STOICHIOMETRY-MIXED BAG

1 This question is about masses, volumes and moles.

(a) Which term is defined by the following statement?

The average mass of naturally occurring atoms of an element on a scale where the ^{12}C atom has a mass of exactly 12 units.

..... [1]

(b) Butane, C_4H_{10}, has a relative **molecular** mass of 58.
Potassium fluoride, KF, has a relative **formula** mass of 58.

Explain why the term relative molecular mass can be used for butane but **cannot** be used for potassium fluoride.

.....

..... [2]

(c) A 0.095 g sample of gaseous element **Y** occupies 60.0 cm^3 at room temperature and pressure.

- Determine the number of moles of element **Y** in 60.0 cm^3.

moles of element **Y** = ... mol

- Calculate the relative molecular mass of element **Y** and hence suggest the identity of element **Y**.

relative molecular mass = ...

identity of element **Y** = ...
[3]

(d) A 1.68 g sample of phosphorus was burned and formed 3.87 g of an oxide of phosphorus.

Calculate the empirical formula of this oxide of phosphorus.

empirical formula = ... [4]

(e) Another oxide of phosphorus has the empirical formula P_2O_3.
One molecule of this oxide of phosphorus contains four atoms of phosphorus.

Calculate the mass of **one** mole of this oxide of phosphorus.

mass = ... g [2]

[Total: 12]

MARKING SCHEME:

(a)	relative atomic mass	**1**
(b)	C_4H_{10} is covalent	**1**
	KF is ionic	**1**
(c)	mol of **Y** = 0.060 / 24.0 = 2.5×10^{-3} or 0.0025	**1**
	M_r = 0.095 / 2.5×10^{-3} = 38(.0)	**1**
	fluorine	**1**
(d)	mass of O = 3.87 g – 1.68 g = 2.19 (g)	**1**
	mol of P and mol of O 1.68 / 31 OR 0.054.. 2.19 / 16 **OR** 0.13…	**1**
	ratio of P to O P = 0.054… / 0.054 O = 0.13… / 0.054… = 1 = 2.5	**1**
	whole number ratio and P_2O_5 = 2 = 5	**1**
(e)	the formula is P_4O_6 or (one mole of) P_2O_3 = 110 (g)	**1**
	mass = 220 (g)	**1**

2 Calcium chlorate(V), $Ca(ClO_3)_2$, is made by reacting calcium hydroxide with chlorine gas.

$$6Ca(OH)_2 + 6Cl_2 \rightarrow Ca(ClO_3)_2 + 5CaCl_2 + 6H_2O$$

(a) 8.88 g of calcium hydroxide and 7200 cm^3 of chlorine gas are mixed together.

(i) How many moles is 8.88 g of calcium hydroxide?

..... mol [2]

(ii) How many moles of chlorine gas is 7200 cm^3?

..... mol [1]

(iii) What is the maximum **number of moles** of calcium chlorate(V) that can be made from 8.88 g of calcium hydroxide and 7200 cm^3 of chlorine gas?

..... mol [1]

(iv) What is the maximum **mass** of calcium chlorate(V) that can be made from 8.88 g of calcium hydroxide and 7200 cm^3 of chlorine gas?

..... g [2]

The experiment is repeated using different amounts of calcium hydroxide and chlorine gas. The maximum mass of calcium chlorate(V) that can be made in the experiment is 4.84 g.

(v) The actual mass of calcium chlorate(V) made in the experiment is 3.63 g.

Calculate the percentage yield.

percentage yield = ... % [1]

(b) Calcium chlorate(V) undergoes thermal decomposition.

The only products are calcium chloride and a colourless gas.

(i) What must be done to calcium chlorate(V) to make it thermally decompose?

..... [1]

(ii) Write a chemical equation for the thermal decomposition of calcium chlorate(V).

..... [2]

(c) Chloric(V) acid, $HClO_3$, is a strong acid. It can be made from calcium chlorate(V).

(i) What colour is methyl orange indicator in chloric(V) acid?

..... [1]

(ii) Define the term *acid* in terms of proton transfer.

..... [1]

(iii) Complete the chemical equation to show $HClO_3$ behaving as an acid in water.

$$HClO_3 + H_2O \rightarrow \text{.....} + \text{.....}$$

[1]

[Total: 13]

MARKING SCHEME:

(a)(i)	74	**1**
	0.12	**1**
(a)(ii)	0.3	**1**
(a)(iii)	0.02	**1**
(a)(iv)	207	**1**
	4.14	**1**
(a)(v)	75%	**1**
(b)(i)	heat it	**1**
(b)(ii)	$Ca(ClO_3)_2 \rightarrow CaCl_2 + 3O_2$ 1 mark for O_2 as product 1 mark for the rest correct and balanced	**2**
(c)(i)	red	**1**
(c)(ii)	proton donor	**1**
(c)(iii)	$\rightarrow ClO_3^- + H_3O^+$	**1**