



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE
NAME

CENTRE
NUMBER

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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.



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

For
Examiner's
Use

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.

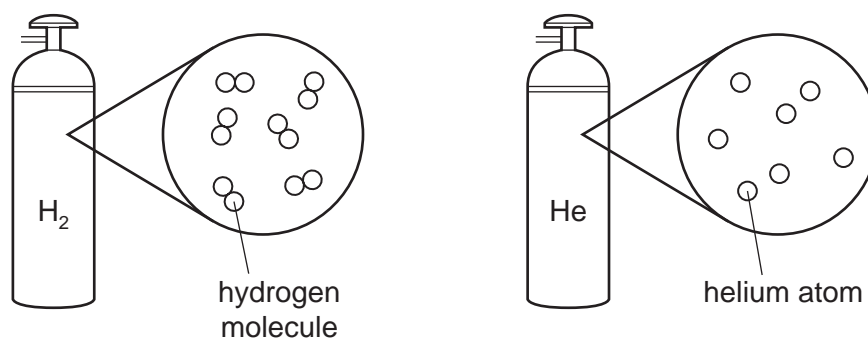


Fig. 1.1

(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]

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Use

(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.

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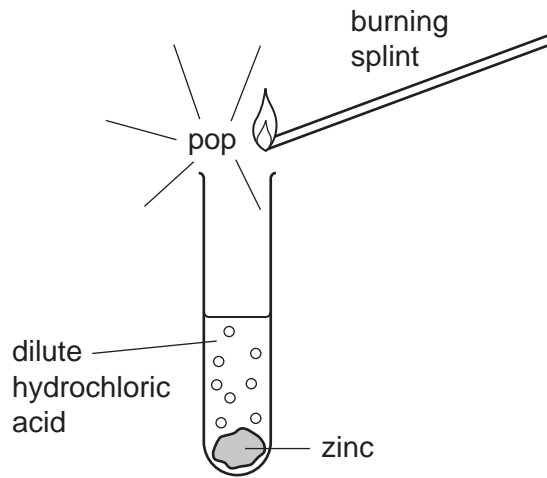


Fig. 1.2

.....

.....

.....

..... [2]

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.

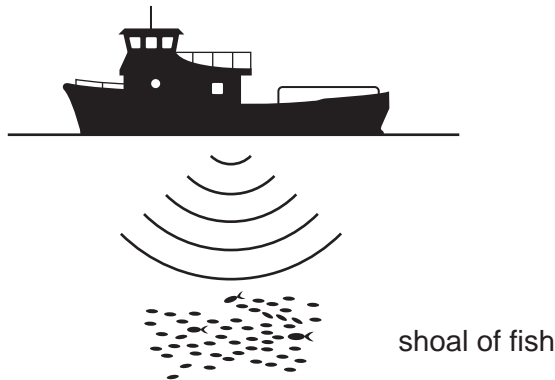


Fig. 2.1

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.

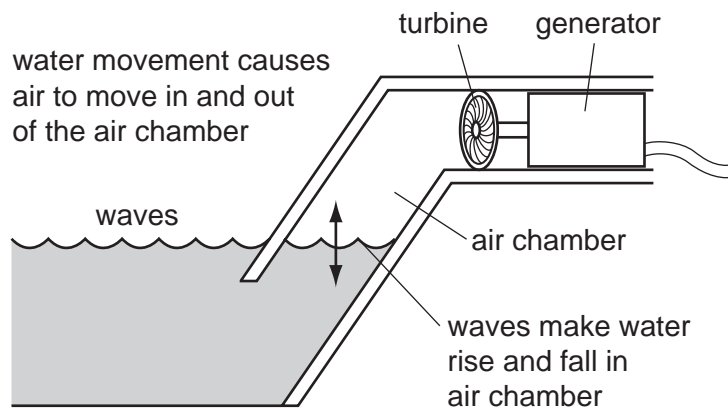


Fig. 2.2

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]

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

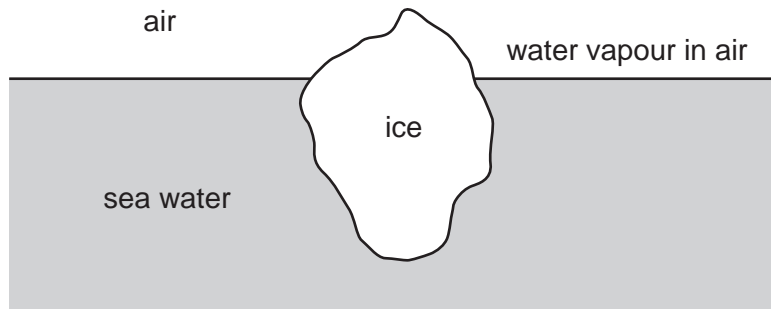


Fig. 2.3

(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
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Use

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

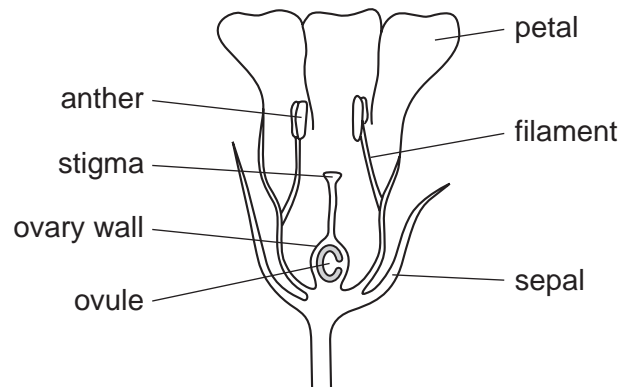


Fig. 3.1

- (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.

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

1

.....

2

..... [2]

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

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Use

(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.

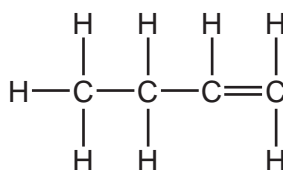


Fig. 4.1

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.

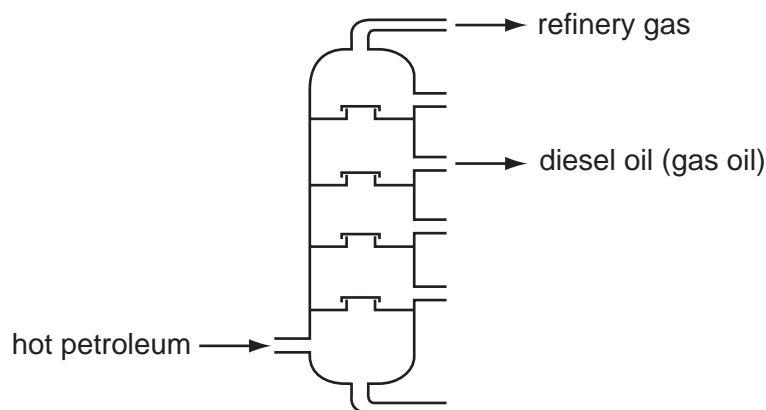


Fig. 4.2

- (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]

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

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Use*

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

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 100g samples of milk from two mammals.

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Use

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.

.....

.....

..... [2]

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

.....

.....

..... [2]

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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.

For
Examiner's
Use

Fig. 6.1 shows the two workers.

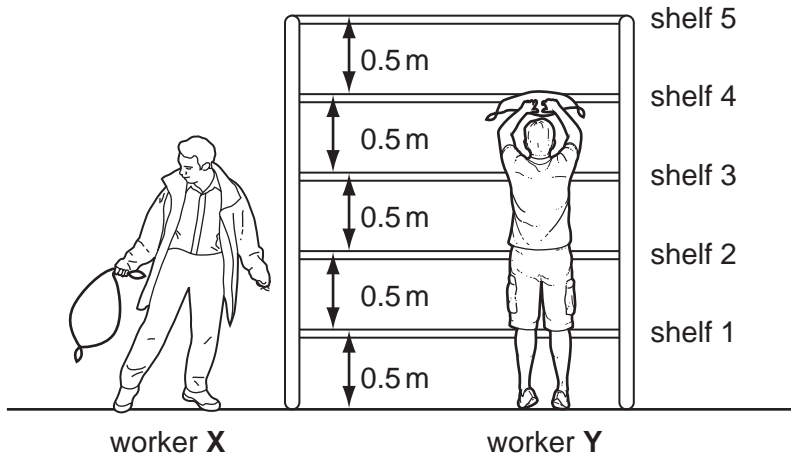


Fig. 6.1

- (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

(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.

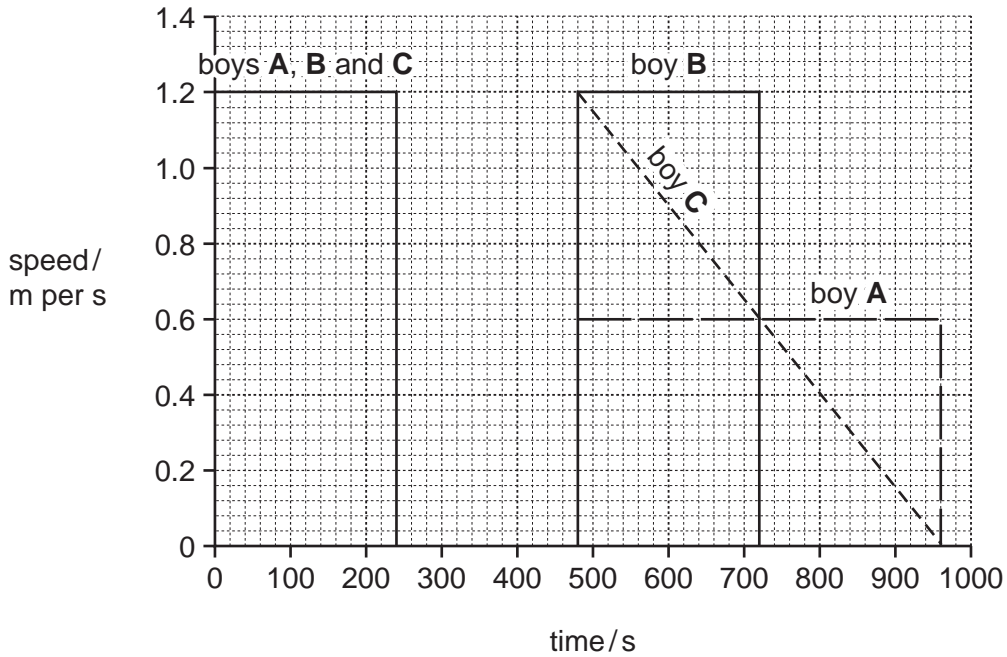


Fig. 6.2

(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]

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



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.

For
Examiner's
Use

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

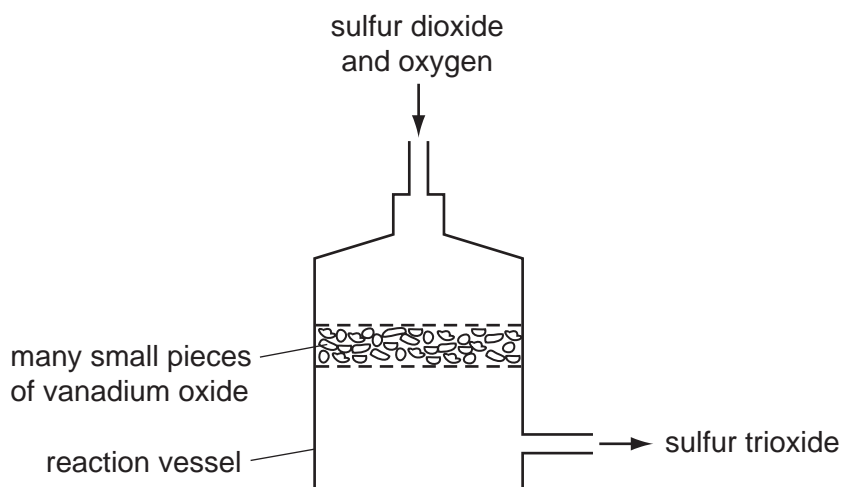


Fig. 7.1

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]

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

For
Examiner's
Use

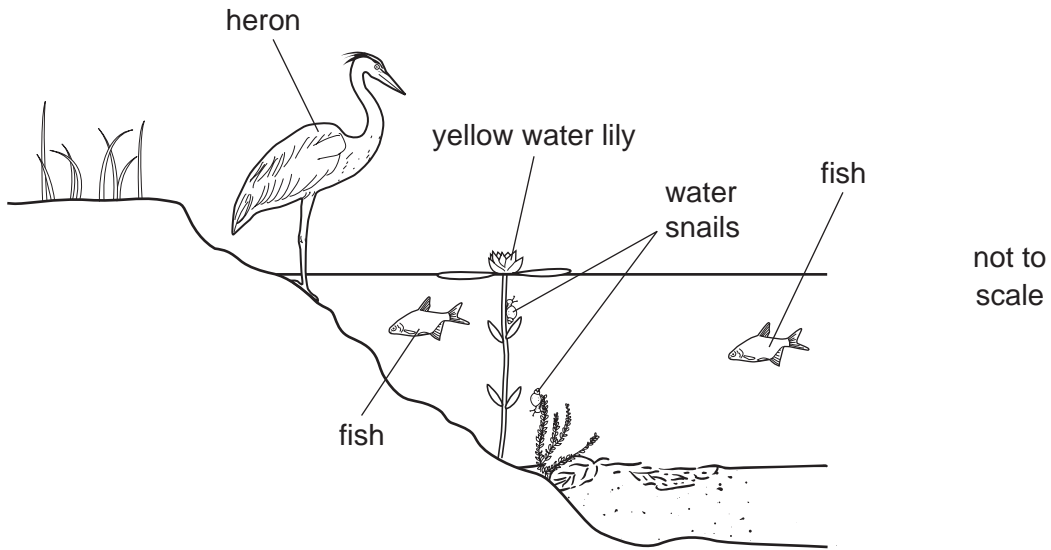


Fig. 8.1

(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.

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.

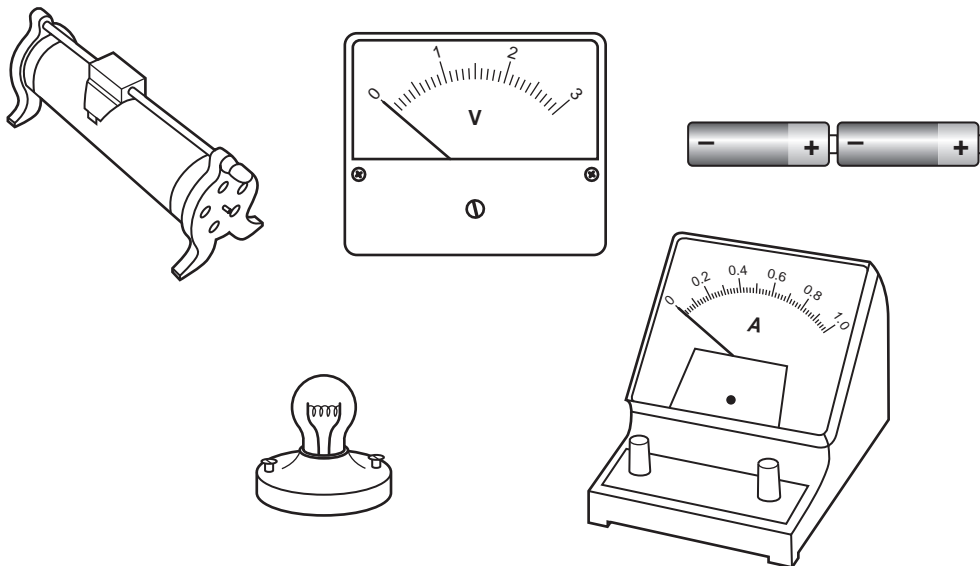


Fig. 9.1

(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 0.3V is applied and the current measured is 0.5A.

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.

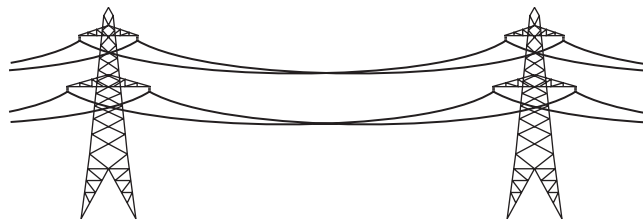


Fig. 9.2

Suggest why the cables are hung loosely.

.....

 [2]

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.

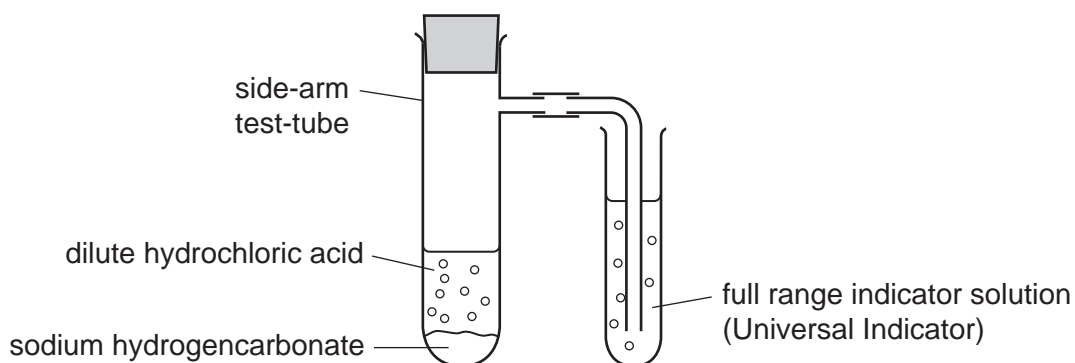


Fig. 10.1

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.

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Use

Fig. 10.2 shows the apparatus she used.

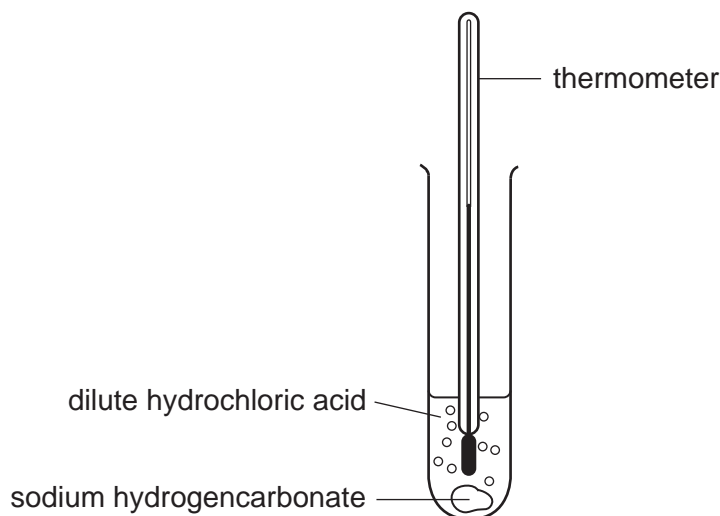


Fig. 10.2

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]

11 Fig. 11.1 shows the human gas exchange system.

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Examiner's
Use

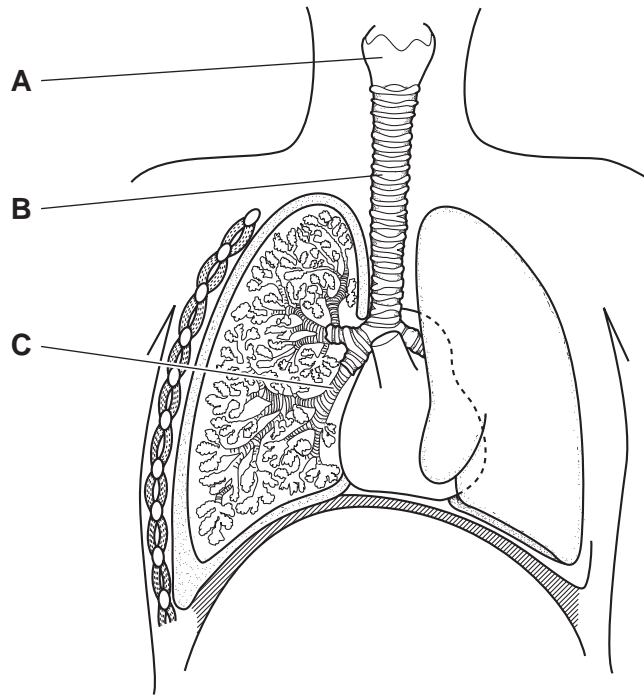


Fig. 11.1

(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]

- (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]

For
Examiner's
Use

- (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]

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

For
Examiner's
Use

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

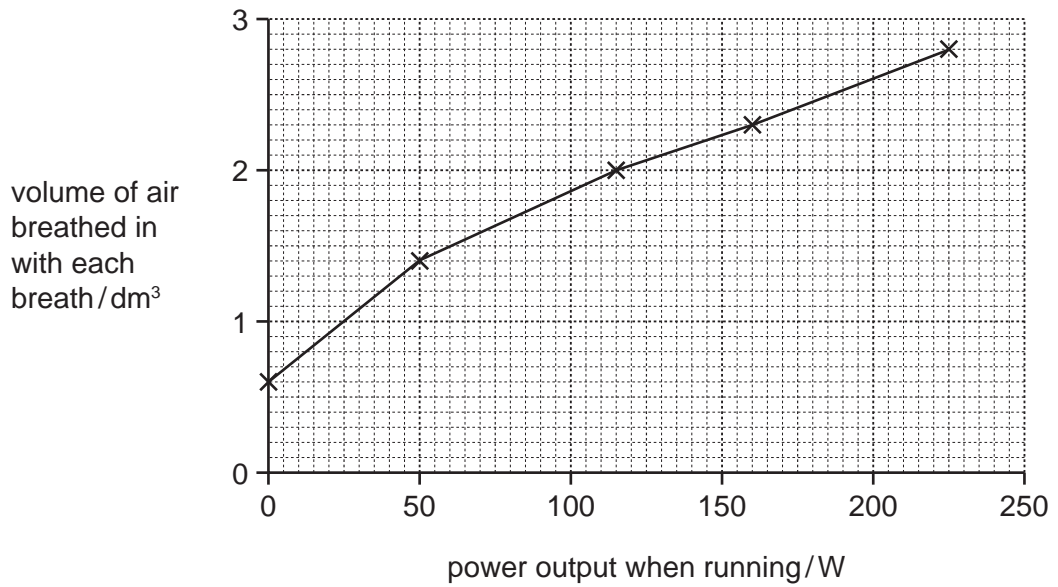


Fig. 11.2

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]

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]

DATA SHEET
The Periodic Table of the Elements

		Group											
		I	II	III	IV	V	VI	VII	VIII	IX	X		
		1 H Hydrogen 1											
		2 He Helium 2											
3	4	7 Li Lithium	9 Be Beryllium									19 F Fluorine	20 Ne Neon
11	12	23 Na Sodium	24 Mg Magnesium									35 Cl Chlorine	40 Ar Argon
19	20	39 K Potassium	40 Ca Calcium									79 Br Bromine	84 Kr Krypton
37	38	85 Rb Rubidium	88 Sr Strontium									127 I Iodine	131 Xe Xenon
55	56	133 Cs Caesium	137 Ba Barium									209 Bi Bismuth	210 Po Polonium
87	88	226 Fr Francium	226 Ra Radium									210 Pb Lead	222 Rn Radon
		5 B Boron											
		6 C Carbon											
		7 N Nitrogen											
		8 O Oxygen											
		9 Al Aluminium											
		10 Si Silicon											
		11 P Phosphorus											
		12 S Sulfur											
		13 Ga Gallium											
		14 Ge Germanium											
		15 As Arsenic											
		16 Se Selenium											
		17 Br Bromine											
		18 Kr Krypton											
		19 Rb Rubidium											
		20 Sr Strontium											
		21 Y Yttrium											
		22 Zr Zirconium											
		23 Nb Niobium											
		24 Mo Molybdenum											
		25 Tc Technetium											
		26 Ru Ruthenium											
		27 Rh Rhodium											
		28 Pd Palladium											
		29 Cu Copper											
		30 Zn Zinc											
		31 Ga Gallium											
		32 Ge Germanium											
		33 As Arsenic											
		34 Se Selenium											
		35 Br Bromine											
		36 Kr Krypton											
		37 Rb Rubidium											
		38 Sr Strontium											
		39 Y Yttrium											
		40 Zr Zirconium											
		41 Nb Niobium											
		42 Mo Molybdenum											
		43 Tc Technetium											
		44 Ru Ruthenium											
		45 Rh Rhodium											
		46 Pd Palladium											
		47 Ag Silver											
		48 Cd Cadmium											
		49 In Indium											
		50 Sn Tin											
		51 Sb Antimony											
		52 Te Tellurium											
		53 I Iodine											
		54 Xe Xenon											
		55 Cs Caesium											
		56 Ba Barium											
		57 La Lanthanum											
		58-71 Lanthanoid series											
		72 Hf Hafnium											
		73 Ta Tantalum											
		74 W Tungsten											
		75 Re Rhenium											
		76 Os Osmium											
		77 Ir Iridium											
		78 Pt Platinum											
		79 Au Gold											
		80 Hg Mercury											
		81 Tl Thallium											
		82 Pb Lead											
		83 Bi Bismuth											
		84 Po Polonium											
		85 At Astatine											
		86 Rn Radon											
		87 Fr Francium											
		88 Ra Radium											
		89 Ac Actinium											
		90 Th Thorium											
		91 Pa Protactinium											
		92 U Uranium											
		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											
		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											
		113 Nh Nihonium											
		114 Fl Flerovium											
		115 Mc Moscovium											
		116 Lv Livermorium											
		117 Ts Tennessine											
		118 Og Oganesson											
		119 Uue Ununennium											
		120 Uub Unbibium											
		121 Uut Ununtrium											
		122 Uuq Ununquadium											
		123 Uup Ununpentium											
		124 Uuq Ununhexium											
		125 Uuq Ununseptium											
		126 Uuq Ununoctium											
		127 Uuq Ununseptium											
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		138 Uuq Ununoctium											
		139 Uuq Ununseptium											
		140 Ce Cerium											
		141 Pr Praseodymium											
		142 Nd Neodymium											
		143 Pm Promethium											
		144 Sm Samarium											
		145 Eu Europium											
		146 Gd Gadolinium											
		147 Tb Terbium											
		148 Dy Dysprosium											
		149 Ho Holmium											
		150 Er Erbium											
		151 Tm Thulium											
		152 Yb Ytterbium											
		153 Lu Lutetium											
		154 Hf Hafnium											
		155 Ta Tantalum											
		156 W Tungsten											
		157 Re Rhenium											
		158 Os Osmium											
		159 Ir Iridium											
		160 Pt Platinum											
		161 Au Gold											
		162 Hg Mercury											
		163 Tl Thallium											
		164 Pb Lead											
		165 Bi Bismuth											
		166 Po Polonium											
		167 At Astatine											
		168 Rn Radon											
		169 Fr Francium											
		170 Ra Radium											
		171 Ac Actinium											
		172 Th Thorium											
		173 Pa Protactinium											
		174 U Uranium											
		175 Np Neptunium											
		176 Pu Plutonium											
		177 Am Americium											
		178 Cm Curium											
		179 Bk Berkelium											
		180 Cf Californium											
		181 Es Einsteinium											
		182 Fm Fermium											
		183 Md Mendelevium											
		184 No Nobelium											
		185 Lr Lawrencium											
		186 Rf Rutherfordium											
		187 Db Dubnium											
		188 Sg Seaborgium											
		189 Bh Bohrium											
		190 Hs Hassium											
		191 Mt Meitnerium											
		192 Ds Darmstadtium											
		193 Rg Roentgenium											
		194 Cn Copernicium											
		195 Nh Nihonium											
		196 Fl Flerovium											
		197 Mc Moscovium											
		198 Lv Livermorium											
		199 Ts Tennessine											
		200 Og Oganesson											

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

a	X	relative atomic mass
b	X	atomic symbol
b	X	proton (atomic) number

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).

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