UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER			

3463335646

CO-ORDINATED SCIENCES **0654/21**

Paper 2 (Core) **May/June 2013**

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 a 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.

For Examiner's Use

1 **(a)** Table 1.1 shows the numbers of protons, neutrons and electrons in four atoms, **A**, **B**, **C** and **D**.

Table 1.1

atom	protons	neutrons	electrons
A	1	0	1
B	8	8	8
C	1	1	1
D	15	16	15

(i) Explain which one of the atoms, **A**, **B**, **C** or **D**, has a nucleon number (mass number) of 16.

atom .....

explanation .....

..... [2]

(ii) Explain which pair of atoms chosen from **A**, **B**, **C** and **D** are isotopes of hydrogen.

atom ..... and atom .....

explanation .....

..... [2]

(iii) Use the information in Table 1.1 to explain why atoms are electrically neutral.

.....

.....

..... [2]

(b) Fig. 1.1 shows containers of hydrogen and helium.

For Examiner's Use

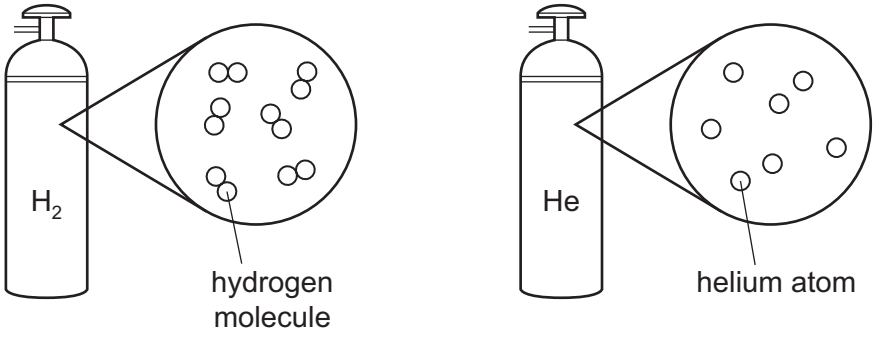

Fig. 1.1

(i) Hydrogen is usually described as a non-metal.

Name the type of chemical bond joining the atoms in a hydrogen molecule.

..... [1]

(ii) Suggest why helium exists as uncombined atoms.

.....

..... [1]

(iii) State **one** use of helium.

..... [1]

(c) Hydrogen is often included in the reactivity series of metals.

Use the idea of reactivity to explain the observations shown in Fig. 1.2.

For Examiner's Use

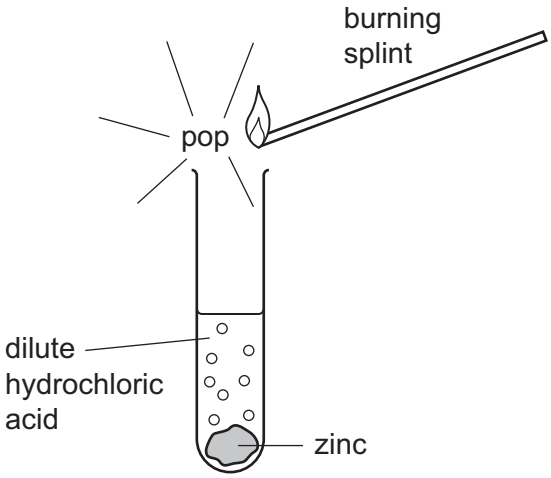

Fig. 1.2

.....

.....

.....

..... [2]

For Examiner's Use

2 **(a)** A fishing boat is floating on the sea.

A fisherman drops a heavy anchor from the boat. The anchor accelerates as it falls through the water.

Name the downward force which makes the anchor accelerate.

..... [1]

(b) A fishing boat uses echo sounding to detect a shoal of fish.

This is shown in Fig. 2.1.

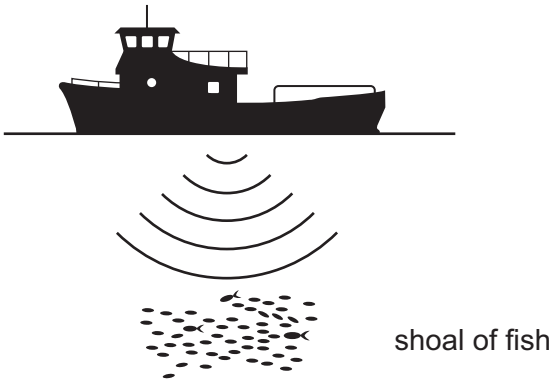

Fig. 2.1

Short pulses of sound are sent out from the boat. The echo from the shoal of fish is detected by a receiver on the boat 0.2 seconds later.

Sound waves travel through water at a speed of 1600 m / s.

Calculate the distance of the shoal of fish below the boat.

State the formula that you use and show your working.

formula

working

..... m [2]

(c) (i) Water waves are a renewable energy resource.

Outline **two** advantages of using renewable energy resources.

1 .....

.....

2 .....

..... [2]

(ii) Fig. 2.2 shows how water waves can be used to produce electricity.

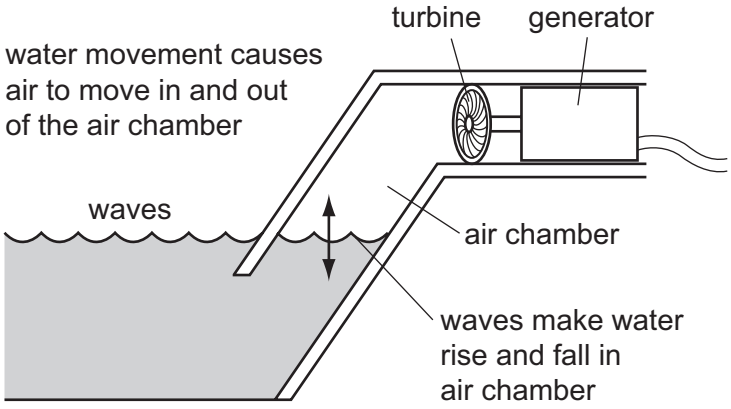

Fig. 2.2

Using the information in Fig. 2.2, describe **two** of the energy transfers that are involved in changing the kinetic energy of the waves into electrical energy.

.....

.....

.....

.....

.....

..... [2]

For Examiner's Use

(d) Fig. 2.3 shows an iceberg floating in the sea.

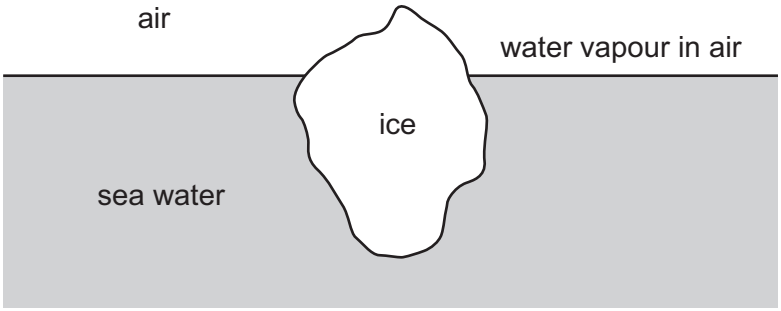

Fig. 2.3

(i) Which material named on Fig. 2.3 best fits the statement below?

"The particles are able to move, are randomly arranged and are closely packed."

..... [1]

(ii) Name the process by which water molecules in the sea become water molecules in the air.

..... [1]

(iii) Name the process by which water changes to ice.

..... [1]

For Examiner's Use

3 Fig. 3.1 shows an insect-pollinated flower cut in half.

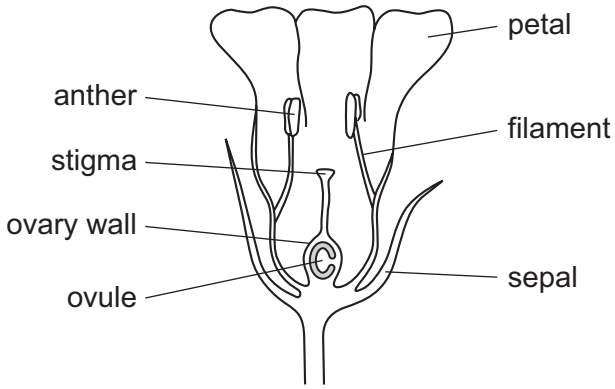

Fig. 3.1

(a) Draw lines to link each structure to its function.

structure	function
petal	protects the flower when it is a bud
anther	receives pollen
stigma	produces pollen
sepal	attracts insects to the flower

[3]

(b) After pollination, the ovule inside the ovary may be fertilised. The ovary develops into a fruit, and the ovule develops into a seed.

List **three** factors that all seeds need for germination.

1 .....

2 .....

3 ..... [3]

(c) Plants use flowers for sexual reproduction.

For Examiner's Use

State **two** ways in which asexual reproduction differs from sexual reproduction.

1 .....

.....

2 .....

..... [2]

For Examiner's Use

4 Petroleum (crude oil) and rock salt occur naturally in the Earth's crust.

(a) Petroleum is a mixture that contains thousands of different compounds. Many of these compounds are hydrocarbons known as alkanes.

(i) Draw the structure of the alkane molecule that contains two carbon atoms. Use short lines to represent covalent bonds.

[2]

(ii) Name the alkane that is the main constituent of natural gas.

..... [1]

(iii) Fig. 4.1 shows the structure of a hydrocarbon molecule.

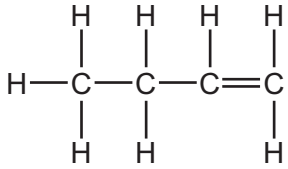

Fig. 4.1

Describe what is observed when this hydrocarbon is shaken with a solution of bromine.

.....

..... [1]

(b) When petroleum is refined, it is separated into fractions.

Fig. 4.2 shows a simplified diagram of apparatus that is used to refine petroleum.

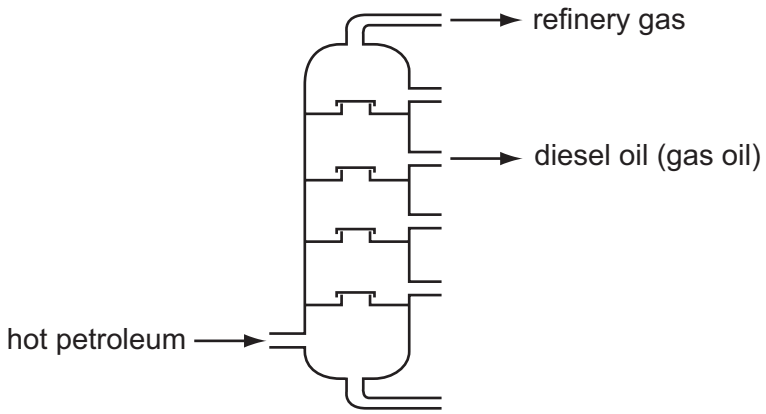

Fig. 4.2

(i) State the full name of the process shown in Fig. 4.2.

..... [1]

(ii) Refinery gas and diesel oil are used as fuels.

Name the **two** compounds that are formed when alkanes in these fuels undergo complete combustion.

..... and ..... [2]

(c) Rock salt contains mainly sodium chloride which is a compound of the alkali metal, sodium, and the halogen, chlorine.

(i) Explain why the uncombined element sodium is **not** found in the Earth's crust.

.....

..... [1]

(ii) When a piece of sodium is placed into a container of chlorine gas, sodium and chlorine atoms are changed into electrically charged atoms known as ions.

Describe briefly what happens when sodium atoms and chlorine atoms are changed into ions.

.....

.....

.....

..... [2]

[Turn over

(iii) Explain briefly why the sodium ions and chloride ions bond together in sodium chloride.

For Examiner's Use

.....

.....

..... [2]

For Examiner's Use

5 Milk is a liquid produced by cows and other mammals, on which they feed their young.

Table 5.1 shows the mass of some of the substances in 100 g samples of milk from two mammals.

Table 5.1

substance	cow's milk	water-buffalo's milk
protein / g	3.2	4.5
fat / g	3.9	8.0
carbohydrate / g	4.8	4.9
calcium / mg	120	195

(a) Which substance shown in Table 5.1 is present in the samples of milk in the smallest quantity?

..... [1]

(b) Suggest which substance, **not** shown in Table 5.1, is present in the samples of milk in the largest quantity.

..... [1]

(c) Explain why both cow's milk and water-buffalo's milk produce a violet colour when tested with biuret solution.

..... [1]

(d) Predict the colour you would see if you added iodine solution to cow's milk.

Explain your answer.

colour .....

explanation ..... [2]

(e) List the components of milk, shown in Table 5.1, that provide energy.

..... [1]

(f) Explain **one** way in which drinking water-buffalo's milk might be better for a person's health than drinking cow's milk.

For Examiner's Use

.....

.....

..... [2]

(g) State and explain which substance in Table 5.1 does **not** need to be digested in the human alimentary canal.

.....

.....

..... [2]

For Examiner's Use

6 **(a)** In a store, two workers are lifting 5 kg bags of flour onto the shelves. There are five shelves, 0.5 m apart. The lowest shelf is 0.5 m from the floor.

Fig. 6.1 shows the two workers.

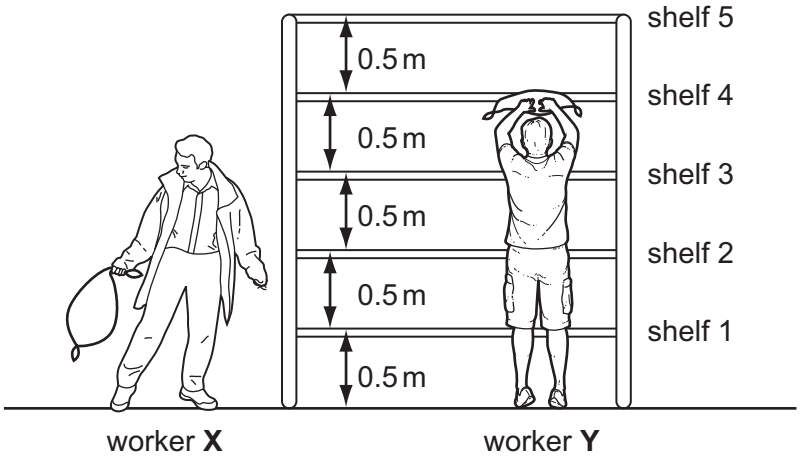

Fig. 6.1

(i) Describe the energy change when a bag of flour falls off the shelf.

..... energy is changed into ..... energy. [2]

(ii) What happens to the energy of the flour as it hits the floor?

..... [1]

(iii) Worker **X** lifts a bag of flour onto shelf 2. Worker **Y** lifts a bag of flour onto shelf 4.

Which worker has done more work?

Explain your answer.

.....

..... [1]

(iv) State the unit in which work and energy are measured.

..... [1]

(v) Each 5 kg bag of flour has a volume of 5500 cm^3.

Calculate the average density of the bag of flour. State your answer in g/cm^3.

State the formula that you use and show your working.

formula

working

..... g/cm^3 [2]

For Examiner's Use

For Examiner's Use

(b) Three boys, **A**, **B** and **C**, walk together from their school to a store. They stay at the store for a few minutes and then return to school.

When they leave the store,

- one boy walks back to school at a steady pace,
- one boy walks back to school at a slower steady pace,
- one boy slows down gradually as he walks back to school.

The graph in Fig. 6.2 shows how their speeds vary with time.

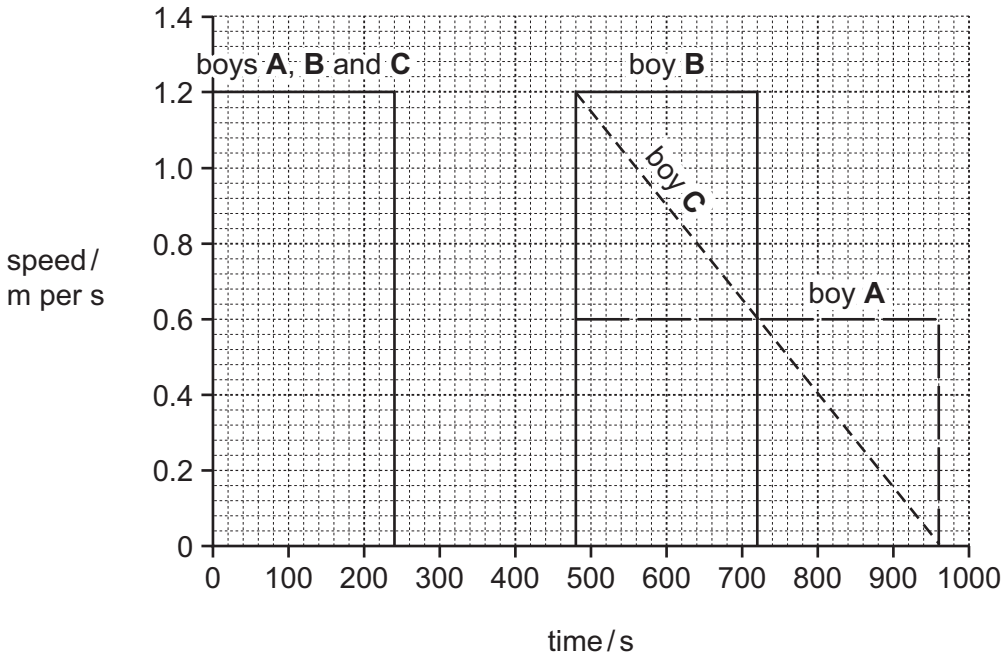

Fig. 6.2

(i) Calculate the distance of the store from the school.

Show your working.

..... m [2]

(ii) For how many seconds do the boys stay in the store?

..... s [1]

(iii) Which boy slowed down on his way back to school?

State a reason for your answer.

boy ..... because .....

..... [2]

For Examiner's Use

7 The metal vanadium is mixed with iron and carbon to make vanadium steel.

(a) (i) State the general name for mixtures containing metals.

.....[1]

(ii) Vanadium steel is used to make tools such as spanners (wrenches) and turbine blades in jet engines.

Suggest **one** advantage of vanadium steel compared to mild steel.

.....

.....[1]

(iii) Vanadium metal may be obtained by reacting vanadium oxide with magnesium.

The equation for the reaction is

vanadium oxide + magnesium ⟶ vanadium + magnesium oxide

Explain which substance is **reduced** in this reaction.

substance .....

explanation .....

.....[2]

(iv) Vanadium is a transition metal and magnesium is in Group 2 of the Periodic Table.

Suggest **two** properties of vanadium which are typical of transition metals and which are **not** possessed by magnesium.

1 .....

.....

2 .....

.....[2]

(b) Vanadium oxide is an important catalyst which is used in making sulfuric acid in the chemical industry.

Fig. 7.1 shows a simplified diagram of the reaction vessel which contains vanadium oxide.

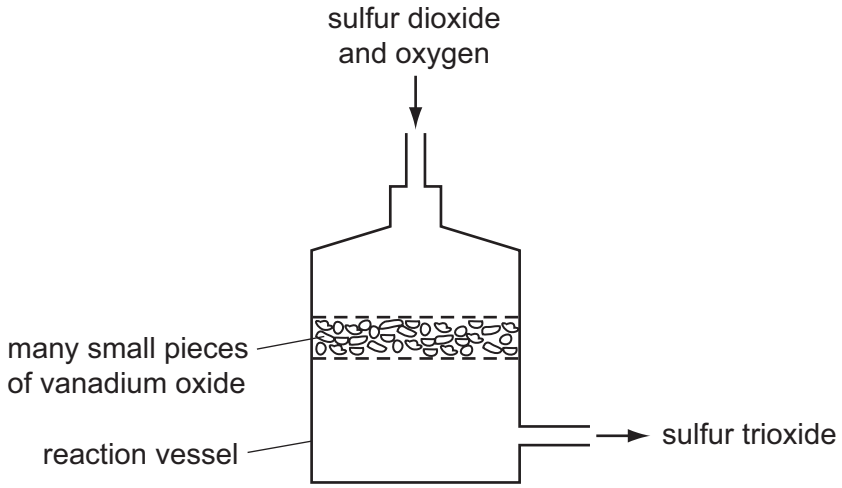

Fig. 7.1

In this reaction vessel, sulfur dioxide and oxygen react together on the surface of vanadium oxide.

(i) State what is meant by the term *catalyst*.

.....

.....

..... [2]

(ii) Use the information in Fig. 7.1 to suggest the **word** chemical equation for the reaction between sulfur dioxide and oxygen.

..... [1]

(iii) Explain why it is very important that none of the gas mixture involved in making sulfuric acid escapes into the air inside the factory.

.....

.....

..... [2]

[Turn over

For Examiner's Use

8 Fig. 8.1 shows some organisms that live in and around a pond.

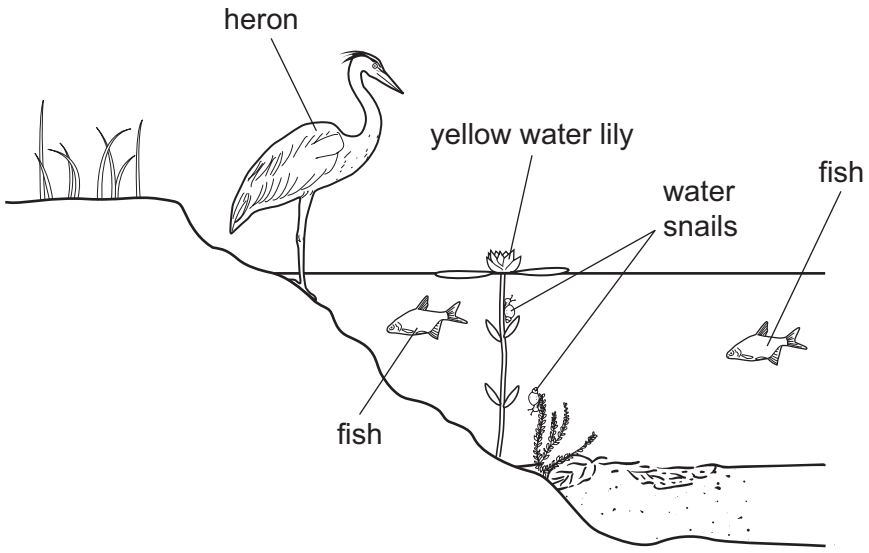

Fig. 8.1

(a) Herons eat fish. Water snails eat water plants, such as yellow water lilies.

Tick **all** the boxes that correctly describe each organism.

	producer	consumer	carnivore	herbivore
heron				
water snail				
yellow water lily				

[3]

(b) The addition of a harmful substance to the environment is called pollution. Two examples of pollution caused by human activities are

- untreated sewage entering a pond,
- the release of methane into the atmosphere.

(i) Explain why untreated sewage entering a pond may cause fish to die.

.....

.....

.....

..... [2]

(ii) Methane is produced by bacteria and other decomposers breaking down organic waste material in rubbish dumps.

For Examiner's Use

Describe how air pollution by methane can harm the environment.

.....

.....

.....

..... [2]

For Examiner's Use

9 **(a)** Complete the following sentences choosing from the terms below.

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

current **parallel** **potential difference**

resistance **series** **watt**

A flow of electric charge is called a ..... .

An ammeter is used to measure ..... .

A ..... drives a current between two points in a circuit. [3]

(b) A student investigated how a change in potential difference across a lamp affected the current flowing through the lamp.

She used wires to connect the components shown in Fig. 9.1 to make a circuit.

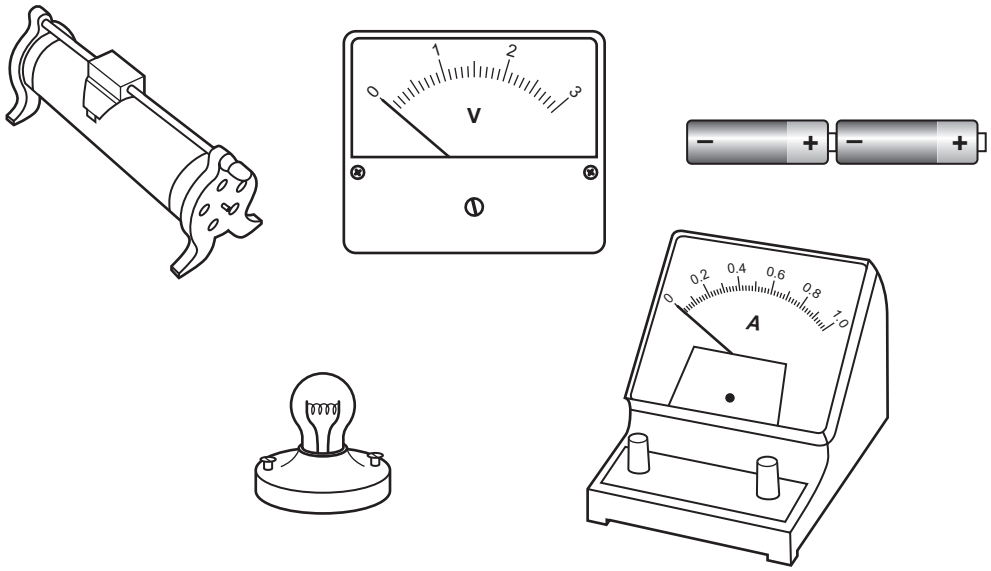

Fig. 9.1

(i) Using the correct circuit symbols, draw a diagram to show the circuit she used.

[4]

(ii) The student measured the current passing through a wire when a potential difference was applied across it.

Calculate the resistance of the wire when a potential difference of 0.3 V is applied and the current measured is 0.5 A.

State the formula that you use and show your working.

formula

working

..... Ω [2]

(c) Electricity is often transmitted through overhead power cables hung from pylons. If these cables are put up on a hot summer day, they are hung loosely from the pylons as shown in Fig. 9.2.

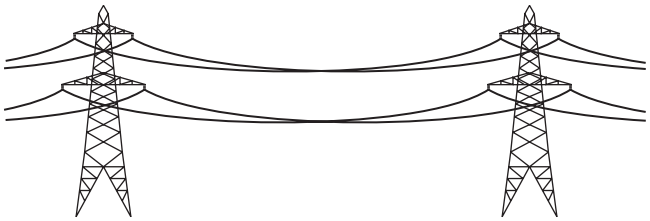

Fig. 9.2

Suggest why the cables are hung loosely.

.....

.....

..... [2]

For Examiner's Use

10 (a) Sodium hydrogencarbonate, $NaHCO_3$, is a white solid compound.

State the number of different elements that are shown combined in the formula, $NaHCO_3$.

..... [1]

(b) Fig. 10.1 shows apparatus a student used to investigate the reaction between sodium hydrogencarbonate and dilute hydrochloric acid.

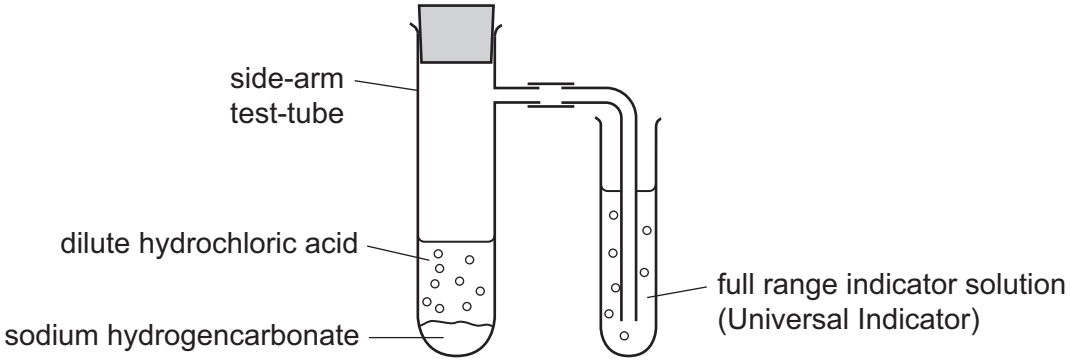

Fig. 10.1

The student observed that the indicator changed colour from green to orange.

Explain this observation.

.....

.....

..... [2]

(c) The student investigated the temperature change when sodium hydrogencarbonate was added to excess dilute hydrochloric acid.

Fig. 10.2 shows the apparatus she used.

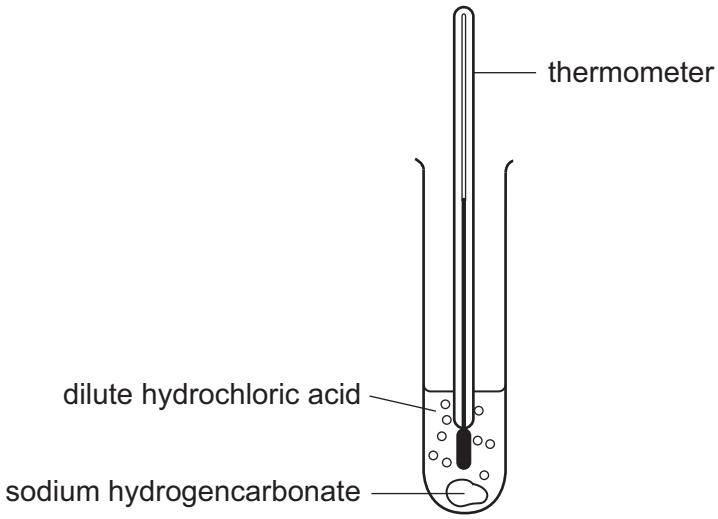

Fig. 10.2

Table 10.1 shows the temperature measurements the student made.

Table 10.1

temperature of the acid before the reaction / °C	19.0
temperature of the reaction mixture after reaction / °C	12.0

(i) Calculate the temperature change that occurred during the reaction.

..... °C [2]

(ii) State the term that is used to describe chemical reactions that cause this **type** of temperature change.

..... [1]

(d) A soluble calcium compound can be made by reacting lemon juice with finely powdered egg shells, which are made mainly of calcium carbonate.

Lemon juice contains a relatively low concentration of acid.

Suggest why the egg shells are used in the form of a fine powder.

.....

.....

..... [2]

For Examiner's Use

11 Fig. 11.1 shows the human gas exchange system.

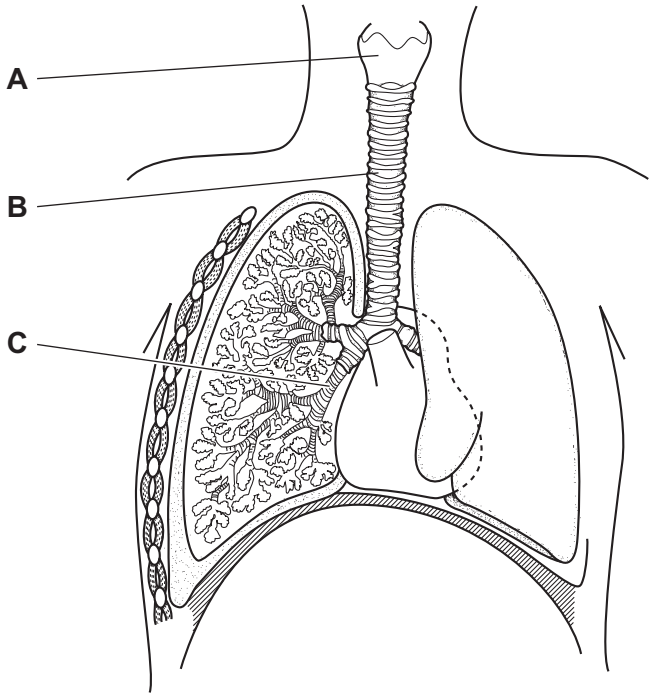

Fig. 11.1

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

A .....

B .....

C ..... [3]

(b) Table 11.1 shows the differences in the composition of inspired and expired air.

Table 11.1

gas	percentage in inspired air	percentage in expired air
nitrogen	78	
oxygen	21	17
carbon dioxide	0.04	4
noble gases	1	

(i) Complete Table 11.1. [1]

(ii) Name **one** noble gas that is present in air.

..... [1]

For Examiner's Use

(iii) Explain why the air that we breathe out (expired air) contains less oxygen and more carbon dioxide than the air we breathe in.

.....

.....

.....

..... [2]

(iv) Describe how you could show that expired air contains more carbon dioxide than inspired air. You can use a diagram if it helps your answer.

.....

.....

.....

..... [3]

(c) An athlete exercised on a treadmill. The treadmill measured her power output, in watts. The faster she ran, the greater her power output.

For Examiner's Use

(i) Explain why the athlete's power output was greater when she ran faster.

.....

.....

.....

..... [2]

For Examiner's Use

(ii) The athlete was connected to a machine that measured the rate and depth of her breathing.

Fig. 11.2 shows how her depth of breathing changed when she ran with different power outputs.

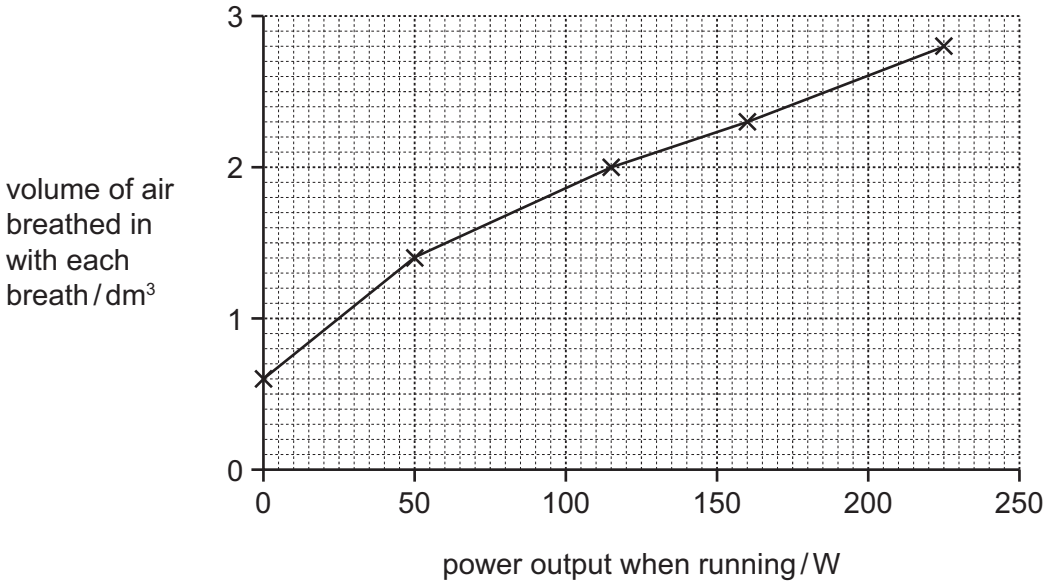

Fig. 11.2

Describe how the athlete's depth of breathing changed when she ran with a greater power output.

.....

.....

.....

..... [2]

(iii) State **one** other way in which her breathing would change when she ran with a greater power output.

..... [1]

For Examiner's Use

12 (a) Light energy travels to the Earth from the Sun.

State whether this transfer of energy is by conduction, convection or radiation.

Explain your answer.

.....

.....

..... [2]

(b) Light waves may change their direction when they travel from air into glass.

Name this effect.

..... [1]

(c) When an object is viewed in a plane mirror, an image can be seen.

Tick the boxes next to the **three** characteristics which correctly describe the image.

same way up as object	☐
upside down compared to object	☐
same size as object	☐
smaller than object	☐
larger than object	☐
laterally inverted	☐
not laterally inverted	☐

[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 Sulfur 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.).