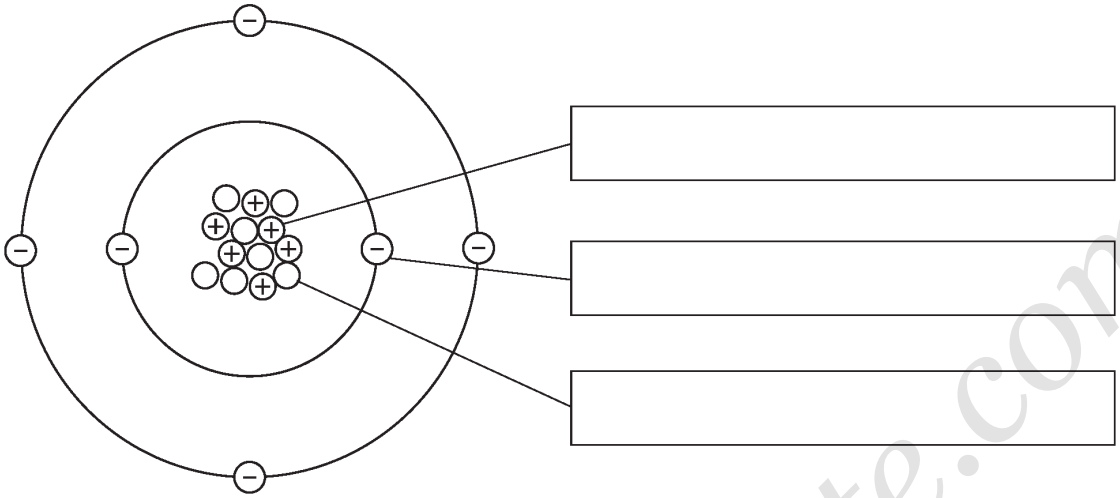
# CHEMISTRY

PAPER 2C, 2CR 2019 - 2023

**1** – (4CH1/2C_Summer_2019_Q1) – *Principles Of Chemistry*

The diagram shows the particles in an atom of an element.



(a) The box gives the names of some particles.

| electron | ion | molecule | neutron | proton |
|---|---|---|---|---|

Use words from the box to label the diagram.

**(3)**

(b) Give the mass number of this atom.

**(1)**

.....

(c) Complete the sentence about isotopes.

**(2)**

Isotopes are atoms that have the same number of .....

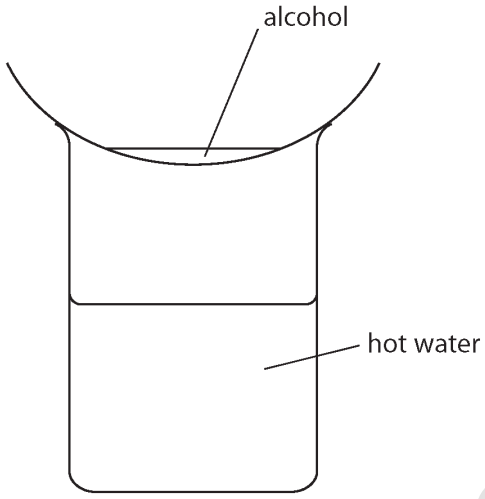
but have a different number of ..... .

**(Total for Question 1 = 6 marks)**

**2** – (4CH1/2C_Summer_2019_Q3) – *Principles Of Chemistry*

Methanol, ethanol, propanol and butanol are alcohols. They are all liquids that evaporate easily when warmed.

A student uses this apparatus to compare the time taken for the four liquids to evaporate.




She uses this method.

- pour some methanol into an evaporating basin
- place the evaporating basin on top of a beaker containing hot water
- measure the time taken for the methanol to evaporate completely
- repeat the experiment with each of the other alcohols, using the same apparatus

(a) State two variables the student should control to make sure her results are valid.

**(2)**

1 .....

.....

2 .....

.....

(b) State why it is not safe to heat the evaporating basin directly with a Bunsen flame.

**(1)**

.....

.....

(c) The table shows the results of experiments done by four students, A, B, C and D.

| Alcohol | Formula of alcohol | Time taken for liquid to evaporate in s | | | | |
|---|---|---|---|---|---|---|
| | | Student A | Student B | Student C | Student D | Mean time in s |
| methanol | $CH_3OH$ | 20 | 24 | 22 | 26 | 23 |
| ethanol | $C_2H_5OH$ | 32 | 34 | 35 | 30 | 33 |
| propanol | $C_3H_7OH$ | 45 | 47 | 50 | 48 | 48 |
| butanol | $C_4H_9OH$ | 64 | 63 | 90 | 60 | |

(i) Calculate the mean (average) time for butanol to evaporate.

**(2)**

mean time = ..... s

(ii) Explain how the results show which alcohol evaporates most easily.

**(2)**

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(iii) State the relationship between the number of carbon atoms in the molecule and how easily the alcohol evaporates.

**(2)**

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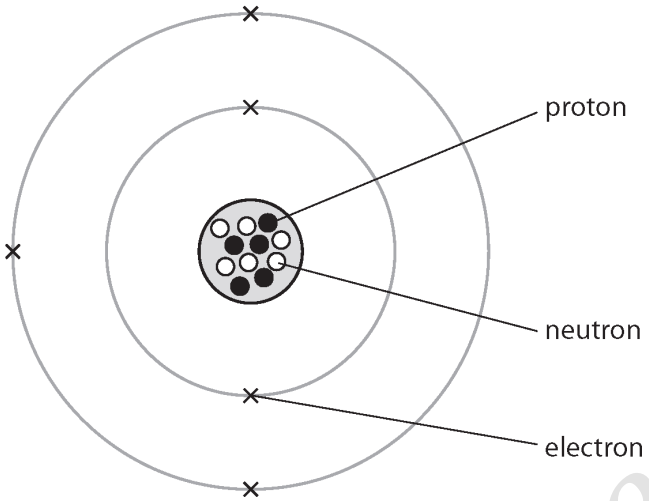
**(Total for Question 3 = 9 marks)**

**3** – (4CH1/2CR_Summer_2019_Q2) – *Principles Of Chemistry*

The diagram represents an atom of boron.




(a) Use information from the diagram to complete the table.

The first row has been done for you.

**(5)**

| | |
|---|---|
| atomic number | 5 |
| mass number | |
| number of neutrons | |
| group in the Periodic Table that contains boron | |
| period in the Periodic Table that contains boron | |
| electronic configuration of an atom of boron | |

(b) Boron has two isotopes, boron-10 and boron-11.

A sample of boron contains 18.7% of boron-10 and 81.3% of boron-11.

Calculate the relative atomic mass of this sample of boron.

**(2)**

relative atomic mass = .....

**(Total for Question 2 = 7 marks)**

**4** – (4CH1/2CR_Summer_2019_Q4) – *Inorganic Chemistry, Principles Of Chemistry*

This question is about the halogens and their compounds.

(a) The table gives the colour and physical state at room temperature of the halogens.

Complete the table by predicting the colour of astatine and the physical state of fluorine at room temperature.

**(2)**

| Halogen | Colour | Physical state at room temperature |
|---|---|---|
| fluorine | pale yellow | |
| chlorine | pale green | gas |
| bromine | red-brown | liquid |
| iodine | dark grey | solid |
| astatine | | solid |

(b) Chlorine gas is bubbled into a colourless solution of potassium bromide.

Explain why the solution turns orange.

**(2)**

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.....

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.....

(c) Potassium bromide is an ionic compound.

Draw diagrams to show the outer electrons in a potassium ion and in a bromide ion.

Include the charges on the ions.

**(3)**

| potassium ion | bromide ion |
|---|---|
| | |

(d) A student sets up a circuit to test the electrical conductivity of water, solid sodium chloride and aqueous sodium chloride.

The table shows the student's results.

| Substance | Conducts electricity? |
|---|---|
| water | no |
| solid sodium chloride | no |
| aqueous sodium chloride | yes |

Explain these results, with reference to the structure and bonding of the substances.

**(5)**

(e) A concentrated aqueous solution of sodium chloride is electrolysed using graphite electrodes.

Chlorine is formed at the positive electrode (anode).

(i) Give an ionic half-equation for the formation of chlorine at the positive electrode.

**(1)**

.....

(ii) State why this ionic half-equation represents an oxidation reaction.

**(1)**

.....

.....

(iii) Which substance is formed at the negative electrode (cathode)?

**(1)**

- ☐ **A** hydrogen
- ☐ **B** oxygen
- ☐ **C** sodium
- ☐ **D** water

**(Total for Question 4 = 15 marks)**

**5** – (4CH1/2C_Summer_2020_Q1) – *Principles Of Chemistry*

A student is given a mixture of salt solution and sand.

She wants to obtain pure water from the mixture.

(a) She separates the sand from the salt solution.

Which method of separation should she use?

**(1)**

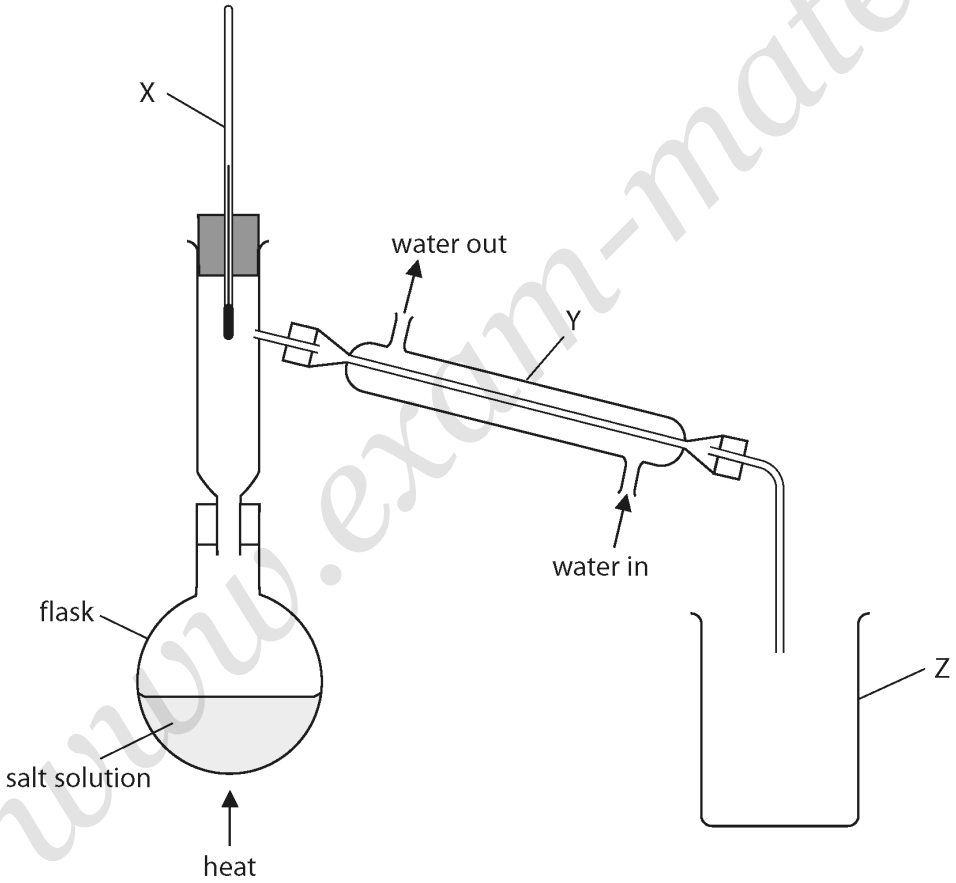
☒ **A** crystallisation

☒ **B** filtration

☒ **C** fractional distillation

☒ **D** simple distillation

(b) The student then uses this apparatus to obtain pure water from the salt solution.



(i) Name the pieces of apparatus labelled X, Y and Z.

**(3)**

.....

.....

.....

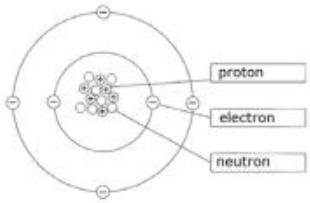
(ii) State what remains in the flask when the separation is complete.

**(1)**

.....

# ANSWERS

**1** – (4CH1/2C_Summer_2019_Q1) – *Principles Of Chemistry*

| | | | |
|---|---|---|---|
| (a) |  | 1 mark for each correct answer | 3 |
| (b) | 13 | | 1 |
| (c) | **M1** protons<br>**M2** neutrons | **IGNORE** electrons | 2 |
| | | **Total** | **6** |

**2** – (4CH1/2C_Summer_2019_Q3) – *Principles Of Chemistry*

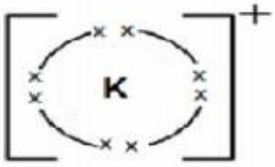
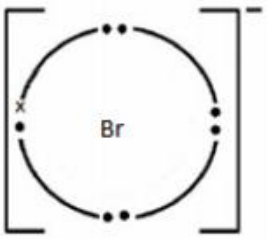
| | | | |
|---|---|---|---|
| (a) | **M1** the volume of liquid/alcohol<br>**M2** the temperature of the water | **ALLOW** amount of liquid/alcohol<br>**IGNORE** mass<br>**IGNORE** volume of water<br>**ALLOW** temperature of surroundings<br>**IGNORE** references to temperature of the alcohol | 2 |
| (b) | alcohols/the liquids are flammable/catch fire easily | **ALLOW** alcohols/the liquids can be easily ignited<br>**ALLOW** any named alcohol from the table | 1 |
| (c) (i) | **M1** (64 + 63 + 60) ÷3<br>**M2** = 62 | **ALLOW** 62.3<br>62/62.3 with no working scores 2<br>**ALLOW** 69/69.25/69.3 for **1** mark | 2 |
| (ii) | An explanation including the following two points:<br>**M1** methanol/$CH_3OH$ (evaporates most easily)<br>**M2** because the time taken is the shortest | **ACCEPT** because has lowest (mean) time | 2 |
| (iii) | **M1** as the number of carbon atoms increases<br>**M2** the ease of evaporation decreases/the less easily the alcohol evaporates | **ALLOW** the less volatile the alcohol<br>**IGNORE** the slower the alcohol evaporates<br>**IGNORE** references to time taken<br>**ALLOW** correct reverse argument | 2 |
| | | **Total** | **9** |

**3** – (4CH1/2CR_Summer_2019_Q2) – *Principles Of Chemistry*

| | | | |
|---|---|---|---|
| (a) | atomic number 5<br>mass number 11<br>number of neutrons 6<br>group in the Periodic table that contains boron 3<br>period in the Periodic table that contains boron 2<br>electronic configuration of an atom of boron 2, 3 | **ACCEPT**<br>$1s^2\ 2s^2\ 2p^1$ | 5 |
| (b) | • Sum of masses multiplied by percentages<br>• Division by 100 to give final answer<br><br>**M1** (18.7 x 10) + (81.3 x 11) **OR** 1081.3<br><br>**M2** 10.8 **OR** answer from **M1** divided by 100 | **ACCEPT** 1080 and 1081<br><br>**ACCEPT** 10.81 and 10.813<br><br>Correct answer without working scores 2<br><br>11 without working scores 0<br>11 with correct working scores 1 | 2<br><br>**Total 7** |

**4** – (4CH1/2CR_Summer_2019_Q4) – *Inorganic Chemistry, Principles Of Chemistry*

| | | | |
|---|---|---|---|
| (a) | **M1** fluorine - gas<br><br>**M2** astatine - black | <br><br>**ACCEPT** very dark grey | 2 |
| (b) | An planation linking the following two points<br><br>**M1** bromine / $Br_2$ is formed / displaced / produced<br><br>**M2** as chlorine is more reactive (than bromine) | <br><br>**REJECT** bromide for bromine<br><br>**ACCEPT** bromine/$Br_2$ shown as the product in an equation<br><br>**IGNORE** state of bromine<br><br>**REJECT** bromide/chloride | 2 |

| | | | |
|---|---|---|---|
| (c) | **M1** correct structure of potassium ion<br>  <br><br>**M2** correct structure of bromide ion<br>  <br><br>**M3** charges on both ions correct (with or without square brackets). | **ACCEPT** any combination of dots and crosses.<br><br>**IGNORE** inner shells even if incorrect | 3 |

| | | | |
|---|---|---|---|
| (d) | An explanation linking the following five points<br><br>**M1** water is covalently bonded / has a simple molecular structure<br><br>**M2** water does not contain any free (moving) charged particles (so does not conduct electricity)<br><br>**M3** sodium chloride has a giant ionic structure / has an ionic lattice structure /is ionically bonded<br><br>**M4** the ions are in fixed positions / cannot move (so does not conduct electricity)<br><br>**M5** in solution/ aqueous sodium chloride the ions are free to flow / move (so the solution does conduct electricity) | **ALLOW** water is a covalent compound<br><br>**ACCEPT** water does not contain any free ions/electrons or delocalised electrons<br><br>**ALLOW** sodium chloride is an ionic compound/ contains ions<br><br>**REJECT** mention of atoms/ molecules/intermolecular forces in Na for **M3** only<br><br>**M4** subsumes **M3**<br><br>**REJECT** electrons being unable to move for M4<br><br>**REJECT** reference to electrons conducting electricity in aqueous sodium chloride for **M5**<br><br>**IGNORE** reference to ions carrying charge/current | 5 |
| (e) | | | |
| (i) | $2Cl^- \rightarrow Cl_2 + 2e^{(-)}$ | **ALLOW** $2Cl^- - 2e \rightarrow Cl_2$ | 1 |
| (ii) | electrons are lost (by chloride ions/ $Cl^-$) | **ACCEPT** oxidation number of chlorine increases (by 1)<br>/ changes from -1 to 0<br><br>**REJECT** chlorine loses electrons<br><br>**IGNORE** references to gain of oxygen | 1 |

| | | | |
|---|---|---|---|
| (iii) | A hydrogen<br><br>B Is incorrect as oxygen is not formed at the cathode<br>C is incorrect as sodium is not formed when graphite electrodes are used<br>D is incorrect as water is not formed at the cathode | | 1<br><br>**Total 15** |

**5** – (4CH1/2C_Summer_2020_Q1) – *Principles Of Chemistry*

| | | | | |
|---|---|---|---|---|
| (a) | | **B** filtration is the correct answer because it will enable sand to be separated from salt solution<br><br>**A** is not correct because crystallisation will not enable sand to be separated from salt solution<br><br>**C** is not correct because fractional distillation will not enable sand to be separated from salt solution<br><br>**D** is not correct because simple distillation will not enable sand to be separated from salt solution | | 1<br>comp |
| (b) | (i) | X is a thermometer<br><br>Y is a (Liebig) condenser<br><br>Z is a beaker | | 3<br>cler |
| | (ii) | salt | | 1<br>cler |