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# Tuesday 10 November2020 – Morning

## GCSE (9–1) Combined Science B (Twenty First Century Science)

**J260/02** Chemistry (Foundation Tier)

**Time allowed: 1 hour 45 minutes**

*8270916542*

**You must have:**
- a ruler (cm/mm)
- the Data Sheet for GCSE (9–1) Combined Science (Chemistry) B (inside this document)

**You can use:**
- an HB pencil
- a scientific or graphical calculator

*J260002*

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

**INSTRUCTIONS**
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

**INFORMATION**
- The total mark for this paper is **95**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*****).
- This document has **24** pages.

**ADVICE**
- Read each question carefully before you start your answer.

Answer **all** the questions.

**1** Atoms contain protons, neutrons and electrons.

**(a) (i)** Complete the table to give information about protons, neutrons and electrons.

| | **Relative mass** | **Relative Charge** | **Location in the atom** |
|---|---|---|---|
| **Proton** | 1 | +1 | ..... |
| **Neutron** | ..... | ..... | ..... |
| **Electron** | ..... | ..... | in shells |

**[3]**

**(ii)** The Periodic Table shows information about atoms of sulfur.

What is the group number and period number for sulfur?

Use the Data Sheet.

**Group number** = .....

**Period number** = .....

**[2]**

**(b)** The diameter of an atom is approximately 0.1 nm.

The diameter of a bacterium is approximately 10 000 times bigger than the diameter of an atom.

Estimate the diameter of a bacterium, in **mm**.

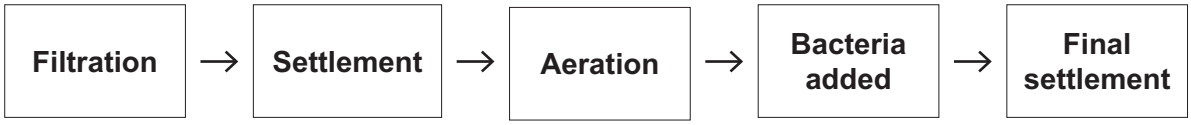
1 mm = 1 000 000 nm

Diameter of bacterium = ..... mm **[2]**

**2** The demand for drinking water in the world is increasing and we need new ways of supplying drinking water.

Waste water from drains and sewers can be treated, and then returned to rivers so that it can be used again.

**(a)** The diagram shows the stages in the treatment of waste water.




Draw lines to connect each **stage** with its **function**.

One has been done for you.

| Stage | Function |
|---|---|
| Aeration | Breaks down organic material |
| Bacteria added | Provides oxygen |
| Filtration | Removes large objects |
| Settlement | Solid falls to bottom of tank |

**[2]**

**(b)** Chlorine can also be added to water to make it safe to drink.

Describe the test and result to identify chlorine.

**Test** .....

.....

**Result** .....

.....

**[2]**

**(c)** Typhoid is a disease which can be spread by drinking unsafe water.

**Fig. 2.1** shows the number of people who had typhoid per 100 000, in a city, every 5 years, from 1890 to 1930.

**Table 2.1** shows data for this city, for two years, 1890 and 1930.

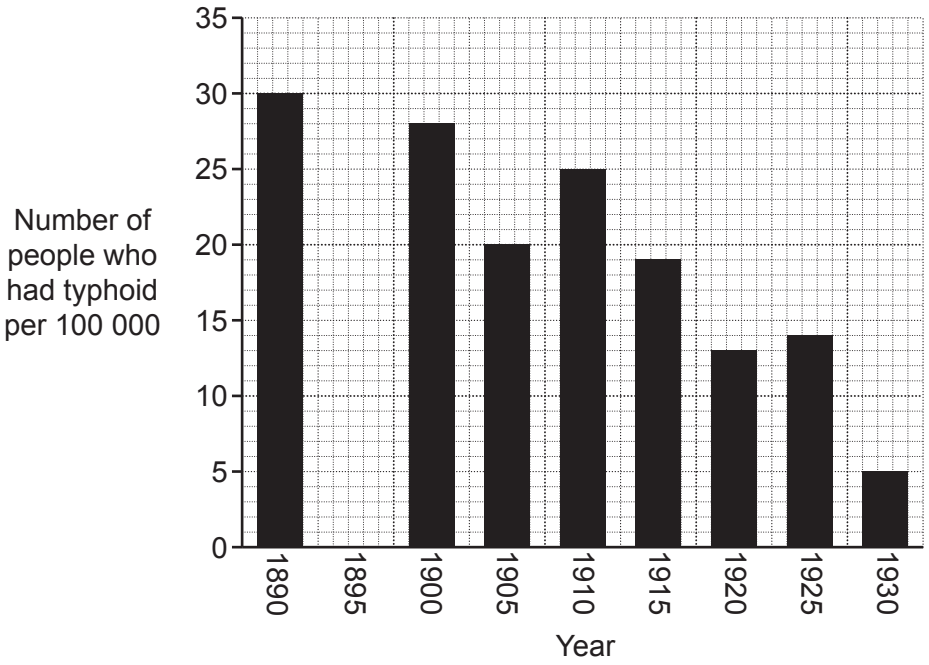



**Fig. 2.1**

| Year | Total population of the city | Number of people who had typhoid per 100 000 | Total number of people who had typhoid |
|---|---|---|---|
| 1890 | 60 000 | ..... | 18 |
| 1930 | 200 000 | 5 | ..... |

**Table 2.1**

**(i)** Complete **Table 2.1**. **[2]**

**(ii)** In 1895, the number of people who had typhoid per 100 000 was 25.

Plot this data on **Fig. 2.1**. **[1]**

**(iii)** Chlorine was added to the drinking water of the city after 1910.

How does the data in **Fig. 2.1** show that adding chlorine to the water after 1910 made the water safer to drink?

.....

.....

.....

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

**(d) (i)** How does chlorine make the water safe to drink?

.....

..... **[1]**

**(ii)** Give **one** benefit and **one** risk of adding chlorine to water.

**Benefit** .....

.....

**Risk** .....

.....

**[2]**

**3** Sodium chloride is an ionic compound.

**(a)** Complete the sentences about the structure and bonding of ionic compounds.

Put a (ring) around the correct words to complete each sentence.

Ions are formed when **electrons / protons** are **shared / transferred**.

The forces holding the ions together are **electrostatic / magnetic**.

Ions are held together in a **lattice / molecule**.

**[3]**

**(b)** **Fig. 3.1** and **Fig. 3.2** show two ways of representing the structure and bonding of sodium chloride NaC$l$.

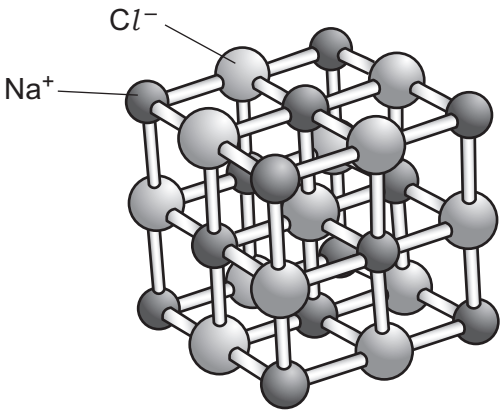



**Fig. 3.1**

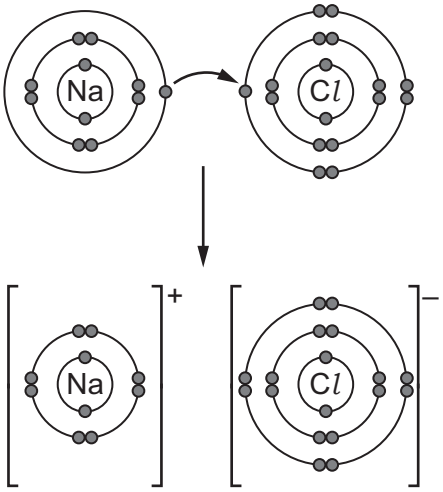



**Fig. 3.2**

Complete the table to identify what is shown in **Fig. 3.1** and **Fig. 3.2**.

Tick (✓) at least **one** box in each row.

| **Statement** | **Fig. 3.1** | **Fig. 3.2** |
|---|---|---|
| How the ions are arranged. | | |
| How the ions are formed. | | |
| The charge on each ion. | | |

**[3]**

**(c)** **(i)** Explain why sodium chloride conducts electricity when it is molten but does **not** conduct electricity when it is solid.

.....

.....

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

**(ii)** When electricity passes through molten sodium chloride it decomposes.

Name the **two** products formed when molten sodium chloride decomposes.

..... and .....

**[2]**

**(d)** Sodium chloride is soluble in water.

Sodium chloride crystals can be made from a solution of sodium chloride in water by the process of **crystallisation**.

Which **two** steps are needed to **produce** large sodium chloride crystals from a pure solution of sodium chloride?

Tick (✓) **two** boxes.

Add universal indicator. ☐

Add more water to the solution. ☐

Heat the solution until most of the solution has evaporated. ☐

Heat the solution until all the water has evaporated. ☐

Leave hot solution to cool slowly. ☐

**[2]**

**(e)** Sea water contains dissolved sodium chloride. It can be used as a source of drinking water if the dissolved sodium chloride is removed.

Which **two** methods can be used to **remove** dissolved sodium chloride from sea water?

Tick (✓) **two** boxes.

Chromatography ☐

Distillation ☐

Filtration ☐

Membrane filtration ☐

Titration ☐

**[2]**

**4** Cotton is a natural fibre made from plants. Polyester is a man-made, synthetic fibre made from crude oil.

**(a)** Which **two** statements explain why plants are more sustainable raw materials than crude oil?

Tick (✓) **two** boxes.

Crude oil is finite. ☐

Crude oil is found underground. ☐

Plants are recyclable. ☐

Plants are renewable. ☐

Plants can be used as food but crude oil cannot. ☐

**[2]**

**(b)** Most shirts are made from polyester or cotton fabric.

The table shows data from two parts of a life-cycle assessment, for both polyester shirts and cotton shirts.

The data is for 1000 polyester shirts and 1000 cotton shirts.

| | **1000 polyester shirts** | **1000 cotton shirts** |
|---|---|---|
| **Production of the two fabrics from raw materials** | | |
| Raw material | Crude oil | From plants |
| Energy used to make fibres from raw materials (MJ) | 97 | 60 |
| Energy used to make the fabric from the fibres (MJ) | 33 | 40 |
| Total water used in production ($dm^3$) | 1307 | 25 900 |
| Total carbon dioxide emissions during production (kg) | 3.8 | 5.3 |
| | | |
| **Disposal of the shirts (by burning)** | | |
| Energy released (MJ) | 33 | 7 |
| Carbon dioxide emissions (kg) | 5.8 | 5.5 |

**(i)** What should be considered when completing a life-cycle assessment for both polyester shirts and cotton shirts?

Tick (✓) **two** boxes.

| | |
|---|---|
| The amount that workers are paid. | ☐ |
| The cost of the shirts. | ☐ |
| The energy used to transport the shirts. | ☐ |
| The energy and water used to wash the shirts. | ☐ |
| Which shirt customers prefer. | ☐ |

**[2]**

**(ii)** Calculate the difference in the **total** energy used for the production of the **two fabrics** from raw materials.

Use data from the table.

Difference in total energy = ..... MJ

**[2]**

**(iii)** Give **two** advantages to the environment of making polyester fabric rather than cotton fabric.

Use data from the table to support your answers.

1. .....

.....

2. .....

.....

**[2]**

**(iv)** Give **one** disadvantage to the environment of making polyester fabric rather than cotton fabric.

Use data from the table to support your answer.

.....

..... **[1]**

**(c) (i)** There are many different methods of disposing of shirts at the end of their life-cycle.

The table gives some information about disposal by burning.

Suggest **two** other methods of disposing of shirts.

1. .....

2. .....

**[2]**

**(ii)** When shirts are disposed of by burning, energy is released.

Suggest **one** use for this energy.

.....

..... **[1]**

**5** **(a)** When acids react with alkalis, a salt is formed.

Different salts can be made by reacting different acids and alkalis together.

**(i)** Draw lines to connect each **salt** with the acid **and** alkali that are used to make it.

| **Acid** | **Salt** | **Alkali** |
|---|---|---|
| Hydrochloric acid | **Calcium sulfate** | Sodium hydroxide |
| Nitric acid | **Sodium chloride** | Potassium hydroxide |
| Sulfuric acid | **Potassium nitrate** | Calcium hydroxide |

**[3]**

**(ii)** Complete the table of information about **three** other salts.

Use the Data Sheet.

| **Name** | **Ions** | **Formula** | **Relative formula mass** |
|---|---|---|---|
| Potassium bromide | $K^+$ and $Br^-$ | KBr | 119 |
| Calcium chloride | ..... and ..... | $CaCl_2$ | ..... |
| Calcium nitrate | $Ca^{2+}$ and $NO_3^-$ | ..... | 164.1 |

**[3]**

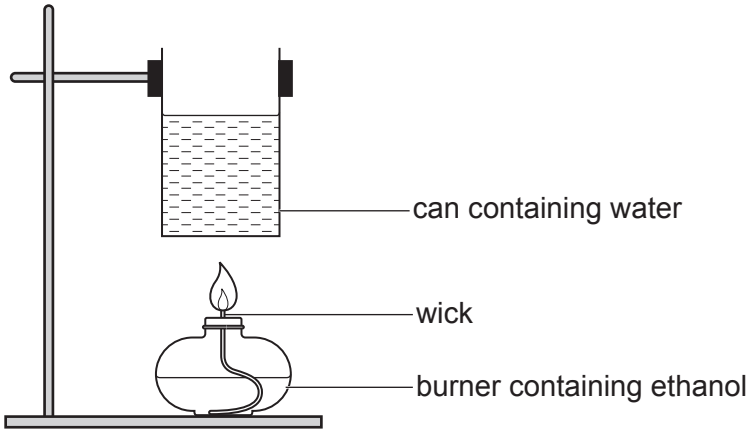
**6** Nina investigates the combustion of ethanol.

**(a)** Complete the **balanced symbol** equation for the combustion of ethanol in air.

$C_2H_5OH$ + ..... $O_2$ → ..... $CO_2$ + ..... $H_2O$

**[2]**

**(b)** Nina uses this apparatus for her experiment.




Nina measures the mass of the burner containing ethanol, and the temperature of the water at the start of the experiment. She also measures the mass of water in the can.

She burns some ethanol, and then measures the temperature of the water and the mass of the burner containing ethanol at the end of the experiment.

**(i)** What apparatus does Nina need to make her measurements?

Put a (ring) around the **two** correct answers.

**balance** **beaker** **condenser** **funnel** **pH meter** **thermometer**

**[2]**

**(ii)** Nina uses a lighted splint to light the wick which starts the ethanol burning.

The flame from the lighted splint provides the activation energy needed to start the ethanol burning.

What is the activation energy in this experiment?

Tick (✓) **two** boxes.

The energy given out when ethanol burns. ☐

The energy needed to boil the ethanol. ☐

The energy needed to break bonds in the ethanol molecules. ☐

The energy supplied by a catalyst. ☐

The minimum energy needed for the reaction to start. ☐

**[2]**

**(c)** Here are the results of Nina's experiment.

| | |
|---|---|
| Mass of water in the can (g) | 200 |
| Mass of burner containing ethanol at the start (g) | 242.1 |
| Mass of burner containing ethanol at the end (g) | 241.7 |
| Temperature of water at the start (°C) | 19 |
| Temperature of water at the end (°C) | 27 |

**(i)** Is the reaction endothermic or exothermic?

Use Nina's results to explain your answer.

.....

..... **[1]**

**(ii)** What is the mass of ethanol burned in Nina's experiment?

Mass of ethanol burned = ..... g **[1]**

**(iii)** What is the temperature change of the water in Nina's experiment?

Temperature change of the water = ..... °C **[1]**

**(iv)** Calculate the energy that was needed to change the temperature of the water in Nina's experiment.

Use the equation:
Energy change (J) = 4200 × mass of water (kg) × change in temperature (°C)

Give your answer in **kJ**.

Energy change = ..... kJ **[3]**

**7** Crude oil is a mixture of hydrocarbons.

**(a) (i)** Hydrocarbons contain carbon and one other element.

What is the name of the other element?

Put a (ring) around the correct answer.

**bromine** **chlorine** **hydrogen** **oxygen** **nitrogen**

**[1]**

**(ii)** Most hydrocarbons in crude oil are in the alkanes homologous series.

Which properties of the members in a homologous series are **true** and which are **false**?

Tick (✓) **one** box in each row.

| **Property** | **True** | **False** |
|---|---|---|
| They have the same molecular formula. | | |
| They have the same general formula. | | |
| They have the same boiling points. | | |
| They show a trend in physical properties. | | |

**[4]**

**(iii)** Why is crude oil an important resource for the chemical industry?

Tick (✓) **two** boxes.

- It is a black, sticky liquid. ☐
- It can be made into lots of other chemicals. ☐
- It will never run out. ☐
- It is a source of fuels. ☐
- It contains many ionic compounds. ☐

**[2]**

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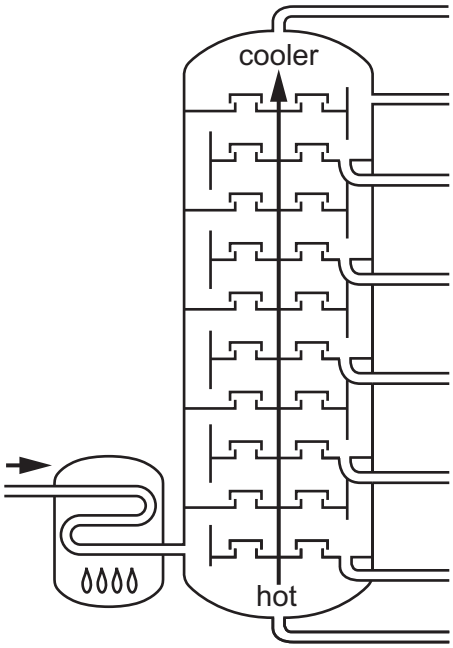
**(b)*** Crude oil is separated into fractions using fractional distillation.

The fractional distillation of crude oil is carried out in a fractionating tower.




The table shows some information about the fractions produced by fractional distillation of crude oil.

| Fraction | Carbon chain length | Boiling point range (°C) | Height reached in tower |
|---|---|---|---|
| Petroleum gas | 1–4 | <40 | top (lower temperature) ↑ |
| Petrol | 5–8 | 40–110 | |
| Naphtha | 8–10 | 110–180 | |
| Kerosene | 10–16 | 180–260 | |
| Diesel oil | 16–20 | 260–320 | |
| Heavy fuel oil | 20–50 | 320–400 | |
| Bitumen | >50 | >400 | bottom (high temperature) |

**17**

Describe and explain how fractional distillation separates crude oil.

Use data from the table to support your answer.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... **[6]**

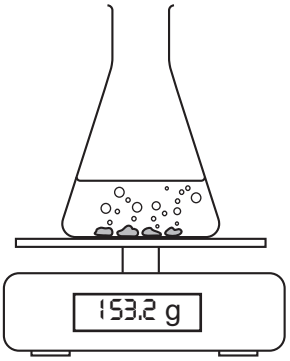
**8** Sundip investigates the rate of reaction between calcium carbonate and hydrochloric acid.

This is the symbol equation for the reaction.

$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$

She adds 50 $cm^3$ of 1 mol / $dm^3$ hydrochloric acid to a flask and puts the flask on a balance.

She adds 10 g of calcium carbonate pieces to the acid.




She measures the mass of the flask and its contents at the start, and again after 1 minute.

**Results**
Mass of flask and contents at the start = 153.2 g
Mass of flask and contents after 1 minute = 152.5 g

**(a) (i)** Why does the mass of the flask and its contents decrease after 1 minute?

Tick (✓) **one** box.

Gases are lighter than liquids. ☐

Gas particles leave the flask. ☐

The products have less total mass than the reactants. ☐

The reactants have less total mass than the products. ☐

**[1]**

**(ii)** Calculate the rate of reaction for this experiment.

Use the equation: rate of reaction (g / s) = $\frac{\text{change in mass (g)}}{\text{time (s)}}$

Give your answer to **2** significant figures.

Rate of reaction = ..... g / s
**[3]**

**(b)** What can Sundip do to make the reaction faster?

Tick (✓) **two** boxes.

Use a smaller volume of acid. ☐

Use larger pieces of calcium carbonate. ☐

Use a lower temperature. ☐

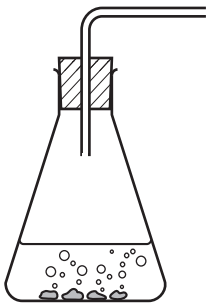
Use more concentrated acid. ☐

Use powdered calcium carbonate instead of pieces. ☐

**[2]**

**(c)** Sundip also collects and measures the volume of gas given off during the reaction.

**(i)** Complete the diagram to show how she could measure the volume of gas given off.



**[2]**

**(ii)** Sundip measures the volume of gas given off after 1 minute.

She repeats the experiment at different temperatures. Here are her results.

| **Temperature (°C)** | 20 | 30 | 40 | 50 |
|---|---|---|---|---|
| **Volume of gas given off after 1 minute ($cm^3$)** | 11 | 22 | 44 | 88 |

Sundip looks at her results and writes this relationship.

**rate of reaction $\propto$ temperature**

Do Sundip's results agree with this relationship?

Yes ☐

No ☐

Use Sundip's results to explain your answer.

.....

.....

.....

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

**9** Elements in the Periodic Table are arranged in order of atomic number.

**(a)** The atomic number and relative atomic mass of an element can be used to work out the number of protons, electrons and neutrons in its atoms and ions.

Complete the table.

Use the Data Sheet.

| **Symbol** | Na **atom** | $F^-$ **ion** |
|---|---|---|
| **Atomic number** | ..... | 9 |
| **Number of protons** | 11 | 9 |
| **Number of electrons** | ..... | ..... |
| **Number of neutrons** | ..... | ..... |

**[3]**

**(b)** **(i)** Magnesium is a metal and phosphorus is a non-metal.

They have different electron arrangements.

| | **Electron arrangement** |
|---|---|
| **Magnesium** | 2.8.2 |
| **Phosphorus** | 2.8.5 |

How do the electron arrangements of magnesium and phosphorus show that they are in the same **period** but in different **groups**?

**Same period** .....

.....

**Different groups** .....

.....

**[2]**

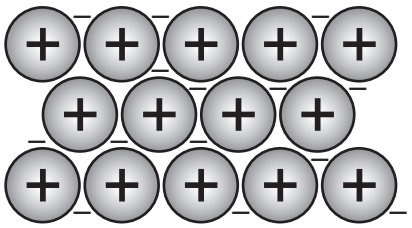
**(ii)** The electron arrangement of argon is 2.8.8.

What does this tell you about the reactivity of argon?

.....

..... **[1]**

**(c)** The diagram shows how the particles in magnesium metal are arranged.



**(i)** Complete the key to the diagram.

**Key**

| | |
|---|---|
| + | |
| – | |

**[1]**

**(ii)** The structure of metals explains why their properties are different from those of non-metals.

Draw lines to connect each metal property with its explanation.

| Metal Property | Explanation |
|---|---|
| | Metal ions can slide over each other |
| Malleable | |
| | Metal ions have positive charges |
| Solid metal conducts electricity | |
| | Outer shell electrons move freely |
| High melting point | |
| | Strong attraction between charged particles in the metal structure |

**[2]**

**END OF QUESTION PAPER**

## ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).