



# Cambridge IGCSE™

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**CO-ORDINATED SCIENCES**

**0654/31**

Paper 3 Theory (Core)

**May/June 2020**

**2 hours**

You must answer on the question paper.

No additional materials are needed.

## INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

## INFORMATION

- The total mark for this paper is 120.
- The number of marks for each question or part question is shown in brackets [ ].
- The Periodic Table is printed in the question paper.

This document has **32** pages. Blank pages are indicated.

1 (a) Fig. 1.1 is a diagram of the human female reproductive system.

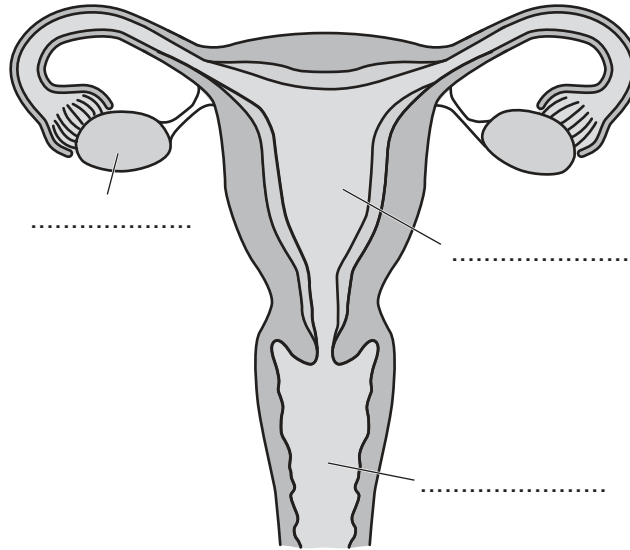


Fig. 1.1

(i) Label Fig. 1.1 using words from the list.

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

**cervix**

**ovary**

**oviduct**

**uterus**

**vagina**

[3]

(ii) The boxes on the left are parts of the human female reproductive system.

The boxes on the right are the functions of the different parts.

Draw one line from each part to its function.

**part**

**function**

ovary

site of fertilisation

oviduct

receives penis during sexual intercourse

uterus

releases female gametes

vagina

where fetus develops

[3]

(b) HIV is a sexually transmitted disease often spread through unprotected sexual intercourse.

Fig. 1.2 is a graph showing the number of new infections of HIV in a country between 1999 and 2009.

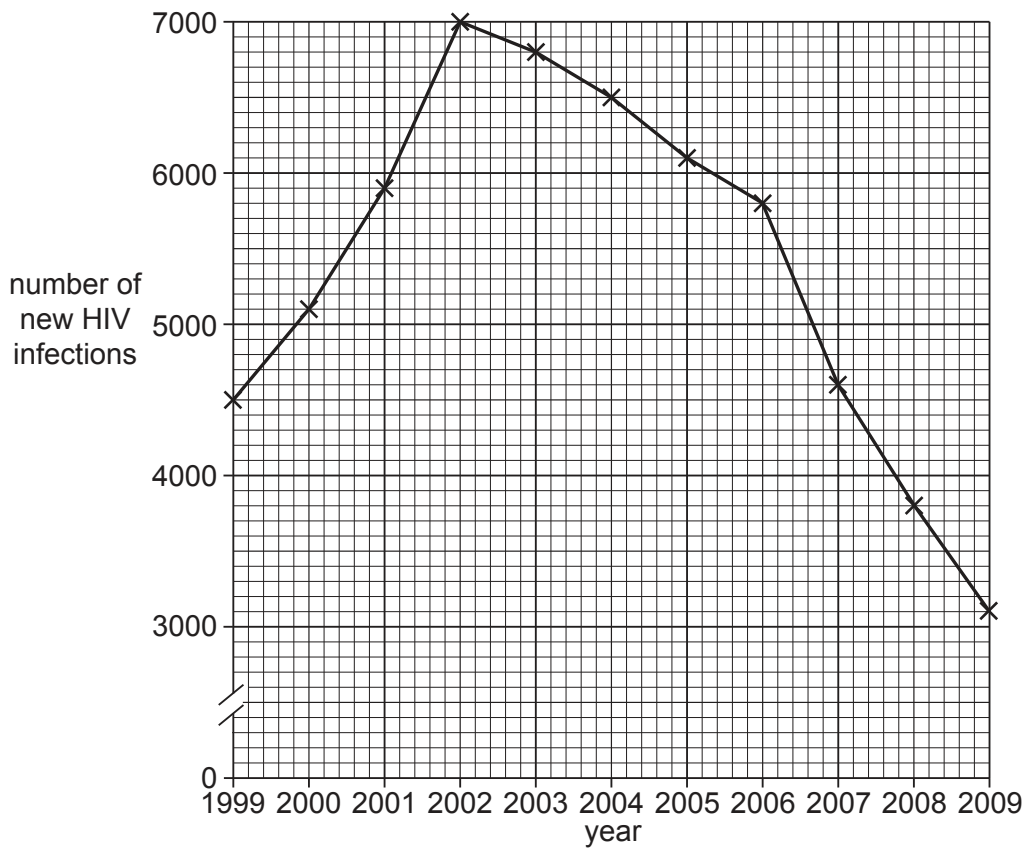


Fig. 1.2

(i) Calculate the overall change in the number of new HIV infections between 1999 and 2009.

..... [1]

(ii) Describe the trends in new HIV infections between 1999 and 2009.

Use data to support your answer.

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

(c) Table 1.1 shows methods of how HIV can be transmitted or controlled.

Complete Table 1.1 to identify if the method is an example of **transmission** or **control**.

**Table 1.1**

<b>method</b>	<b>transmission or control</b>
barrier contraception	
contaminated blood transfusion	
sharing needles when taking drugs	

[2]

[Total: 11]

- 2 (a) The diagram in Fig. 2.1 shows part of the water cycle.
- Clouds form above the sea and rain falls from the clouds.
- Clouds are made up of very small drops of liquid water.

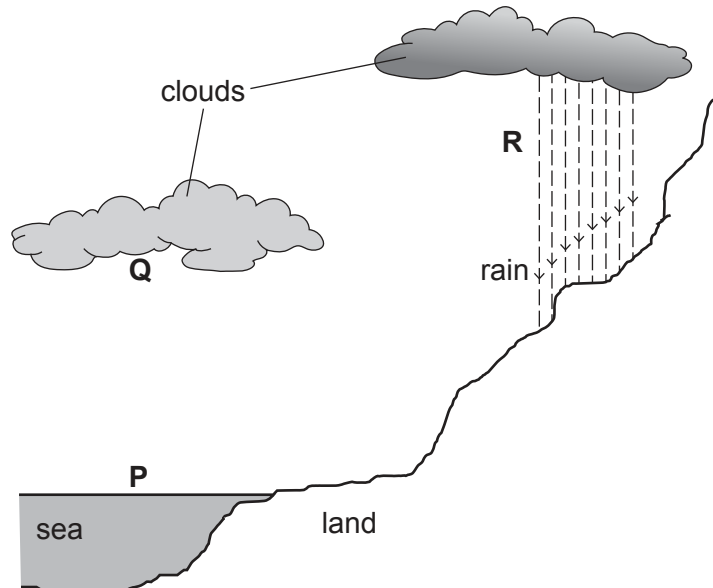


Fig. 2.1

The letters **P**, **Q** and **R** show locations where **physical** changes happen in the water cycle.

- (i) Use the letters **P**, **Q** and **R** to complete Table 2.1.

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

Table 2.1

description of change	location
water vapour condenses	
liquid water gains kinetic energy	
water molecules move closer together	
water evaporates	

[3]

- (ii) Explain why the changes **P**, **Q** and **R** are **physical** changes.

.....

..... [1]

(b) Carbon dioxide in the air dissolves in rainwater. This causes the rainwater to become slightly acidic.

(i) Water is **neutral**.

State the pH value of water.

.....

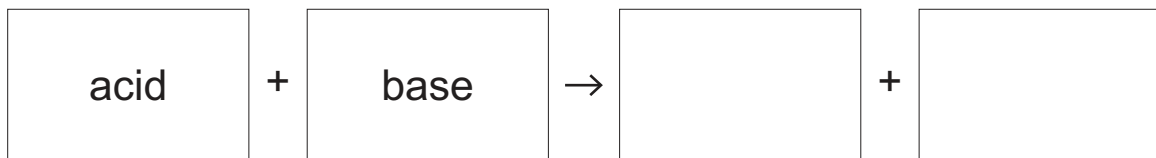
[1]

(ii) Suggest a pH value of rainwater.

.....

[1]

(c) Complete the word equation for the neutralisation reaction between an acid and a base.



[1]

(d) Table 2.2 shows some oxides.

It also shows whether they are acidic or basic.

**Table 2.2**

oxide	acidic or basic
carbon dioxide	acidic
chlorine oxide	acidic
magnesium oxide	basic
phosphorus oxide	acidic
sodium oxide	basic

(i) Predict whether nitrogen dioxide is acidic or basic.

Explain your answer.

nitrogen dioxide is .....

explanation .....

.....

[1]

(ii) Nitrogen dioxide is an air pollutant.

Describe **one** human activity that releases nitrogen dioxide into the air.

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

(iii) Identify **one** other gaseous air pollutant that is harmful to humans.

..... [1]

[Total: 10]

- 3 (a) Fig. 3.1 shows a skier at the top of a slope.

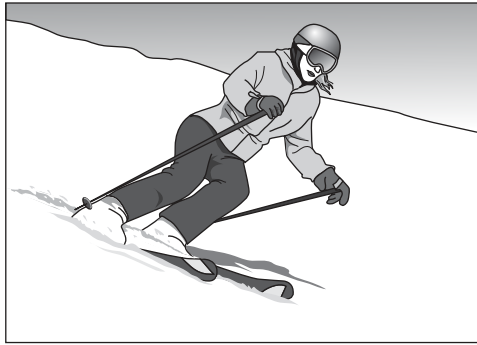


Fig. 3.1

- (i) The skier travels 310.5 m in 20 s.

Calculate the average speed of the skier.

average speed = ..... m/s [2]

- (ii) Fig. 3.2 shows a speed-time graph of the skier.

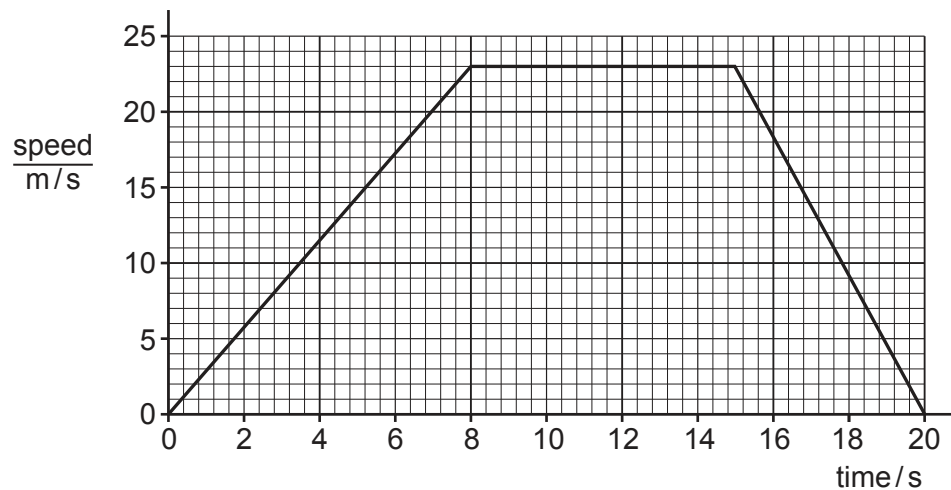


Fig. 3.2



Use Fig. 3.2 to determine the distance travelled while the skier has constant acceleration during the first 8 seconds.

distance = ..... m [2]

(iii) State the name of the force that impedes the skier's motion.  
..... [1]

(b) (i) The skier has a mass of 85 kg.  
The gravitational field strength  $g$  is 10 N/kg.  
Calculate the weight of the skier.

weight = ..... N [2]

(ii) State the source of the gravitational field that causes the skier to accelerate down a slope.  
..... [1]

(iii) When the skier goes to the top of a slope, he does work.  
As he climbs, his gravitational potential energy increases.  
Choose from the list the correct word to complete the sentence below.

- created                  gained                  lost                  transferred**

The work done by the skier is equal to the total energy ..... [1]

[Total: 9]

4 A student investigates photosynthesis using an aquatic plant (Elodea).

Fig. 4.1 shows the apparatus the student uses.

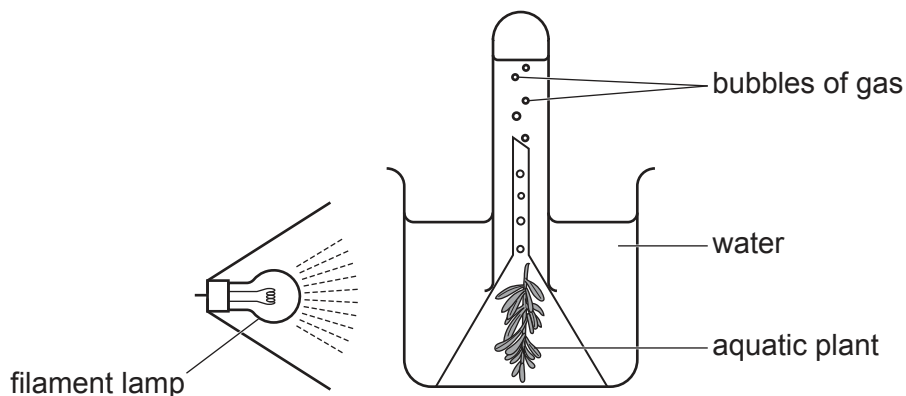


Fig. 4.1

(a) (i) The aquatic plant releases bubbles of gas.

Name the gas the bubbles are made from.

..... [1]

(ii) The investigation was repeated with the filament lamp removed.

Explain why the number of bubbles produced decreases.

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

(b) Photosynthesis is an enzyme-controlled reaction.

(i) Define the term *enzyme*.

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

(ii) Suggest why placing a hot filament lamp too close to the water could stop the plant producing bubbles.

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

(c) Fig. 4.2 is a photomicrograph of the cells in an Elodea leaf.

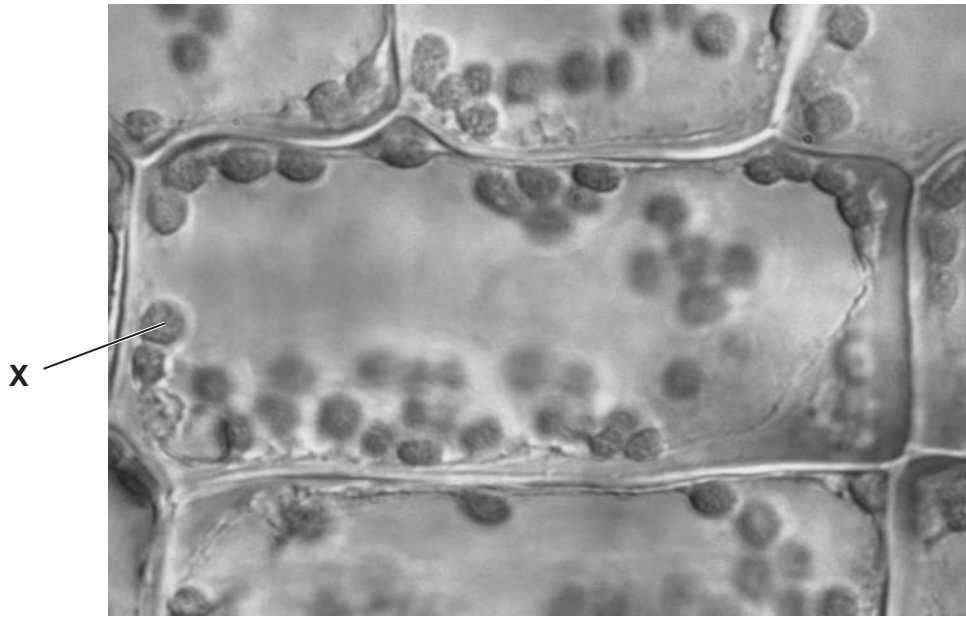


Fig. 4.2

(i) Identify the part of the cell labelled **X** in Fig. 4.2.

..... [1]

(ii) Name three parts of a cell found in **both** plant cells and animal cells.

1 .....

2 .....

3 .....

[3]

(iii) Suggest **two** ways the structure of root hair cells would differ from the cells shown in Fig. 4.2.

.....

..... [2]

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

.....

..... [1]

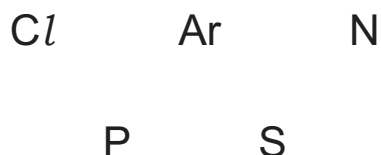
[Total: 12]

5 Non-metallic elements are placed in groups towards the right hand side of the Periodic Table.

(a) Describe what is meant by a group in the Periodic Table.

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

(b) Fig. 5.1 shows the chemical symbols of five non-metallic elements.



**Fig. 5.1**

(i) One of the symbols in Fig. 5.1 is **not** in the same **period** of the Periodic Table as the others.

Identify the symbol and explain your answer.

symbol .....

explanation .....

.....  
 .....

[1]

(ii) Select **two** elements from Fig. 5.1 that are contained in fertilisers.

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

(iii) State **one** reason why fertiliser is added to soil.

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

(c) Select **one** element from Fig. 5.1 that is used to treat water to make it safe to drink.

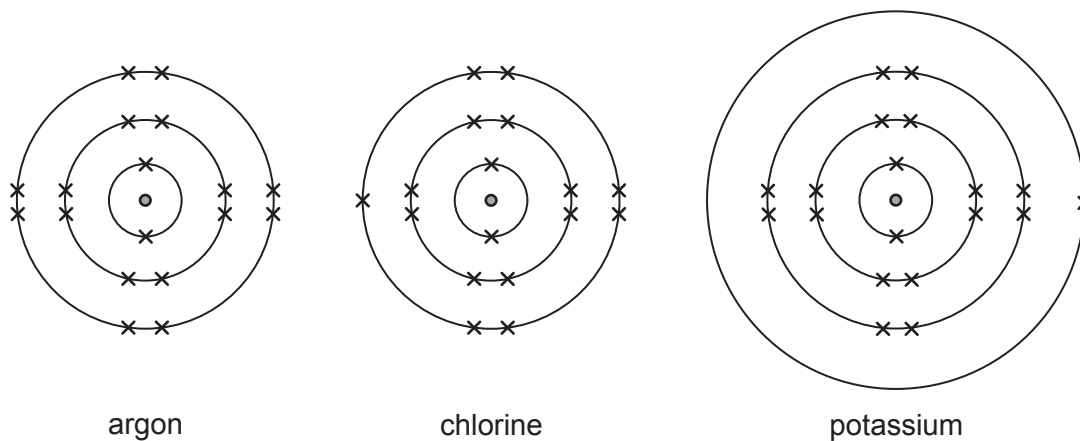
Explain how it does this.

element .....

explanation .....

..... [2]

(d) Fig. 5.2 shows the electronic structures of atoms of argon, chlorine and potassium.



**Fig. 5.2**

(i) Argon does **not** react with potassium.

Explain why.

Use ideas about electronic structures in your answer.

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

(ii) Potassium reacts with chlorine to form potassium chloride.

Describe how the electronic structures of a potassium atom and of a chlorine atom change when potassium and chlorine react.

change in potassium .....

.....

change in chlorine .....

.....

[2]

(iii) Name the type of chemical bonding in potassium chloride.

..... [1]

[Total: 11]

6 (a) Solar cells can be used to generate electricity for a house.

State one advantage and one disadvantage, apart from cost, of solar cells.

advantage .....

disadvantage .....

[2]

(b) Fig. 6.1 shows an ice cube and a thermometer in a glass of water.

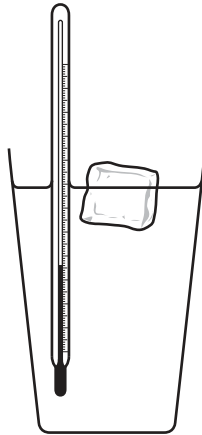


Fig. 6.1

(i) The water provides thermal energy which melts the ice.

State what happens to the temperature of the ice as it is melting.

..... [1]

(ii) Fig. 6.2 shows that more ice cubes have been added to the glass of water.

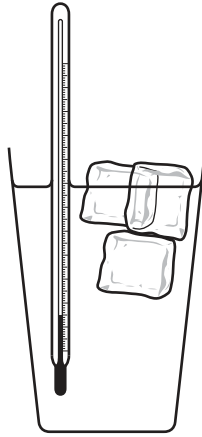


Fig. 6.2

The ice cubes reduce the temperature of the water. The scale on the liquid-in-glass thermometer shows this decrease in temperature.

Explain this action of the liquid-in-glass thermometer.

Use ideas about particles in your answer.

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

(iii) The water in the glass is evaporating.

Describe evaporation in terms of the motion of the water molecules.

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

[Total: 7]

7 (a) A teacher measured the height of the students in a class to the nearest cm.

Table 7.1 shows the results.

Table 7.1

height range/cm	frequency in class
140–145	2
146–150	6
151–155	8
156–160	12
161–165	5
166–170	2
171–175	1

(i) State the most common height range in the class.

..... cm [1]

(ii) State the type of variation shown by height.

..... [1]

(iii) State the evidence from Table 7.1 that supports your answer in (a)(ii).

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

(b) Use words from the list to complete the sentences about natural selection.

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

- alleles**
- cells**
- competition**
- die**
- react**
- survive**
- variety**

Individuals in a population produce offspring.

If there are not enough resources for all the individuals there is increased

.....

Individuals that are better adapted to the environment .....

Individuals that are not adapted .....

Individuals that ..... can reproduce passing their alleles to the next generation.

[4]



(c) Lack of resources can cause extinction of a species.

Suggest two ways humans can cause extinction.

1 .....

2 .....

[2]

[Total: 9]

8 Calcium and copper are metals.

(a) (i) State two **physical** properties of metals.

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

(ii) Copper is a transition metal. Calcium is **not** a transition metal.

State two properties of transition metals that are **not** properties of calcium.

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

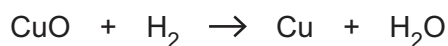
(iii) Calcium and copper are added to separate amounts of water.

Describe the reaction, if any, for each metal.

- calcium .....
- copper ..... [2]

(b) Copper metal is produced when copper(II) oxide reacts with hydrogen gas.

The equation for this reaction is shown.



(i) Explain why this equation is described as *balanced*.

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

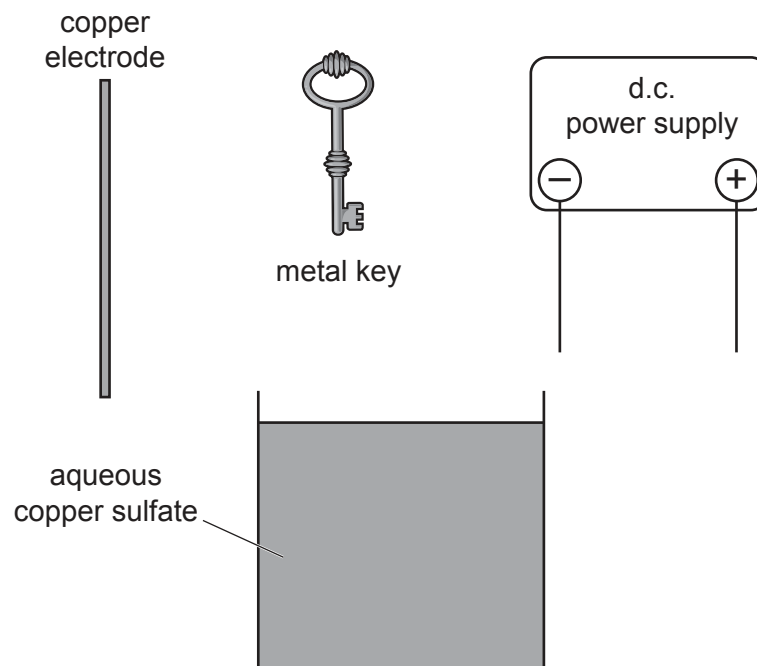
(ii) Identify which substance is **reduced** in this reaction.

Explain your answer.

- substance .....
- explanation .....
- ..... [2]

(c) Metals are covered with a thin layer of copper during electroplating.

Fig. 8.1 shows apparatus and materials to electroplate a metal key with copper.



**Fig. 8.1**

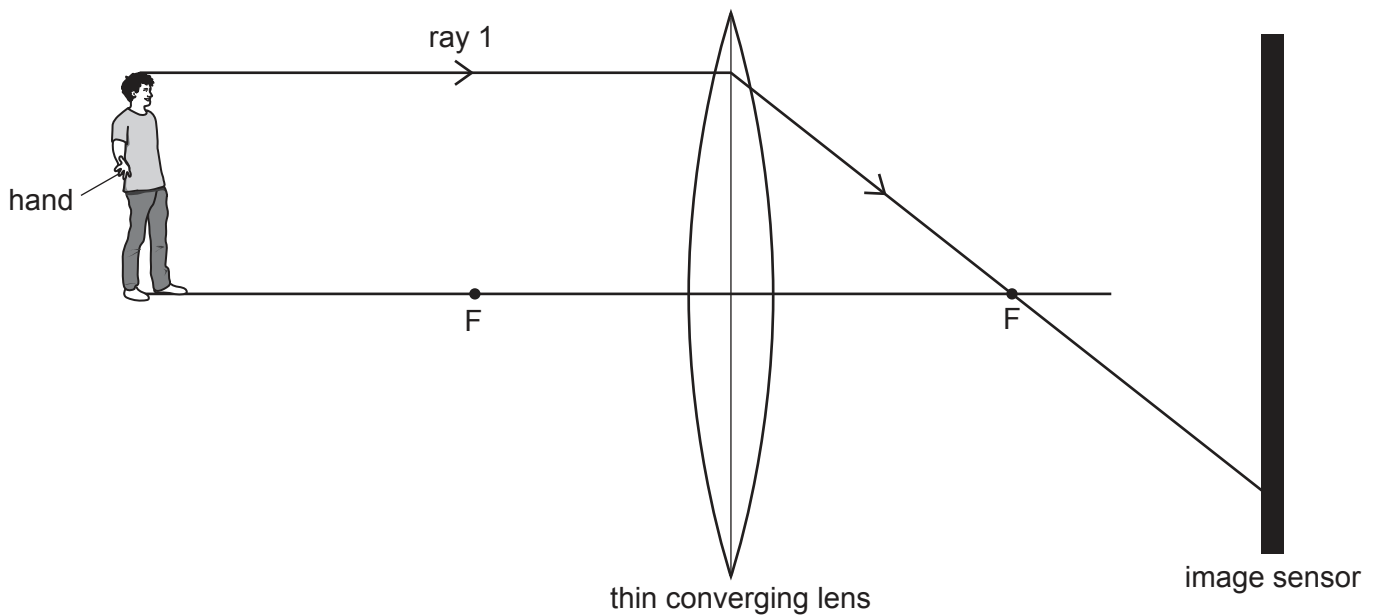
Draw a diagram to show the apparatus and materials set up to electroplate the metal key with copper.

[2]

[Total: 11]

- 9 (a) Fig. 9.1 shows a thin converging lens used in a digital camera.

A ray of light has been drawn from a man's head to the image sensor.



**Fig. 9.1**

- (i) On Fig. 9.1 draw a ray of light from the man's **hand** to show where it will be detected on the image sensor of the camera. [2]
- (ii) The image is formed on the image sensor.

Circle the **two** correct words or phrases that describe the image.

**diminished**

**enlarged**

**inverted**

**same size**

**upright**

[2]

- (iii) The camera detects visible light, and has an infrared sensor.

Write **visible light** and **infrared** in the correct positions in the electromagnetic spectrum in Fig. 9.2.



[2]

Fig. 9.2

- (b) The camera is used to photograph a thunder storm.

Thunder and lightning are caused at the same time. The photographer sees the flash of lightning before he hears the thunder.

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

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

- (ii) Explain why an astronaut orbiting the Earth in a space-station sees the lightning but does **not** hear the thunder.

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

(c) When electronic equipment is recycled, some of the materials can be sorted using magnets.

(i) In a recycling factory an electromagnet is used to sort steel from other metals.

Explain why an electromagnet is used to sort the steel.

.....

.....

..... [2]

(ii) Some materials at the recycling factory were tested to see if they conducted electricity.

Complete Table 9.1 by placing a tick (✓) in the electrical conductor column or electrical insulator column to correctly describe each material.

**Table 9.1**

	electrical conductor	electrical insulator
aluminium		
cardboard		
copper		
polystyrene		
PVC		

[2]

[Total: 13]



10 Fig. 10.1 is a drawing of a person doing a parachute jump.

Before the jump the person experiences a large increase in the production of the hormone adrenaline, which targets the liver and the heart.



Fig. 10.1

(a) Describe how adrenaline is transferred to the heart and the liver.

.....

..... [1]

(b) Place ticks (✓) in the boxes to show **all** the effects of adrenaline on the body in Table 10.1.

Table 10.1

decreased pulse rate	
increased breathing rate	
increased transpiration	
mutation of DNA	
widened pupils	

[2]



(c) One other effect of adrenaline is an increased rate of respiration.

(i) State the word equation for respiration.

..... [2]

(ii) State why respiration is needed for muscle contraction.

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

(d) Respiration is one of the characteristics of living things.

State two **other** characteristics of living things.

1 .....

2 ..... [2]

[Total: 8]

11 Petroleum and natural gas are extracted from the Earth.

(a) Gasoline is a useful product made from petroleum by fractional distillation.

(i) State a use for gasoline.

..... [1]

(ii) State **one other** useful product made from petroleum by fractional distillation.

..... [1]

(b) Compound **G** is the main constituent of natural gas.

(i) State the name of compound **G**.

..... [1]

(ii) Fig. 11.1 is a diagram of one molecule of compound **G**.

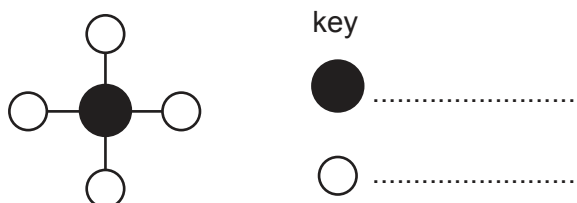


Fig. 11.1

On Fig. 11.1, complete the key to identify the atoms in the molecule of **G**. [1]

(c) Alkanes are **saturated** compounds.

Alkenes are **unsaturated** compounds.

(i) Describe a test and its results that shows whether a compound is an alkane or an alkene.

test .....

result with an alkane .....

.....

result with an alkene .....

.....

[2]

(ii) Describe the difference in the covalent bonding in alkanes and in alkenes.

.....

..... [1]

(iii) State the name of the chemical reaction that makes alkenes from alkanes.

..... [1]

[Total: 8]

12 (a) Fig. 12.1 shows a circuit containing a battery of 4 cells.

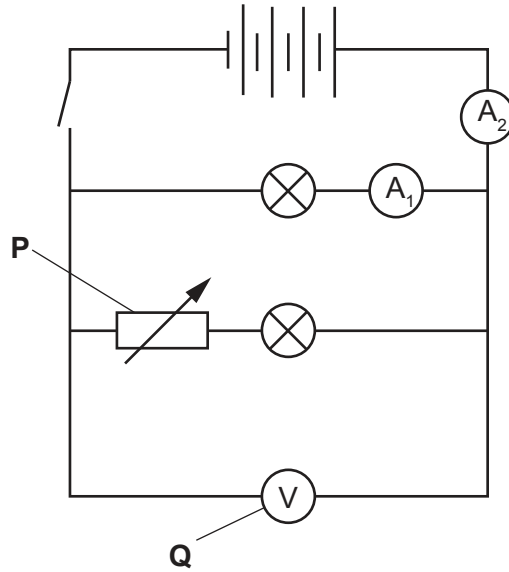


Fig. 12.1

(i) Name the components P and Q.

component P .....

component Q .....

[2]

(ii) The battery is a source of electromotive force (e.m.f.).

State the unit of e.m.f.

unit = .....

[1]

(iii) The switch is closed and both lamps light up.

Readings are recorded on ammeters A<sub>1</sub> and A<sub>2</sub>.

Describe the difference, if any, in the readings of A<sub>1</sub> and A<sub>2</sub>.

Explain your answer.

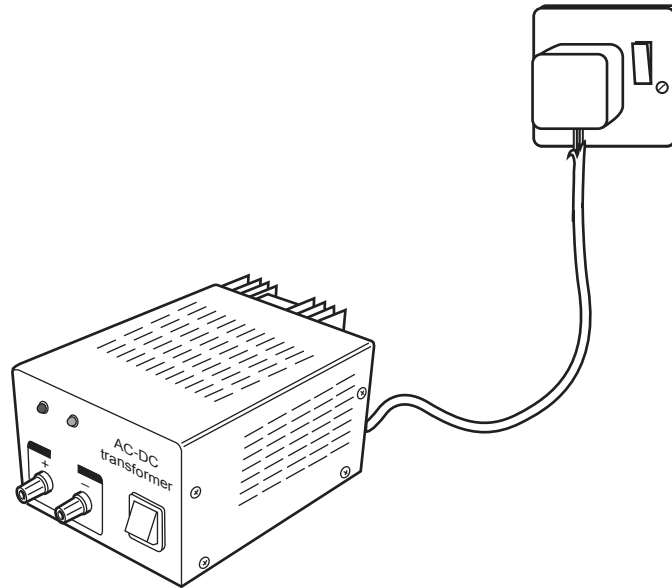
difference .....

explanation .....

.....

[2]

(b) Fig. 12.2 shows a mains operated d.c. power source.



**Fig. 12.2**

Identify one electrical hazard on Fig. 12.2.

..... [1]

(c) Argon gas is used in some types of lamp.

An argon atom has the chemical symbol  ${}_{18}^{40}\text{Ar}$ .

State the composition of the nucleus of an atom of Argon.

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

(d) A sample of radioactive rock was tested to see if it emitted  $\alpha$ -particles.

(i) Describe how a radiation detector could be used to show that  $\alpha$ -particles were being emitted.

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

(ii) When the sample of radioactive rock is removed from the detector, the detector continues to record some radiation.

Explain this observation.

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

[Total: 11]

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## The Periodic Table of Elements

		Group															
I	II	III	IV	V	VI	VII	VIII										
3 Li lithium 7	4 Be beryllium 9	1 H hydrogen 1	5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20									
11 Na sodium 23	12 Mg magnesium 24	<b>Key</b> atomic number atomic symbol name relative atomic mass															
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium —	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium —	85 At astatine —	86 Rn radon —
87 Fr francium —	88 Ra radium —	89–103 actinoids	104 Rf rutherfordium —	105 Db dubnium —	106 Sg seaborgium —	107 Bh bohrium —	108 Hs hassium —	109 Mt meitnerium —	110 Ds darmstadtium —	111 Rg roentgenium —	112 Cn copernicium —	114 Fl flerovium —	116 Lv livermorium —	—	—	—	—

lanthanoids

actinoids

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

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