Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

CO-ORDINATED SCIENCES **0654/43**

Paper 4 (Extended) **October/November 2018**

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.

DC (ST/JG) 153919/3

CAMBRIDGE International Examinations

1 Fig. 1.1 shows a diagram of the male reproductive system.

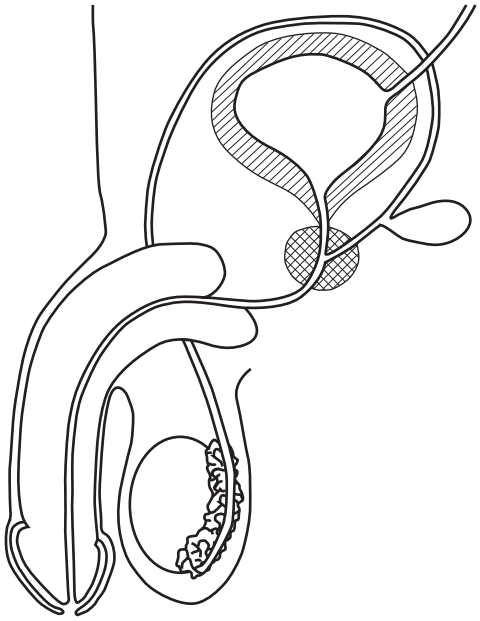

Fig. 1.1

(a) (i) Mark an **X** on Fig. 1.1 to show where sperm cells are made. [1]

(ii) State the type of cell division that produces sperm cells.

.....[1]

(iii) State **two** structures through which sperm cells must pass on their way out of the body.

1 .....

2 .....
[2]

(b) Table 1.1 compares some of the features of sperm cells and egg cells in humans.

Complete Table 1.1.

Table 1.1

feature	sperm cells	egg cells
size compared to the other sex cell		
number produced during lifetime compared to the other sex cell		
ability to move themselves		unable to move themselves

[3]

(c) The nuclei of sperm cells can be described as haploid.

State the meaning of the term *haploid nuclei*.

.....

.....[1]

(d) During fertilisation, the nuclei of the sperm cell and the egg cell join.

State where in the human body fertilisation occurs.

.....[1]

[Turn over

2 Group VII of the Periodic Table contains reactive non-metallic elements.

In 2016, a new Group VII element was identified. It is called tennessine and has the symbol Ts.

Group VII in the Periodic Table on page 32 does **not** include tennessine. The position of tennessine is shown as an empty box below astatine.

Table 2.1 shows some information about Group VII elements.

Table 2.1

name	symbol	melting point / °C	boiling point / °C	physical state at 20 °C
fluorine	F	–220	–188	
chlorine	C*l*	–102	–34	
bromine	Br	–7	59	
iodine	I	114	184	
astatine	At	302	337	
tennessine	Ts	not known	not known	

(a) (i) Use the information in Table 2.1 to predict the physical states of the Group VII elements at 20 °C.

Write only the words **solid**, **liquid** or **gas** in Table 2.1. [3]

(ii) Explain your answers in **(a)(i)** for:

bromine .....

.....

tennessine. .....

.....

[2]

(b) (i) Predict the number of valency (outer) electrons in an atom of tennessine.

Explain how you used the position of the empty box for tennessine in the Periodic Table to make your prediction.

number of outer electrons .....

explanation .....

.....

[2]

(ii) Use information in the Periodic Table on page 32 to predict the atomic number of tennessine.

atomic number ..... [1]

(iii) Predict **and** explain the total number of electrons in an atom of tennessine.

number of electrons .....

explanation .....

.....

.....
[1]

(c) State **and** explain, in terms of numbers of protons and electrons, the electrical charge of a chloride ion.

charge .....

explanation .....

.....

.....
[2]

3 **(a)** Fig. 3.1 shows the speed-time graph for part of a journey made by a train.

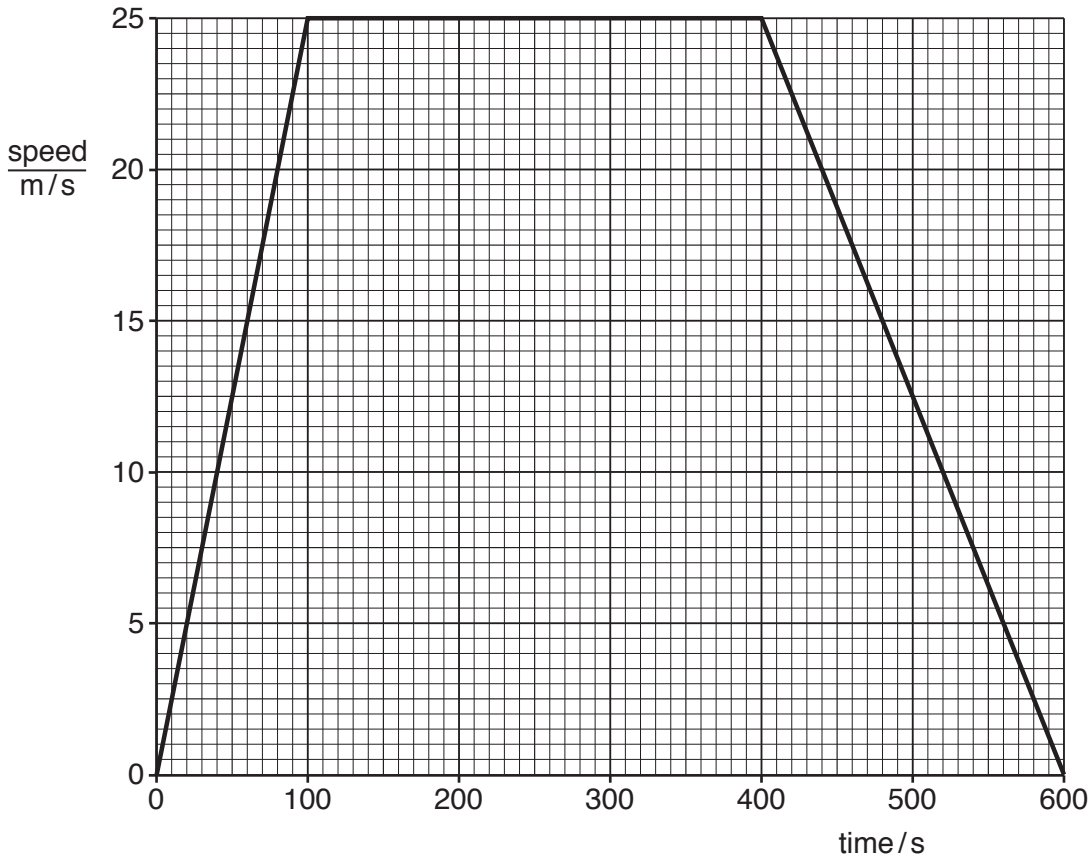

Fig. 3.1

(i) Show that the acceleration of the train at 60 s is 0.25 m/s^2.

State the formula that you use and show your working.

formula

working

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

(ii) The train has a mass of 7.5×10^5 kg.

Calculate the resultant force causing an acceleration of $0.25\,m/s^2$.

State the formula you use and show your working.

formula

working

force = ... N [2]

(b) The electric motor in the train operates at 2000 V. The electrical supply to the train is 25 000 V. A transformer is used to reduce the voltage.

Complete the sentences about a transformer using words from the list.

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

copper **current** **iron** **plastic**

primary **secondary** **voltage**

An alternating ..... passes through the primary coil. This produces a magnetic field that continuously changes direction. The soft ..... core increases the strength of the magnetic field. The changing magnetic field passes through the secondary coil, inducing a ..... across the ends of the coil. In order to reduce the 25 000 V supply to 2000 V, the transformer in the train has more turns on the ..... coil than on the ..... coil. [3]

4 Fig. 4.1a and Fig. 4.1b show an eye of the same person in two different environments.

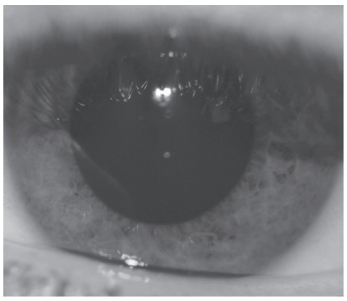

Fig. 4.1a

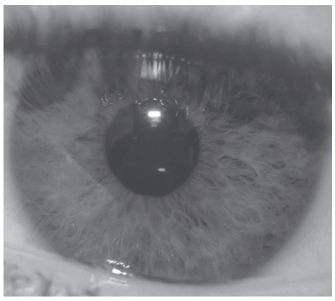

Fig. 4.1b

(a) **(i)** Suggest how the environment of the eye in Fig. 4.1b is different from the environment of the eye in Fig. 4.1a.

.....[1]

(ii) Describe the changes that occur in the eye to cause the response seen in Fig. 4.1b.

.....

.....

.....[2]

(b) Explain the importance of the pupil reflex.

.....[1]

(c) The boxes on the left show some of the parts of the eye.

The boxes on the right show the functions of these parts of the eye.

Draw four lines to link each part of the eye with its correct function.

part of eye	**function**
ciliary muscle	carries impulses to brain
cornea	contracts and relaxes to enable the eye to focus on near or distant objects
lens	refracts light and focuses light onto the retina
optic nerve	refracts light as it enters the eye

[3]

5 **(a)** Five elements are listed in order of reactivity.

aluminium	most reactive
carbon	
iron	
copper	
gold	least reactive

Identify a **metallic** element from the list that is:

extracted from its oxide in a blast furnace

.....

obtained from its oxide by electrolysis

.....

found in the Earth as the uncombined metal.

.....

[2]

(b) Fig. 5.1 shows apparatus a student uses to investigate the reaction between excess zinc powder and copper sulfate solution.

She uses a temperature sensor to record the temperature during the investigation.

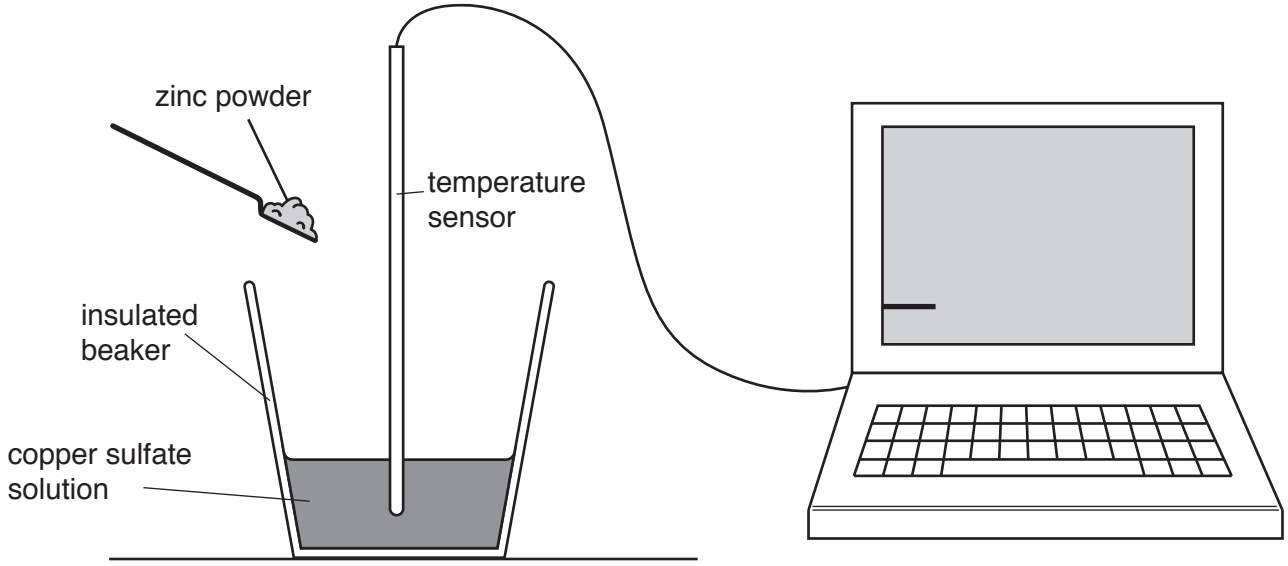

Fig. 5.1

She stirs the copper sulfate solution for one minute and then adds the zinc powder.

She continues to stir the mixture for a further eight minutes.

Fig. 5.2 shows a graph of the results.

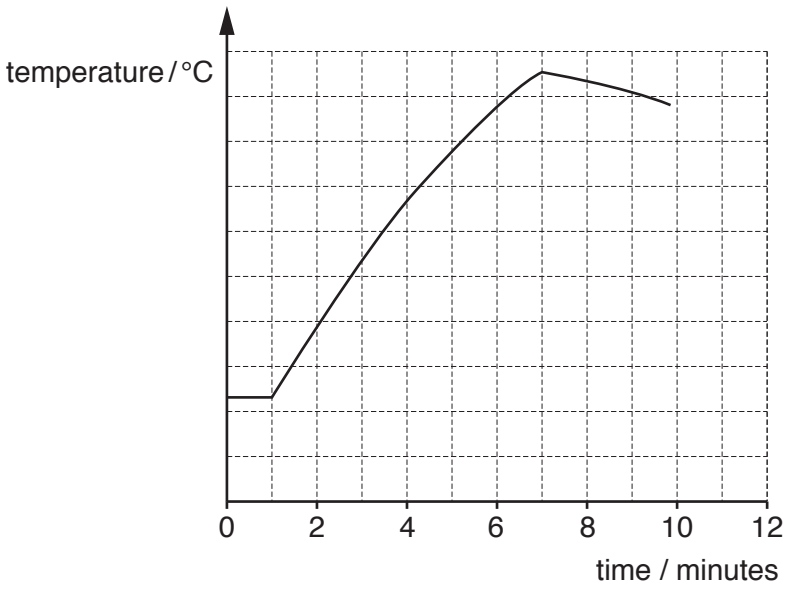

Fig. 5.2

(i) State the term used to describe all chemical reactions that cause an increase in temperature.

.....[1]

(ii) State the energy change that occurs in the reaction between zinc and copper sulfate solution.

from [..... energy] to [..... energy]

[1]

(iii) State for how long the zinc reacts with the copper sulfate solution.

..... minutes [1]

(c) The reaction between aqueous copper ions and zinc atoms is represented by the ionic equation shown.

$$Cu^{2+}(aq) + Zn(s) \longrightarrow Zn^{2+}(aq) + Cu(s)$$

Explain how this equation shows that zinc atoms are oxidised.

.....

.....[1]

(d) The student repeats her experiment.

She uses copper sulfate solution that has a **higher** concentration, but she does not change any other variable.

State how the rate of reaction in the second experiment compares with the rate of reaction in the first experiment.

Explain your answer using ideas about collisions between aqueous copper ions and zinc atoms.

.....

.....

.....

.....

.....[3]

6 **(a)** X-rays and γ-rays are both used in hospitals.

They are both examples of ionising radiation.

Before using an X-ray machine, the doctor moves and stands behind a lead screen.

(i) Describe how X-rays are a hazard to living things.

.....

.....[1]

(ii) Suggest why the screen is made of lead.

.....

.....[1]

(b) **(i)** State, in terms of waves, the meaning of the term *frequency*.

.....

.....[1]

(ii) The speed of all electromagnetic waves *in vacuo* is 3×10^8 m/s.

X-rays have a wavelength of 5 nm. (1 nm = 10^{-9} m).

Calculate the frequency of X-rays.

State the formula you use and show your working.

formula

working

frequency = ... Hz [2]

(c) Fig. 6.1 shows a cylinder containing oxygen used in a hospital.

Fig. 6.1

(i) Describe how the oxygen molecules exert a pressure on the wall of the cylinder.

.....

.....

.....[2]

(ii) The cylinder releases 350 dm^3 of oxygen into the atmosphere at a pressure of 101 000 Pa.

The volume inside the cylinder is 3.0 dm^3.

Calculate the pressure of the oxygen in the cylinder before the gas is released.

The temperature of the oxygen does not change.

State the formula you use and show your working.

formula

working

pressure = ... Pa [2]

(d) Doctors use radium-223 to treat body cancers.

Small quantities of radium-223 are put inside the body.

Radium-223 has a half-life of 11.43 days and emits α-radiation.

(i) Suggest why an α-source is used to treat cancer cells.

.....

.....[1]

(ii) Suggest why radium-223 is a suitable α-source for this purpose.

.....

.....[1]

(iii) $^{223}_{88}Ra$ decays by α-emission to produce an isotope of radon.

Use the correct nuclide notation to complete a symbol equation for this decay process.

$$^{223}_{88}Ra \longrightarrow {}^{\cdots\cdots}_{\cdots\cdots}Rn + {}^{\cdots\cdots}_{\cdots\cdots}He$$ [2]

7 Fig. 7.1 shows the percentage of the population of different age groups that smoke in a country. Fig. 7.1 includes data from the years 2001 and 2011.

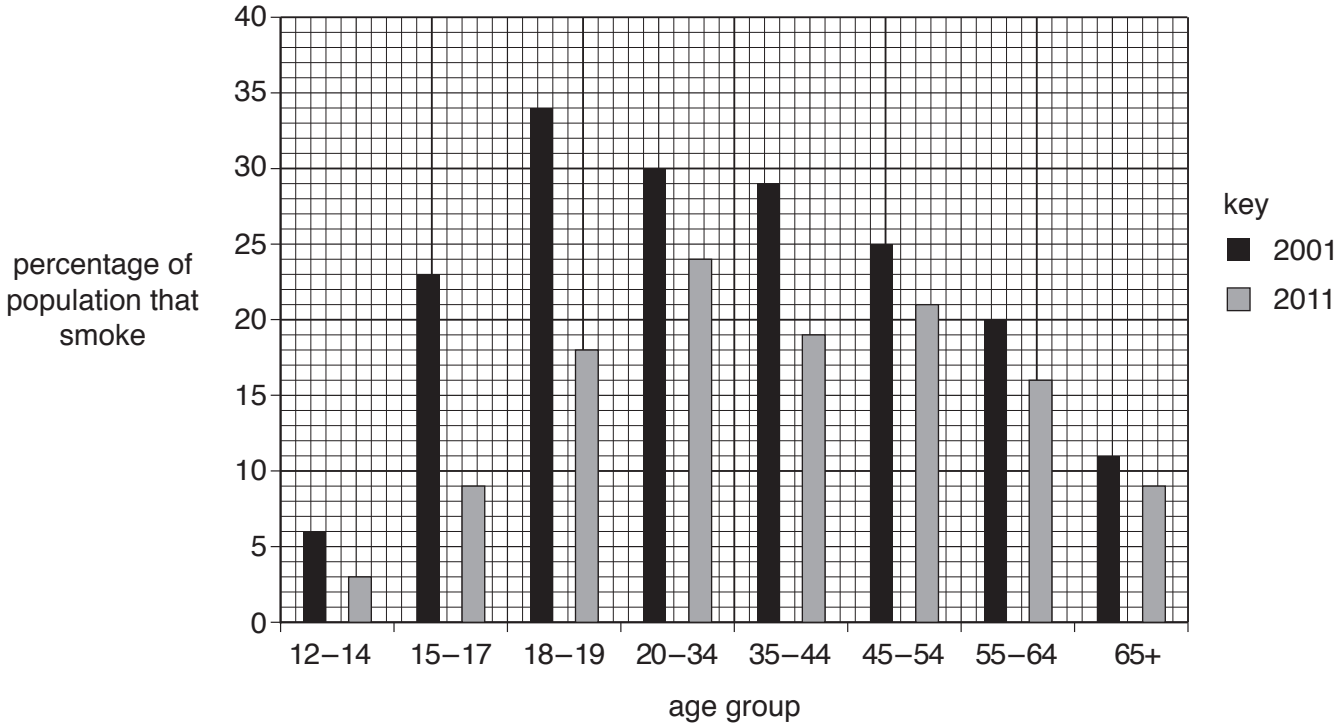

Fig. 7.1

(a) (i) State the age group containing the largest percentage of smokers in **2011**.

.....[1]

(ii) State the percentage of 55–64 year old people who smoked in **2001**.

.....[1]

(iii) Use Fig. 7.1 to describe the trends in percentage of smokers as age increases in **2001**.

.....

.....

.....[2]

(iv) Suggest **one** reason why there is a difference between the percentage of smokers in all age groups in 2011 compared to 2001.

.....

.....[1]

[Turn over

(b) When a cigarette is burnt, it produces smoke particles.

Describe how the gas exchange system removes smoke particles from airways.

Use the words **mucus** and **cilia** in your answer.

.....

.....

.....[2]

8 Sulfur is found in compounds and as an element.

(a) Fig. 8.1 represents how atoms are arranged in a molecule of solid sulfur.

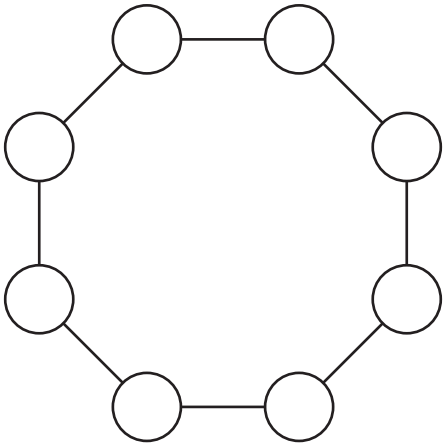

Fig. 8.1

State the chemical formula of this sulfur molecule.

.....[1]

(b) Natural gas contains the impurity hydrogen sulfide, H_2S.

(i) Fig. 8.2 shows the outer electrons of a sulfur atom and of a hydrogen atom.

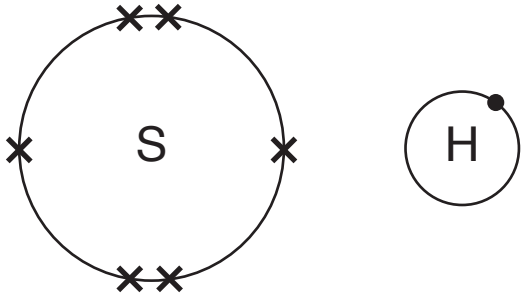

Fig. 8.2

Draw a dot-and-cross diagram below to show the covalent bonding in a hydrogen sulfide molecule.

Show all the outer shell electrons in your diagram.

[2]

(ii) Explain why sulfur compounds are removed from fuels before the fuels are burned.

.....

.....

.....[2]

(c) Sulfur is a raw material used in the Contact process.

Fig. 8.3 shows part of the Contact process in which sulfur dioxide molecules are oxidised.

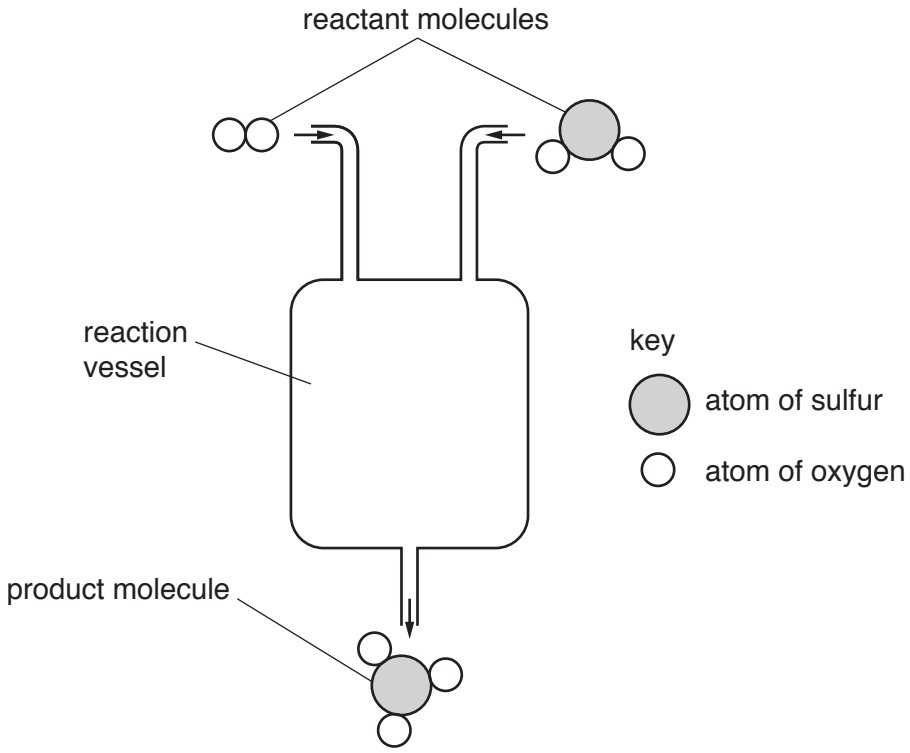

Fig. 8.3

(i) State **two** of the conditions required for the reaction taking place inside the reaction vessel shown in Fig. 8.3.

1 .....

2 .....
[2]

(ii) **Name** the compound that is produced when sulfur dioxide is oxidised.

.....[1]

(iii) Use the information in Fig. 8.3 to construct the **balanced symbol** equation for the oxidation of sulfur dioxide.

.....[2]

9 **(a)** In the school science laboratory, a student investigates how the resistance of a circuit component **Z** changes with temperature.

Fig. 9.1 shows his results.

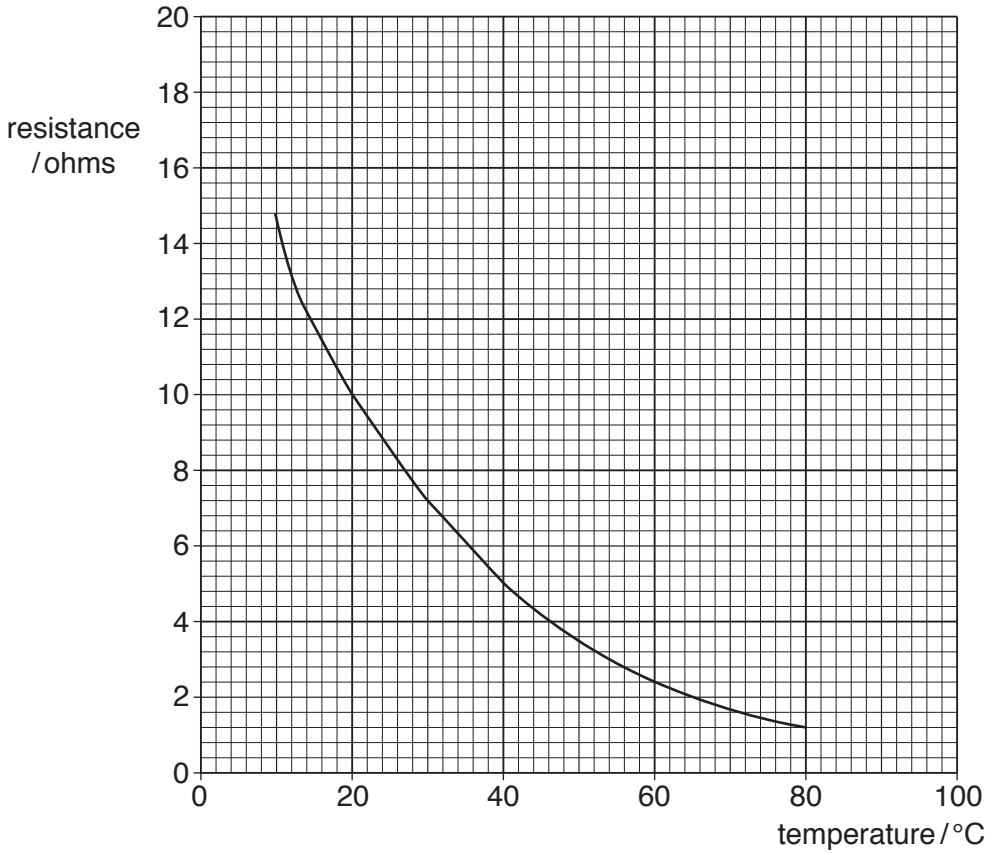

Fig. 9.1

(i) Name component **Z**.

.....[1]

(ii) State the resistance of component **Z** at 20 °C.

..... Ω [1]

(iii) Calculate the current passing through component **Z** at 20 °C when a 6 V supply is connected across it.

State the formula you use and show your working.

formula

working

current = ... A [2]

(b) To change the temperature around component **Z**, it is placed in a plastic bag in a water bath.

The water bath contains 4.0 kg of water at an initial temperature of 15 °C.

To raise the temperature of the water to 80 °C requires 1087 kJ.

Calculate the specific heat capacity of water.

State the formula you use and show your working.

formula

working

specific heat capacity = ... kJ / (kg°C) [2]

(c) At the end of the lesson, a bell rings. The bell produces sound waves.

The sound waves travel through the air as a series of compressions and rarefactions.

Describe, in terms of particles, the difference between a compression and a rarefaction.

.....

.....[1]

10 Two plant cells are placed in different solutions.

- Plant cell **A** is placed in a concentrated salt solution.
- Plant cell **B** is placed in water.

Fig. 10.1 shows the appearance of the plant cells after one hour.

plant cell **A** plant cell **B**

Fig. 10.1

(a) (i) Explain the appearance of plant cell **B**.

.....

.....

.....

.....

.....[4]

(ii) An animal cell is placed in water.

Predict what will happen to the animal cell during the next hour.

Give a reason for your answer.

prediction .....

reason .....

.....
[2]

(b) Plant cells in leaves are adapted to carry out photosynthesis.

(i) State the **balanced symbol** equation for photosynthesis.

.....[2]

(ii) Describe **one** way in which plant cells in leaves are adapted for photosynthesis.

.....

.....[1]

11 Ethene, C_2H_4, has the smallest molecules in the homologous series of alkenes.

(a) **(i)** State the name of the alkene that contains three carbon atoms in each of its molecules.

.....[1]

(ii) Complete the structure in Fig. 11.1 to show an alkene molecule that contains **four** carbon atoms.

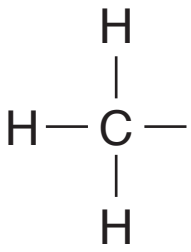

Fig. 11.1

[2]

(b) Ethene reacts with bromine to form the compound dibromoethane, $C_2H_4Br_2$.

The balanced equation for the reaction is shown.

$$C_2H_4 + Br_2 \longrightarrow C_2H_4Br_2$$

(i) State the type of chemical reaction that occurs between ethene and bromine.

.....[1]

(ii) Deduce the colour, if any, of the compound dibromoethane.

Explain your answer.

colour .....

explanation .....

.....[2]

(c) Ethene reacts with steam to produce ethanol, C_2H_5OH.

The balanced equation for the complete combustion of ethanol is shown.

$$C_2H_5OH + 3O_2 \longrightarrow 2CO_2 + 3H_2O$$

Complete **steps 1** to **4** to calculate the volume of oxygen gas that reacts with 1.15 g of ethanol.

Show your working.

step 1
Show that the relative formula mass of ethanol is 46.

[A_r: C, 12; H, 1; O, 16]

.....

step 2
Calculate the number of moles of ethanol in 1.15 g.

number of moles of ethanol = ...

step 3
Using your answer to **step 2** and the balanced equation, state the number of moles of oxygen that reacts with 1.15 g of ethanol.

number of moles of oxygen = ...

step 4
Using your answer to **step 3**, calculate the volume, in dm^3, of oxygen gas that reacts with 1.15 g of ethanol.
[Molar gas volume = 24 dm^3]

volume of oxygen gas = ... dm^3
[4]

12 (a) The body of a car is usually made from steel.

The bodies of some cars are made from aluminium.

Suggest a simple way of deciding whether the body of a car is made from either steel or aluminium.

Explain your answer.

.....

.....

..... [1]

(b) In a car, relays are often used as switches in electrical circuits that use large currents.

Explain why relays are used in this way.

.....

.....

.....[1]

(c) A car driver uses mirrors to see behind the car.

Fig. 12.1 shows a ray of light striking a mirror.

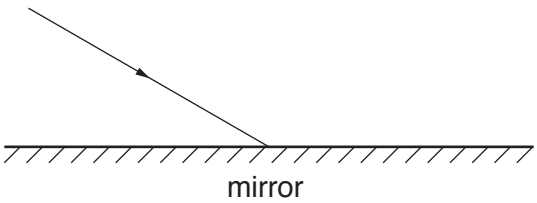

Fig. 12.1

(i) On Fig. 12.1, draw the normal at the point where the ray strikes the mirror **and** label with the word ***normal***. [1]

(ii) On Fig. 12.1, draw the reflected ray **and** label with the words ***reflected ray***. [1]

(iii) On Fig. 12.1, mark the angle of reflection **and** label with the letter ***r***. [1]

(d) Fig. 12.2 shows a black car and a white car.

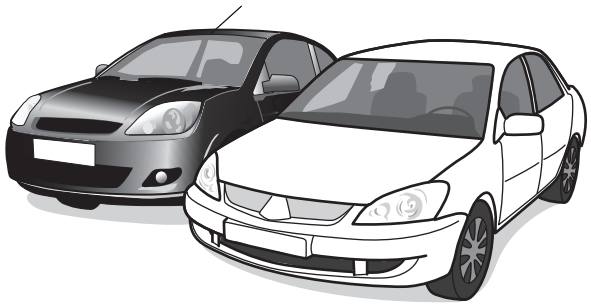

Fig. 12.2

The cars are parked next to each other on a sunny day.

Suggest why the black car gets hotter than the white car.

.....

.....[1]

(e) The black car accelerates up a hill.

Apart from thermal energy, state **two** forms of energy gained by the car as it accelerates up the hill.

1 ..... energy

2 ..... energy

[2]

(f) During a journey, the black car travels 1500 m along a straight road in 90 s.

The driving force of the car's engine is 14 000 N.

(i) Calculate the work done by the driving force.

State the formula you use and show your working.

formula

working

work done = ... J [2]

(ii) Calculate the useful power output from the car's engine during this period.

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

formula

working

power = ... unit ..... [3]

13 (a) Table 13.1 shows the average global temperature of the Earth's surface from 1880 to 1980.

Table 13.1

year	average global temperature / °C
1880	13.6
1900	13.7
1920	13.8
1940	14.0
1960	13.9
1980	14.2

(i) Calculate the difference in temperature between the years 1880 and 1980.

.....°C [1]

(ii) State the name given to gases such as carbon dioxide and methane that contribute to global warming.

.....[1]

(iii) Explain how carbon dioxide is thought to cause global warming.

.....

.....

.....[2]

(b) State **two** biological processes that release carbon dioxide into the atmosphere.

1 .....

2 .....
[2]

(c) Deforestation slows down the removal of carbon dioxide from the atmosphere.

State **and** explain the effect that deforestation has on the concentration of oxygen in the atmosphere.

.....

.....

.....[2]

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The Periodic Table of Elements

Group

I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											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											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
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 –		

Key

atomic number atomic symbol name relative atomic mass

lanthanoids	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
actinoids	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^3 at room temperature and pressure (r.t.p.).