Centre Number	Index Number	Name

CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CO-ORDINATED SCIENCES 0654/03

Paper 3

May/June 2003

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 in the spaces provided on the Question Paper.
You may use a soft pencil for any diagrams, graphs, tables or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions.
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.
A copy of the Periodic Table is printed on page 24.

If you have been given a label, look at the details. If any details are incorrect or missing, please fill in your correct details in the space given at the top of this page.

Stick your personal label here, if provided.

For Examiner's Use	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
Total	

This document consists of **21** printed pages and **3** blank pages.

MML 3040 4/02 S38078/4

UNIVERSITY of CAMBRIDGE
Local Examinations Syndicate

1 **(a)** Fig. 1.1 shows a flower which is pollinated by insects.

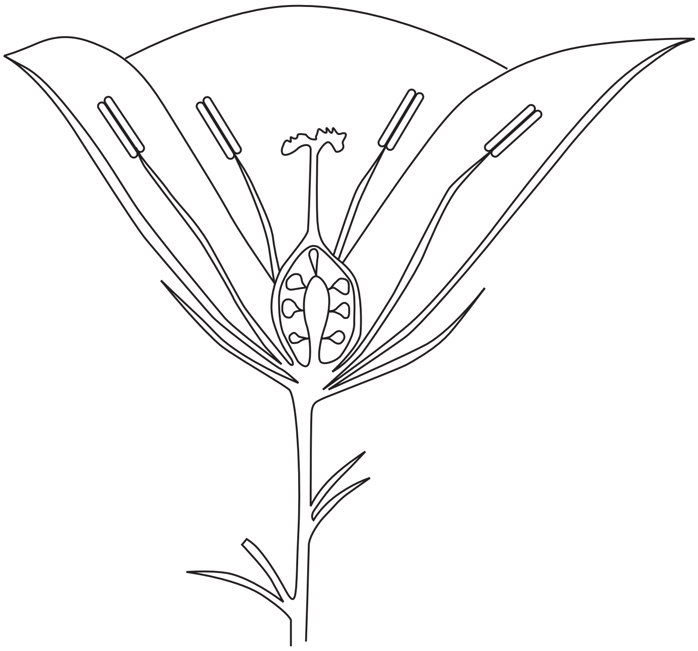


Fig. 1.1

(i) On Fig. 1.1, draw label lines to each of the following:

- a place where pollen grains are made, and label it **M**
- a place where pollen grains are deposited, and label it **D**. [2]

(ii) Describe two structures, visible in Fig. 1.1, which indicate that this is an insect-pollinated flower and not a wind-pollinated flower.

1. ....

....

2. ....

.... [2]

(iii) Explain the difference between **pollination** and **fertilisation** in a flower.

....

....

....

.... [3]

For Examiner's Use

(b) After fertilisation, the ovule develops into a seed inside a fruit. Fruits help to disperse seeds.

(i) **Name** one example of a plant whose fruits or seeds are dispersed by animals. Describe how the structure of these fruits or seeds helps them to be dispersed in this way. You may draw a labelled diagram if this helps your answer.

....

....

....

[2]

(ii) Outline two ways in which fruit or seed dispersal is advantageous to plants.

1. ....

....

2. ....

.... [2]

2 **(a)** A 30 dm^3 steel cylinder contained air at atmospheric pressure.

Another 100 dm^3 of air, which had also been at atmospheric pressure, was pumped into the cylinder. Atmospheric pressure is 100 000 N/m^2.

(i) State the total volume of air at atmospheric pressure before compression.

.... [1]

(ii) Calculate the final pressure of the air inside the cylinder.

Show your working and state any formula that you use.

.... [2]

(iii) When the pressure in the cylinder was actually measured it was found to be 450 000 N/m^2.

Suggest why this value is different from the value you calculated in **(ii)**.

....

....

....

.... [2]

For Examiner's Use

(b) Fig. 2.1 shows a heat sensor. The plate activates the alarm when the sensor gets too hot.

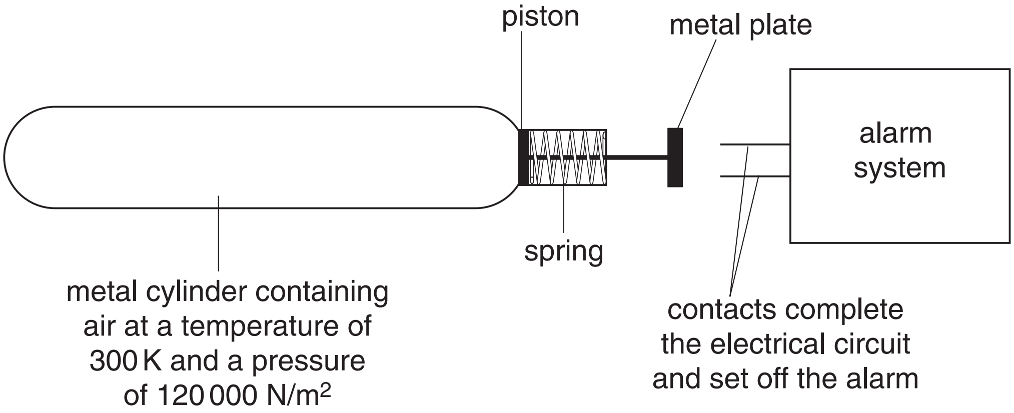


Fig. 2.1

(i) Suggest how this sensor works.

....

....

....

.... [3]

(ii) The pressure in the metal tube is 120 000 N/m^2 at 300 K.

A pressure of 180 000 N/m^2 is required to activate the alarm.

Calculate the minimum temperature, in K, at which the alarm is activated.

Show your working and state any formula that you use.

.... [2]

[Turn over

3 Fig. 3.1 shows apparatus used to record both temperature and pH during a neutralisation reaction between hydrochloric acid and potassium hydroxide.

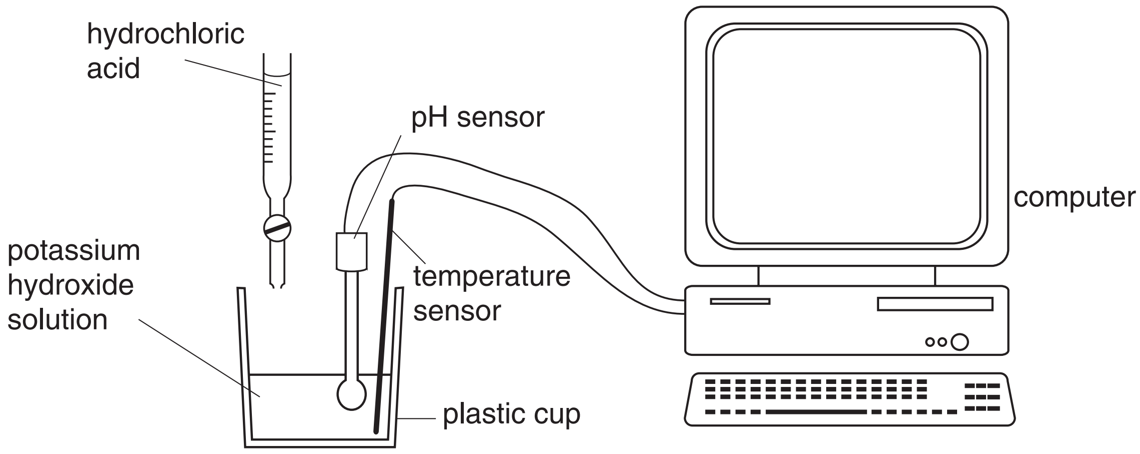


Fig. 3.1

Fig. 3.2 shows the display on the computer screen at the end of the experiment.

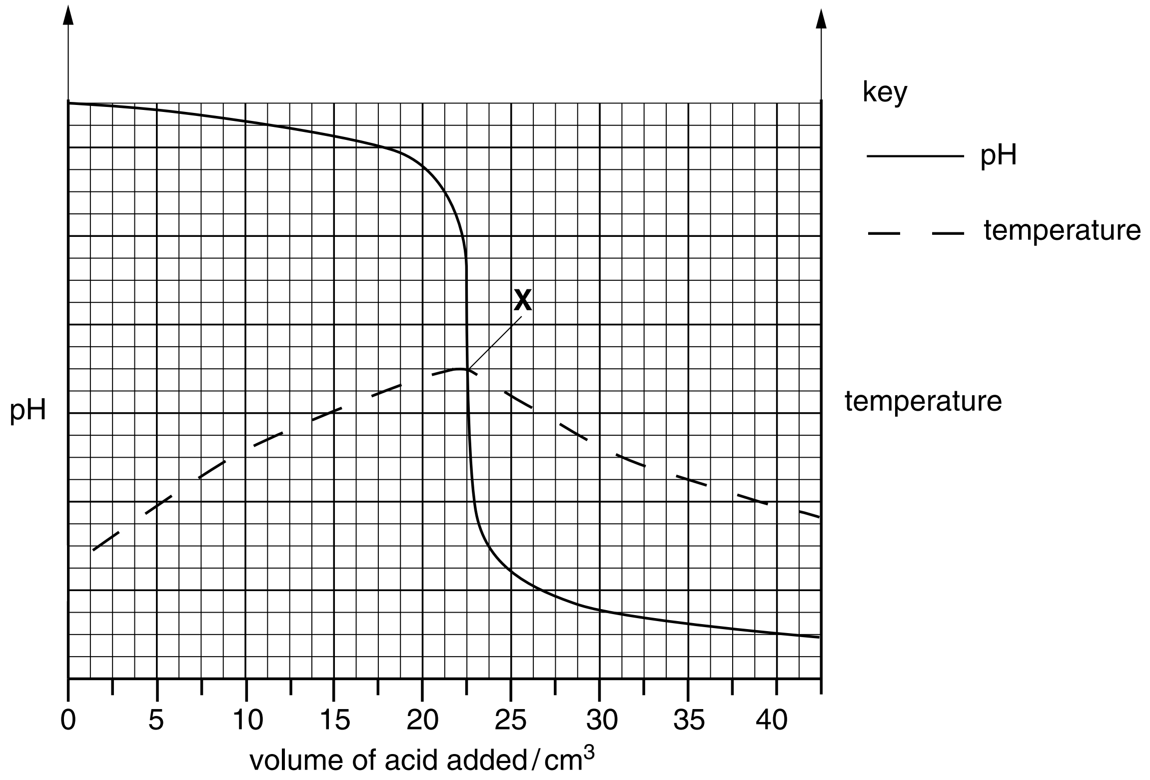


Fig. 3.2

(a) **(i)** State the evidence shown on the screen that neutralisation is an exothermic reaction.

....

....

.... [2]

(ii) Predict and explain the value of pH at the point **X**.

....

....

.... [2]

(iii) Use the information in Fig. 3.2 to find the volume of hydrochloric acid which just neutralised the potassium hydroxide solution.

.... [1]

(b) **(i)** Write a balanced equation for the reaction between hydrochloric acid and potassium hydroxide.

.... [2]

(ii) State the **two** ions which react together in a neutralisation reaction to form water molecules.

.... [2]

(c) **(i)** Calculate the mass of 0.1 mol of potassium hydroxide.

Show your working and state the unit.

.... [2]

(ii) Calculate the mass of potassium hydroxide which must be dissolved in 0.25 dm^3 of water to make a solution whose concentration is 0.1 mol / dm^3.

Show your working and state the unit.

.... [2]

4 (a) (i) Complete Fig. 4.1 to show the composition of inspired and expired air.

gas	percentage in inspired air	percentage in expired air
carbon dioxide	0.03	
oxygen		18
nitrogen	78	

Fig. 4.1 [3]

(ii) Name **one** other gas which is always present in unpolluted air.

.... [1]

(b) A 30 year old man volunteered to take part in an investigation into the effect of carbon dioxide concentration on his rate of breathing. He sat quietly in an enclosed chamber in which the composition of the air could be controlled. Each time the composition of the air was altered, the investigators waited for 5 minutes before measuring his breathing rate.

The same experiment was repeated with an echidna (a small mammal which lives in Australia) instead of the man. The results of both experiments are shown in Fig. 4.2.

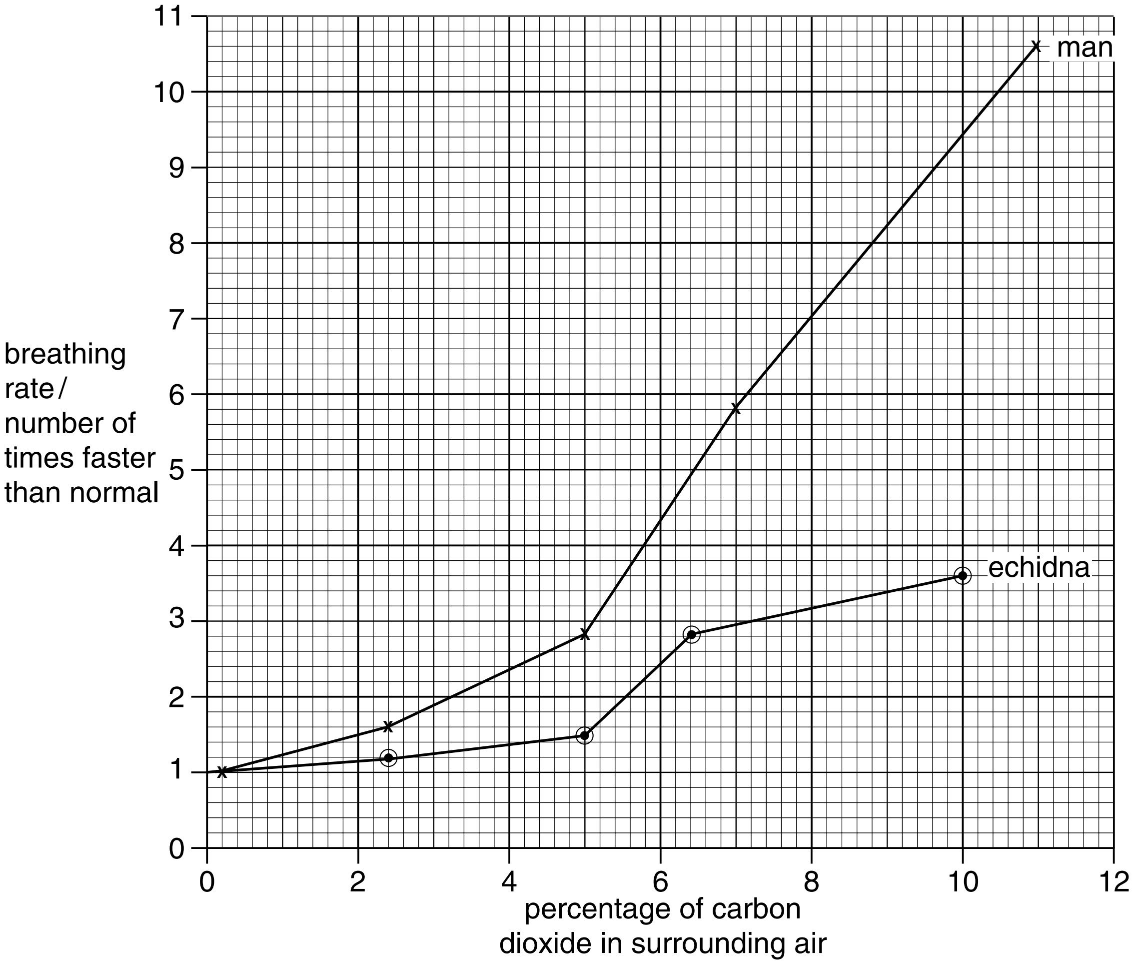


Fig. 4.2

(i) Suggest why the investigators waited for five minutes before measuring the breathing rate in each new carbon dioxide concentration.

....

.... [1]

(ii) Fig. 4.2 shows that both the man and echidna breathed faster as carbon dioxide concentration increased.

Give two ways in which the response of the echidna to increasing carbon dioxide concentration is different from the response of the man.

1. ....

....

2. ....

.... [2]

(c) The brain actually detects the concentration of carbon dioxide in the blood, not the concentration in the air. When the concentration of carbon dioxide in the air increases, so does the concentration of carbon dioxide in the blood.

(i) With reference to gas exchange in the lungs, explain why the concentration of carbon dioxide in the air affects the concentration of carbon dioxide in the blood.

....

....

.... [2]

(ii) Suggest why it is useful for the breathing rate to increase when the concentration of carbon dioxide in the blood increases.

....

....

.... [2]

For Examiner's Use

(d) Complete the statements for the boxes with dotted lines to show the major blood vessels and the parts of the heart through which a carbon dioxide molecule would pass as it travelled from a muscle towards the lungs.

from the muscle

↓

into the vena cava
(large vein)

↓

into the right …………………… of the heart

↓

into the ……………………

…………………… of the heart

↓

into the pulmonary

……………………

↓

into the capillaries
in the lungs

[4]

For Examiner's Use

5 **(a)** Many power stations burn fossil fuels to generate electricity.

(i) Give two reasons why scientists and engineers are developing alternative methods of producing electricity that do not use fossil fuels.

1. ....

....

2. ....

.... [2]

(ii) Give **one** disadvantage of nuclear power stations compared to power stations that burn fossil fuels.

....

.... [1]

(iii) Give **one** disadvantage of using wind turbines to generate electricity compared to power stations that burn fossil fuels.

....

.... [1]

(b) Transformers alter the voltage of the electricity generated at a power station.

(i) Explain why this is done.

....

....

.... [2]

(ii) A transformer at a power station steps up the voltage from 25 000 V to 400 000 V.

Use the equation $\frac{Vp}{Vs} = \frac{Np}{Ns}$ to calculate the ratio of turns on the primary coil to turns on the secondary coil.

....

.... [2]

[Turn over

6 Ammonia is made industrially by combining nitrogen from the air with hydrogen in the Haber process.

Fig. 6.1 shows a simplified diagram of the reaction vessel in the Haber process.

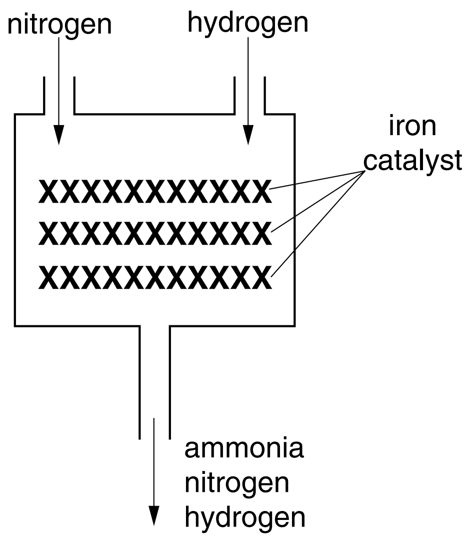


Fig. 6.1

(a) Describe a chemical test for ammonia.

....

....

.... [2]

(b) **(i)** Suggest a reason why the gas leaving the reactor in Fig. 6.1 is not pure ammonia.

....

.... [1]

(ii) Suggest and explain what would happen to the percentage of ammonia if the iron catalyst was not present.

....

....

.... [2]

(c) Much ammonia is oxidised to produce nitric acid, HNO_3. Ammonia and nitric acid react together to form ammonium nitrate which is used as a fertiliser.

(i) Explain briefly, in terms of its properties, why plants are not able to use nitrogen gas directly.

....

.... [1]

(ii) Name **two** substances that are required to convert ammonia to nitric acid.

....

.... [2]

(d) Describe how a solution of ammonia could be used to prepare crystals of ammonium sulphate. You should name the other substance required and describe the main steps in the process.

....

....

....

....

....

....

.... [4]

7 A farmer sprayed fertilisers containing ammonium nitrate onto a field in which young wheat seedlings were growing.

(a) Explain why farmers often add nitrogen-containing fertilisers to the soil where crops are growing.

....

....

.... [2]

(b) **(i)** Describe how the ammonium and nitrate ions would be absorbed by the wheat plants.

....

....

.... [2]

(ii) Name the tissue that would transport the ammonium and nitrate ions through the plant.

.... [1]

(c) Some of the fertiliser was washed into a river which ran alongside the wheat field.

Fig. 7.1 shows how this affected the numbers of bacteria, algae and fish in the river, downstream from the wheat field. It also shows how it affected the oxygen concentration.

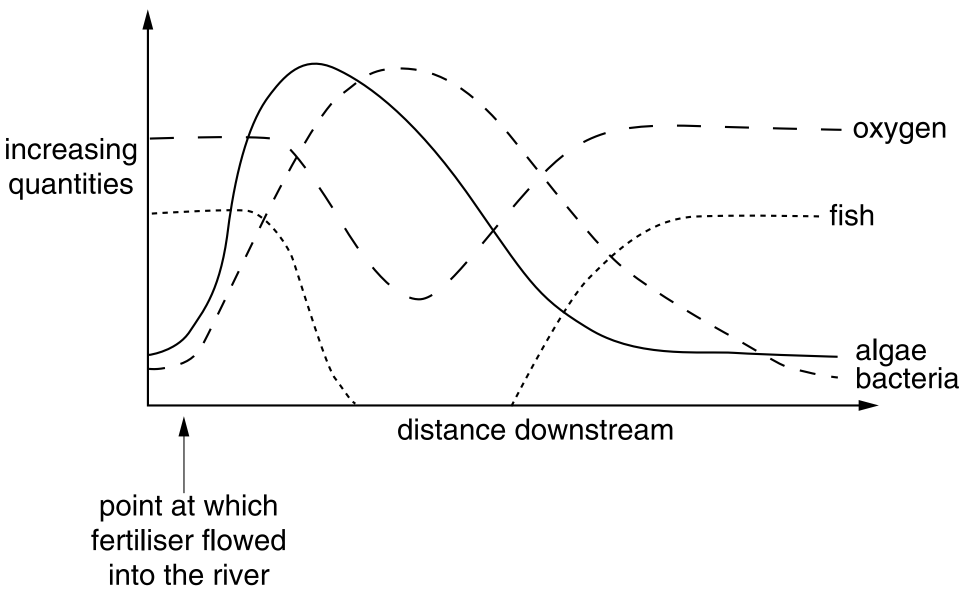


Fig. 7.1

(i) Explain the shape of the curve for the numbers of algae.

....

....

.... [2]

(ii) With reference to the curves for bacteria and oxygen in Fig. 7.1, explain the shape of the curve for fish.

....

....

....

....

.... [4]

8 **(a)** Fig. 8.1 shows the electrical circuit inside a device that can circulate air around a room. It can also be used to heat this air.

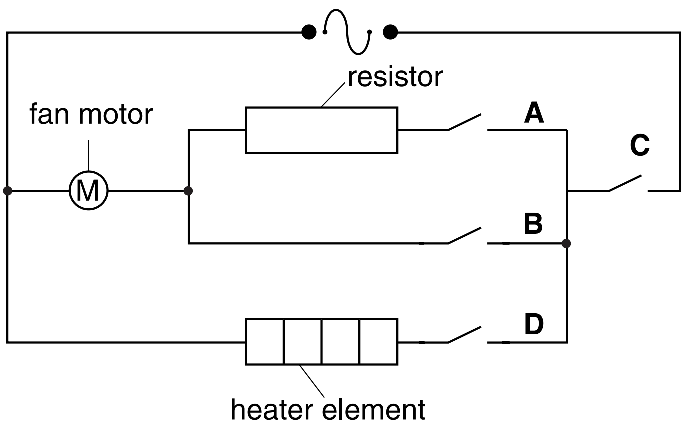


Fig. 8.1

The fan motor must be switched on to blow air.

The heater must be switched on for the air to be warmed.

When the resistor is part of the circuit, the fan motor goes more slowly.

(i) Complete the table in Fig. 8.2 to show which switches must be on to give the results shown.

result	switch **A**	switch **B**	switch **C**	switch **D**
cold air, blown slowly	on	off	on	off
hot air, blown slowly				
cold air, blown quickly				
hot air, blown quickly				

Fig. 8.2

[3]

(ii) Explain why the fan motor goes more slowly when the resistor is part of the circuit.

....

.... [2]

(iii) State the potential difference across the heater element when switches **B**, **C** and **D** are all on.

.... [1]

(iv) Explain why, for every coulomb of electric charge flowing through the heater element, 240 joules of heat energy are released.

....

.... [1]

(b) A different heater element is used to heat a 2 kg sample of water from 20 °C to 70 °C.

The specific heating capacity of water is 4200 J / kg °C.

Calculate the minimum amount of energy which the heater must have supplied.

Show your working and state any formula that you use.

.... [3]

For Examiner's Use

9 A gas fire heats a room by burning methane (natural gas).

When the fire is working properly, the waste gases do not enter the room but leave through a chimney.

(a) **(i)** State **one** natural source of methane (natural gas).

....

.... [1]

(ii) Methane has the chemical formula CH_4. Draw a dot and cross diagram of a methane molecule showing how the outer electrons are arranged.

[2]

(iii) Propane is an alkane which has three carbon atoms in each of its molecules.

Draw the displayed (graphical) formula of a propane molecule.

[2]

(iv) Complete the **word** equation for the complete combustion of propane.

propane + oxygen $\longrightarrow$ .... + ...

[2]

(b) Sometimes the chimney of a gas fire can become blocked, and waste gases containing carbon monoxide, CO, can escape into the room. Carbon monoxide is a colourless gas which has no odour.

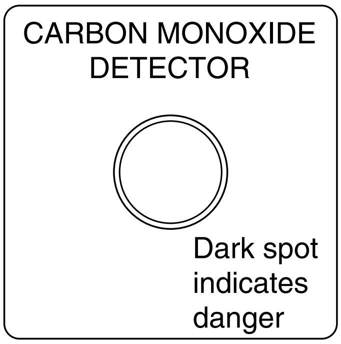
(i) The symbolic equation for the incomplete combustion of methane is shown below. This equation is not balanced.

Balance the equation.

$$CH_4 \quad + \quad O_2 \longrightarrow 2CO \quad + \quad 4H_2O$$

[1]

(ii) Carbon monoxide detectors have a coloured spot which becomes darker when carbon monoxide is present in the air.



The coloured spot contains palladium chloride, $PdCl_2$.

The charge of a chloride ion is Cl^-. Deduce the charge of a palladium ion. Explain your answer.

....

....

.... [2]

(iii) Suggest why it is advisable to place a carbon monoxide detector in a room which is heated by a gas fire.

....

....

....

.... [2]

[Turn over

For Examiner's Use

10 **(a)** **(i)** A car travelling at 60 km / h has four times the kinetic energy of the same car travelling at 30 km / h.

Explain this by means of a calculation.

[2]

(ii) Use your answer to **(i)** to explain why the speed of a car involved in an accident with a pedestrian makes such a big difference to the injuries caused.

....

....

.... [2]

(b) A car of mass 1000 kg is travelling along a road. The driver applies the brakes which give a constant force of 4000 N.

(i) Calculate the deceleration of the car.

Show your working and state any formula that you use.

.... [2]

(ii) The car took 32 metres to stop.

Use the formula

$$\text{distance} = {}^{1}/_{2}\,at^{2}$$

to calculate the time taken to stop.

.... [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** Sulphur 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 †															
				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

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

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.).