Candidate Name Mark Scheme

Centre Number	Candidate Number

International General Certificate of Secondary Education
UNIVERSITY OF CAMBRIDGE LOCAL EXAMINATIONS SYNDICATE

CO-ORDINATED SCIENCES 0654/3

PAPER 3

Monday **18 MAY 1998** Afternoon 2 hours

Candidates answer on the question paper.
No additional materials are required.

Bio ✓
Chem ✓
Phys ✓

TIME 2 hours

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces at the top of this page.
Answer **all** questions.
Write your answers in the spaces provided on the question paper.

INFORMATION FOR CANDIDATES

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.
You may use a calculator.

FOR EXAMINER'S USE	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

This question paper consists of 22 printed pages and 2 blank pages.

[Turn over

1 (a) (i) Complete the table.

formula of ion	*number of protons*	*number of electrons*
Ag^+	47	46
O^{2-}	8	10

[2]

(ii) Use the information in the table to deduce the chemical formula of silver oxide. Show your reasoning.

$2 \times Ag^+$ balances $1 \times O^{2-}$ in charge

$2 \times (+1) + 1 \times (-2) = 0$

Ag_2O

[2]

(b) Silver can be found uncombined in nature. Zinc is found only in compounds, and has to be extracted from these compounds.

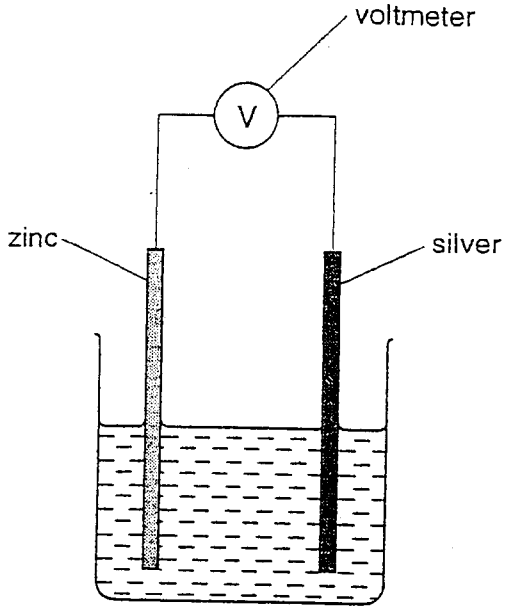
Explain this difference in terms of the relative positions of these metals in the reactivity series.

Zinc is quite reactive and therefore will be found combined with other elements

Silver is very unreactive and therefore found uncombined [2]

For Examiner's Use

(c) Strips of zinc and silver can be used as electrodes in a simple electrical cell.



(i) Suggest which **two** of the liquids below could be used in this cell, so that a voltage would be recorded by the voltmeter.

Explain your answer.

ethanol, C_2H_6O (*l*)
heptane, C_7H_{16} (*l*)
sodium chloride solution, NaCl (*aq*)
zinc sulphate solution, $ZnSO_4$ (*aq*)

liquids which can be used ..... NaCl(aq) or ZnSO4(aq) .....

.....

explanation ..... liquid needs to be an electrolyte ie contain free/mobile charged particles (ions) when can complete the circuit, ethanol & heptane are molecular ..... [3]

(ii) By using the idea of metal reactivity, explain how the voltage of the cell could be **increased** by changing **one** of the electrodes.

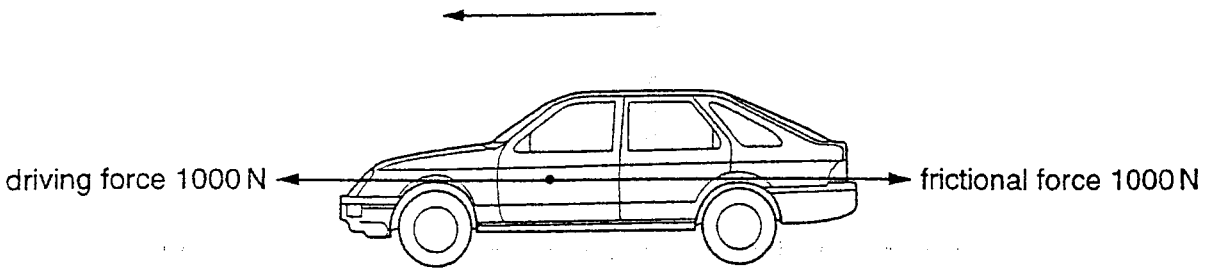
..... change zinc for a more reactive metal such as magnesium gold/platinum
..... or change silver for a less reactive metal " " "
reason — the larger the difference in the reactivity the greater the voltage ..... [2]

For Examiner's Use

(d) Explain briefly why batteries used in watches need to be replaced regularly, whereas car batteries do not.

car batteries are re-chargeable whereas batteries in watches are not (ie when the chemical reaction in the battery is complete, the process cannot be reversed) [2]

2 The diagram shows the driving force and frictional force acting on a car of mass 1000 kg travelling forward at a constant speed of 20 m/s.



(a) How much work is done by the driving force in one minute? Show your working and state any formula which you use.

$W = Fxd = 1000 \times (20 \times 60)$

$= 1200\,000$ J

[3]

(b) Why does the car not accelerate?

The forces balance.

[1]

(c) (i) The kinetic energy of the car travelling at this speed is 200 000 J.

Calculate the kinetic energy of the same car when it is travelling at a speed of 40 m/s.

Show your working and state any formula which you use.

$KE = \frac{1}{2}mv^2 = \frac{1}{2} \times 1000 \times 40^2$

$= 800\,000$ J

[3]

For Examiner's Use

(ii) The car is stopped using a braking force of 8000 N.

Calculate the distance needed to stop the car when it is travelling at 20 m/s and at 40 m/s.

Discuss the significance of your answers.

Show your working and state any formula which you use.

$W = F \times d$ so $d = W/F$

20 m/s :

$\frac{200\,000}{8000} = 25\text{m}$

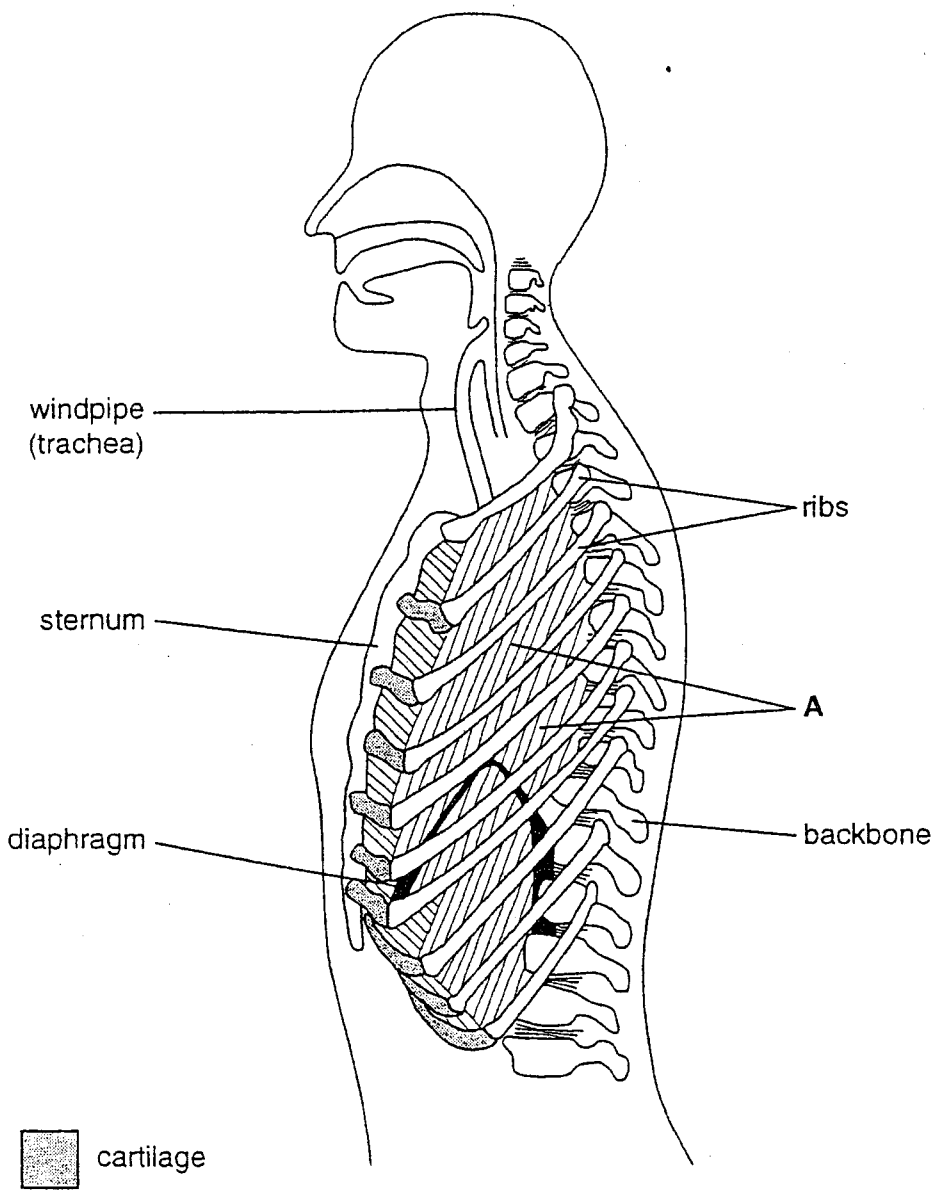
40 m/s :

$\frac{800\,000}{8000} = 100\text{m}$

- If the speed doubles, the distance is 4 times greater.
- Increasing speed causes a much greater braking distance, therefore much more chance of an accident. [5]

For Examiner's Use

3 The diagram shows some of the contents of a person's thorax, while they are breathing out.



(a) The ribs, backbone and sternum are made of bone. The shaded parts at the ends of the ribs are made of cartilage.

(i) Describe **one** difference between the properties of bone and cartilage.

Bone is harder than Cartilage

[1]

(ii) Suggest why these parts of the ribs are made of cartilage rather than bone.

flexibility to allow lung expansion

[1]

For Examiner's Use

(b) (i) Name the structures labelled **A**.

Intercostal Muscles [1]

(ii) Describe the action of these structures when the person breathes **in**, and explain how this helps air to be drawn into the lungs.

Any 4 points

Contraction of intercostal muscles;
Causes ribs to move up + out;
Increases volume in the thorax;
Reduces pressure in the thorax;
Air moves/forced in from outside;
to equalize pressure;

[4]

(c) (i) Complete the table to show the percentage composition of inspired and expired air.

gas	*percentage of gas in inspired air*	*percentage of gas in expired air*
oxygen	20	16 (1)
carbon dioxide	0.04	4.0
nitrogen	79	79 (1)

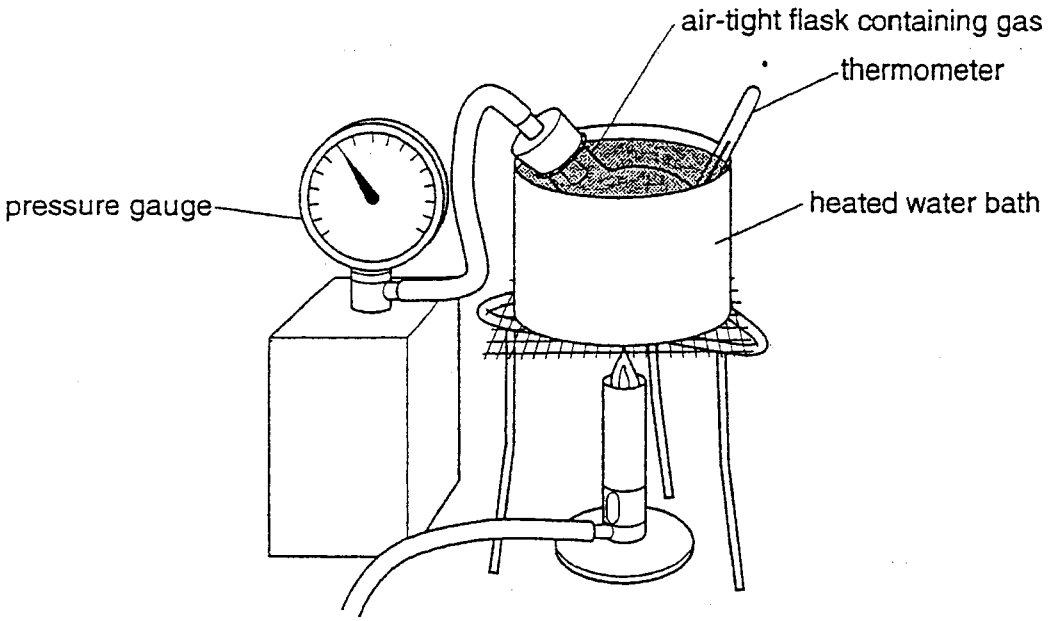
[2]

(ii) Explain why the percentage of carbon dioxide in expired air is greater than that in inspired air.

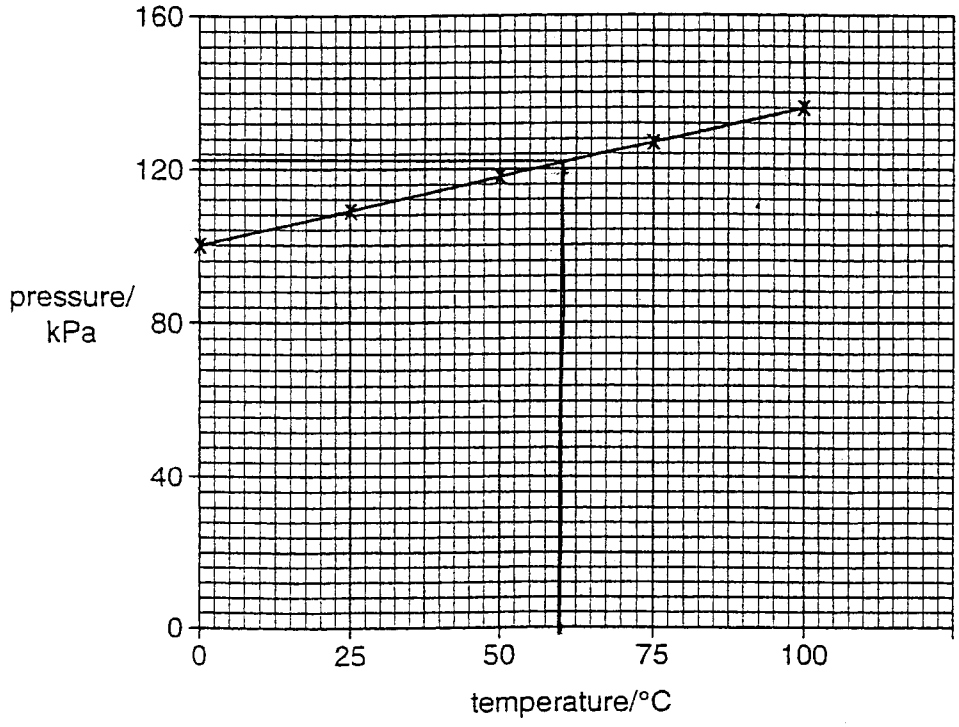
Respiration produces Carbon Dioxide;
Transported to lungs in blood;
Diffuses out of Blood into alveoli;

[3]

4 An experiment is carried out to investigate the relationship between the pressure and temperature of a gas.



A graph of the results is plotted.



(a) (i) What was the pressure when the temperature was 60 °C? Show your working on the graph.

122 kPa

..... [2]

For Examiner's Use

(ii) What is the relationship between the pressure and the temperature?

Pressure ∝ (absolute) temperature.

..... [1]

(iii) The graph shows that the pressure is not zero when the temperature is 0 °C. At what temperature in degrees celsius does the pressure become zero?

−273°C

..... [1]

(b) Explain the results of the experiment in terms of particles.

- When temp. increases particles move faster
- They hit the walls of the flask harder and more frequently
- Exerting a greater force, therefore greater pressure

..... [3]

(c) Explain in terms of particles, why it is easy to compress a gas but very difficult to compress a liquid.

- Gas particles have no bonds, so are far apart and can be easily forced closer together.

(Opposite for liquids) ..... [2]

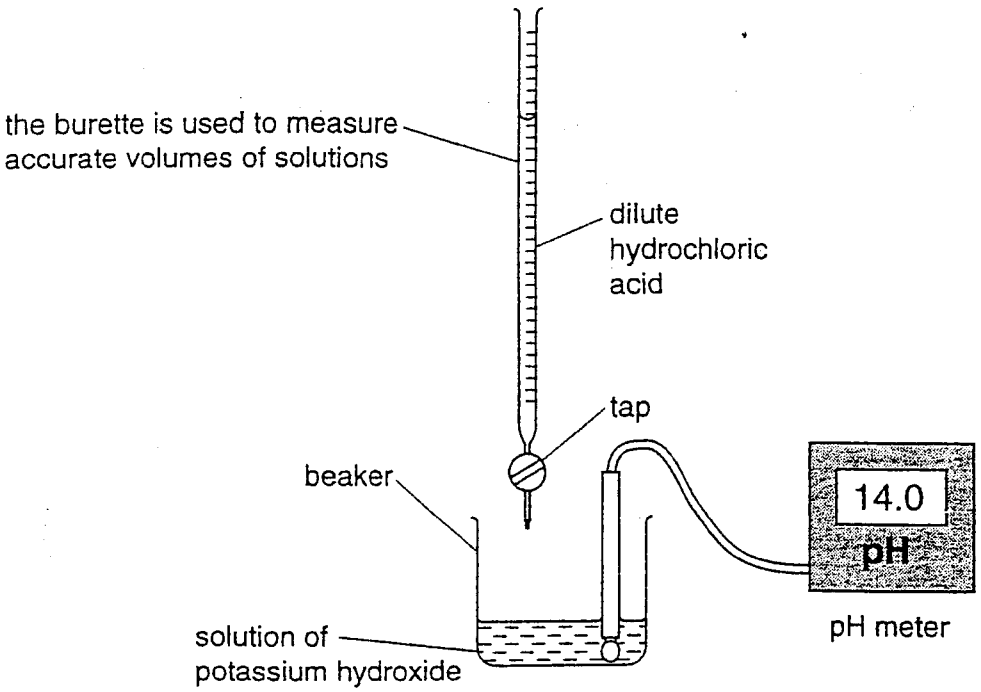
(d) Describe one application where a liquid transmits a force from one place to another.

eg hydraulic brakes on cars.

eg syringes for injections

..... [2]

5 The apparatus in the diagram was used to study the reaction between dilute hydrochloric acid and potassium hydroxide solution. The pH meter measures the pH of the mixture in the beaker.



(a) (i) Name the type of chemical reaction which occurs when the dilute hydrochloric acid is added to the potassium hydroxide solution.

neutralisation [1]

(ii) Complete the chemical equation for the reaction.

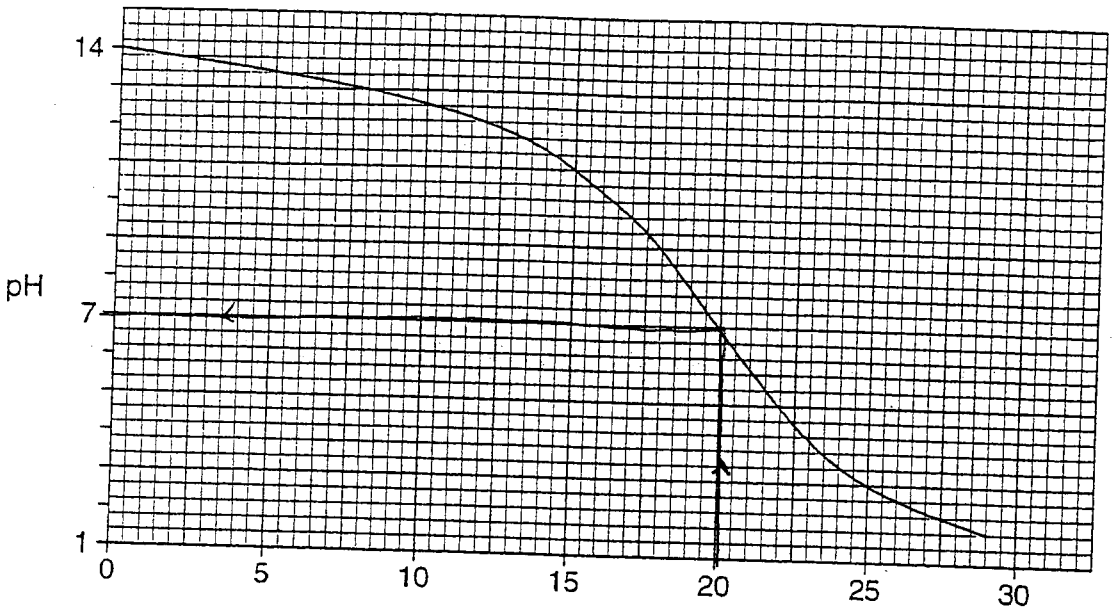
$HCl + KOH \rightarrow$ ...KCl... + ...H_2O... [2]

For Examiner's Use

(b) In the experiment, 20.0 cm^3 of potassium hydroxide solution were placed in the beaker. The concentration of the potassium hydroxide solution was 0.1 mol per dm^3.

The hydrochloric acid was added carefully, in stages, to the beaker, and the pH of the mixture was recorded after each addition.

A graph of the results is shown below.



(i) Using the graph, deduce the total volume of acid added at the point when all the alkali had just been used up.

Explain your answer and show your working on the graph.

20 cm^3. When this volume of acid had been added the mixture was neutral (pH 7) indicating all the acid had been used up [3]

(ii) Deduce the concentration of the acid in mol per dm^3.

Explain your answer.

mols of KOH = mols of HCl (from equation)

mols of KOH used = $\frac{20}{1000} \times 0.1 = 0.002$ = mols of HCl

Volume of HCl used = 20 cm^3

$\Rightarrow$ concentration = $\frac{1000}{20} \times 0.002 = 0.1$ mols/dm^3 [3]

alternative method

Since mols of HCl = mols of KOH and volumes are equal then concentrations are also equal ie 0.1 mols/dm^3!

[Turn over

(c) Calculate the mass of potassium hydroxide crystals needed to give an amount of 0.1 mole. You will need to use information shown in the Periodic Table on page 24. Show your working.

mass = mols × Mr of KOH
= 0.1 × (39 + 16 + 1)
= 0.1 × 56
= 5.6g

..... [3]

6 Sound is transmitted through the air as a longitudinal wave.

(a) Describe how sound waves travel through the air. You may draw a diagram if it helps your answer.

By passing vibrations from particle to particle.

.....

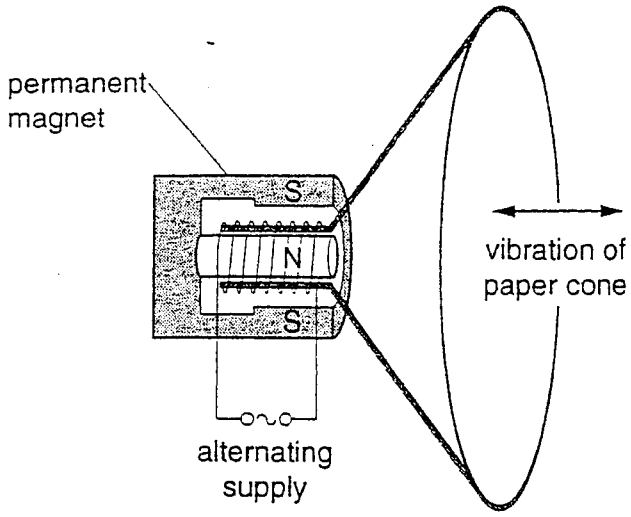
..... [1]

(b) The speed of sound in air is 330 m/s. Calculate the wavelength of a sound wave that has a frequency of 100 Hz. Show your working and state any formula which you use.

$V = f\lambda \quad \lambda = \frac{V}{f} = \frac{330}{100} = 3.3$ m

..... [3]

The diagram shows a loudspeaker.



(c) Explain why the cone vibrates when an alternating current passes through the coil.

- Coil has an alternating magnetic field
- This interacts with the permanent magnetic field
- To produce an alternating force.

[3]

7 In temperate climates, melons are grown in glasshouses. This allows the grower to control temperature and carbon dioxide concentration.

(a) Explain why it is useful for these two factors to be controlled.

(i) *temperature*:

Temperature affects enzyme activity; low temps – enzymes have less energy; fewer collisions; slower rate of reaction; (Higher temps, reverse) except too high temp. leads to denaturing of enzymes; [2]

(ii) *carbon dioxide concentration*:

CO_2 is needed for P/S; ↑ CO_2 Conc. → ↑ rate of P/S; → ↑ growth rate; Provided other factors are not limiting; [2]

Melon plants grown in glasshouses are often infested with red spider mites. The red spider mites feed on the sap of the melon plants, and breed rapidly. If the grower does not control the numbers of red spider mites, then the crop may be destroyed.

An experiment was carried out to compare two ways of controlling the red spider mite populations on a melon crop. Some of the melon plants were sprayed with **chemical pesticides**. Some of the melon plants were treated by **biological control**, using a larger predatory mite which preys on the red spider mites.

The melons were grown in three identical glasshouses.

In **glasshouse 1**, chemical pesticides were sprayed onto the melon plants at intervals from March onwards.

In **glasshouse 2**, the predators were introduced in March.

In **glasshouse 3**, the predators were introduced in February.

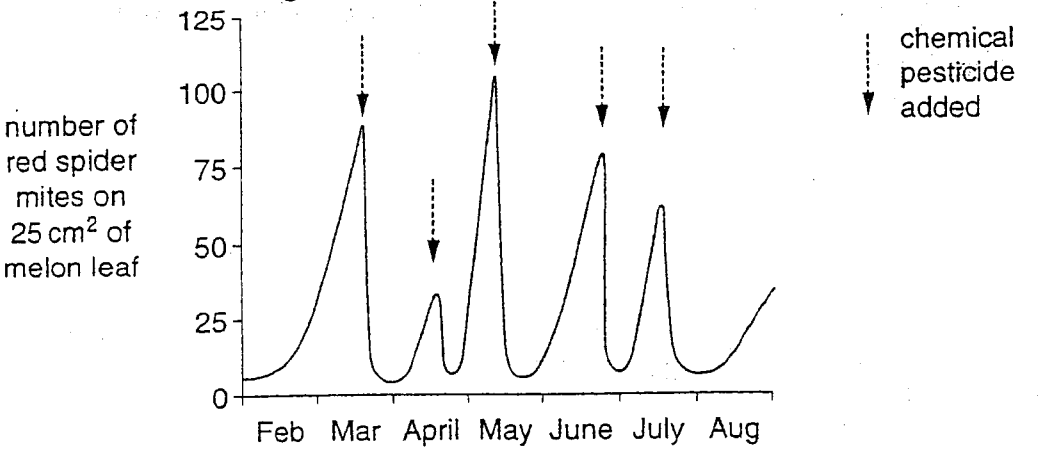
The graphs show the results of the experiments.

(b) (i) Suggest **one** other experiment which should have been done as a control, to see if either the chemical pesticide or the predatory mite had any effect on the population of red spider mites.

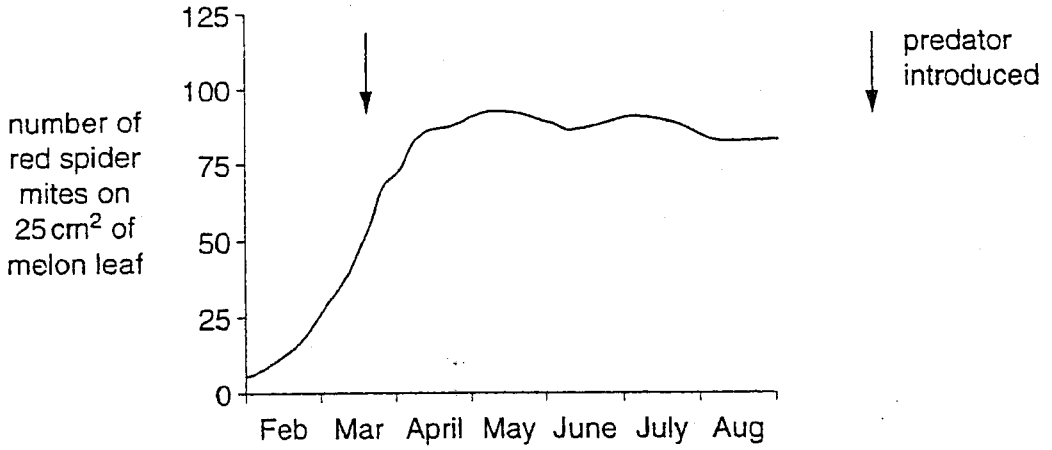
No chemicals or predators [1]

For Examiner's Use

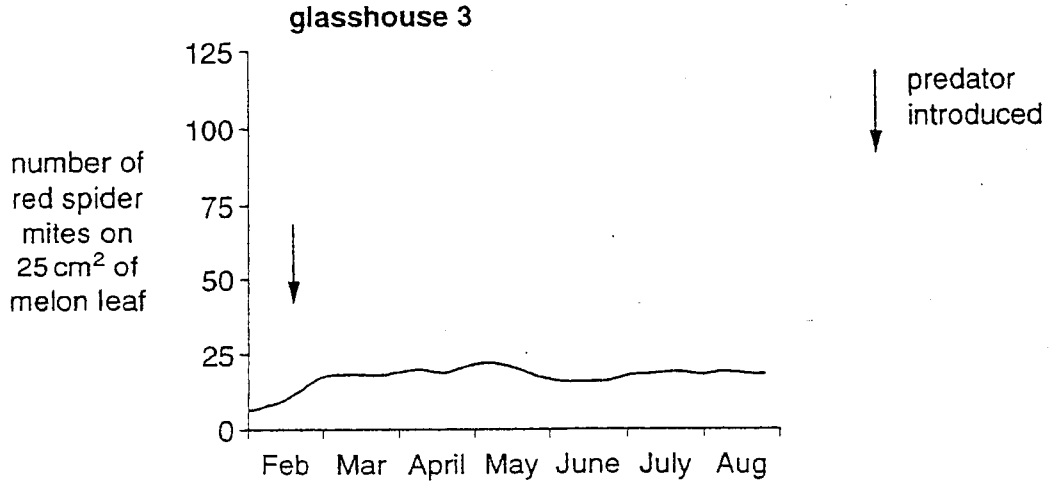
glasshouse 1



glasshouse 2



glasshouse 3



[Turn over

For Examiner's Use

(ii) Suggest **one** other experiment which should have been done, in order to make a fairer comparison between the effectiveness of chemical pesticides and biological control in this situation.

Add the chemical just once ?

[1]

(c) (i) By comparing the results in glasshouses 1 and 3, outline **two** advantages of using biological control rather than chemical pesticides.

advantage 1 Chemicals Not added to Enviroment

advantage 2 Reduces Nº of mites for a Longer period of time
No resistance developed to predators [2]

(ii) By comparing the results in all three glasshouses, outline **one** advantage of using chemical pesticides rather than biological control.

Does not depend on when the contrd is used.

[1]

(d) Suggest why plants are not sprayed with pesticide during the four weeks before the melons are harvested for human consumption.

Pesticide may be toxic to humans;
may be washed of melons by rain in a 4 week period; [2]

For Examiner's Use

8 One of the waste products formed in nuclear power stations is the isotope barium-144. Details of this isotope of barium are

mass number	144
atomic number	56
half life	11 seconds

Barium-144, like other waste products from nuclear reactors, has been formed by nuclear fission.

(a) What happens when fission occurs in a nuclear reactor?

large nuclei split into 2 smaller nuclei

..... [1]

(b) Using the information about barium-144, work out

(i) the number of protons in a barium-144 atom;

56 ..... [1]

(ii) the number of neutrons in a barium-144 atom.

144 − 56 = 88 ..... [1]

(c) Barium-144 decays by beta particle emission.

(i) What is a beta particle?

a (fast moving) electron ..... [1]

(ii) Use the Periodic Table to deduce what element is formed when barium-144 atoms decay.

Lanthanum (ie atomic no. 57) ..... [1]

(d) A scientist was monitoring the activity of the isotope and measured a count rate of 800 counts per second. Calculate the time taken, in seconds, for the count rate to drop to 50 counts per second.

$\frac{800}{50} = 16$ $\quad 2^4 = 16$

4 half-lives = 4 × 11 = 44 seconds

..... [3]

9 (a) A hydrocarbon, **X**, contains 3 carbon atoms in each of its molecules.

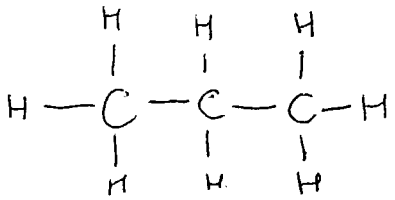
A sample of **X** was shaken up with some bromine solution. The solution remained orange.

(i) Name the homologous series (family of hydrocarbons) to which **X** belongs.

alkanes [1]

(ii) One molecule of **X** contains 8 hydrogen atoms.

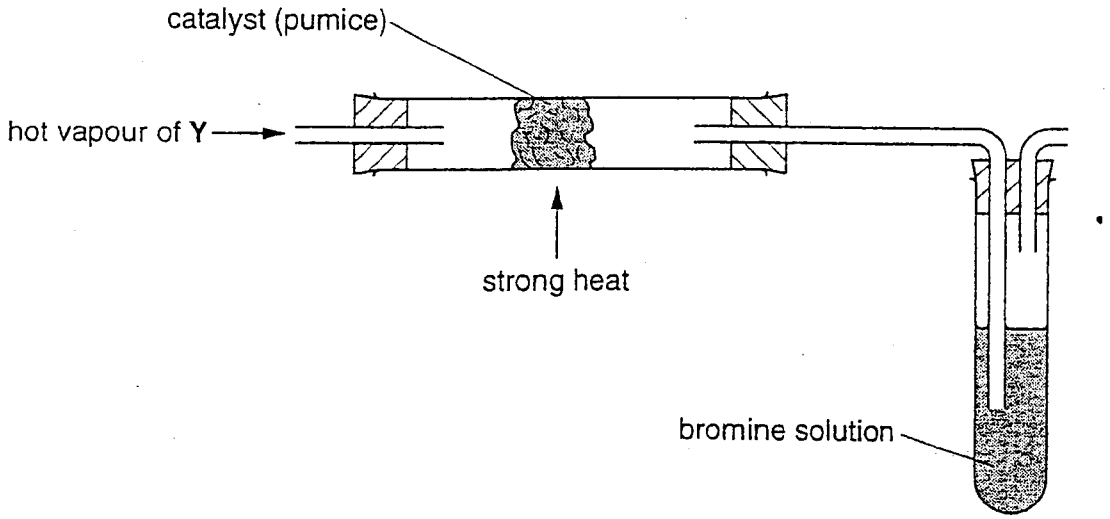
In the space below draw the graphical formula of **X**.



[2]

(b) A saturated liquid hydrocarbon, **Y**, contains 15 carbon atoms per molecule.

Some **Y** was boiled, and the vapour was passed into the apparatus shown below.



The mixture of products was bubbled through the bromine solution. It quickly turned the solution from orange to colourless.

(i) Explain the meaning of the word *saturated* when used to describe hydrocarbon molecules.

contain carbon to carbon bonds [1]

For Examiner's Use

(ii) Name the type of reaction which occurs on the catalyst surface, and explain as fully as you can what is happening in both parts of the apparatus shown in the diagram.

Cracking occurs at the catalyst surface
ie large hydrocarbon molecules are broken
down into smaller molecules, some of which are unsaturated molecules.
In the test tube the unsaturated hydrocarbon
molecules react with the bromine water solution
and change it from orange to colourless (this is an
~~Bromination~~ example of an addition reaction)

[4]

(c) Methane, CH_4, and steam are important as raw materials for the production of hydrogen gas. The hydrogen produced can be used in industry to make ammonia.

(i) Balance the equation.

$$CH_4 + H_2O \rightarrow CO + 2\,H_2$$ [1]

(ii) Write a **word** equation for the industrial formation of ammonia.

nitrogen + hydrogen → ammonia

[1]

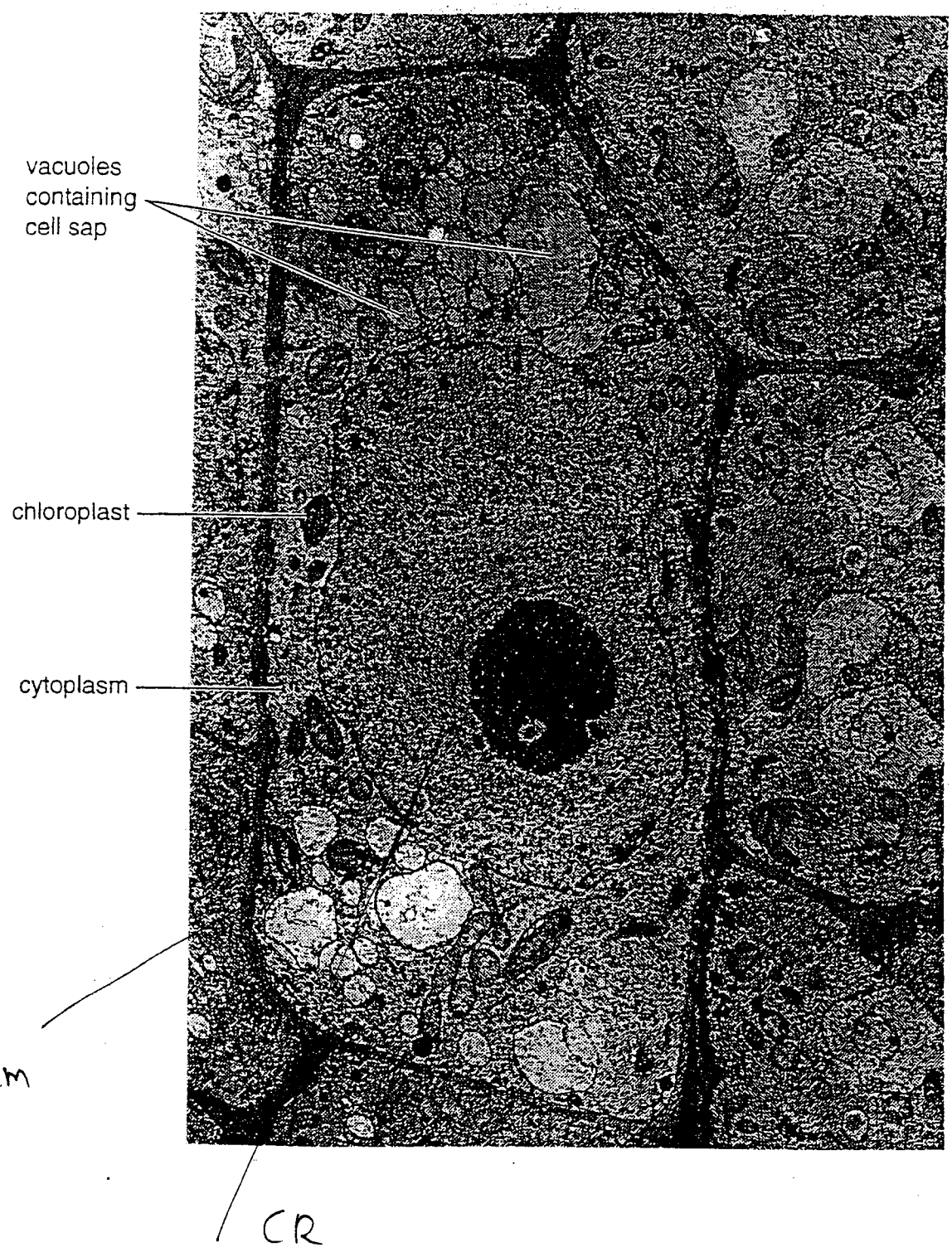
(iii) Thousands of tonnes of ammonia are manufactured daily. Most of the ammonia is made into fertiliser for use in agriculture.

Name a compound used as a fertiliser and describe very briefly how it is produced from ammonia.

ammonium nitrate
by reacting ammonia with nitric acid
(neutralisation reaction) [2]

For Examiner's Use

10 The photograph is an electron micrograph of a plant cell, surrounded by several other cells.



(a) How many other cells are in contact with the cell in the centre of the electron micrograph?

6 [1]

For Examiner's Use

(b) (i) State and explain the colour which the chloroplasts would be, in a living cell.

Green;
Chlorophyll reflects green light. [2]

(ii) Suggest **one** part of the plant from which the cell could have been taken.

Leaf (Anything Sensible) [1]

(c) Apart from the presence of chloroplasts, state **two** features visible in the electron micrograph, which suggests that the cell is from a plant and not from an animal.

1. Cell wall.
2. Vacuoles containing Sap. [2]

(d) (i) On the electron micrograph, accurately draw a label line to the cell membrane, and label it **CM**. anything 'inside' the cell wall. [1]

(ii) Describe the function of the cell membrane in a plant cell.

Controls what passes into;
and out of the cell; [2]

(e) (i) On the electron micrograph, draw a label line to the area where chromosomes would be found, and label it **CR**. Anywhere in the nucleus [1]

(ii) Describe the function of the chromosomes in a cell.

Control the cell;
Contain the genetic code;
Controls which proteins are made; [2]

DATA SHEET
The Periodic Table of the Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
																	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 †															

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

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.)

0654/3/S98