Centre Number	Candidate Number

Candidate Name _____

International General Certificate of Secondary Education

CAMBRIDGE INTERNATIONAL EXAMINATIONS

CO-ORDINATED SCIENCES 0654/3

PAPER 3

OCTOBER/NOVEMBER SESSION 2002

2 hours

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

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 20.

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

This question paper consists of 20 printed pages.

UNIVERSITY of CAMBRIDGE
Local Examinations Syndicate

[Turn over

1 **(a)** Sound travels at 330 m/s in air.

The table in Fig. 1.1 shows some information about three tuning forks. Complete Fig. 1.1 by calculating the missing values.

Show your working in the space underneath the table.

tuning fork	frequency / Hz	wavelength in air / m
1	288	1.146
2	320	
3		0.773

Fig. 1.1

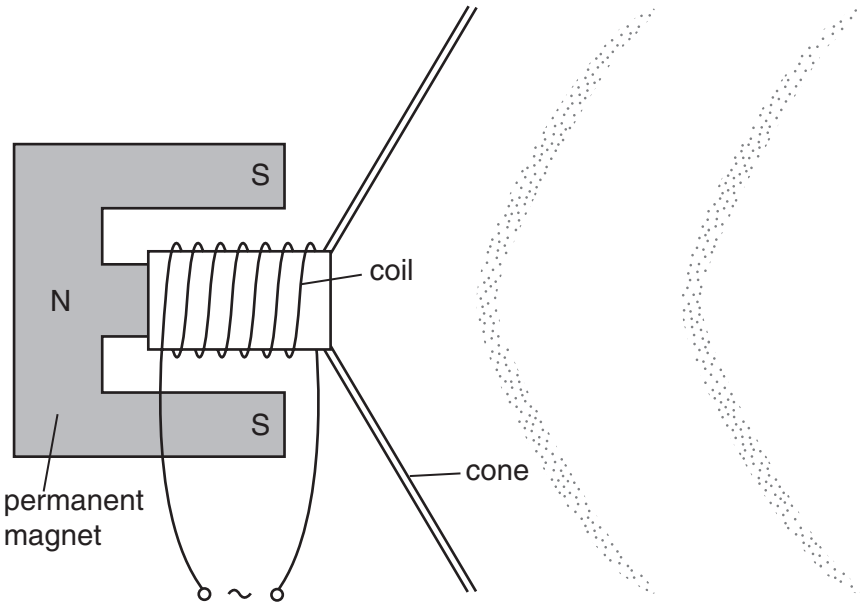
[3]

(b) The frequencies of the tuning forks in **(a)** are easily heard by humans. State the maximum and minimum frequency which humans can usually hear.

maximum frequency .....

minimum frequency ..... [2]

(c) A loudspeaker works in the same way as an earphone.



Number the statements below from one to six to explain how a loudspeaker works. The first has been completed for you.

The coil becomes an electromagnet. The strength of the electromagnet varies with the current.	
This makes the coil move backwards and forwards to correspond with the electrical signal.	
The movement of the coil makes the cone move in and out.	
A variable electrical signal is passed through a coil that is held loosely in the magnetic field of a permanent magnet.	1
A variable force occurs between the electromagnet and the permanent magnet.	
The moving paper cone makes the air vibrate, making sound waves.	

[3]

(d) When sound signals need to be transmitted over long distances, they are first converted to radio waves. The radio waves are modulated.

Explain what is meant by wave modulation.

.....

.....

.....

.....[2]

2 In Canada, where it is cold at some times of year, cucumbers are grown in greenhouses. Growers usually increase the concentration of carbon dioxide in the atmosphere in the greenhouse to about 0.1%, because this increases the yield of fruit from the plants.

(a) (i) State the normal concentration of carbon dioxide in the atmosphere.

..... [1]

(ii) Explain why increasing the concentration of carbon dioxide increases the yield of fruit from the cucumber plants.

.....

.....

.....[2]

(b) In winter, the greenhouses are heated and are kept completely closed. In summer however, when it is warmer outside, ventilators in the greenhouse roof have to be opened to prevent the temperature from getting too high. This means that it is wasteful to add extra carbon dioxide to the greenhouse in summer, because much of it would escape through the open ventilators.

The ventilators open automatically when the temperature reaches a certain level. An experiment was carried out to find the best temperature at which the ventilators should open, when the atmosphere in the greenhouse contains 0.1% CO_2. The table in Fig. 2.1 shows the results.

temperature at which ventilators open / °C	mean number of fruit per plant	mean mass of fruit per plant / kg
23	9.9	4.48
25	11.4	5.20
27	11.1	5.14

Fig. 2.1

(i) Explain how opening the ventilators would allow the greenhouse to cool down.

.....

.....[2]

(ii) Using the information above, and also your own knowledge about how temperature affects living organisms, explain why there is a better yield of cucumbers when the ventilators open at 25 °C than when they open at 23 °C.

.....

.....

.....

.....[3]

(iii) Suggest an explanation for the differences between the yield of fruit when the ventilators open at 27 °C and when they open at 25 °C.

.....

.....

.....[2]

(c) The investigation also looked at the best kind of material from which to make the greenhouses. Four identical greenhouses were constructed, using either glass or poly(ethene). In one of each type of greenhouse, extra light was provided. No extra carbon dioxide was provided, and the greenhouses were not heated. The results are shown in Fig. 2.2.

	glass		poly(ethene)	
	no extra light	extra light	no extra light	extra light
mean number of fruit per plant	4.83	7.00	4.75	7.42
mean mass of fruit per plant / kg	2.26	3.38	3.71	4.96

Fig. 2.2

(i) State one property shared by glass and poly(ethene) that makes them suitable for constructing greenhouses.

.....[1]

(ii) Suggest why the yields from the cucumber plants in this experiment are almost all lower than the yields shown in the first experiment.

.....

.....[1]

(iii) Using all the results from both experiments, suggest the growing conditions that would produce the highest yield of cucumbers when grown in a greenhouse.

.....

.....

.....[2]

[Turn over

3 Fig. 3.1 shows some data about the elements in the second period of the Periodic Table.

symbol	**Li**	**Be**	**B**	**C**	**N**	**O**	**F**	**Ne**
melting point / °C	181	1283	2027	3727	–210	–219	–220	–248
electron configuration of atoms	2,1	2,2	2,3	2,4	2,5	2,6	2,7	2,8

Fig. 3.1

(a) (i) The melting points and electron configurations of the elements lithium to neon are part of a periodic pattern.

Explain briefly what is meant by the term *periodic pattern*.

.....

.....

.....

.....[2]

(ii) Predict which element in the third period, sodium to argon, will have the highest melting point.

Explain your answer briefly.

.....

.....

.....[2]

(b) Explain in terms of their structures why the melting point of carbon is much higher than that of neon. You may wish to draw diagrams to help your answer.

.....

.....

.....

.....[3]

(c) Nitrogen, N_2, combines with fluorine, F_2, to form the covalent compound nitrogen trifluoride, NF_3.

(i) Draw a diagram of one molecule of nitrogen trifluoride, showing how all the outer electrons are arranged.

[2]

(ii) Write a balanced equation for the formation of nitrogen trifluoride.

.....[1]

4 Fig. 4.1 shows a circuit containing three identical 6 ohm resistors.

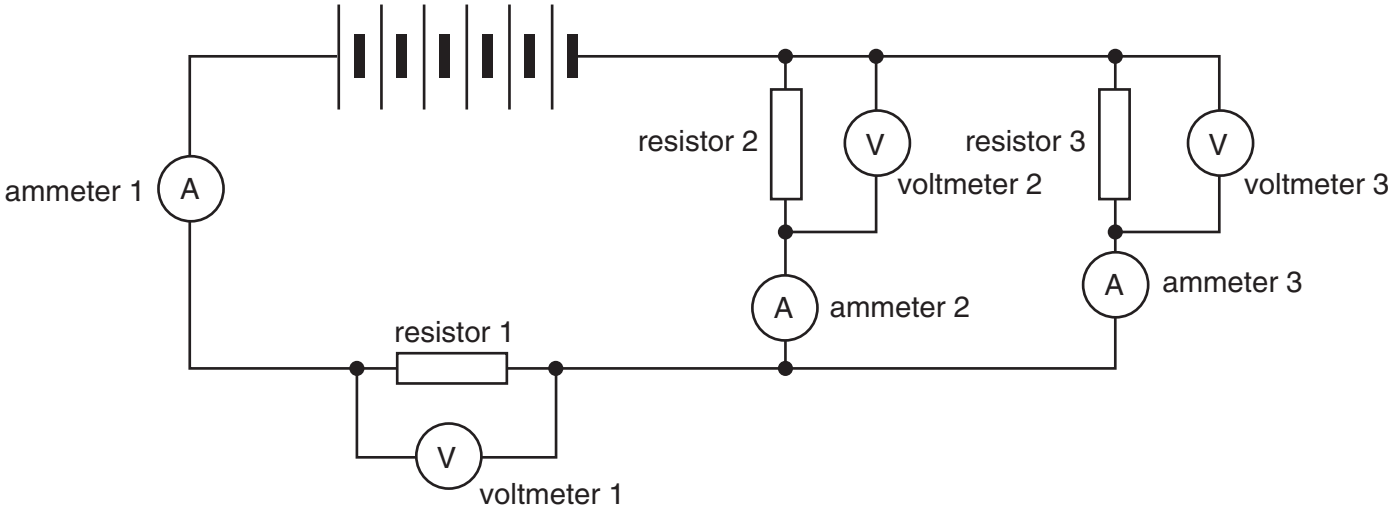


Fig. 4.1

(a) Ammeter 1 reads 1 A.
State the reading on

ammeter 2 .....

ammeter 3 ..... [2]

(b) Each cell supplies 1.5 V.
What is the total voltage supplied?

..... [1]

(c) Voltmeter 2 reads 3 V.
State the reading on

voltmeter 1 .....

voltmeter 3 ..... [2]

(d) Calculate the combined resistance of resistors 2 and 3.
Show your working.

Combined resistance = ...[3]

(e) When a poly(ethene) rod is rubbed with a cloth, it acquires a negative electrostatic charge. During this process a very small electric current flows.

Explain what is happening.

.....

.....

.....

.....

.....

.....[4]

5 Fig. 5.1 shows the human excretory system.

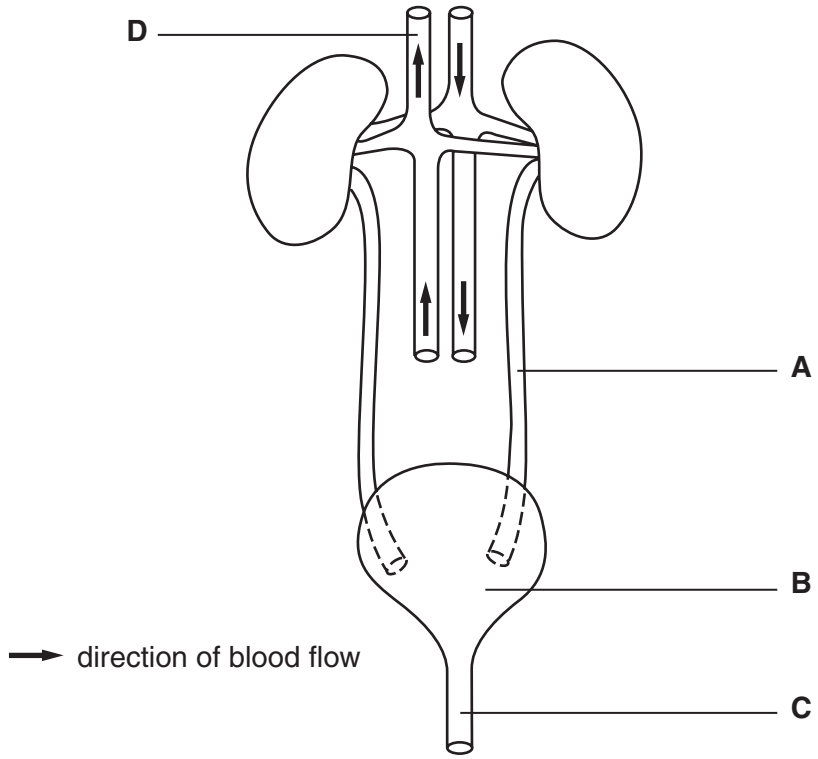


Fig. 5.1

(a) (i) Name the structures labelled **A**, **B** and **C**.

A .....

B .....

C ..... [3]

(ii) On Fig. 5.1, draw a label line to a blood vessel that contains a relatively high concentration of urea, and label it **U**. [1]

(iii) State the chamber of the heart into which blood in vessel **D** will flow.

.....[1]

(b) Explain why the volume of urine that is excreted by the kidneys is likely to be much greater on a cold day than on a hot day.

.....

.....

.....

.....[3]

(c) Waste liquid from a house, including urine, is carried to a sewage works where it is treated and then released into the sea.

With reference to the processes taking place in the water cycle, explain how some of the water in urine could become part of a tree many miles away from the sea.

.....

.....

.....

.....[3]

[Turn over

6 Fig. 6.1 shows an electrochemical cell in which pieces of zinc and copper are used as the electrodes. The diagram also shows the direction that electrons move in the circuit.

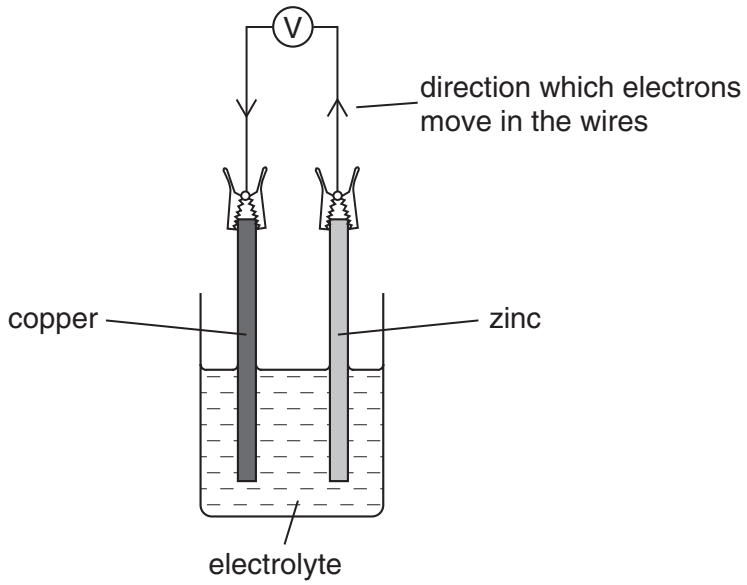


Fig. 6.1

Electrons move through the wires when metal atoms in the electrodes change into ions.

(a) Suggest how a suitable electrolyte for this cell could be made.

.....

.....[1]

(b) **(i)** Explain why the zinc electrode is described as being oxidised when the cell is working.

.....

.....[1]

(ii) How does the direction of the electron flow in this cell show that zinc is a more reactive metal than copper?

.....

.....

.....[2]

(iii) Copper is more reactive than silver.

State and explain how the voltmeter reading will change if the copper electrode is replaced by silver.

.....

.....

.....[2]

(c) Describe the bonding in a typical metal such as copper, and explain briefly why metals are good conductors of electricity. You should draw a diagram to help your answer.

.....

.....[3]

(d) Magnesium reacts with copper sulphate solution according to the equation below.

$$Mg + CuSO_4 \longrightarrow MgSO_4 + Cu$$

(i) Describe one observation which could be made during this reaction.

.....

.....[1]

(ii) Calculate the mass of copper which is produced when 0.48 g of magnesium react in excess copper sulphate solution.

Show your working.

.....[3]

(e) Fig. 6.2 represents atoms in some pieces of magnesium, calcium and strontium.

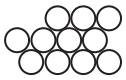
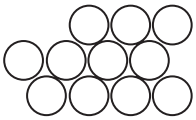
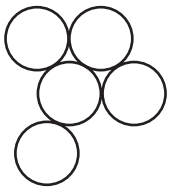
			
element	magnesium	calcium	strontium
combined mass of these atoms / atomic mass units	264	440	440

Fig. 6.2

Explain which two of these elements a chemist would say are present in the *same amount*.

.....

.....

.....[2]

7 **(a)** For each of the four proteins listed below, describe where they are found and explain their functions.

(i) haemoglobin

.....

.....

.....[2]

(ii) antibody

.....

.....

.....[2]

(iii) protease

.....

.....

.....[2]

(iv) insulin

.....

.....

.....[2]

(b) Describe how you would find out if a sample of food contained protein.

.....

.....

.....

.....[3]

8 Fig. 8.1 shows a car lift being used to lift a car, which weighs 10 000 N.

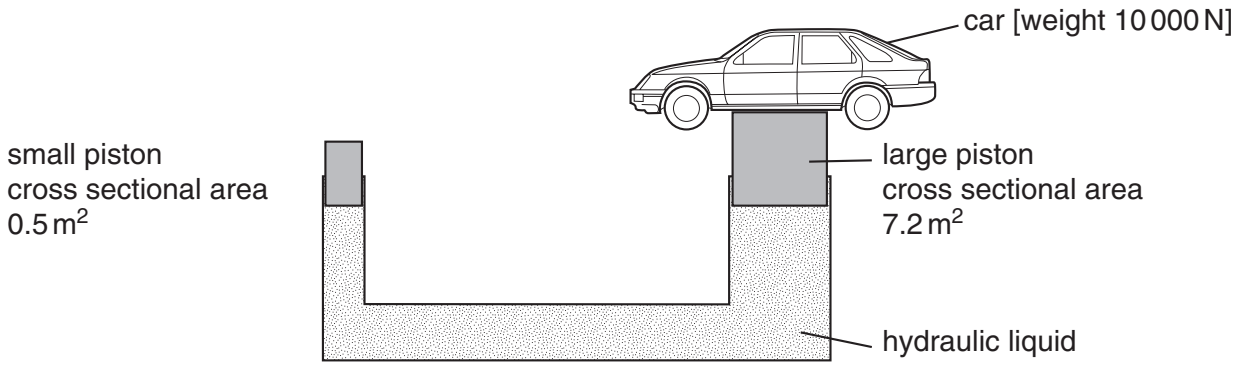


Fig. 8.1

(a) (i) Calculate the pressure that is exerted on the large piston.

Show your working and state any formula that you use.

.....[3]

(ii) State the pressure that the small piston exerts on the fluid.

Explain your answer.

.....

.....[2]

(b) The car lift is an example of a hydraulic lift, which is a *force multiplier*.

With reference to Fig. 8.1, explain the meaning of this term.

.....

.....

.....[2]

(c) A hydraulic lift uses a liquid to transmit pressure.

(i) Explain in terms of particles why liquids can be used to transmit pressure in this way.

.....

.....

.....[2]

(ii) Explain why it is important that hydraulic liquids should contain no gas bubbles.

.....

.....[2]

(d) (i) Describe what happens to the pressure of a fixed volume of gas when the temperature is raised.

.....

.....[2]

(ii) At what temperature would a gas have zero pressure? Explain your answer.

.....

.....[2]

9 The chemical formulae of three ionic compounds are shown below.

$NaCl$	$CaCl_2$	Na_2CO_3
sodium chloride	calcium chloride	sodium carbonate

(a) The symbols and charges of some of the ions in these compounds are shown below.

Na^+ Ca^{2+} Cl^-

Deduce the formula and charge of the carbonate ion.

Show your working.

.....[2]

(b) The presence of calcium chloride in water causes permanent hardness. Washing soda contains sodium carbonate and may be added to hard water in order to soften it.

The reaction between calcium chloride and sodium carbonate produces a precipitate.

(i) Complete the word equation.

calcium chloride + sodium carbonate $\rightarrow$

[2]

(ii) Explain why this reaction softens the water.

.....

.....[1]

(iii) Describe a simple experiment, using soap solution, which could show that sodium carbonate softens permanently hard water.

.....

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.....

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.....

.....

.....[4]

(iv) State **one** other method of softening permanently hard water and explain briefly how it works.

.....

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.....

.....

.....[3]

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 = 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.).