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| Name | Date started | Target end date |
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## GCE AS / A LEVEL – CHEMISTRY UNIT 1 QUESTION PACK

1091-01 (Legacy CH1) · New spec Unit 1 Topic 4 · AS unit, first sat 2016, 80 marks, 1h 30min paper

# REVISE

.wales

## CHEMISTRY – UNIT 1 · ELECTRON CONFIGURATION & IONISATION ENERGIES

*Topic 1.2 – Electronic configuration (s/p/d), orbital shapes, and ionisation-energy evidence for sub-shells*

*Writing s/p/d electron configurations, sketching orbital shapes, and using first and successive ionisation energy trends as evidence for sub-shells and electronic structure.*

### LEGACY 2008 SPECIFICATION

**Estimated time for entire question pack: ~3 h 4 min**

*Derived from the legacy CH1 paper's pace of ~1.1 min/mark, padded for long-prose answers (115 marks over 23 questions).*

*You are advised to **not** attempt to complete all of this in one sitting.*

### ABOUT THIS QUESTION PACK

This is a **comprehensive practice question pack**, not a single mock paper. It contains every question from the legacy WJEC CH1 papers (2008 modular spec, Jan 2009 – Jun 2016) that maps onto the new-spec AS Unit 1 Topic 1.2.

Questions are ordered by source paper date.

### INSTRUCTIONS

Use black ink or black ball-point pen. Show all working – quality of written communication will affect marks. A calculator is allowed. You may need the WJEC Periodic Table / Data Booklet.

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*For Examiner's use only*

| Q  | Source    | Max | Mark | Q  | Source     | Max          | Mark       |
|----|-----------|-----|------|----|------------|--------------|------------|
| 1  | Jan 09 Q4 | 3   |      | 13 | Jan 13 Q2  | 1            |            |
| 2  | Jun 09 Q5 | 11  |      | 14 | Jan 13 Q10 | 15           |            |
| 3  | Jan 10 Q1 | 1   |      | 15 | Jun 13 Q4  | 1            |            |
| 4  | Jan 10 Q2 | 2   |      | 16 | Jun 13 Q5  | 1            |            |
| 5  | Jan 10 Q5 | 1   |      | 17 | Jan 14 Q8  | 18           |            |
| 6  | Jun 10 Q4 | 1   |      | 18 | Jun 14 Q1  | 1            |            |
| 7  | Jan 11 Q1 | 1   |      | 19 | Jun 15 Q5  | 11           |            |
| 8  | Jun 11 Q2 | 0   |      | 20 | Jun 15 Q6  | 12           |            |
| 9  | Jan 12 Q1 | 1   |      | 21 | Jun 16 Q1  | 1            |            |
| 10 | Jan 12 Q8 | 14  |      | 22 | Jun 16 Q2  | 1            |            |
| 11 | Jun 12 Q1 | 1   |      | 23 | Jun 16 Q10 | 13           |            |
| 12 | Jun 12 Q5 | 4   |      |    |            |              |            |
|    |           |     |      |    |            | <b>Total</b> | <b>115</b> |

# Electron Configuration & Ionisation Energies – what the new spec asks

WJEC GCE AS / A Level Chemistry (from 2015) · Unit 1: The Language of Chemistry, Structure of Matter & Simple Reactions · Topic 1.2.

## s, p, d sub-shells

- s: spherical; holds 2 electrons (1 orbital).
- p: dumbbell; holds 6 electrons (3 orbitals).
- d: more complex; holds 10 electrons (5 orbitals).
- Order: 1s 2s 2p 3s 3p 4s 3d 4p ...

## Writing electron configurations

- Fill lower-energy sub-shells first (Aufbau).
- Pair electrons only after all orbitals in a sub-shell have one (Hund's rule).
- Pairs spin opposite (Pauli).
- Notation:  $1s^2 2s^2 2p^6 \dots$

## Anomalies

- Cr:  $[\text{Ar}] 3d^5 4s^1$  (half-filled stable).
- Cu:  $[\text{Ar}] 3d^{10} 4s^1$  (full d stable).
- Ions: remove from 4s before 3d for transition metals.

## Ionisation energy

- 1st IE:  $M(g) \rightarrow M^+(g) + e^-$ .
- Successive IEs always increase (smaller positive ion).
- Large jump indicates electron removed from new sub-shell.
- Evidence for s, p, d shell structure.

## Trends

- Across a period: IE increases (nuclear charge  $\uparrow$ , radius  $\downarrow$ ).
- Down a group: IE decreases (extra shells shield outer  $e^-$ ).
- Dips: e.g. Mg  $\rightarrow$  Al (3p easier than 3s); P  $\rightarrow$  S (paired 3p easier).

# Electron Configuration & Ionisation Energies in one page

Quick-reference notes – revisit before each question.

## Energy ordering

$1s < 2s < 2p < 3s < 3p < 4s < 3d < 4p$ .

4s fills before 3d but empties first when ionising.

## Orbital shapes

s = sphere.

p = dumbbell (3 perpendicular:  $p_x$ ,  $p_y$ ,  $p_z$ ).

d = clover (5 orbitals).

## Filling rules

Aufbau: lowest energy first.

Hund: one electron per orbital before pairing.

Pauli: paired electrons have opposite spin.

## Common configs

O:  $1s^2 2s^2 2p^4$ .

Cl:  $[\text{Ne}] 3s^2 3p^5$ .

Cr:  $[\text{Ar}] 3d^5 4s^1$ ; Cu:  $[\text{Ar}] 3d^{10} 4s^1$ .

## IE trends across period

Increase: nuclear charge  $\uparrow$ , atomic radius  $\downarrow$ .

Dips: Be  $\rightarrow$  B ( $2p > 2s$ ), N  $\rightarrow$  O (paired 2p).

## Successive IE jumps

Big jump = removing from inner shell.

Na: small after 1, big jump  $1 \rightarrow 2$ .

Mg: small to 2, big jump  $2 \rightarrow 3$  (inner  $2p^6$ ).

4. The values for some standard molar ionisation energies are given in the table.

| Element   | Standard molar ionisation energies / $\text{kJ mol}^{-1}$ |        |
|-----------|---|--------|
|           | First   | Second |
| Argon     | 1521  | 2666   |
| Potassium | 419   | 3051   |

- (i) Give two reasons why the first standard molar ionisation energy for potassium is much less than that of argon. [2]

1. ....

.....

2. ....

.....

- (ii) Give a reason why the value for the second standard molar ionisation energy of potassium is larger than that of argon. [1]

.....

.....

Section A Total [10]

## SECTION B

Answer all the questions in the spaces provided.

5. (a) The table below shows the molar first ionisation energy values, IE, for the first ten elements of the Periodic Table.

| Element                   | H    | He   | Li  | Be  | B   | C    | N    | O    | F    | Ne   |
|---------------------------|------|------|-----|-----|-----|------|------|------|------|------|
| IE / kJ mol <sup>-1</sup> | 1310 | 2370 | 520 | 900 | 800 | 1090 | 1400 | 1310 | 1680 | 2080 |

- (i) Complete the graph shown on the next page, to show how first ionisation energy varies for the first ten elements.

Four of the points have been plotted for you. [3]

- (ii) Explain why

I. helium has a higher first ionisation energy than neon, [2]

.....

.....

.....

II. neon has a higher first ionisation energy than nitrogen, [1]

.....

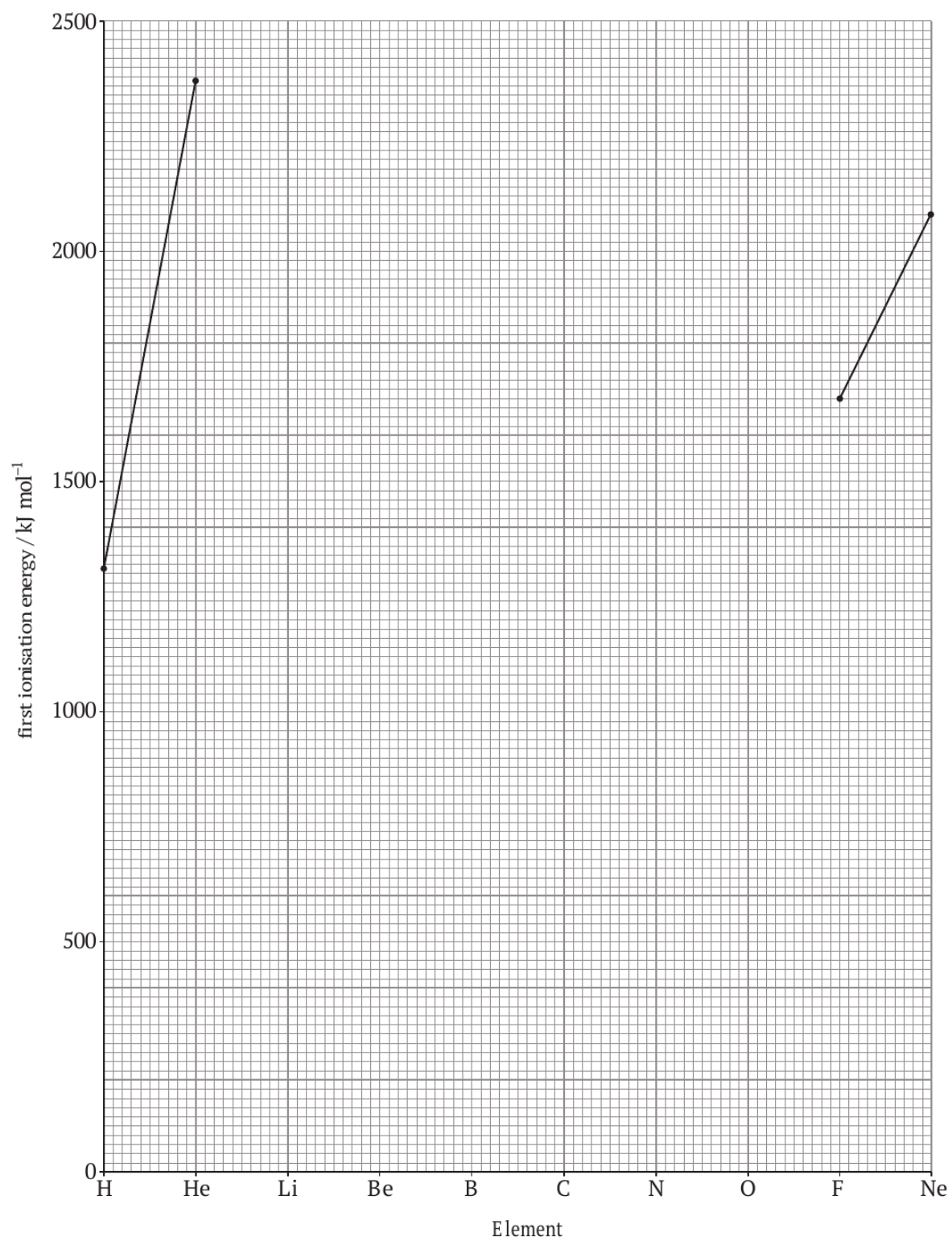
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III. nitrogen has a higher first ionisation energy than oxygen. [2]

.....

.....

.....



(b) The use of lead compounds in paints and pigments has been common for many centuries, although, due to its toxicity, this is now rare.

(i) 'White lead', which is based on lead carbonate, was used as a skin whitening cosmetic by Queen Elizabeth I in the 16th century.

Analysis of lead carbonate shows that it has the following percentage composition by mass: Pb 77.5%; C 4.50%; O 18.0%.

Calculate the empirical formula of lead carbonate.  
Show your working.

[2]

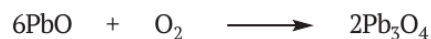
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(ii) 'Red lead', which is based on lead oxide,  $\text{Pb}_3\text{O}_4$ , is used in anti-corrosive paint. It is formed by oxidising lead(II) oxide with oxygen.



I. Calculate the molar mass of  $\text{Pb}_3\text{O}_4$ . [1]

.....

II. Calculate the mass of  $\text{Pb}_3\text{O}_4$  that could be formed from 134 g of PbO. [3]

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Total [14]

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## SECTION A

Answer **all** the questions in the spaces provided.

1. Complete the boxes below, by inserting arrows to represent electrons, to show the electron configuration of an atom of aluminium, Al. [1]



2. State which **one** of the following letters represents the first five ionisation energies of aluminium, Al. Give a reason for your choice. [2]

*Ionisation energy / kJ mol<sup>-1</sup>*

|          | 1st  | 2nd  | 3rd  | 4th   | 5th   |
|----------|------|------|------|-------|-------|
| <b>A</b> | 496  | 4563 | 6913 | 9544  | 13352 |
| <b>B</b> | 578  | 1817 | 2745 | 11578 | 14831 |
| <b>C</b> | 1402 | 2856 | 4578 | 7475  | 9445  |
| <b>D</b> | 789  | 1577 | 3232 | 4356  | 16091 |

*Letter* .....

*Reason* .....

.....  
 .....

## SECTION A

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| <b>A</b> | 496  | 4563 | 6913 | 9544  | 13352 |
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*Letter* .....

*Reason* .....

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5. Sketch a diagram to show the shape of a p-orbital.

[1]

6. (a) Explain the term *dynamic equilibrium* for a chemical system.

[1]

.....

.....

(b) Explain how you would tell, from the properties of the system, that equilibrium has been reached.

[1]

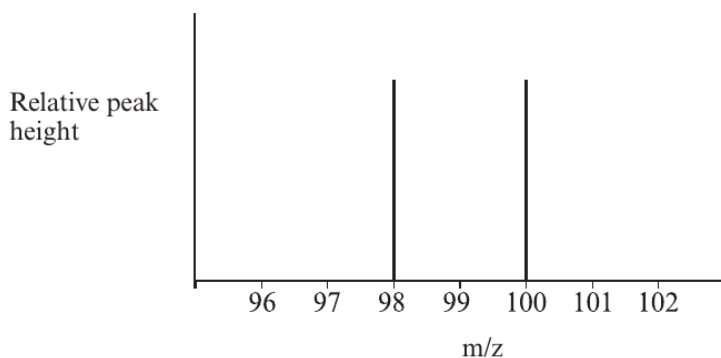
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**Section A Total [10]**

Examiner  
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3. The mass spectrum of the colourless gas bromine fluoride,  $\text{Br}^{19}\text{F}$ , shows two molecular ions.



- (i) State the mass numbers of the two bromine isotopes present in bromine fluoride. [1]  
 ..... and .....
- (ii) Bromine fluoride is unstable and readily gives  $\text{Br}^{19}\text{F}_3$ .  
 State the mass/charge ( $m/z$ ) value for the molecular ion  $\text{Br}^{19}\text{F}_3^+$ , when all the bromine is present as the isotope  $^{85}\text{Br}$ . [1]  
 .....

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4. The first two standard molar ionisation energies for magnesium are shown in the table.

| Electron removed | Standard molar ionisation energy/ $\text{kJ mol}^{-1}$ |
|------------------|--|
| first            | 736  |
| second           | 1450   |

State which of the following is the value for the third molar standard ionisation energy, in  $\text{kJ mol}^{-1}$ , of magnesium. [1]

- A 457  
 B 923  
 C 2170  
 D 7740  
 .....

## SECTION A

Answer **all** questions in the spaces provided.

1. By inserting arrows to represent electrons, complete the boxes below to show the electronic configuration of a calcium atom. [1]



2. (a) Calculate the molar mass, in  $\text{g mol}^{-1}$ , of calcium sulfate dihydrate,  $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ . [1]

.....

.....

- (b) Calculate the percentage of water, by mass, in calcium sulfate dihydrate. [1]

.....

.....

3. Ions of two isotopes of the metal lithium are shown below.



State which **one** of the following statements is **correct**. [1]

- A The electron arrangement of both these  $\text{Li}^+$  ions is  $1s^2 2s^1$ .
- B The  ${}^7\text{Li}^+$  ion will have more protons in its nucleus than the  ${}^6\text{Li}^+$  ion.
- C The  ${}^7\text{Li}^+$  ion will be deflected more than the  ${}^6\text{Li}^+$  ion in a mass spectrometer.
- D Both of these  $\text{Li}^+$  ions have the same number of electrons.

.....

## SECTION A

Answer **all** questions in the spaces provided.

1. Enter the number of protons, neutrons and electrons present in the atoms/ions listed in the table below.

| Atom/ion              | Number of protons | Number of neutrons | Number of electrons |
|-----------------------|-------------------|--------------------|---------------------|
| $^{24}\text{Mg}$      |                   |                    |                     |
| $^{26}\text{Mg}$      |                   |                    |                     |
| $^{24}\text{Mg}^{2+}$ |                   |                    |                     |

[3]

2. By inserting arrows to represent electrons, complete the boxes below to show the electronic configuration of an iron atom, Fe. The 1s, 2s and 2p orbitals are assumed to be already filled.

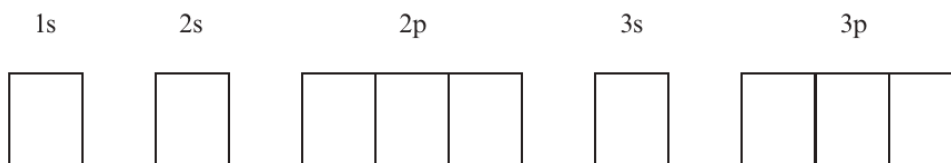


[1]

## SECTION A

Answer **all** questions in the spaces provided.

1. By inserting arrows to represent electrons, complete the boxes below to show the electronic configuration of a sulfur atom. [1]



2. State the number of protons present in an aluminium ion,  $\text{Al}^{3+}$ . [1]

- A 10  
B 13  
C 14  
D 16
- .....

3. Weak *acids* establish a *dynamic equilibrium* when dissolved in water. Give brief explanations of what is meant by the following terms. [2]

*Acid* .....

.....

*Dynamic equilibrium* .....

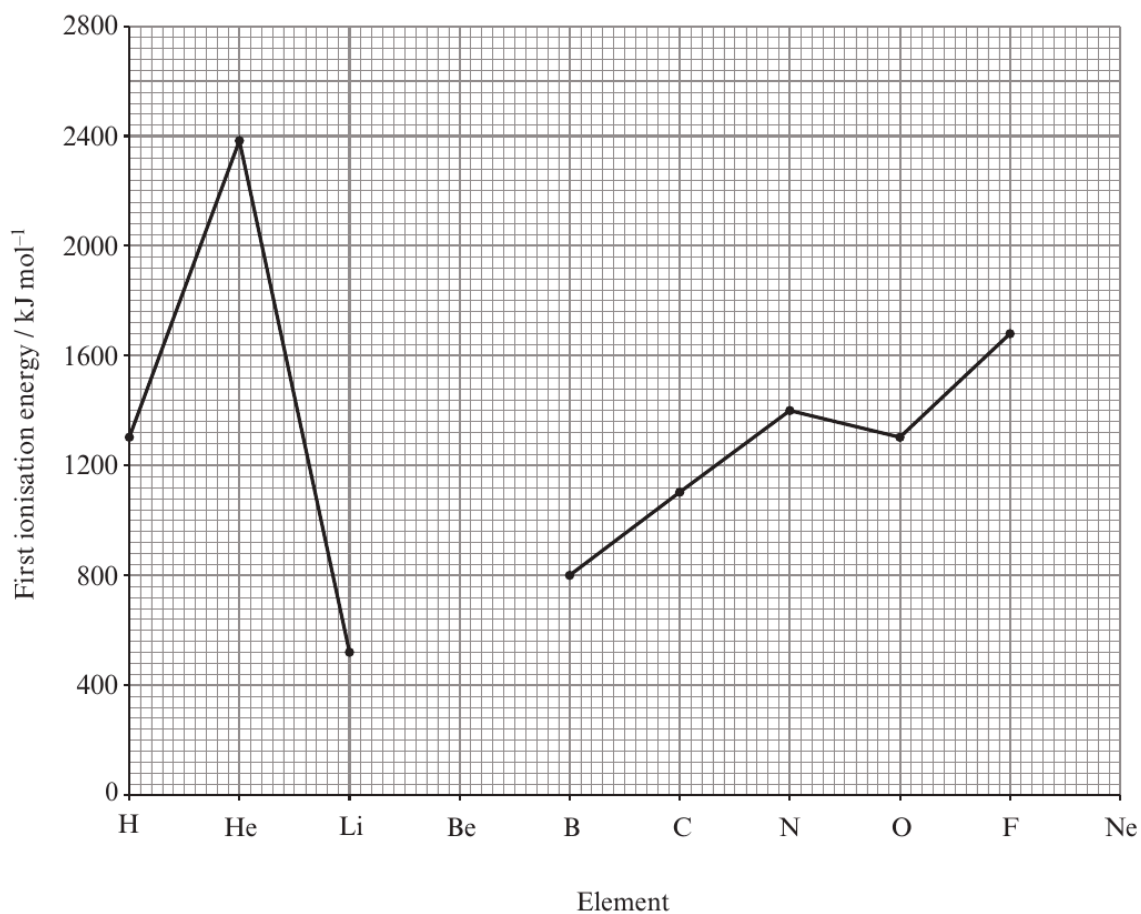
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8. The graph below shows the first molar ionisation energies for a selection of the first 10 elements.



- (a) Complete the graph above by adding points that represent the first ionisation energies for the elements beryllium and neon. [2]
- (b) Write an equation to represent the first ionisation of a beryllium atom. [1]
- .....



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(c) Explain why

(i) helium has a higher first ionisation energy than hydrogen, [2]

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.....  
.....

(ii) nitrogen has a higher first ionisation energy than oxygen. [2]

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(d) The atomic emission spectrum can be used to calculate the ionisation energy of hydrogen.

(i) Explain how the lines in the atomic emission spectrum are formed. [3]  
QWC [1]

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(ii) Explain how the ionisation energy of a hydrogen atom can be calculated from a feature in the atomic emission spectrum. [3]

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Total [14]



## SECTION A

Answer **all** questions in the spaces provided.

1. Sketch a diagram to show the shape of a *p* orbital. [1]

2. Complete the following definition of *relative atomic mass*: [1]

The relative atomic mass of an element is the average mass of one atom of the element relative to

.....  
.....

3. State which **one** of the following contains the greatest number of molecules. [1]

A 3 g of hydrogen

B 32 g of oxygen

C 36 g of water

D 66 g of carbon dioxide .....

4. Phosgene is a compound of carbon, oxygen and chlorine. It is used to make polyurethanes and polycarbonates. Its percentage composition, by mass, is as follows.

C 12.1%    O 16.2%    Cl 71.7%

- (a) Calculate the **empirical** formula of this compound. [2]

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.....  
.....  
.....

- (b) What other information would you need to know to be able to deduce the **molecular** formula of this compound? [1]

.....



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Examiner  
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5. (a) The electronic structures of five atoms, **A** to **E**, are listed below. Arrange these atoms in order of increasing molar first ionisation energy. [2]

| Atom                 | <b>A</b> | <b>B</b>    | <b>C</b>         | <b>D</b>         | <b>E</b>         |
|----------------------|----------|-------------|------------------|------------------|------------------|
| Electronic structure | $1s^2$   | $1s^2 2s^2$ | $1s^2 2s^2 2p^1$ | $1s^2 2s^2 2p^3$ | $1s^2 2s^2 2p^6$ |

lowest ..... highest

- (b) State, giving a reason for your choice, which **one** of the following gives the first four ionisation energies for silicon, Si. [2]

|          | Ionisation energy / $\text{kJ mol}^{-1}$ |      |      |       |
|----------|--|------|------|-------|
|          | 1st                                      | 2nd  | 3rd  | 4th   |
| <b>W</b> | 496                                      | 4563 | 6913 | 9544  |
| <b>X</b> | 578                                      | 1817 | 2745 | 11578 |
| <b>Y</b> | 738                                      | 1451 | 7733 | 10541 |
| <b>Z</b> | 789                                      | 1577 | 3232 | 4356  |

Letter .....

Reason .....

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Section A Total [10]



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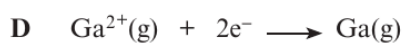
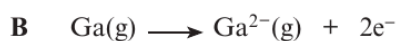
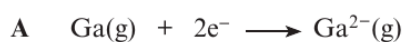
## SECTION A

Answer **all** questions in the spaces provided.

1. The mass number of an isotope of gallium is 70.

State the number of neutrons in an atom of this isotope. .... [1]

2. Write the letter which represents the correct equation for the **second** ionisation energy of gallium in the box below. [1]



3. An enriched isotopic mixture of lithium contains  ${}^6\text{Li}$  12.0% and  ${}^7\text{Li}$  88.0% by mass. Showing your working, calculate the relative atomic mass of this sample of lithium. Give your answer to **three** significant figures. [2]

Relative atomic mass = .....



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Examiner only

10. (a) Potassium hydroxide contains potassium ions,  $K^+$ .  
Give the electron configuration of a potassium **atom** and use this to explain why most potassium compounds contain the potassium ion. [2]

.....

.....

.....

(b) Michael was asked to make  $250\text{ cm}^3$  of a solution of potassium hydroxide and to record the maximum rise in temperature that occurred as it dissolved.  
He measured  $250\text{ cm}^3$  of water in a glass beaker and then added 7.01 g (0.125 mol) of solid potassium hydroxide to this, with stirring.  
He noticed that the temperature rose from  $20.2^\circ\text{C}$  to a maximum of  $25.0^\circ\text{C}$ .

(i) Calculate the molar enthalpy change of solution of potassium hydroxide by use of the formula

$$\Delta H = - \frac{mc\Delta T}{n}$$

- where m = mass of the solvent in grams (assume  $1\text{ cm}^3$  has a mass of 1 g)
- c =  $4.2\text{ J g}^{-1}\text{ }^\circ\text{C}^{-1}$
- $\Delta T$  = change in temperature of the solution
- n = number of moles of the solute
- $\Delta H$  = molar enthalpy change of solution

You should show the **units** in your answer. [3]

$\Delta H =$  .....

(ii) Michael's measurements produced a value for the enthalpy of solution of potassium hydroxide that was different to the literature value.

Use the information given to suggest and explain **two** factors that might produce a different result. [2]

1. ....
- .....
2. ....
- .....



Examiner  
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- (c) Solid potassium hydroxide can be used in analysis to find the percentage of carbon dioxide present in a mixture of gases. The equation for the reaction that occurs is given below.



2.0 m<sup>3</sup> of a gas mixture was passed through potassium hydroxide. Analysis showed that 0.050 mol of potassium carbonate had been formed.

- (i) State the number of moles of carbon dioxide necessary to produce 0.050 mol of potassium carbonate. [1]

- (ii) Calculate the volume of carbon dioxide that produced 0.050 mol of potassium carbonate. [1]

[1 mol of carbon dioxide has a volume of 24.0 dm<sup>3</sup> under these conditions]

*Volume of carbon dioxide = ..... dm<sup>3</sup>*

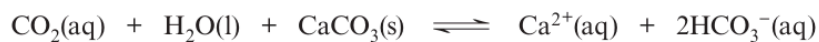
- (iii) Calculate the percentage of carbon dioxide in the gas mixture, in terms of volume. [2]

[1 dm<sup>3</sup> = 0.001 m<sup>3</sup>]

*Percentage of carbon dioxide = ..... %*



- (d) Scientists have commented that ‘an increase in the amount of carbon dioxide dissolved in sea water will cause problems for animals whose shells are composed of calcium carbonate’.



Use the equation above to help you discuss the problem that is caused for these animals by this increase in carbon dioxide concentration.

[3]

QWC [1]

Examiner  
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Total [15]



1 7

Examiner  
only**SECTION A***Answer all questions in the spaces provided.*

1. Carbon-14 is a radioactive isotope of carbon. Give the numbers of protons, neutrons and electrons present in an atom of carbon-14. [2]

*Number of protons* .....

*Number of neutrons* .....

*Number of electrons* .....

2. Circle **all** of the following that carry a negative charge. [2]

electron     $\alpha$ -particle     $\gamma$ -ray    proton    neutron     $\beta$ -particle

3. Many industrial processes use catalysts.  
Explain how a catalyst increases the rate of a chemical reaction. [2]

.....  
.....  
.....

4. Sketch the shape of **one** *p*-orbital. [1]



0 2

5. Name an element that has a half-filled set of  $p$ -orbitals. [1]

.....

6. Vinegar is a dilute solution of a weak acid.

(a) State what is meant by an *acid*. [1]

.....

.....

(b) Suggest a pH value for vinegar. [1]

.....

**Section A Total [10]**

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Examiner  
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- (c) (i) Hydrogen has a first ionisation energy of  $1312 \text{ kJ mol}^{-1}$ .  
Explain why helium has a higher first ionisation energy than hydrogen. [2]

.....

.....

.....

- (ii) Beryllium and magnesium are both in Group 2 of the Periodic Table.  
Explain why beryllium has a higher first ionisation energy than magnesium. [2]

.....

.....

.....

- (iii) The table below gives the first three ionisation energies for boron and potassium.

| Element | Ionisation energy/ $\text{kJ mol}^{-1}$ |      |      |
|---------|---|------|------|
|         | 1st                                     | 2nd  | 3rd  |
| B       | 800                                     | 2420 | 3660 |
| K       | 419                                     | 3051 | 4412 |

- I Suggest why compounds containing  $\text{B}^{3+}$  ions are unlikely to exist. [1]

.....

.....

- II Write an equation to represent the **second** ionisation energy of potassium. [1]

.....

.....

- III State how the first three ionisation energies of calcium would differ from those of potassium. [2]

.....

.....

.....

Total [19]

Examiner  
only**SECTION A***Answer all questions in the spaces provided.*

1. Complete the electronic structure for the sulfide ion present in Na<sub>2</sub>S. [1]

1s<sup>2</sup> .....

2. Which isotope is the standard used in defining relative atomic masses? [1]

.....

3. State **one** example of an industrially or environmentally important heterogeneous catalyst. You should identify the reaction catalysed and name the catalyst. [1]

.....

.....

4. Hydrated sodium carbonate has the formula Na<sub>2</sub>CO<sub>3</sub>·10H<sub>2</sub>O.

- (a) Calculate the relative molecular mass (*M<sub>r</sub>*) of Na<sub>2</sub>CO<sub>3</sub>·10H<sub>2</sub>O. [1]

*M<sub>r</sub>* = .....

- (b) Calculate the mass of Na<sub>2</sub>CO<sub>3</sub>·10H<sub>2</sub>O needed to make 250 cm<sup>3</sup> of a 0.10 mol dm<sup>-3</sup> solution. [1]

Mass = ..... g

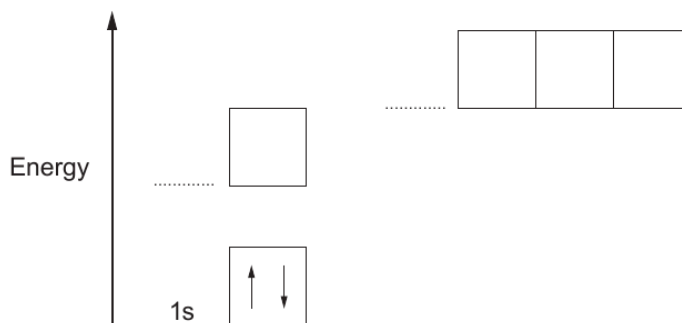


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## SECTION B

Answer all questions in the spaces provided.

5. (a) Electrons are arranged in energy levels. The diagram below shows two electrons in the 1s level in a nitrogen atom.

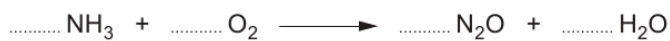


Complete the diagram for the electrons in a nitrogen atom by labelling the sub-shell levels and showing how the electrons are arranged. [2]

- (b) Nitrogen forms several oxides.
- (i) An oxide of nitrogen contains 25.9% by mass of nitrogen. Calculate the empirical formula of this oxide. [2]

Empirical formula .....

- (ii) Dinitrogen oxide is formed when ammonia is oxidised.



Balance the equation above.

[1]



Examiner  
only

- (iii) Nitrogen dioxide is formed when calcium nitrate decomposes.



Calculate the total volume of gas, measured at room temperature and pressure, which would be produced when 0.886 g of calcium nitrate decomposes. [3]

[1 mol of gas occupies 24.0 dm<sup>3</sup> at room temperature and pressure]

Volume = ..... dm<sup>3</sup>

- (c) Hydrated calcium nitrate can be represented by the formula Ca(NO<sub>3</sub>)<sub>2</sub>·xH<sub>2</sub>O.

A 6.04 g sample of Ca(NO<sub>3</sub>)<sub>2</sub>·xH<sub>2</sub>O contains 1.84 g of water of crystallisation.

Calculate the value of *x* in Ca(NO<sub>3</sub>)<sub>2</sub>·xH<sub>2</sub>O. You **must** show your working. [3]

*x* = .....

Total [11]

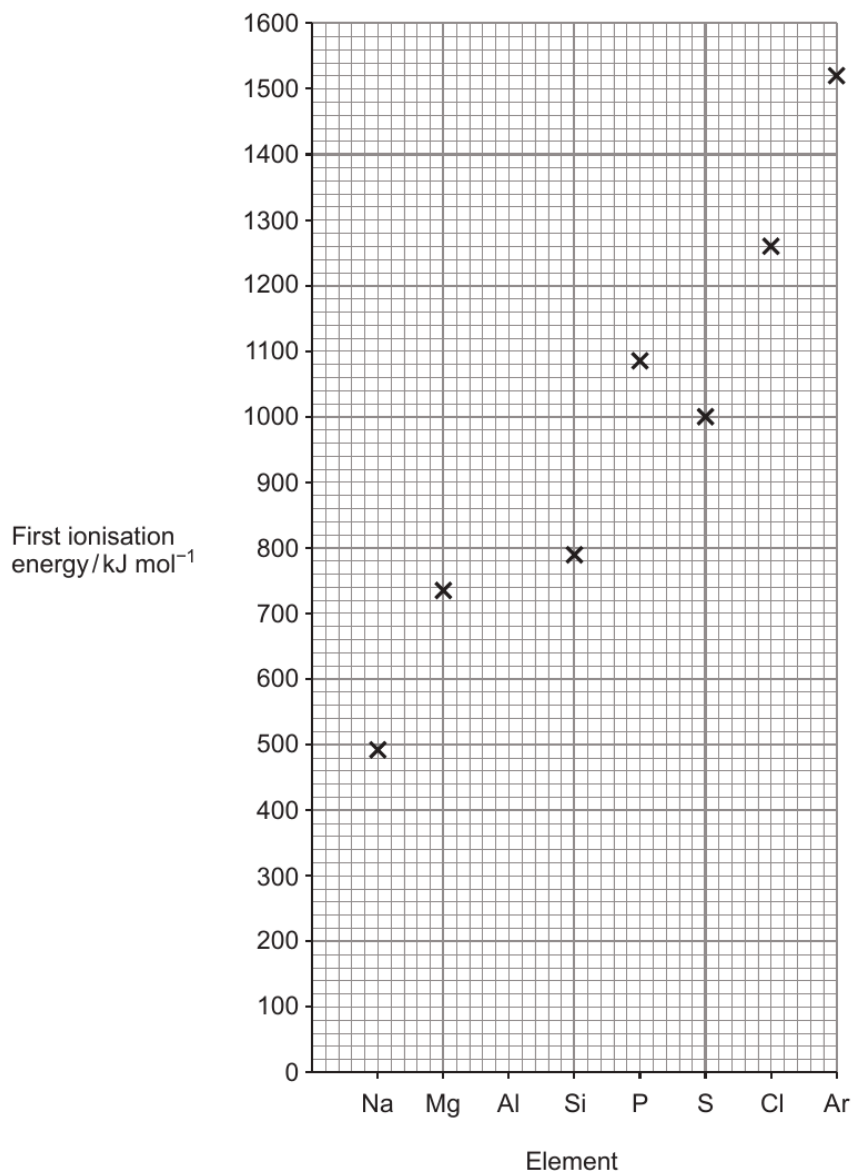
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Examiner  
only

6. Ionisation energies and atomic spectra provide evidence for the arrangement of electrons in atoms.

(a) The following diagram shows the first ionisation energies of the Period 3 elements.



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- (i) State the meaning of the term *molar first ionisation energy*. [2]

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- (ii) Draw a cross on the diagram to suggest the first ionisation energy of aluminium. [1]

- (iii) Explain why the value of the first ionisation energy of sulfur is less than that of phosphorus. [2]

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- (b) The table below gives some ionisation energies for magnesium.

|   | 1st | 2nd  | 3rd | 4th   | 5th   |
|---|-----|------|-----|-------|-------|
| Ionisation energy /<br>kJ mol <sup>-1</sup> | 736 | 1450 |     | 10500 | 13629 |

- (i) Explain why the second ionisation energy is greater than the first. [1]

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- (ii) Complete the table by suggesting a value for the third ionisation energy of magnesium. [1]

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(c) Explain briefly how the lines in the visible atomic emission spectrum of hydrogen are formed and why the lines become closer together at the high frequency end of the spectrum.

[4]

QWC [1]

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Total [12]

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**SECTION A**

Answer **all** questions in the spaces provided.

1. Using the convention of arrows to represent electrons, complete the electronic structure of an atom of chromium. [1]

|    |    |          |    |    |    |    |
|----|----|----------|----|----|----|----|
| 1s | 2s | 2p       | 3s | 3p | 3d | 4s |
| ↑↓ | ↑↓ | ↑↓ ↑↓ ↑↓ |    |    |    |    |

2. State which **one** of the following statements is true. [1]

- A The first ionisation energy of neon is greater than the first ionisation energy of helium.
- B The first ionisation energy of sodium is less than the first ionisation energy of neon.
- C The first ionisation energy values increase down Group 1.
- D The second ionisation energy of sodium is less than the first ionisation energy of sodium.

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3. The half-life of a radioactive isotope  ${}^{24}_x\text{Z}$  is 15.0 hours. It decays by beta emission to a stable isotope of magnesium,  ${}_{12}\text{Mg}$ .

- (a) Give the atomic number and symbol of this radioactive isotope. [1]

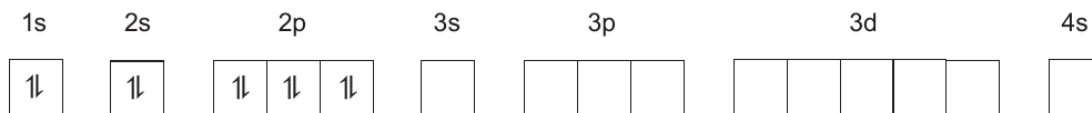
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- (b) After a period of 45.0 hours from the start of the decay, only 0.15 g of  ${}^{24}_x\text{Z}$  remains.  
Calculate the starting mass of the radioactive isotope  ${}^{24}_x\text{Z}$ . [2]

Starting mass = ..... g

Examiner  
only**SECTION A**Answer **all** questions in the spaces provided.

1. Using the convention of arrows to represent electrons, complete the electronic structure of an atom of chromium. [1]



2. State which **one** of the following statements is true. [1]

- A** The first ionisation energy of neon is greater than the first ionisation energy of helium.
- B** The first ionisation energy of sodium is less than the first ionisation energy of neon.
- C** The first ionisation energy values increase down Group 1.
- D** The second ionisation energy of sodium is less than the first ionisation energy of sodium.

.....

3. The half-life of a radioactive isotope  ${}^A_Z X$  is 15.0 hours. It decays by beta emission to a stable isotope of magnesium,  ${}_{12}\text{Mg}$ .

- (a) Give the atomic number and symbol of this radioactive isotope. [1]

.....

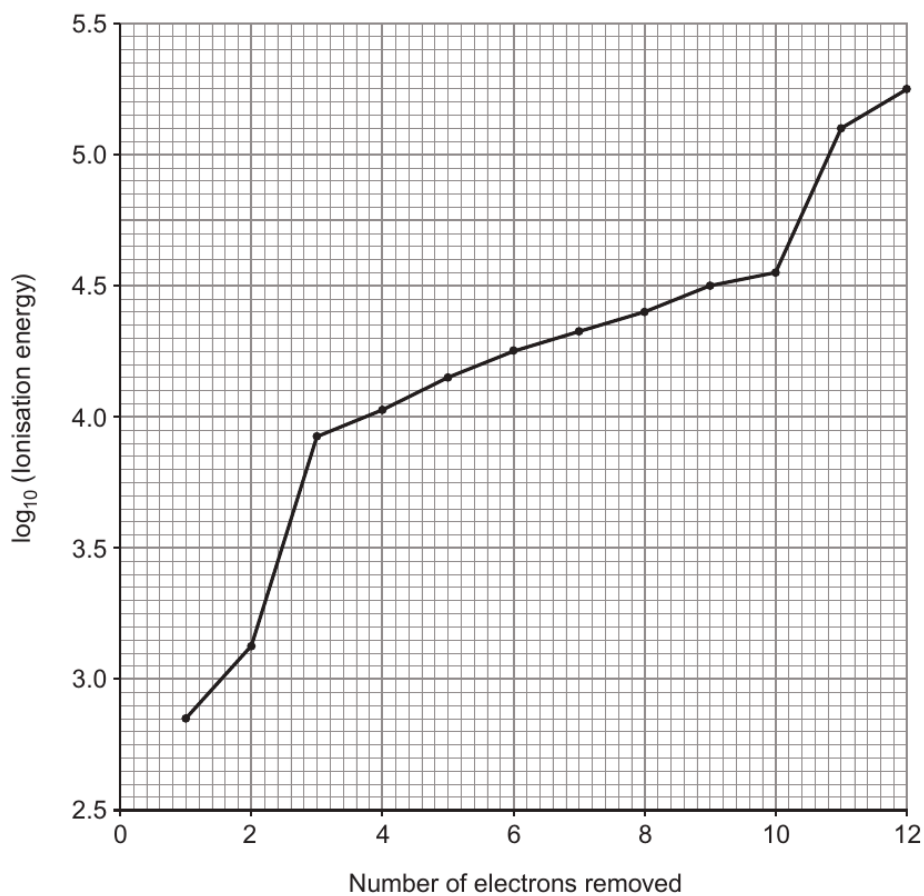
- (b) After a period of 45.0 hours from the start of the decay, only 0.15 g of  ${}^A_Z X$  remains.

Calculate the starting mass of the radioactive isotope  ${}^A_Z X$ . [2]

Starting mass = ..... g

10. (a) The graph below shows the log of the successive ionisation energies for magnesium.

Examiner  
only



Using the electron configuration for magnesium discuss how and why the values for the ionisation energies change according to the number of electrons removed.

[4]

QWC [1]

Examiner  
only

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- (b) Strontium, Sr, is another metal found in Group 2 of the Periodic Table. It reacts rapidly with cold water to produce a solution of the strong base strontium hydroxide,  $\text{Sr}(\text{OH})_2$ , and hydrogen.



In an experiment 1.260 g of strontium gave 0.0140 mol of hydrogen gas.

- (i) Use this information to calculate the relative atomic mass of strontium in this sample. [2]

Relative atomic mass of strontium = .....

- (ii) A solution of strontium hydroxide can be used to obtain crystals of hydrated strontium hydroxide,  $\text{Sr}(\text{OH})_2 \cdot x\text{H}_2\text{O}$ . On heating to  $100^\circ\text{C}$  the water is lost giving anhydrous strontium hydroxide.



A sample of hydrated strontium hydroxide of mass 11.95 g was heated and produced 5.47 g of anhydrous strontium hydroxide ( $M_r$  121.62).

Calculate the value of  $x$  in  $\text{Sr}(\text{OH})_2 \cdot x\text{H}_2\text{O}$ . [3]

$x =$  .....

Examiner  
only

- (iii) Use the information in the question to suggest another method that could be used to find the value of  $x$  in  $\text{Sr}(\text{OH})_2 \cdot x\text{H}_2\text{O}$  and how this method could be used to produce the value of  $x$ . [3]

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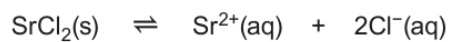
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- (c) A solution that cannot dissolve any more solute is called a saturated solution. A saturated solution of strontium chloride can be represented as an equilibrium mixture between the solid and its solution.



When hydrochloric acid is added, the clear solution of strontium chloride becomes cloudy.

Use Le Chatelier's Principle to explain the appearance of this cloudiness. [2]

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Total [15]

## **END OF QUESTION PACK**

23 questions · 115 marks · ~3 h 4 min

Source: WJEC CH1 (2008 modular spec, Jan 2009 – Jun 2016)

Curated for WJEC Chemistry 2015 spec AS Unit 1 – Topic 4 (1.2)

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