



**Cambridge International Examinations**  
Cambridge International General Certificate of Secondary Education

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**COMBINED SCIENCE**

**0653/21**

Paper 2 (Core)

**October/November 2016**

**1 hour 15 minutes**

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.

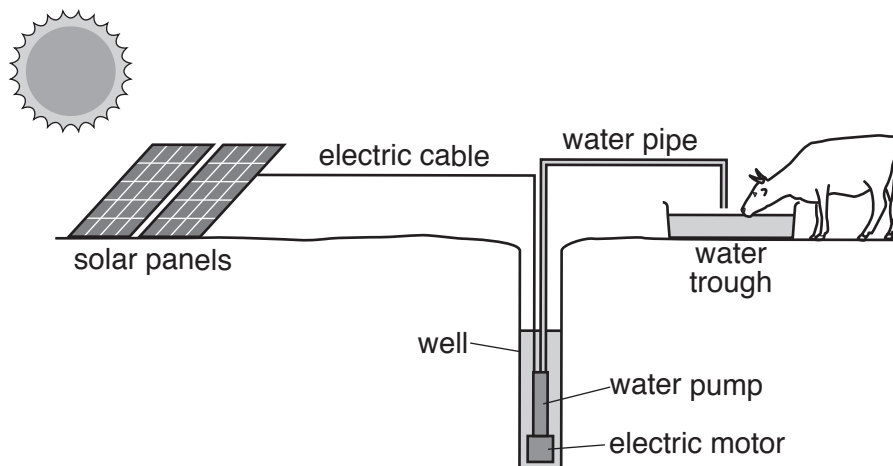
A copy of the Periodic Table is printed on page 20.

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 **20** printed pages.

- 1 Fig. 1.1 shows a solar-powered pump used to fill a water trough from a well on a farm. Animals in a field on the farm drink from the trough.



**Fig. 1.1**

The solar panels use sunlight to generate electricity.  
 The motor uses the electricity to drive the pump.  
 The pump moves water from the well to the water trough.

- (a) (i) Complete the sequence of energy transformations that takes place as the water pipe is filled when the pump is switched on.

from ..... energy

to ..... **electrical** ..... energy

to ..... energy

to ..... **potential** ..... energy

[2]

- (ii) The pipe from the pump to the trough is 900 cm long. When the pump starts, it takes 12 s for the water to move from the well to the trough.

Calculate the average speed of the water through the pipe.

State the formula you use and show your working.

formula

working

speed = ..... cm/s [2]

(iii) The area of the cross-section of the pipe is  $10\text{ cm}^2$ .

Use your answer to (ii) to calculate the volume of water in cubic centimetres flowing into the trough in one minute.

State any formula you use and show your working.

formula

working

volume in one minute = .....  $\text{cm}^3$  [3]

(b) The solar panel works well on farms with a lot of sunshine. But farms with less sunshine need a different energy resource to power a water pump in a field.

Suggest a different renewable energy resource the farmer can use to generate the electricity for the pump. Describe how this resource would be used.

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

- 2 (a) Fig. 2.1 shows the structure of an atom of sodium.

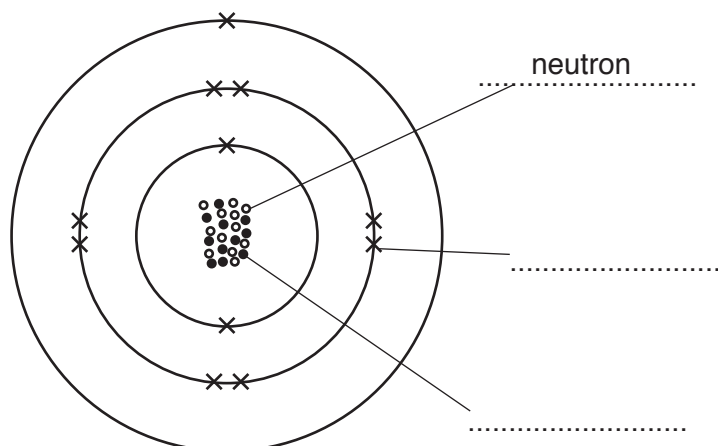


Fig. 2.1

- (i) Complete the labels for the atom of sodium in Fig. 2.1. [2]
- (ii) State the nucleon number for this atom of sodium.

..... [1]

- (b) The word equation for the reaction between sodium and oxygen is



- (i) In this reaction sodium atoms become sodium ions,  $\text{Na}^+$ .

Describe, in terms of electrons, how a sodium atom becomes a sodium ion.

..... [2]

- (ii) State the type of chemical reaction in which sodium gains oxygen.

..... [1]

- (iii) In this reaction the temperature of the sodium rises.

State the type of reaction that causes a temperature rise.

..... [1]

- (iv) Sodium oxide contains two sodium ions for each oxide ion.

Deduce the formula of sodium oxide.

..... [1]

(c) In Group I of the Periodic Table, potassium is below sodium.

(i) State the trend in the reactivities of the metals down Group I.

.....[1]

(ii) State the trend in the melting points of the metals down Group I.

.....[1]

- 3 Some cress seeds are placed on damp cotton wool in a dish. They are left to germinate in a light-proof box for a few days.

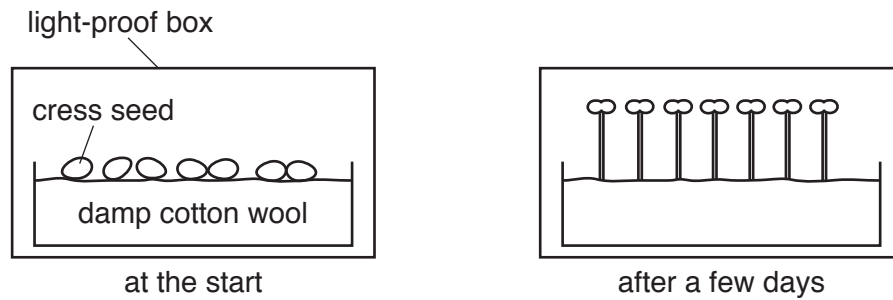


Fig. 3.1

- (a) (i) State **two** environmental conditions, not already mentioned, that are required for the germination of seeds.

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

- (ii) Fig. 3.1 shows that the seedlings grow directly upwards.

Name this response.

..... [1]

- (b) The dish of seedlings is removed from the box and lit from one side.

Fig. 3.2 shows what happens.

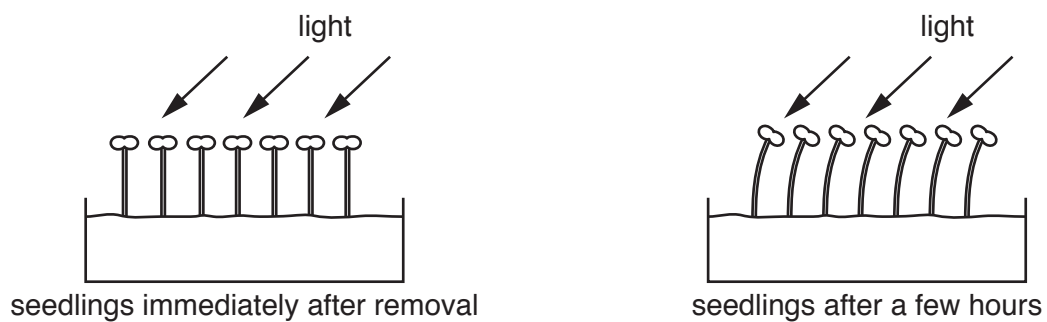


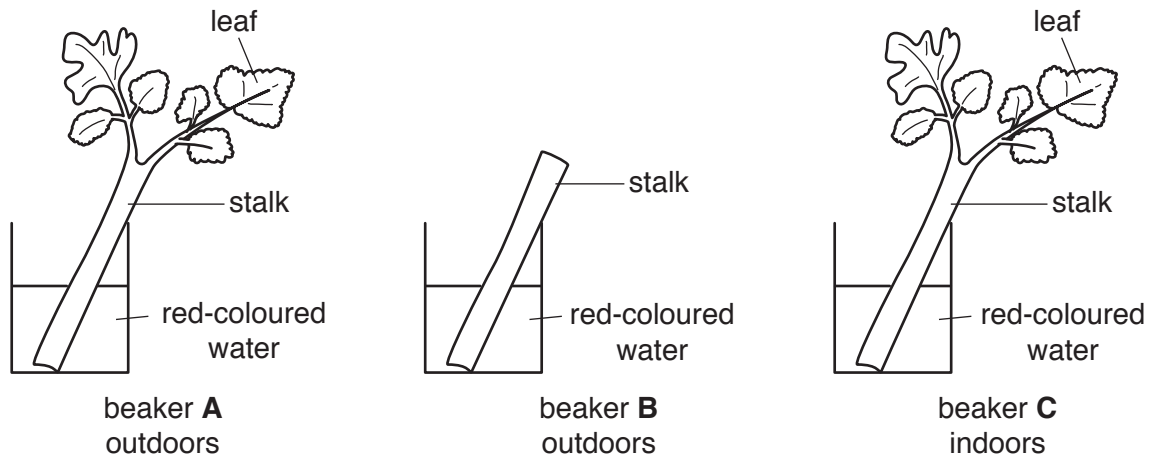
Fig. 3.2

Describe the advantage to the seedlings of the response shown in Fig. 3.2.

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

(c) A student takes three similar pieces of celery and removes the leaves from one of them. He then places the celery in separate beakers of red-coloured water.

He places beakers **A** and **B** outdoors. He keeps beaker **C** indoors as shown in Fig. 3.3.



**Fig. 3.3**

He examines them after two hours. His observations are shown in Table 3.1.

**Table 3.1**

beaker	observation
<b>A</b>	the leaves turn red
<b>B</b>	the coloured water does not enter the stalk
<b>C</b>	the coloured water reaches half-way up the stalk

(i) Name the tissue through which the red-coloured water travels to reach the leaves of the celery in beaker **A**.

.....[1]

(ii) Suggest why the coloured water does not move in the celery in beaker **B**.

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

(iii) Describe **two** ways in which the environmental conditions could be different for beaker **C** compared with **A**, which could explain the difference in the results.

1. ....  
 2. ....

[2]

- 4 Fig. 4.1 shows a water trough full of water left in a field on a hot day. In the evening the farmer sees that the level of water in the trough has gone down, as shown in Fig. 4.2. There are no animals in the field.

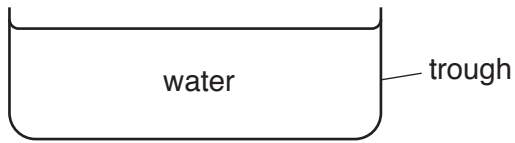


Fig. 4.1



Fig. 4.2

- (a) (i) Name the process that causes the level of water in the trough to go down.

.....[1]

- (ii) The thermal energy needed for this process comes from the Sun as electromagnetic radiation.

State the part of the electromagnetic spectrum that is transformed to thermal energy in this process.

.....[1]

- (iii) Explain in terms of the energy and movement of water molecules why the level of water goes down in the trough on a hot day.

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



(iv) Fig. 4.3 below shows a close-up of the surface of the water in the trough.

In the box on the diagram, draw the arrangement of water molecules below the surface of the water.

Some molecules have been drawn for you, above and below the surface. You should draw a total of at least 10 more molecules to show the arrangement below the surface.

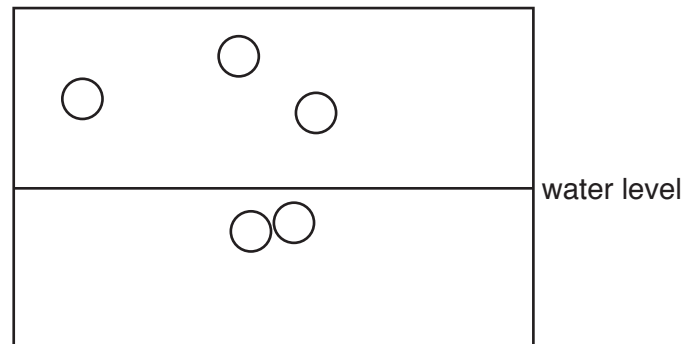


Fig. 4.3

[2]

(b) Fig. 4.4 shows the farmer looking at an image of the evening Sun reflected in the water surface.

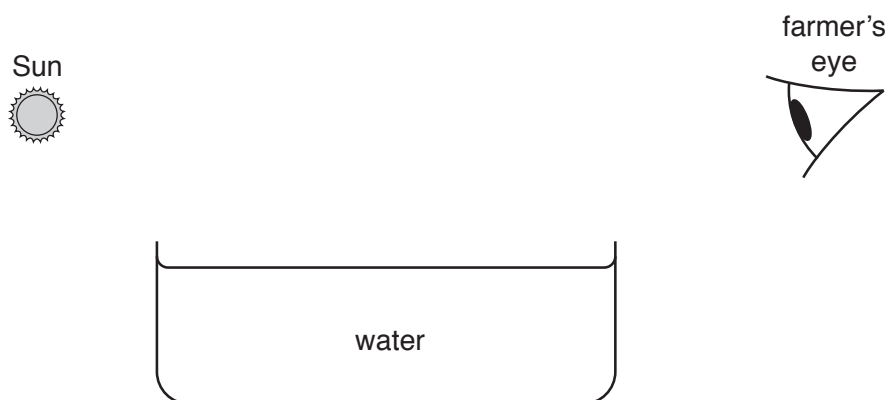
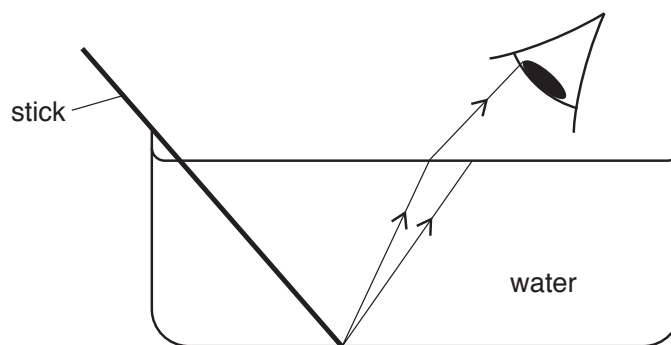


Fig. 4.4

On Fig. 4.4, draw a ray diagram using one ray to show how the farmer is able to see the image of the Sun reflected in the water. [2]

(c) Fig. 4.5 shows the farmer looking at a stick lying in the water trough.



**Fig. 4.5**

The farmer says that the stick looks bent where it goes into the water.

- (i) On Fig. 4.5 complete the second ray on the ray diagram to reach the eye. [1]
- (ii) Extend the rays and draw the image of the end of the stick as seen by the farmer. [1]

(d) The farmer speaks to someone on his mobile phone (cell phone).

State the type of electromagnetic radiation used by the mobile phone to communicate with another mobile phone.

.....[1]

5 (a) Fig. 5.1 shows how petroleum is separated into useful products.

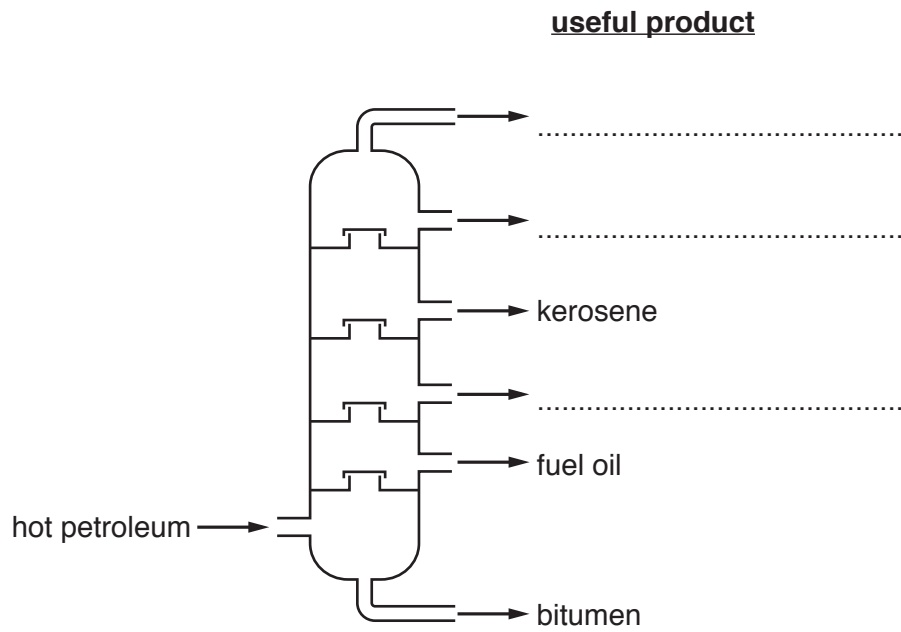


Fig. 5.1

(i) State the name of this process.

..... [1]

(ii) Complete Fig. 5.1 by writing the labels for gas oil, gasoline and refinery gas. [2]

- (iii) Some products obtained from petroleum are used as fuels. Fig. 5.2 shows some uses and products.

Complete Fig. 5.2 by drawing **three** more straight lines to link the products to their use as fuels.

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

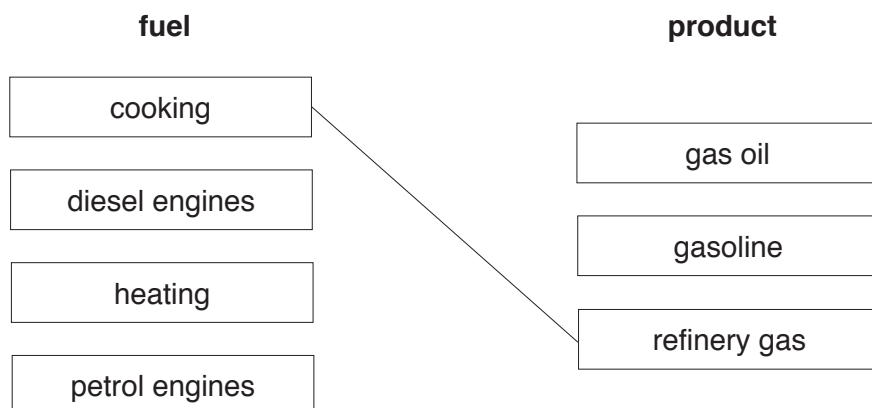
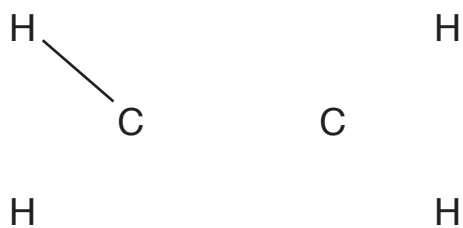


Fig. 5.2

[3]

- (b) (i) Complete the diagram to show the structure of ethene.



[1]

- (ii) When ethene burns, it produces a gas that turns limewater milky.

Name this gas.

.....[1]

- (iii) Water is also produced when ethene burns.

Describe a **chemical** test for water and state the result.

test .....

result .....

[2]

- 6 (a) Table 6.1 shows some of the substances present in milk.

**Table 6.1**

substance	mass/g per 100cm <sup>3</sup> of milk
protein	3.4
fat	3.6
carbohydrate	4.7
calcium (mineral salt)	0.1
fibre	none

- (i) A balanced diet contains five nutrient groups, as well as fibre and water.

Name the nutrient group, present in milk, which is **not** listed in Table 6.1.

.....

Describe the importance of including this nutrient group in a balanced diet.

.....

.....

.....

[2]

- (ii) State the process by which energy is released in the body.

.....[1]

- (iii) List the substances in milk from Table 6.1 that can release energy in the body.

.....[2]

- (iv) There is no fibre contained in the milk.

Suggest one food that would provide fibre.

.....[1]

(b) Large numbers of cows are bred by farmers to produce milk.

Use the following words or phrases to complete the sentences about the effects on the environment caused by people keeping cows.

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

- noble      greenhouse      digestive      disease      global warming**  
**methane      oxygen      respiratory      sulfur dioxide**

The ..... systems of cows release  
..... into the air. This is a .....  
gas which can contribute to ..... . [4]

- 7 Fig. 7.1 shows a circuit diagram for a solar-powered electric motor.

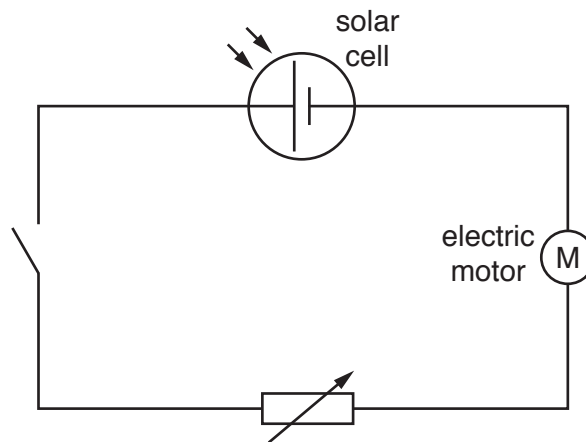


Fig. 7.1

- (a) Use words or phrases from the list to fill in the missing words in the sentences below.


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

**decreases      electrons      increases**

**neutrons      protons      stays the same**

The current is a flow of ..... in the wires of the circuit.

The size of the current ..... around the circuit. [2]

- (b) (i) Name the component which has the symbol  ..... [1]

- (ii) Describe how this component controls the speed at which the motor turns.

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

- (iii) On Fig. 7.1 draw the symbol for a voltmeter correctly connected to measure the p.d. across the motor. [1]

- 8 (a) The Periodic Table lists all of the elements.

Complete the following sentences about the Periodic Table by using words from the list below. Each word may be used once, more than once or not at all.

**high**      **low**      **mass**      **metallic**  
**negative**      **non-metallic**      **nucleon**  
**positive**      **proton**

Elements are arranged in the Periodic Table in order of .....  
number.

The ..... elements are on the left-hand side of the  
Periodic Table and the ..... elements are on the right-hand  
side of the Periodic Table.

The transition elements, which have ..... densities and  
..... melting points, are found in the middle of the  
Periodic Table.

[3]



(b) (i) Three beakers, **A**, **B** and **C**, are shown in Fig. 8.1.

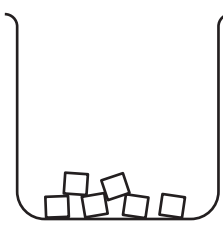
Each beaker contains pieces of a **different** metal.

The three metals are **calcium**, **iron** and **magnesium**.

A student tests the metals in each beaker. Her results are shown next to each beaker.

Complete Fig. 8.1 by writing the correct name of the metal in each beaker.

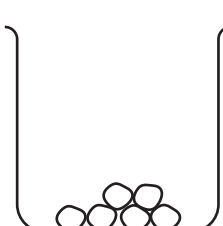
beaker **A**



no visible reaction with water  
a few bubbles of gas with dilute hydrochloric acid

name of metal .....

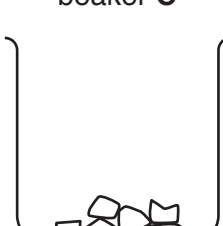
beaker **B**



rapid fizzing in water  
violent reaction with dilute hydrochloric acid

name of metal .....

beaker **C**



slow fizzing in water  
lots of bubbles of gas with dilute hydrochloric acid

name of metal .....

**Fig. 8.1**

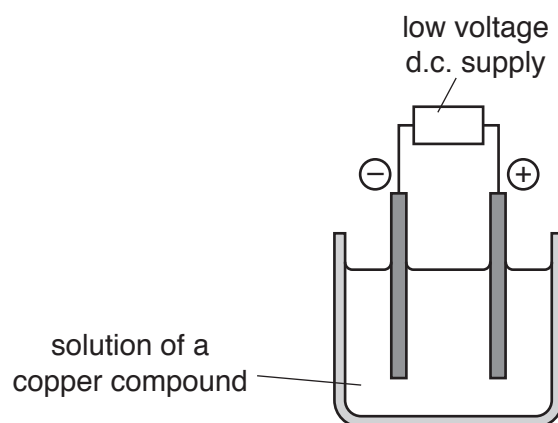
[2]

(ii) When magnesium reacts with dilute hydrochloric acid, magnesium chloride is formed.

Suggest **one** other substance that reacts with hydrochloric acid to form magnesium chloride.

.....[1]

(c) A solution of a copper compound is electrolysed, as shown in Fig. 8.2.



**Fig. 8.2**

A gas is produced at the anode. It turns damp blue litmus paper red and then white.

Name the gas.

.....[1]

9 Fig. 9.1 shows the reproductive system of a female.

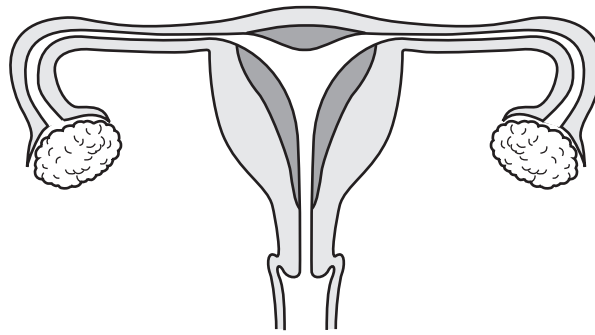


Fig. 9.1

(a) On Fig. 9.1 label with the correct names

1. a place where haploid cells are found,
2. a place where fertilisation may take place.

[2]

(b) (i) After fertilisation the zygote develops into a ball of cells.

Describe in detail where the ball of cells continues its development.

.....

.....

.....[2]

(ii) Explain why the place you described in (b)(i) is a good environment for this ball of cells to develop.

.....

.....[1]

(c) Describe **two** ways in which HIV can be transmitted.

1. ....

.....

2. ....

.....[2]

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
3 <b>Li</b> lithium 7	4 <b>Be</b> beryllium 9	<b>Key</b> atomic number atomic symbol name relative atomic mass										5 <b>B</b> boron 11	6 <b>C</b> carbon 12	7 <b>N</b> nitrogen 14	8 <b>O</b> oxygen 16	9 <b>F</b> fluorine 19	10 <b>Ne</b> neon 20
11 <b>Na</b> sodium 23	12 <b>Mg</b> magnesium 24											13 <b>Al</b> aluminium 27	14 <b>Si</b> silicon 28	15 <b>P</b> phosphorus 31	16 <b>S</b> sulfur 32	17 <b>Cl</b> chlorine 35.5	18 <b>Ar</b> argon 40
19 <b>K</b> potassium 39	20 <b>Ca</b> calcium 40	21 <b>Sc</b> scandium 45	22 <b>Ti</b> titanium 48	23 <b>V</b> vanadium 51	24 <b>Cr</b> chromium 52	25 <b>Mn</b> manganese 55	26 <b>Fe</b> iron 56	27 <b>Co</b> cobalt 59	28 <b>Ni</b> nickel 59	29 <b>Cu</b> copper 64	30 <b>Zn</b> zinc 65	31 <b>Ga</b> gallium 70	32 <b>Ge</b> germanium 73	33 <b>As</b> arsenic 75	34 <b>Se</b> selenium 79	35 <b>Br</b> bromine 80	36 <b>Kr</b> krypton 84
37 <b>Rb</b> rubidium 85	38 <b>Sr</b> strontium 88	39 <b>Y</b> yttrium 89	40 <b>Zr</b> zirconium 91	41 <b>Nb</b> niobium 93	42 <b>Mo</b> molybdenum 96	43 <b>Tc</b> technetium —	44 <b>Ru</b> ruthenium 101	45 <b>Rh</b> rhodium 103	46 <b>Pd</b> palladium 106	47 <b>Ag</b> silver 108	48 <b>Cd</b> cadmium 112	49 <b>In</b> indium 115	50 <b>Sn</b> tin 119	51 <b>Sb</b> antimony 122	52 <b>Te</b> tellurium 128	53 <b>I</b> iodine 127	54 <b>Xe</b> xenon 131
55 <b>Cs</b> caesium 133	56 <b>Ba</b> barium 137	57–71 lanthanoids	72 <b>Hf</b> hafnium 178	73 <b>Ta</b> tantalum 181	74 <b>W</b> tungsten 184	75 <b>Re</b> rhenium 186	76 <b>Os</b> osmium 190	77 <b>Ir</b> iridium 192	78 <b>Pt</b> platinum 195	79 <b>Au</b> gold 197	80 <b>Hg</b> mercury 201	81 <b>Tl</b> thallium 204	82 <b>Pb</b> lead 207	83 <b>Bi</b> bismuth 209	84 <b>Po</b> polonium —	85 <b>At</b> astatine —	86 <b>Rn</b> radon —
87 <b>Fr</b> francium —	88 <b>Ra</b> radium —	89–103 actinoids	104 <b>Rf</b> rutherfordium —	105 <b>Db</b> dubnium —	106 <b>Sg</b> seaborgium —	107 <b>Bh</b> bohrium —	108 <b>Hs</b> hassium —	109 <b>Mt</b> meitnerium —	110 <b>Ds</b> darmstadtium —	111 <b>Rg</b> roentgenium —	112 <b>Cn</b> copernicium —	114 <b>Fl</b> flerovium —	116 <b>Lv</b> livermorium —	—	—	—	—

57 <b>La</b> lanthanum 139	58 <b>Ce</b> cerium 140	59 <b>Pr</b> praseodymium 141	60 <b>Nd</b> neodymium 144	61 <b>Pm</b> promethium —	62 <b>Sm</b> samarium 150	63 <b>Eu</b> europium 152	64 <b>Gd</b> gadolinium 157	65 <b>Tb</b> terbium 159	66 <b>Dy</b> dysprosium 163	67 <b>Ho</b> holmium 165	68 <b>Er</b> erbium 167	69 <b>Tm</b> thulium 169	70 <b>Yb</b> ytterbium 173	71 <b>Lu</b> lutetium 175
89 <b>Ac</b> actinium —	90 <b>Th</b> thorium 232	91 <b>Pa</b> protactinium 231	92 <b>U</b> uranium 238	93 <b>Np</b> neptunium —	94 <b>Pu</b> plutonium —	95 <b>Am</b> americium —	96 <b>Cm</b> curium —	97 <b>Bk</b> berkelium —	98 <b>Cf</b> californium —	99 <b>Es</b> einsteinium —	100 <b>Fm</b> fermium —	101 <b>Md</b> mendelevium —	102 <b>No</b> nobelium —	103 <b>Lr</b> lawrencium —

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