

## Mark Scheme - 1.2 Basic Ideas about Atoms

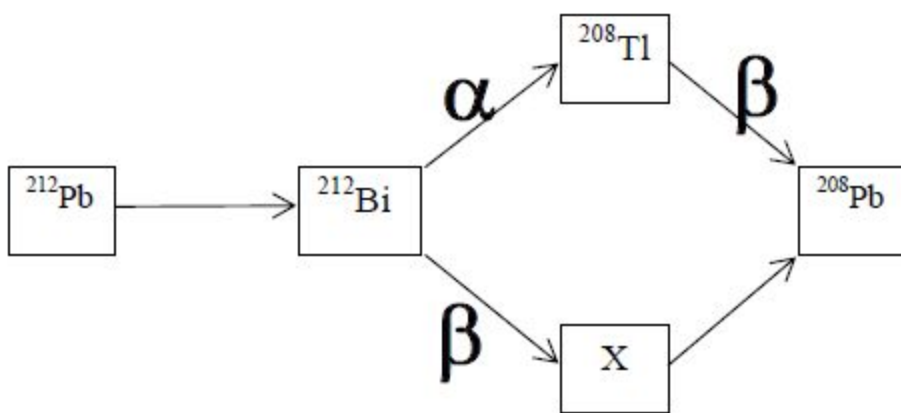
1.

- (a) Oil is non-renewable / will run out (1)  
Contribution of CO<sub>2</sub> to global warming (1)  
Oil has other important uses (1) [2]  
(Maximum 2 marks)
- (b) (i) Power stations / fossil fuels used to generate the electricity needed to make H<sub>2</sub> (1)  
Resulting in CO<sub>2</sub> formation (global warming) / acid rain (1)  
Manufacture of car produces pollution (1) [2]  
(Maximum 2 marks)  
QWC Legibility of text; accuracy of spelling, punctuation and grammar, clarity of meaning [1]
- (ii) Disagree, no fuel is 100% safe / petrol can burn explosively  
(Accept agree if valid reason given e.g. in terms of lives being lost) [1]
- (c) (i) Hydrogen since frequency is inversely proportional to wavelength / smaller wavelength [1]
- (ii) Hydrogen since energy is proportional to frequency / greater frequency /  $E = hf$  [1]
- (d) In Ne greater shielding of *outer* electron (1) outweighs larger nuclear charge (1) / He has greater effective nuclear charge (1) / He *outer* electron closer to nucleus (1)  
- max 1 if no reference to *outer* electron [2]  
(Maximum 2 marks)
- (e) (i) <sup>218</sup>Po [1]
- (ii) Since radon is a gas / inhaled,  $\alpha$  particles will be given off in the lungs (which may cause cancer) [1]

Total [12]

2.

- (a)  $M_r(\text{PbS}) = 239.1$       $M_r(\text{PbO}) = 223$  (1)  
 Moles of PbS =  $20,000 \div 239.1 = 83.65$  moles (1)  
 Mass of PbO =  $83.65 \times 223 \div 1000 = 18.7$  kg (1) [3]
- (b) (i) Sulfur dioxide: Acid rain (1)  
 Carbon dioxide: Climate change / global warming / acidification of oceans (1) [2]
- (ii) I. Sum of  $M_r$  of reactants =  $223 + 28 = 251$  (1)  
 Atom economy =  $(207 \div 251) \times 100 = 82.5\%$  (1) [2]
- (ii) II. Method 1 as higher atom economy means less waste / more useful product [1]
- (c) (i) Symbol = Po (1)     Mass number = 212 (1) [2]
- (ii) All three arrows labelled correctly, as shows below, gives two marks  
 Any two arrows labelled correctly gives one mark [2]



- (iii)  $\gamma$ -radiation is high energy / frequency electromagnetic waves (1)  
 It affects neither atomic number nor mass number / it changes neither the number of protons nor neutrons (1) [2]
- (iv) 31.8 hours = 3 half lives (1)  
 Mass remaining after 3 half lives = 3mg (1) [2]
- (d)  $A_r = [(206.0 \times 25.48) + (207.0 \times 22.12) + (208.0 \times 52.40)] \div 100$  (1)  
 $A_r = 207.3$  (1)  
 1 mark for correct significant figures (answer must be reasonable) [3]

Total [19]

3. (a) Electrons within atoms occupy fixed energy levels or shells of increasing energy / nitrogen has electrons in two shells (1)  
 $1s^2 2s^2 2p^3$  (1)
- Electrons occupy atomic orbitals within these shells /  
 The first shell in nitrogen has s orbitals and the second shell s and p orbitals (1)
- A maximum of two electrons can occupy any orbital /  
 Each s orbital in nitrogen contains two electrons (1)
- Each with opposite spins (1)
- Orbitals of the same type are grouped together as a sub-shell / There are three p orbitals in nitrogen's p sub-shell (1)
- Each orbital in a sub-shell will fill with one electron before pairing starts / In nitrogen's p sub-shell each orbital contains one electron (1)
- (configuration mark + any 3 of above) [4]
- QWC The information is organised clearly and coherently, using specialist vocabulary where appropriate* [1]
- (b) Atomic spectrum of hydrogen is a series of lines (1)  
 that get closer as their frequency increases (1)  
 (credit possible from labelled diagram)
- Lines arise from atom / electrons being excited by absorbing energy (1)  
 electron jumping up to a higher energy level (1)  
 falling back down and emitting energy (in the form of electromagnetic radiation) (1)  
 to the  $n = 2$  level (1)  
 (any **three** points for maximum 3 marks)
- Since lines are discrete energy levels must have fixed values / Since energy emitted is equal to the difference between two energy levels,  $\Delta E$  is a fixed quantity or quantum (1) [6]
- (c) (i) It has greater nuclear charge (1)  
 but little / no extra shielding (1) [2]
- (ii) In Be less shielding of outer electron (1)  
 outweighs smaller nuclear charge (1)
- or
- Be outer electron closer to nucleus (1)  
 Be has greater effective nuclear charge (1) [2]
- (iii) I. Too much energy required to form  $B^{3+}$  ion [1]
- II.  $K^+(g) \rightarrow K^{2+}(g) + e^-$  [1]
- III. Value of  $1^{st}$  and  $3^{rd}$  I.E. will be higher (1)  
 Value of  $2^{nd}$  I.E. will be smaller (1)  
 (accept large jump in I.E. value would be between  $2^{nd}$  and  $3^{rd}$  electrons for 1 mark) [2]

Total [19]

4.

- (a) (i) 12 [1]  
 (ii) 14 [1]  
 (iii) Percentage / abundance / ratio / proportion of each isotope [1]

- (b) (i) 0.125 g [1]  
 (ii) e.g. Cobalt-60 (1) in radiotherapy (1) / Carbon-14 (1) in radio carbon dating (1) / Iodine-131 (1) as a tracer in thyroid glands (1) [2]

- (c) (i) Atoms are hit by an electron beam / electrons fired from an electron gun (and lose electrons) [1]  
 (ii) To be able to accelerate the ions (to high speed) / so that they can be deflected by a magnetic field  
 - no credit for 'so that *atoms* can be deflected...' [1]  
 (iii) They are deflected by a magnetic field / according to the m/z ratio [1]

(d)

1s	2s	2p	3s	3p
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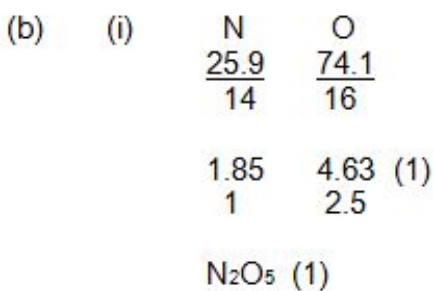
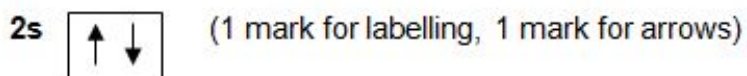
[1]

- (e) (i)  $\text{Mg}_3\text{N}_2 + 6\text{H}_2\text{O} \longrightarrow 3\text{Mg}(\text{OH})_2 + 2\text{NH}_3$  [1]  
 (ii) moles  $\text{Mg}(\text{OH})_2 = 1.75/58.32 = 0.0300$  (1)  
 moles  $\text{Mg}_3\text{N}_2 = 0.0100$  (1)  
 mass  $\text{Mg}_3\text{N}_2 = 0.01 \times 100.9 = 1.01 \text{ g}$  (1) [3]  
 - must be 3 significant figures to gain third mark

Total [14]



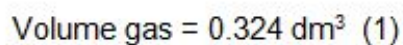
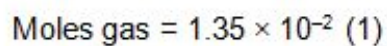
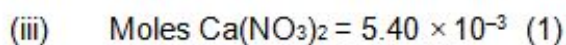
5.



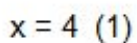
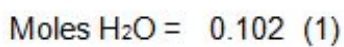
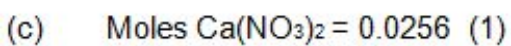
[2]



[1]



[3]



[3]

**Total [11]**

6.

- (a) same number of protons and electrons (1)  
0, 1 and 2 neutrons (1) [2]
- (b) (i) 3 energy levels between  $n = 2$  and  $n = \infty$   
becoming closer together  
first gap must be  $<$  that between  $n = 1$  and  $n = 2$  [1]
- (ii) any arrow pointing upwards (1)  
from  $n = 1$  to  $n = \infty$  (1) [2]
- (c) (i) visible [1]
- (ii) (not correct because) Balmer series corresponds to energy transitions involving  $n = 2$  (1)  
for ionisation energy need Lyman series / energy transitions involving  $n = 1$  (1) [2]
- (d) (i)  $Q(g) \rightarrow Q^+(g) + e$  / accept any symbol [1]
- (ii) Group 6 [1]
- (iii) In T there is more shielding (1)  
The outer electron is further from the nucleus (1)  
The increase in shielding outweighs the increase in nuclear charge / there is less effective nuclear charge (1) [3]  
*Legibility of text; accuracy of spelling, punctuation and grammar; clarity of meaning QWC* [1]

**Total [14]**

7.

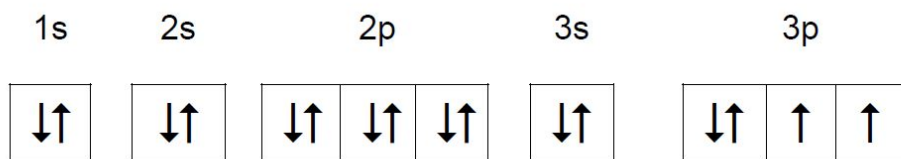
(a) C B D E A [2]

(1 mark if one mistake e.g. A in wrong place)

(b) Z (1)

Si is in Group 4 therefore large jump in ionisation energy would be after the fourth ionisation, not before it / W, X and Y have a large jump before the fourth ionisation energy so cannot be in Group 4 (1)

[2]



[1]

8.

(a) C [1]

(b) B [1]

9.

- (a)  $K \rightarrow 1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$  (1)  
There is one outer electron and the loss of this electron gives a stable potassium ion with a full outer shell/ ion more stable than the atom (1) [2]

- (b) (i)  $\Delta T = 4.8\text{ }^{\circ}\text{C}$  (1)  
$$\Delta H = -\frac{250 \times 4.2 \times 4.8}{0.125} = -40320\text{ J mol}^{-1} / -40.3\text{ kJ mol}^{-1}$$
 (2) [3]  
✓ for negative sign  
✓ correct value with relevant units

- (ii) e.g. The volume used was not precise in measurement as the readings on a beaker are only approximate (1)  
The experiment was performed in a beaker and this was not insulated and heat was lost to the surroundings (1) [2]

there may be other acceptable answers here, for example based on slow dissolving

- (c) (i) 0.050 [1]  
(ii)  $(0.050 \times 24.0) = 1.20\text{ (dm}^3\text{)}$  [1]  
(iii)  $\% \text{ v/v} = \frac{1.20 \times 0.001 \times 100}{2}$  (1) = 0.06 (1) [2]

- (d) An increase in the concentration of (aqueous) carbon dioxide causes the position of equilibrium to move to the right. (1)  
This causes calcium carbonate to become aqueous calcium (and hydrogencarbonate) ions / dissolve (1)  
weakening shells / causing difficulty in formation of shells (1) [3]

*Organisation of information clearly and coherently; using specialist vocabulary where appropriate* QWC [1]

**Total [15]**



10.

- (a) Electrons within atoms occupy fixed energy levels or shells of increasing energy / nitrogen has electrons in two shells (1)  
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 (accept large jump in I.E. value would be between  $2^{nd}$  and  $3^{rd}$  electrons for 1 mark) [2]

**Total [19]**

11.

- (a) (i) A helium (atom) nucleus / 2 protons and 2 neutrons /  ${}^4\text{He}^{2+}$  [1]
- (ii) b.....22 (1) X.....Ne (1) [2]
- (iii)  $(4 \times 2.6) = 10.4$  [1]
- (b) The frequency of the green line at 569 nm is HIGHER. than the frequency of the yellow-orange line at 589 nm. Another line is seen at 424 nm, this is caused by an electronic transition of HIGHER. energy than the line at 569 nm. [1]
- (c) (i)
- |                          |   |                  |   |                       |     |           |
|--------------------------|---|------------------|---|-----------------------|-----|-----------|
| $\text{Na}_2\text{CO}_3$ |   | $\text{NaHCO}_3$ |   | $2\text{H}_2\text{O}$ |     |           |
| ↓                        |   | ↓                |   | ↓                     |     |           |
| 106                      | + | 84               | + | 36                    | (1) | → 226 [1] |
- (or by other appropriate method – note mark is for the working)
- (ii) Atom economy =  $\frac{\text{'M}_r \text{ required product} \times 100}{\text{Total 'M}_r \text{ of the reactants}}$  (1)
- $= \frac{318 \times 100}{452} = 70.4 / 70.35 (\%)$  (1) [2]
- (iii) Carbon dioxide is produced (and released into the air) and this contributes to the greenhouse effect / increases acidity of sea (1)  
It should be trapped / a use found for it. (1) [2]
- (d) (i) Water is acting as a proton donor (1) and this combines with the carbonate ion /  $\text{CO}_3^{2-}$ , giving the hydrogencarbonate ion /  $\text{HCO}_3^-$  (1) [2]
- (ii) The pH scale runs from 0-14 / measure of acidity / alkalinity (1)  
pH <7 acid / >7 alkali (1)  
acid stronger as pH value decreases / alkali stronger as pH value increases / 11.4 is strong alkali (1) [3]

Total [15]