2 (a) Calculate the relative formula mass of each of the following substances.

(A)

(Relative atomic masses: H=1, N=14, O=16, Na=23, S=32, Ca=40)

(i) sodium nitrate $NaNO_3$

_____ [1]

(ii) sulfuric acid H_2SO_4

_____ [1]

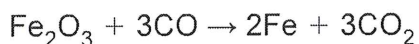**(iii)** calcium hydroxide $Ca(OH)_2$

_____ [1]

(b) What is meant by one mole of a substance?

_____

_____

_____ [2]

(c) This part of the question is about the amount of iron that can be produced from a certain amount of iron(III) oxide. The equation for the reaction is given below:

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

The relative formula mass of Fe_2O_3 is 160.

(i) How many moles of Fe_2O_3 are in 80 g of the substance?

Answer _____ moles [1]

(ii) How many moles of iron could be produced from 80 g of Fe_2O_3?

Answer _____ moles [1]

Examiner Only	
Marks	Remark

(iii) Calculate the maximum mass of iron that could be produced from 80 g of Fe_2O_3. You may find your Data Leaflet useful when answering this question.

Answer _____ g [1]

(iv) Calculate the maximum mass of iron that could be produced from 8 tonnes of Fe_2O_3. (1 tonne = 1000 kg)

Answer _____ tonnes [1]

(d) The final part of this question is about the effect that dilution has on the concentration of a solution and the number of moles in the solution.

(i) If 800 cm³ of water is added to 200 cm³ of a 1 mol/dm³ solution of hydrochloric acid, to make a 1 dm³ solution, what happens to the **concentration** of the acid? Tick (✓) the correct answer.

It stays the same ☐

It becomes 0.25 mol/dm³ ☐

It becomes 0.20 mol/dm³ ☐

[1]

(ii) If 800 cm³ of water is added to 200 cm³ of a 1 mol/dm³ solution of hydrochloric acid, what happens to the **number of moles** of acid in the solution? Tick (✓) the correct answer.

It stays the same ☐

It becomes 25% of its original value ☐

It becomes 20% of its original value ☐

[1]

4 This question is about relative atomic mass, relative formula masses and using mole calculations.

(B)

(a) What do you understand by the **relative atomic mass** of an element?

_____

_____

_____ [3]

(b) Calculate the relative formula mass of each of the substances given below. (Relative atomic masses: H = 1, O = 16, Na = 23, Al = 27, S = 32)
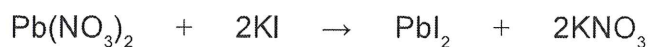
    (i) Sodium sulfate Na_2SO_4

                                                            _____ [1]

    (ii) Aluminium hydroxide $Al(OH)_3$

                                                            _____ [1]

(c) Lead iodide can be produced by reacting lead nitrate with potassium iodide. This reaction is carried out by mixing a solution of lead nitrate with a solution of potassium iodide. Solid lead iodide is formed.

$$Pb(NO_3)_2 \quad + \quad 2KI \quad \rightarrow \quad PbI_2 \quad + \quad 2KNO_3$$

Relative formulae masses: lead nitrate   331
                                   potassium iodide 166
                                     lead iodide   461

    (i) How many moles of potassium iodide would be needed to react with 33.1 g of lead nitrate?

Answer _____ moles [2]

(ii) Use the equation:

$$Pb(NO_3)_2 \ + \ 2KI \ \rightarrow \ PbI_2 \ + \ 2KNO_3$$

to calculate the maximum mass of lead iodide that could be obtained from 33.1 g of lead nitrate.

Answer _____ g [2]

(iii) If a student used 0.2 moles of lead nitrate and 0.2 moles of potassium iodide, how many moles of lead iodide would be produced?

Answer _____ moles [1]

4 This question is about relative formula masses and using and understanding the term mole.

(a) Calculate the relative formula mass of each of the following substances.

(relative atomic masses: H = 1, C = 12, O = 16, N = 14, Na = 23, Mg = 24)

(i) ammonia NH_3

_____ [1]

(ii) sodium carbonate Na_2CO_3

_____ [1]

(iii) magnesium hydroxide $Mg(OH)_2$

_____ [1]

(b) What do you understand by the term "a mole of a substance"?

_____

_____

_____ [2]

(c) (i) The relative formula mass of sulfur dioxide is 64. What is the mass of 0.6 moles of sulfur dioxide?

_____ g [1]

(ii) How many moles are in 320 grams of sulfur dioxide?

_____ [1]

(d) Solid silver chloride can be formed by mixing silver nitrate solution with magnesium chloride solution.

$$2AgNO_3 + MgCl_2 \rightarrow 2AgCl + Mg(NO_3)_2$$

Relative formula masses:
silver nitrate = 170, magnesium chloride = 95, silver chloride = 143.5

(i) How many moles of magnesium chloride would be needed to react with 8.5 g of silver nitrate?

_____ moles [2]

(ii) Use the equation:

$$2AgNO_3 + MgCl_2 \rightarrow 2AgCl + Mg(NO_3)_2$$
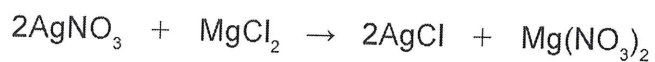
to calculate the mass of silver nitrate needed to produce 14.35 g of silver chloride.

_____ g [2]

4   This question is about relative formula masses, moles and relative atomic masses.

(a) Complete the definition below:

The relative atomic mass of an atom is _____

_____

_____

_____ [3]

(b) Calculate the relative formula mass of each of the following substances.

(relative atomic masses: H = 1, N = 14, O = 16, S = 32, K = 39, Ca = 40)
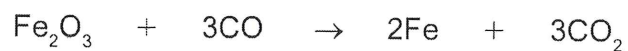
(i)   hydrogen peroxide H_2O_2

_____ [1]

(ii) potassium sulfate K_2SO_4

_____ [1]

(iii) calcium nitrate $Ca(NO_3)_2$

_____ [1]

(c) The key reaction in the manufacture of iron in the blast furnace is:

$$Fe_2O_3 \;+\; 3CO \;\rightarrow\; 2Fe \;+\; 3CO_2$$

relative formula masses: iron(III) oxide   160
                                   carbon monoxide 28
                                   iron   56
                                   carbon dioxide 44

(i) How many moles of carbon monoxide would be needed to react with 800 g of iron(III) oxide?

_____ [2]

(ii) What mass of iron(III) oxide would be needed to produce 56 **tonnes** of iron?

_____ [2]

6 This question is about relative formula masses, moles and the percentage of an element by mass in a compound.

(a) Complete the sentence below to define the term **relative atomic mass**.

The relative atomic mass (A_r) of an atom is the _____

_____

_____ [3]

(b) Calculate the relative formula mass of each of the following substances.
(relative atomic masses: C = 12, N = 14, O = 16, Mg = 24, Ca = 40)

(i) calcium carbonate, $CaCO_3$

_____ [1]

(ii) magnesium nitrate, $Mg(NO_3)_2$

_____ [1]

(c) The relative formula mass of ethane, C_2H_6, is 30.

(i) Calculate the number of moles in 150 g of ethane.

_____ g [1]

(ii) Calculate the percentage of carbon, by mass, in ethane, C_2H_6.

Show your working out.

_____ [3]

6   This question is about relative formula masses, moles and the percentage of an element by mass in a compound.

(F)

(a) Calculate the relative formula mass of each of the following substances.
     (relative atomic masses: H =1, N = 14, O = 16, S = 32, K = 39)

   (i)   potassium nitrate KNO_3

                                                    _____ [1]

   (ii) ammonium sulfate $(NH_4)_2SO_4$

                                                    _____ [1]

(b) The relative formula mass of ammonium nitrate, NH_4NO_3 is 80.
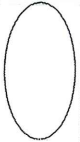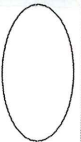
   (i)   What is the mass of 0.60 moles of ammonium nitrate?

                                                    _____ g [1]
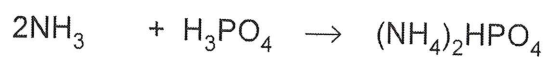
   (ii) Ammonium nitrate is used as a fertiliser because it has a high nitrogen content.

         Calculate the percentage of nitrogen, by mass, in ammonium nitrate, NH_4NO_3.

                                                    _____ % [3]

(c) The fertiliser diammonium phosphate can be made from ammonia and phosphoric acid. The overall equation can be represented as:

$$2NH_3 + H_3PO_4 \rightarrow (NH_4)_2HPO_4$$

Relative formula masses:

$$NH_3 = 17$$
$$H_3PO_4 = 98$$
$$(NH_4)_2HPO_4 = 132$$

(i) What is the minimum mass of ammonia needed to make 660 g of diammonium phosphate?

Show your working out.

_____ g [3]

(ii) In a laboratory experiment a chemist used the correct amounts of ammonia and phosphoric acid to give a theoretical yield of 660 g of diammonium phosphate but the actual yield was 561 g.

Calculate the percentage yield in this experiment.

_____ % [2]

(iii) Give one reason why the actual yield of diammonium phosphate was less than 100%.

_____ [1]

8 This question is about relative atomic mass, relative formula masses and using mole calculations.

Ⓖ

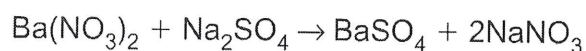**(a)** What do you understand by the relative atomic mass of an atom?

_____

_____

_____ [3]

(b) Barium sulfate can be produced by reacting barium nitrate with excess sodium sulfate.

$$Ba(NO_3)_2 + Na_2SO_4 \rightarrow BaSO_4 + 2NaNO_3$$

(i) Calculate the relative formula mass of barium sulfate.
($Ba = 137$; $S = 32$; $O = 16$)

Answer _____ [1]

(ii) Calculate the relative formula mass of barium nitrate.
($Ba = 137$; $N = 14$; $O = 16$)

Answer _____ [1]

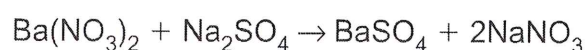**(iii)** Calculate the number of moles of barium nitrate in 13.05 g of the compound.

Answer _____ mole [1]

(iv) Use your answer to **(b)(i)** and **(b)(iii)** and the equation:

$$Ba(NO_3)_2 + Na_2SO_4 \rightarrow BaSO_4 + 2NaNO_3$$

to calculate the maximum mass of barium sulfate that can be obtained from 13.05 g of barium nitrate.

Answer _____ g [1]

(c) A solution of dilute sodium hydroxide is described as 2.0 mol/dm^3.

(i) What does 2.0 mol/dm^3 mean?

_____

_____ [2]

(ii) How much water must be added to 100 cm^3 of 2.0 mol/dm^3 sodium hydroxide to make a 1.0 mol/dm^3 solution?

_____ [1]