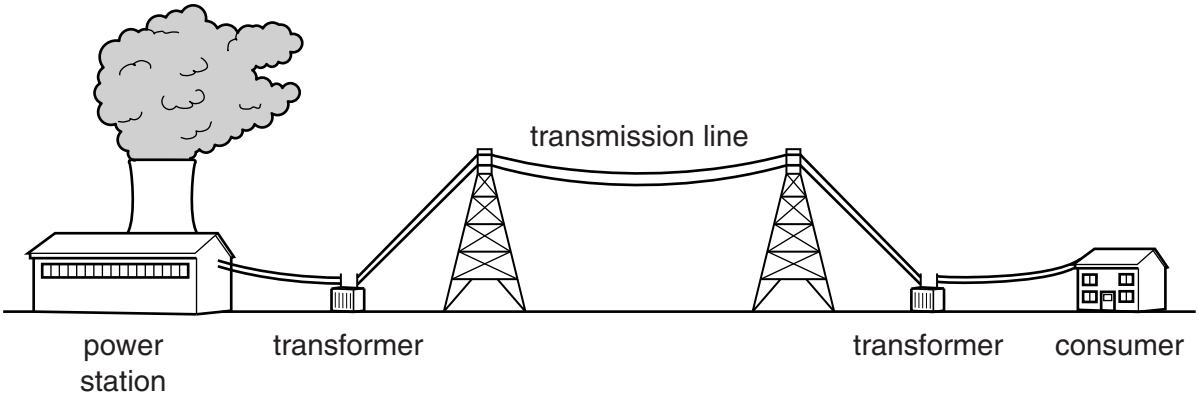


Fig. 8.1

(i) Choose numbers or words from the list to complete the sentences below.

You may use each number or word once, more than once or not at all.

12	**230**	**25 000**
decreases	**increases**	**larger**
smaller	**step-up**	**step-down**

Electricity is transmitted at .....V but is supplied to consumers' homes at .....V. This requires a ..... transformer. The transmission voltage used makes the current ....., which ..... the energy lost in the cable (transmission line). [2]

(ii) The input power into a small transformer is 500W and the useful output power is 450W.

Calculate the percentage efficiency of the transformer.

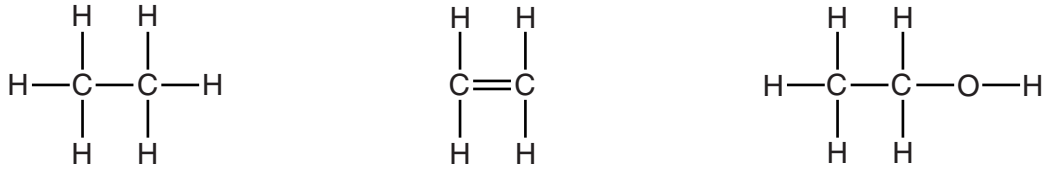
State the formula that you use and show your working.

formula

working

..... % [2]

9 Fig. 9.1 shows molecules of ethane, ethene and ethanol.



ethane ethene ethanol

Fig. 9.1

(a) (i) State and explain which of these compounds are hydrocarbons.

compounds .....

explanation .....

.....[2]

(ii) State and explain which **one** of the three compounds named above is an unsaturated compound.

compound .....

explanation .....

.....[1]

(iii) Describe what is observed when the compound in **(a)(ii)** reacts with a solution of bromine.

.....

.....[1]

(b) (i) State **two** uses of ethanol.

1 .....

2 .....
[2]

(ii) In industry, ethanol is made in a chemical reaction involving ethene.

Name the substance that reacts with ethene to produce ethanol.

.....[1]

(iii) State **two** of the reaction conditions needed for the reaction in **(b)(ii)**.

1 .....

2 .....
[2]

(iv) Name the type of reaction in **(b)(ii)**.

.....[1]

(c) Ethanol, C_2H_6O, reacts with a compound **X** to produce a mixture containing ethanoic acid, $C_2H_4O_2$, which is a compound found in vinegar.

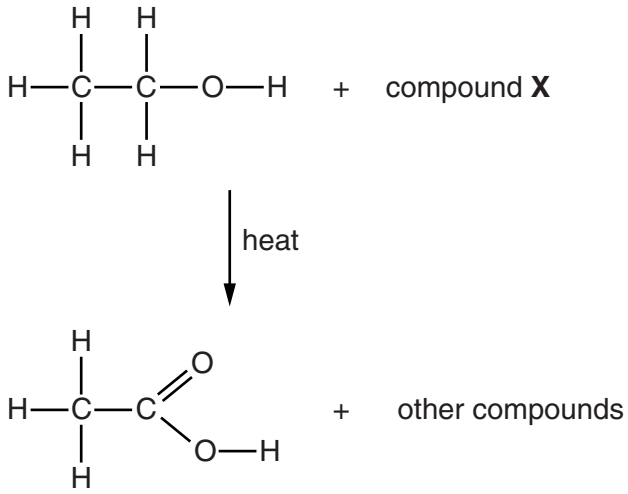


Fig. 9.2

The reaction between ethanol and compound **X** is a redox reaction.

Use the information in Fig. 9.2 to explain why **X** is reduced.

.....

.....

.....[2]

10 A motorcycle is driven along a straight road. Fig. 10.1 shows a speed/time graph for the motion of the motorcycle from the time the rider sees a car approaching.

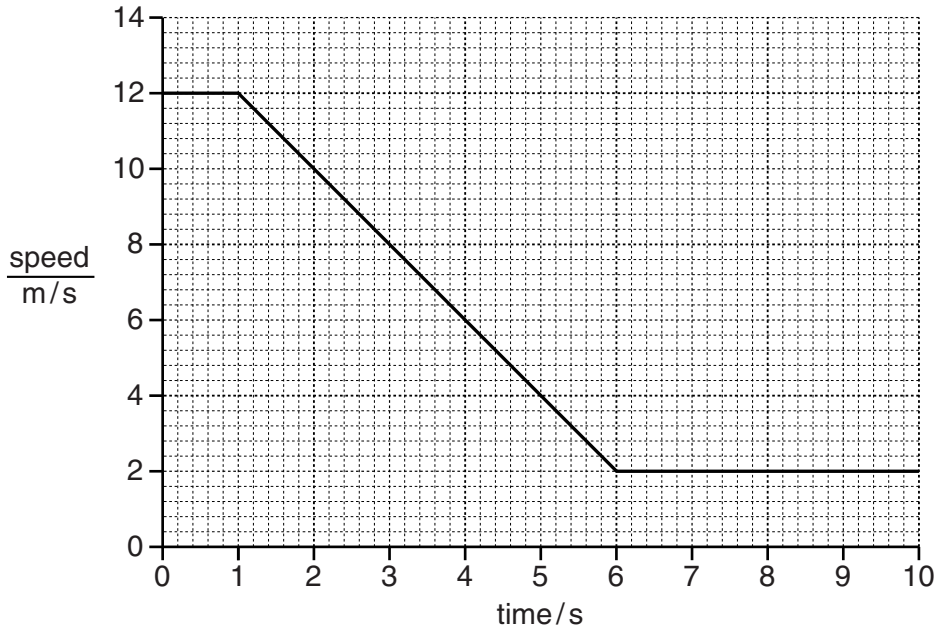


Fig. 10.1

(a) (i) Calculate the distance the motorcycle travels while it is slowing down.

Show your working.

distance = ...m [3]

(ii) Calculate the deceleration of the motorcycle.

Show your working.

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

(b) The motorcycle rider notices that the sound from a car's engine becomes louder as the car approaches and drops in pitch as the car passes.

Describe these changes in terms of the frequency and amplitude of sound waves released.

becomes louder .....

.....

has a lower pitch .....

.....

[2]

11 Fig. 11.1 shows two liver cells, as seen under a light microscope.

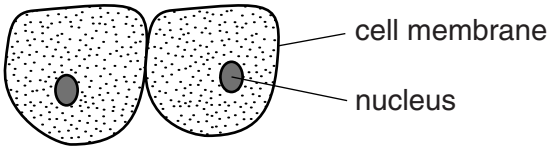


Fig. 11.1

(a) **(i)** Liver cells produce bile. Describe the role of bile in the digestion of fats.

.....

.....

.....[2]

(ii) State **two** other functions of liver cells apart from bile production.

1 .....

2 .....
[2]

(b) Under a more powerful microscope, the cell membranes of the liver cells can be seen to be folded. Suggest why this is important for the functioning of the cells.

.....

.....

.....[2]

(c) Red blood cells and plant root hair cells also have structural features that are important for their function.

(i) State **one** function of root hair cells.

.....[1]

(ii) State the function of a red blood cell, and give **two** ways in which its structure is related to its function.

function .....

how the structure is related to the function

1 .....

.....

2 .....

.....

[3]

12 (a) The Periodic Table lists the elements in order of their proton numbers.

Fig. 12.1 shows the positions of the first eighteen elements.

The letters are **not** the chemical symbols of the elements.

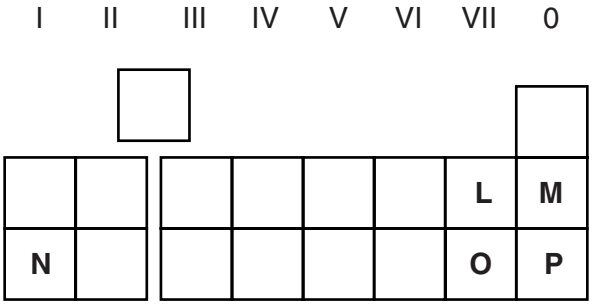


Fig. 12.1

(i) State the meaning of the term *proton number*.

.....

.....[1]

(ii) Element **L** has similar chemical properties to element **O** but different chemical properties from element **M**.

Explain this in terms of atomic structure.

.....

.....

.....[2]

(b) A student attempted to draw a dot-and-cross diagram for a molecule of carbon dioxide.

Fig. 12.2 shows the diagram he produced, but it is **incorrect**.

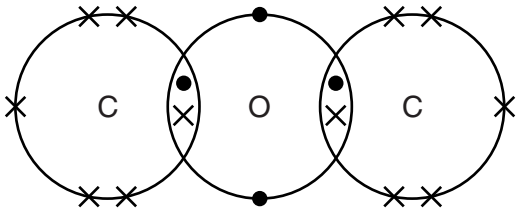


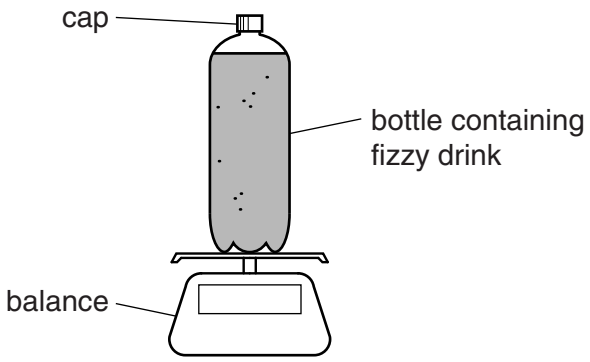
Fig. 12.2

Draw the **correct** dot-and-cross diagram for a molecule of carbon dioxide in the space below.

[3]

(c) A student investigates how much carbon dioxide gas is contained in a carbonated (fizzy) drink.

He measures the mass of a full bottle of fizzy drink.



He shakes the bottle. He releases the carbon dioxide by carefully unscrewing the cap.

He measures the mass of the bottle and cap, and liquid without the carbon dioxide.

His results are shown in Table 12.1.

Table 12.1

mass of bottle filled with fizzy drink /g	mass of bottle and cap, and liquid without carbon dioxide /g	volume of the liquid /cm^3
476.2	474.0	454.0

(i) State the mass of carbon dioxide that is released from the fizzy drink.

.....[1]

(ii) Calculate the number of moles of carbon dioxide released from the fizzy drink.

Show your working.

.....[2]

(iii) Calculate the concentration of carbon dioxide in the original fizzy drink.

State your answer in units of mol/dm^3.

Show your working.

..... mol/dm^3 [2]

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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	209 **Po** Polonium 84	210 **At** Astatine 85	222 **Rn** Radon 86
223 **Fr** Francium 87	226 **Ra** Radium 88	227 **Ac** Actinium 89 †															

140 **Ce** Cerium 58	141 **Pr** Praseodymium 59	144 **Nd** Neodymium 60	147 **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	231 **Pa** Protactinium 91	238 **U** Uranium 92	237 **Np** Neptunium 93	244 **Pu** Plutonium 94	243 **Am** Americium 95	247 **Cm** Curium 96	247 **Bk** Berkelium 97	251 **Cf** Californium 98	252 **Es** Einsteinium 99	257 **Fm** Fermium 100	258 **Md** Mendelevium 101	259 **No** Nobelium 102	260 **Lr** Lawrencium 103

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

Key: a / **X** / b

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

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