Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

4784847566

CO-ORDINATED SCIENCES **0654/43**

Paper 4 (Extended) **May/June 2017**

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 soft 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.

This document consists of **31** printed pages and **1** blank page.

CAMBRIDGE International Examinations

1 Fig. 1.1 is a diagram of the alimentary canal and associated organs.

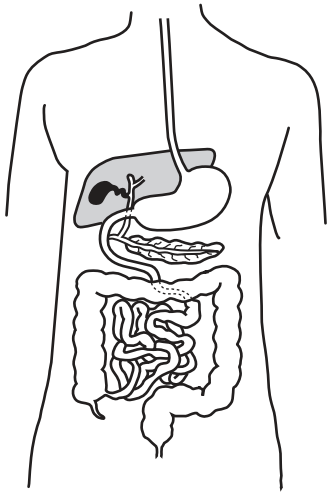

Fig. 1.1

(a) Add labels and label lines to Fig. 1.1 to show the liver and the pancreas. [2]

(b) The liver produces bile.

Describe how bile helps to improve digestion.

.....

.....

.....[2]

(c) The liver is also responsible for controlling the glucose concentration of the blood.

After eating a meal, a person's blood glucose concentration increases.

Describe how the pancreas and the liver act to return the blood glucose concentration to normal.

.....

.....

.....

.....[3]

(d) Control of blood glucose concentration is an example of negative feedback.

(i) Explain what is meant by the term *negative feedback.*

.....

.....

.....[2]

(ii) Name **one** other example of negative feedback.

.....[1]

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2 **(a)** Table 2.1 shows information about atoms of the elements hydrogen and nitrogen.

Complete Table 2.1.

Table 2.1

element	atomic number	mass number	number of protons	number of neutrons
hydrogen			1	0
nitrogen	7	14		

[2]

(b) In the Haber process, nitrogen and hydrogen combine to form ammonia.

Fig. 2.1 shows gas particles flowing through the reaction vessel.

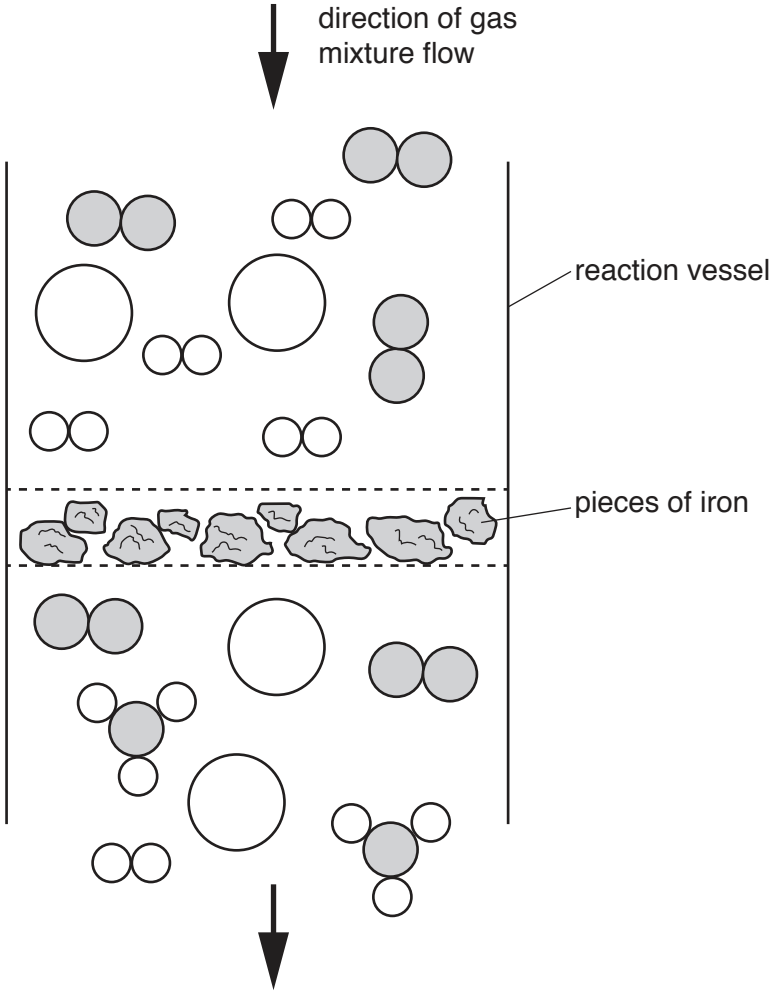

Fig. 2.1 (not to scale)

[Turn over

The mixture of gas particles flowing through the reaction vessel contains argon atoms as an impurity.

(i) On Fig. 2.1, label one of the argon **atoms**. [1]

(ii) Explain your answer to **(b)(i)**.

Use ideas about the electronic structure of argon atoms in your answer.

.....

.....

.....[2]

(iii) State the purpose and describe the effect of the pieces of iron in the Haber process.

purpose .....

effect .....

.....
[2]

(c) The maximum mass of ammonia that dissolves in 100 cm^3 of water is called the solubility of ammonia.

Fig. 2.2 shows the solubility of ammonia at different temperatures.

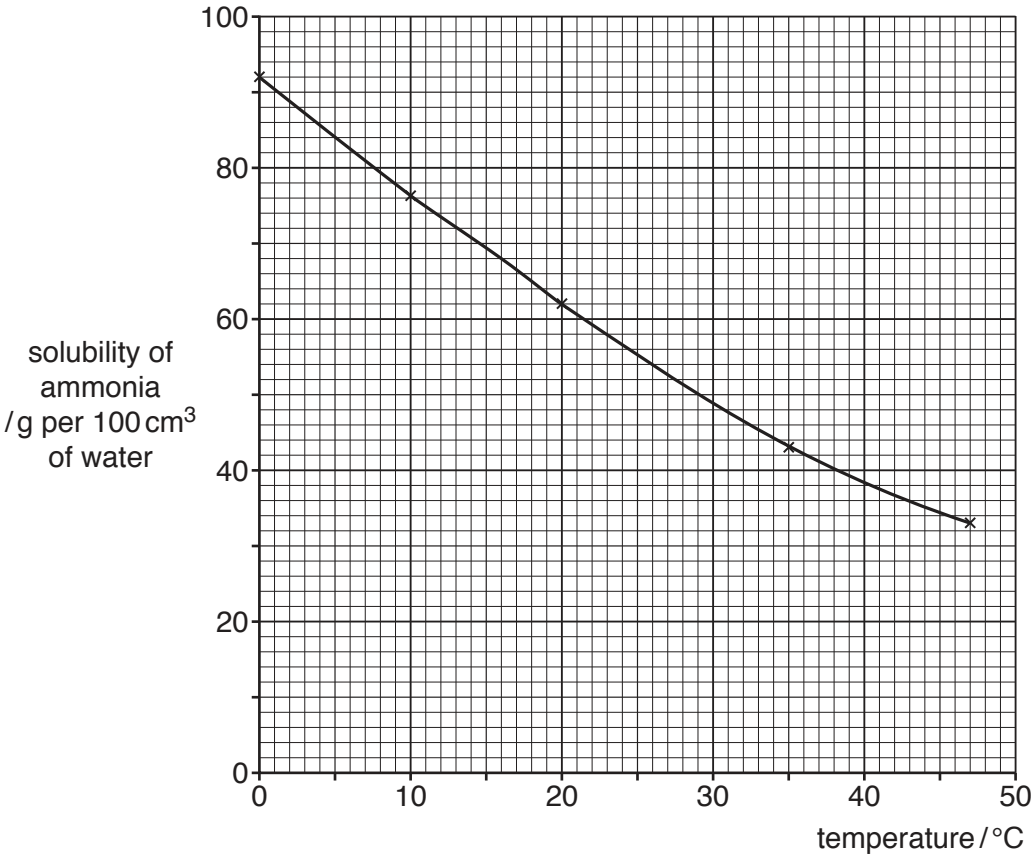

Fig. 2.2

(i) Describe the trend shown in Fig. 2.2.

.....

.....[1]

(ii) Use steps 1, 2 and 3 to calculate the maximum volume of ammonia that dissolves in 100 cm^3 of water at a temperature of 16 °C.

Show your working in each step.

Step 1
State the maximum mass of ammonia that dissolves in 100 cm^3 of water at 16 °C.

mass of ammonia = ... g

Step 2
Calculate the number of moles of ammonia, NH_3, contained in the mass from Step 1.

[A_r : N, 14; H, 1]

moles of ammonia = ...

Step 3
Calculate the volume in dm^3 occupied by the ammonia you calculated in Step 2.

Assume that one mole of ammonia occupies 24 dm^3.

volume of ammonia = ... dm^3
[4]

[Turn over

3 Fig. 3.1 is a diagram of the gas exchange system.

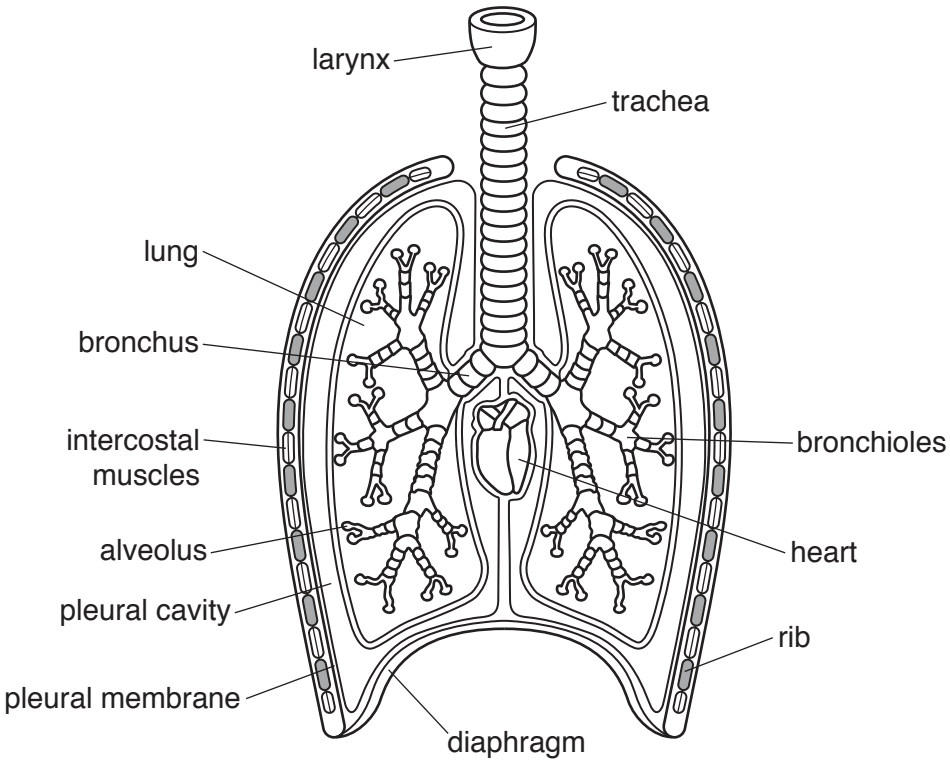

Fig. 3.1

(a) The alveoli form the gas exchange surface.

The walls of the alveoli are only one cell thick.

(i) Describe the advantage of thin walls in a gas exchange surface.

.....

.....[1]

(ii) State **two** ways, apart from thin walls, in which gas exchange surfaces are adapted for their function.

1 .....

.....

2 .....

.....

[2]

(b) The airways that lead to the alveoli are lined with cilia and goblet cells.

The goblet cells produce mucus.

Fig. 3.2 is a diagram of the cells lining the airways.

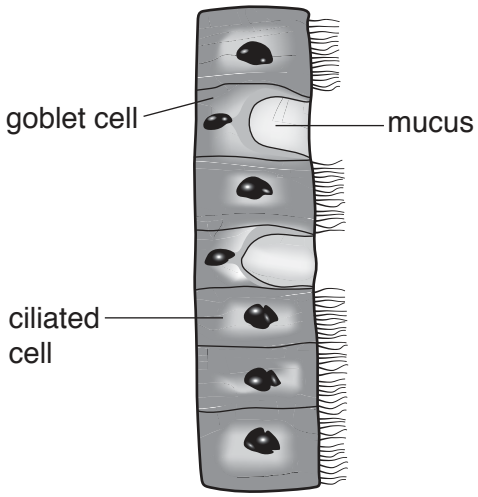

Fig. 3.2

(i) Describe how mucus and cilia work to protect the gas exchange system.

.....

.....

.....[2]

(ii) Cigarette smoke destroys cilia.

Describe the effect this would have on the gas exchange system.

.....

.....

.....[2]

(c) Cigarette smoke contains many toxic components including tar. Tar also destroys cilia.

Describe **another** effect that tar has on the gas exchange system.

.....

.....[1]

4 **(a)** A polar bear of mass 400 kg is swimming in the sea.

Fig. 4.1 shows the speed-time graph for the polar bear over a time interval of 300 s.

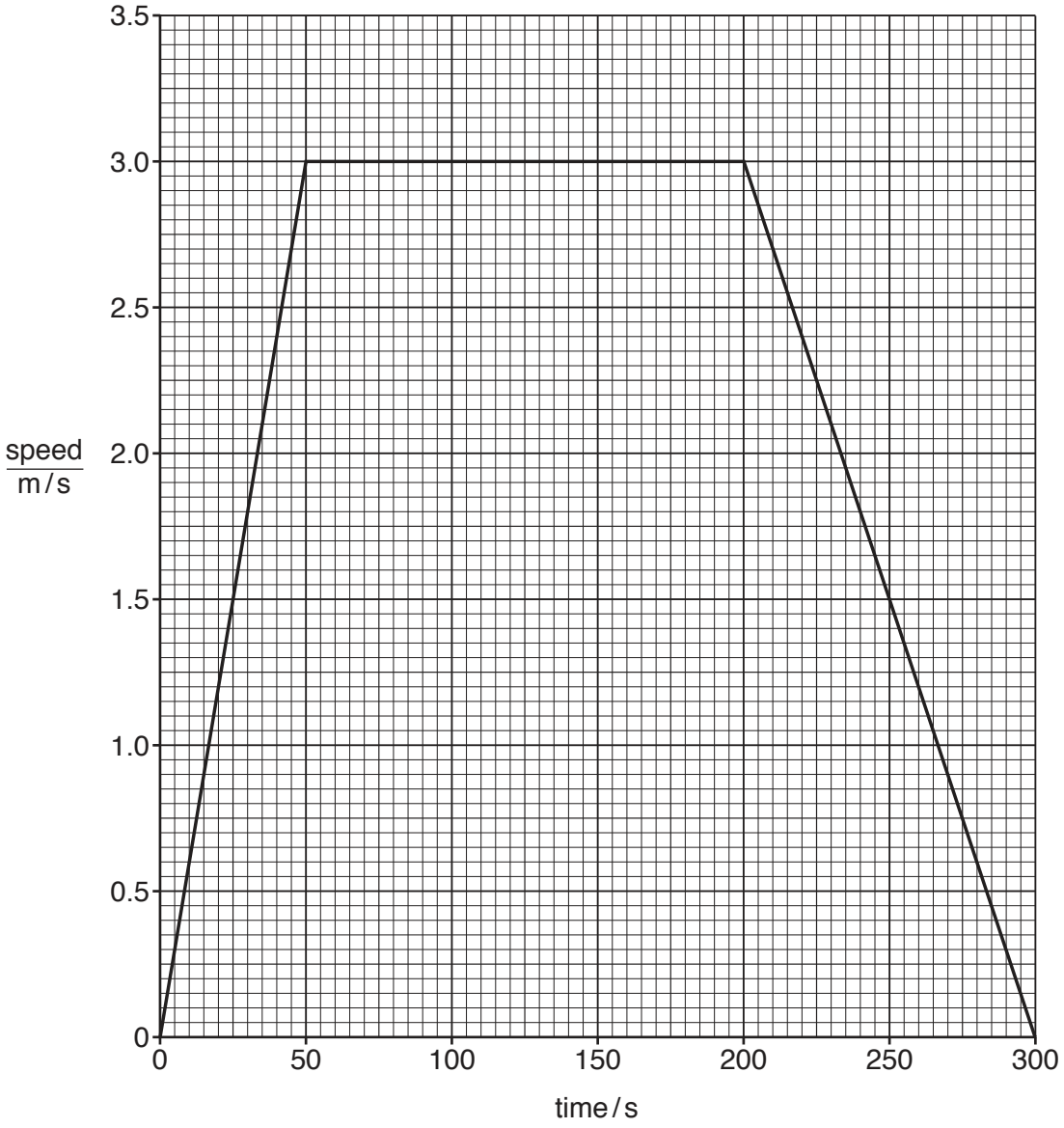

Fig. 4.1

(i) Calculate the distance travelled by the polar bear over the 300 s.

Show your working.

distance = ... m [2]

(ii) Calculate the acceleration of the polar bear at 25 seconds.

Show your working.

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

(iii) Calculate the maximum kinetic energy of the polar bear.

State the formula you use and show your working.

formula

working

kinetic energy = ... J [3]

(b) The polar bear has a weight of 4000 N .

The polar bear stands with all four feet in contact with the ice. Each foot of the polar bear has an area of 0.035 m^2.

Calculate the pressure exerted by the polar bear on the ice.

State the formula you use and show your working.

formula

working

pressure = ... N/m^2 [2]

(c) Recent research suggests that the audible frequency range for polar bears is between 50 Hz and 35 000 Hz.

(i) Ultrasound waves have a very high frequency that cannot be heard by humans. Devices which emit ultrasound waves have been tested to see if they can keep polar bears away from people.

Suggest a suitable frequency for the waves emitted by such a device.

..... Hz [1]

(ii) A polar bear hears a sound.

Fig. 4.2 represents the sound wave travelling through the air as a series of compressions **(C)** and rarefactions **(R)**.

Fig. 4.2

Describe **two** differences between a region of compression and a region of rarefaction.

1 .....

.....

2 .....

.....

[2]

(d) Scientists use thermal imaging cameras to detect polar bears travelling on the ice.

Thermal imaging cameras use infra-red radiation. Infra-red radiation is part of the electromagnetic spectrum.

Name **one** radiation in the electromagnetic spectrum that has a lower frequency than infra-red radiation.

.....[1]

Question 5 starts on page 14.

5 Human activities and natural events cause air pollution.

Fig. 5.1 shows some of the gases that pass into the air during a volcanic eruption.

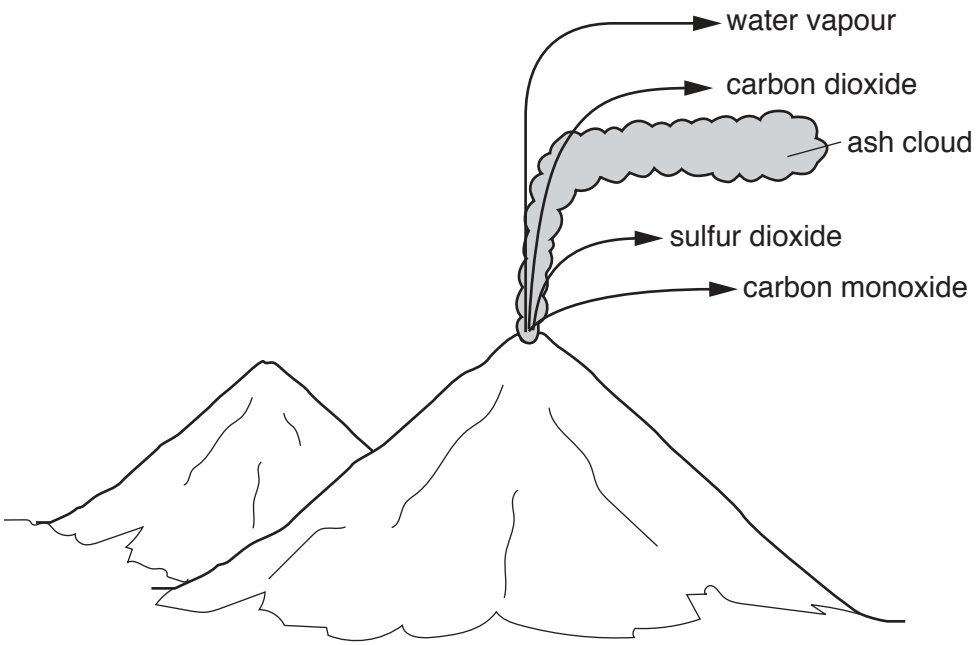

Fig. 5.1

(a) (i) Water vapour is a greenhouse gas which contributes to global warming.

State which **one** of the other gases in Fig. 5.1 also contributes to global warming.

.....[1]

(ii) Describe how human activity causes the release of carbon **monoxide**.

.....

.....

.....[2]

(b) Complete the dot-and-cross diagram in Fig. 5.2 to show all of the outer-shell electrons in a molecule of carbon dioxide.

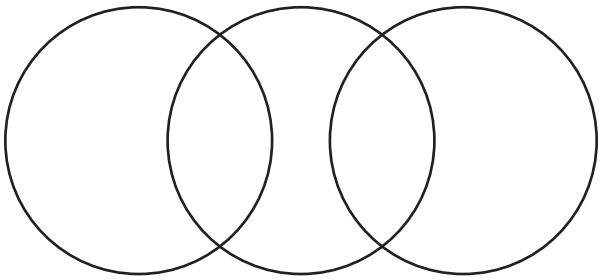

Fig. 5.2

[2]

(c) Table 5.1 shows the pH values of three colourless liquids contained in test-tubes **A**, **B** and **C**.

Table 5.1

test-tube	colourless liquid	pH
A	acid rain	4
B	water	7
C	dilute sulfuric acid	1

A student compares the rate of reaction at constant temperature between these three liquids and magnesium.

Fig. 5.3 shows what the student observes.

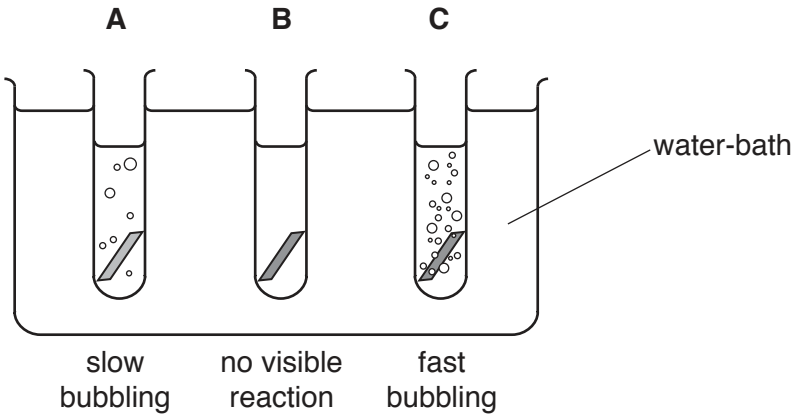

Fig. 5.3

Use the information in Table 5.1 to explain the differences in the rates of reaction the student observes in Fig. 5.3.

Your answer should refer to collisions between reacting particles.

.....

.....

.....

.....[3]

6 A student cuts a seed in half. Fig. 6.1 shows a drawing that the student made of this seed.

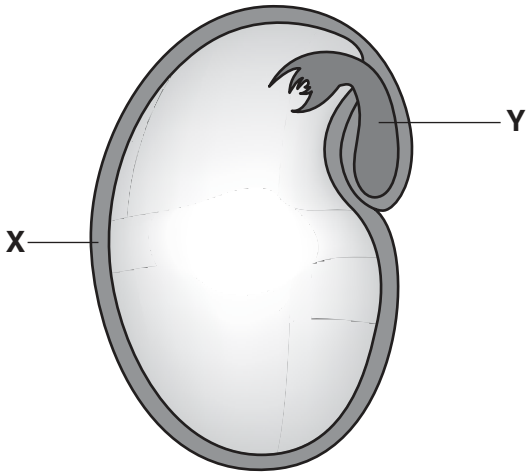

Fig. 6.1

(a) Identify the parts of the seed labelled **X** and **Y** in Fig. 6.1.

X .....

Y .....
[2]

(b) State the conditions necessary for the germination of seeds.

.....

.....

.....[1]

(c) **(i)** Describe how the food stores in the cotyledon are transported to the growing plumule.

.....

.....

.....

.....[3]

(ii) Suggest **one** reason why seeds planted too deeply in the soil do not survive.

.....

.....[1]

(d) Some seeds rely on animals for dispersal.

(i) Describe **one** way that seeds are dispersed by animals.

.....

.....[1]

(ii) Suggest **one** way in which seeds are adapted for the method of dispersal you describe in **(d)(i)**.

.....

.....[1]

[Turn over

7 **(a)** A driver gets out of his truck after a journey and receives an electric shock.

The electric shock is caused by a current of 0.003 A passing for 0.15 ms.

Calculate the charge that passes.

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

formula

working

charge = ... unit ..... [3]

(b) When the truck stops, the engine cooling system contains 40 kg of water at 90 °C which then cools to 70 °C.

Calculate the thermal energy lost from the water.

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

State the formula you use and show your working.

formula

working

energy lost = ... J [3]

8 **(a)** Black ink in marker pens is a mixture of several dyes (coloured compounds).

A student places a spot of black ink on a pencil line on a piece of chromatography paper and dips the paper into water in a test-tube.

Fig. 8.1 shows the positions of the dyes after 10 minutes.

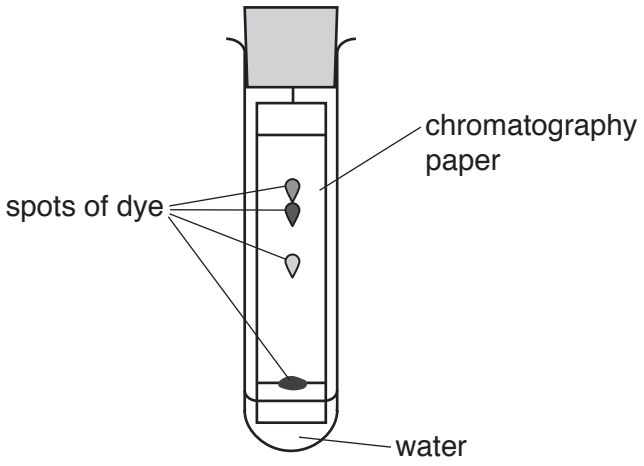

Fig. 8.1

Dyes which dissolve more easily in water move up the chromatography paper more quickly.

(i) Suggest why some dyes do **not** move up the paper.

.....

.....[1]

(ii) The student concludes that the original black ink contains only four dyes.

Explain why this conclusion may be incorrect.

.....

.....[1]

(iii) Explain why the separation of the dyes in the black ink is a physical change and **not** a chemical change.

.....

.....[1]

(b) Table 8.1 shows descriptions of three types of chemical reaction.

The name of one type of reaction is shown.

Complete Table 8.1 by naming the other two types of reaction.

Table 8.1

description	type of reaction
acid reacting with a base	neutralisation
alkenes being produced by heating alkanes with a catalyst	
proteins breaking down into amino acids by heating with aqueous acid	

[2]

(c) Magnesium reacts with chlorine to form magnesium chloride.

The electronic structure of a magnesium atom and of a chlorine atom are shown in Table 8.2.

Table 8.2

atom	electronic structure
Mg	2,8,2
C*l*	2,8,7

(i) Describe the transfer of electrons that occurs when magnesium and chlorine react to form magnesium chloride.

You may wish to draw a diagram to help you answer this question.

.....

.....

.....[2]

(ii) State the formula of magnesium chloride.

.....[1]

(d) (i) Fig. 8.2 shows the electrolysis of dilute aqueous magnesium chloride.

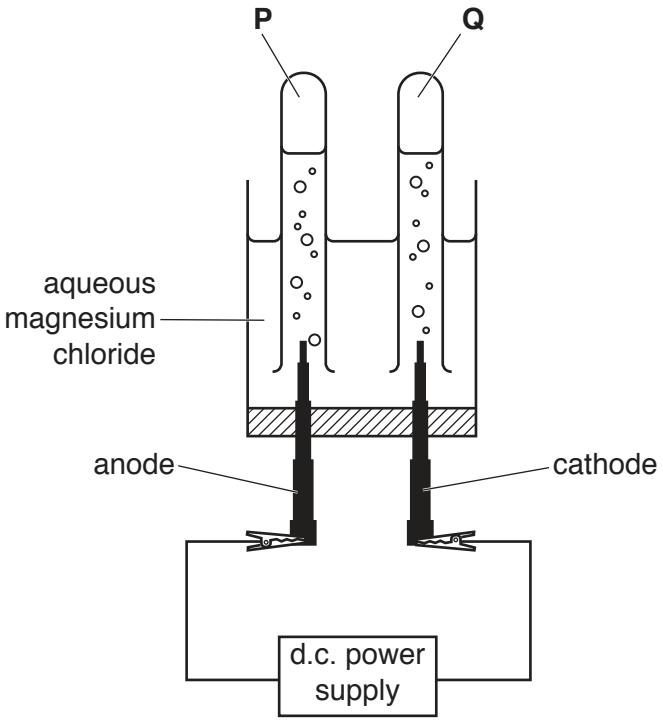

Fig. 8.2

Predict the names of gases **P** and **Q**.

P .....

Q .....
[1]

(ii) In an industrial process, magnesium metal is produced from magnesium chloride using electrolysis.

Suggest how the electrolyte used in the industrial process is different from the electrolyte used in Fig. 8.2.

.....[1]

[Turn over

9 Fig. 9.1 shows the average number of species of fish found in lakes of different pH in New York state, USA.

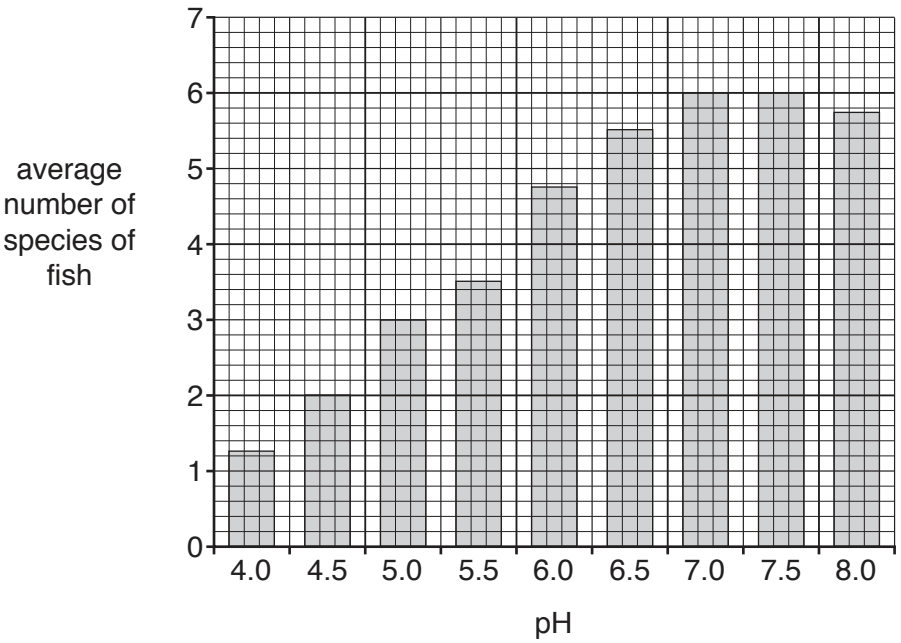

Fig. 9.1

(a) Describe the effect of pH on the average number of species of fish.

.....

.....

.....[2]

(b) Many lakes have been polluted by acid rain.

(i) Describe how acid rain is formed.

.....

.....

.....[2]

(ii) Describe **two** effects of acid rain on the environment.

1 .....

.....

2 .....

.....

[2]

(iii) Describe **one** way to reduce the incidence of acid rain.

.....

.....[1]

10 A student investigates how the masses of six potato cubes change when they are immersed in different concentrations of salt solution.

The student records the mass of each potato cube at the start of the investigation and after the cubes have been immersed for one hour. The student calculates the percentage change in mass.

Table 10.1 shows the student's results.

Table 10.1

concentration of salt solution / mol per dm^3	mass of cube at start / g	mass of cube after one hour / g	% change in mass
0.0	2.5	3.1	+24.0
0.2	2.4	2.8	+16.7
0.4	2.5	2.5	0.0
0.6	2.4	2.2	–8.3
0.8	2.6	2.2	–15.4
1.0	2.5	2.0	–20.0

(a) (i) Another potato cube is immersed in a salt solution with a concentration of 0.9 mol per dm^3.

Use the data in Table 10.1 to predict the percentage change in mass after one hour.

..... % [1]

(ii) State which concentration of salt solution has the same water potential as the potato cube.

Explain your answer.

concentration ..... mol per dm^3

explanation .....

.....

[2]

(b) Explain why the mass of the potato cube increases when it is immersed in a salt solution with a concentration of 0.2 mol per dm^3.

.....

.....

.....

.....

.....[3]

11 **(a)** A house is situated in a country where the climate is very sunny and hot during the day, and very cold at night.

Explain how painting the house white helps to keep a comfortable temperature during both the day and the night.

during the day .....

.....

during the night .....

.....
[2]

(b) Fig. 11.1 shows a woman standing in front of a mirror mounted on a wall in the house.

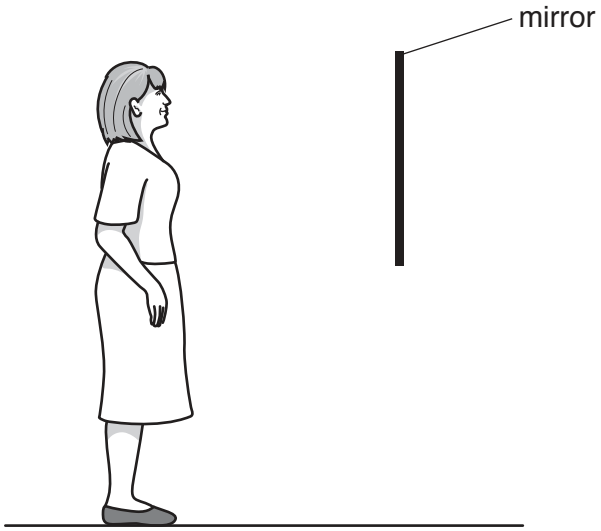

Fig. 11.1

(i) On Fig. 11.1, draw a cross (**X**) to show the position of the image of her nose. [2]

(ii) On Fig. 11.1, using your knowledge of the law of reflection, draw a ray of light from the woman's shoe to the bottom of the mirror and then reflecting from the mirror. Use a ruler to help you. [1]

(iii) Use your answer to **(b)(ii)** to explain why the woman cannot see the reflection of her shoe in the mirror.

.....

.....[1]

(c) The house has an emergency generator in case there is a power cut.

Fig. 11.2 shows a simple generator.

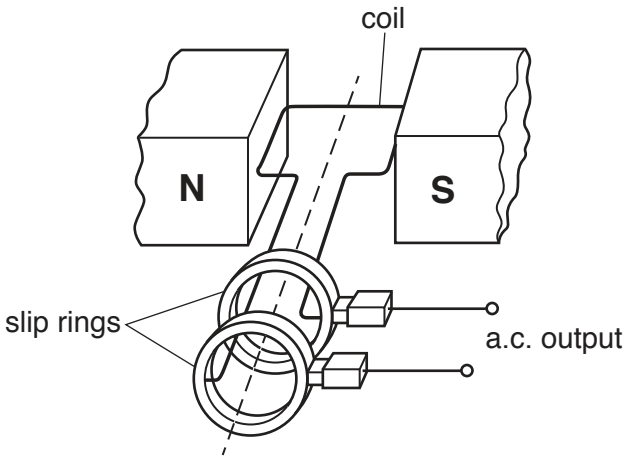

Fig. 11.2

(i) The voltage output is measured using a voltmeter.

On Fig. 11.2, complete the diagram to show how to connect a voltmeter to measure the voltage output.

Use the correct circuit symbol for a voltmeter. [2]

(ii) On the grid in Fig. 11.3, sketch a graph of voltage output against time for the generator when the coil is rotating at constant speed.

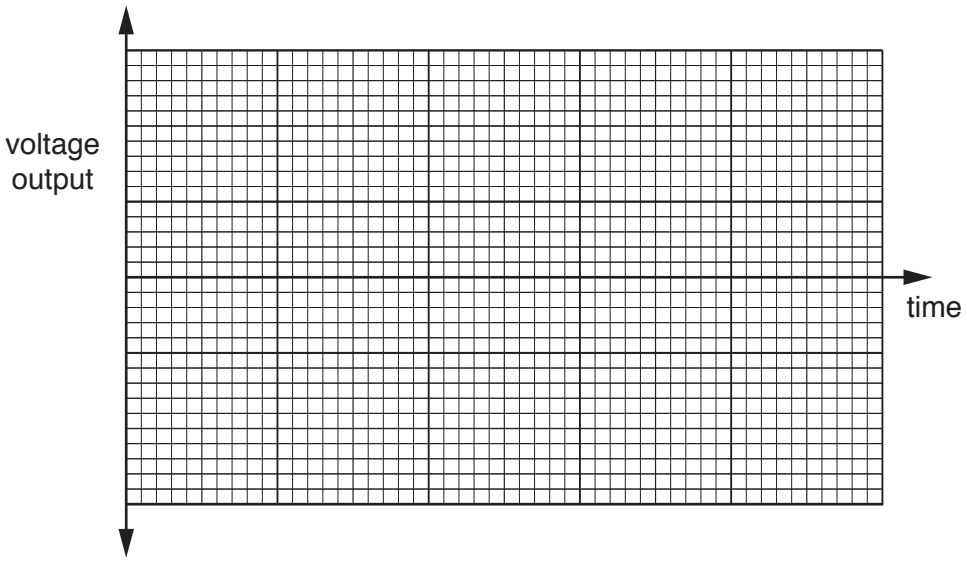

Fig. 11.3

[2]

(iii) Describe how the rotation of the coil in the magnetic field and the use of slip rings produce an alternating current.

.....

.....

.....

.....

.....

.....[3]

12 Fig. 12.1 shows part of a wave-powered electrical generator.

At the bottom, the sea water is able to flow in and out.

At the top, air is either pushed out or drawn in.

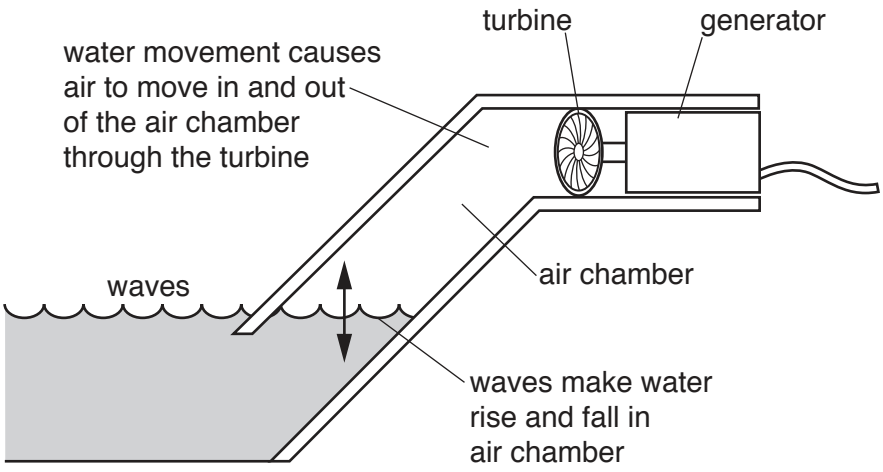

Fig. 12.1

(a) Using the information in Fig. 12.1, describe the energy transfers and transformations that are involved in the generation of electrical energy.

.....

.....

.....

.....

.....[3]

(b) The distance between two waves on the surface of the ocean is 12 m. The waves travel at 2.0 m / s along the surface of the ocean.

Calculate the frequency of the waves.

State the formula you use and show your working.

formula

working

frequency = ... Hz [2]

(c) Water vapour is produced by the evaporation of water from the ocean.

Describe the process of evaporation in terms of the movement and energy of water molecules and the forces between water molecules.

.....

.....

.....

.....

.....[3]

13 Ethanol is an organic compound with the formula C_2H_6O.

(a) Complete the diagram in Fig. 13.1 to show the structure of **one** molecule of ethanol.

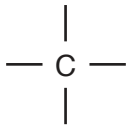

Fig. 13.1

[2]

(b) Fig. 13.2 shows apparatus a student uses to investigate the combustion of ethanol.

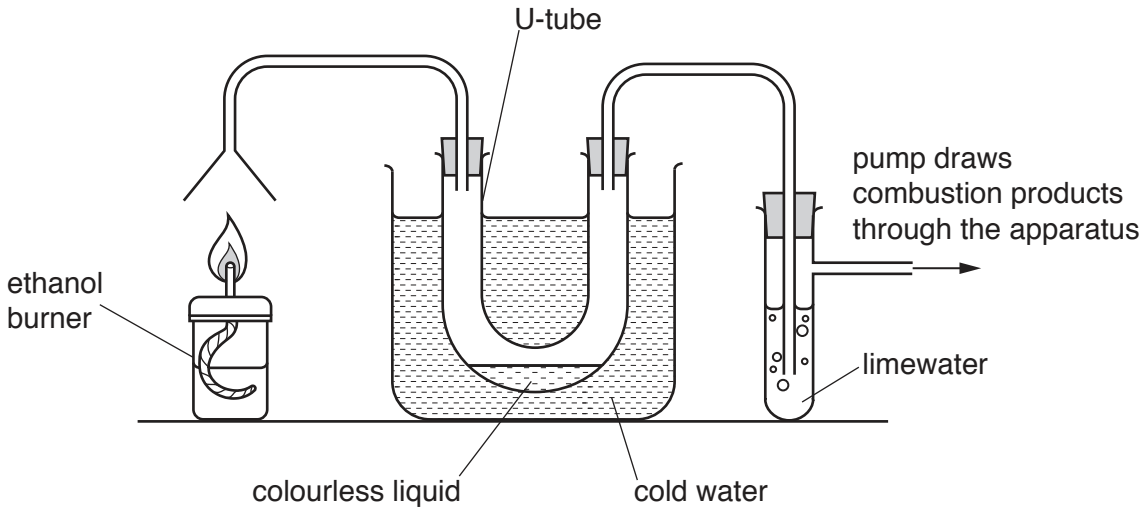

Fig. 13.2

Shortly after the ethanol burner is lit, a colourless liquid collects inside the U-tube and the limewater becomes milky.

(i) Describe a chemical test to show that the colourless liquid inside the U-tube is water.

test .....

result .....

[2]

(ii) State an energy transformation that occurs when ethanol burns in air.

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

[1]

(iii) Complete the balanced symbolic equation for the complete combustion of ethanol.

$$C_2H_6O \; + \; \ldots. \; \ldots\ldots\ldots \; \longrightarrow \; 2 \; \ldots\ldots\ldots \; + \; \ldots. \; H_2O$$

[2]

(c) Fig. 13.3 shows laboratory apparatus that a student uses to separate a mixture of ethanol and water using fractional distillation.

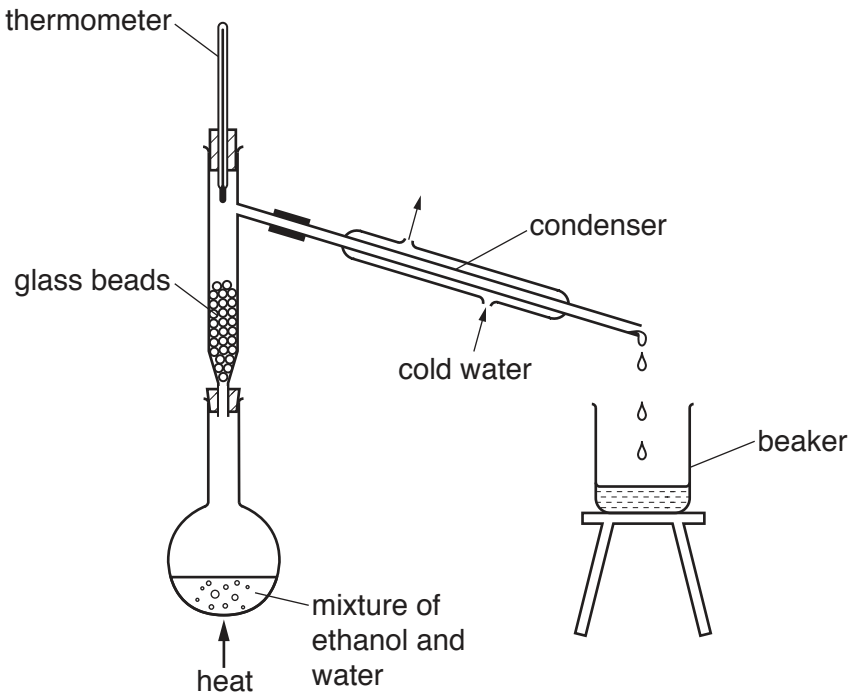

Fig. 13.3

Suggest and explain, in terms of boiling point and the attractive forces between molecules, why the liquid that collects first in the beaker contains mainly ethanol.

.....

.....

.....

.....[3]

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
				Key			1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9			atomic number atomic symbol name relative atomic mass								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 –		

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.)