1.2 Reacting Masses & Volumes

Question Paper

Course	DP IB Chemistry
Section	1. Stoichiometric Relationships
Topic	1.2 Reacting Masses & Volumes
Difficulty	Easy

Time allowed: 50

Score: /38

Percentage: /100

Question 1a

a)
In a firework, solid potassium nitrate, KNO_3, decomposes to form solid potassium nitrite, KNO_2, and oxygen, O_2.

(i)
Write a balanced symbol equation for this reaction.

(ii)
Use section 6 of the data booklet to calculate the amount, in g, of potassium nitrate, KNO_3, required to make 1.5 g of oxygen. Give your answer to 2 significant figures.

[4 marks]

Question 1b

b)
Use section 2 of the data booklet to calculate the volume of gas at STP, in dm^3, that is produced in the reaction outlined in part (a). Give your answer to 2 significant figures.

[1 mark]

Question 1c

c)
Potassium can form a superoxide, $KO_2(s)$, which will react with carbon dioxide, $CO_2(g)$, to produce potassium carbonate, $K_2CO_3(s)$ and oxygen, $O_2(g)$, as shown in the equation below.

$$4KO_2(s) + 2CO_2(g) \rightarrow 2K_2CO_3(s) + 3O_2(g)$$

(i)
Calculate the amount, in moles, of 5.00 g of potassium superoxide. Give your answer to 3 significant figures

(ii)
Calculate the amount, in moles, and therefore volume, in dm^3, of carbon dioxide which will react with the superoxide. Give your answer to 3 significant figures.

[3 marks]

Question 1d

d)
A student calculated that 4.86 g of potassium carbonate, KCO_3, should be produced during the reaction outlined in part (c), 2.61 g of potassium carbonate, KCO_3, was produced when the experiment was carried out. Calculate the percentage yield for the production of potassium carbonate. Give your answer to 2 decimal places.

[1 mark]

Question 2a

A student carried out a series of titration experiments. Their results from their experiments are shown in the table below.

Titration	Rough	1	2	3
Final reading / cm^3	25.45	21.95	43.65	22.10
Initial reading / cm^3	0.00	0.05	21.90	0.10
Titre / cm^3	25.45	21.90	21.75	22.00

a)
Calculate the mean titre using the concordant results. Give your answer to 2 decimal places.

[2 marks]

Question 2b

b)
The student added 0.10 mol dm^{-3} hydrochloric acid, HCl (aq), to the burette and performed the titration using a 25.00 cm^3 sample of an unknown carbonate solution. The equation for the neutralisation reaction is shown below.

$$M_2CO_3\,(aq) + 2HCl\,(aq) \rightarrow 2MCl\,(aq) + CO_2\,(g) + H_2O\,(l)$$

(i)
Using your answer to part (a), calculate the amount, in moles, of hydrochloric acid used. Give your answer to 2 decimal places.

(ii)
Calculate the amount, in moles, of the aqueous carbonate solution. Give your answer to 2 decimal places.

[2 marks]

Question 2c

c)
Using your answer to part (b) (i) determine the concentration in mol dm^{-3} of the aqueous carbonate. Give your answer to 2 decimal places.

[1 mark]

Question 2d

d)
The student used 1.38 g of the unknown carbonate to make up a 250 cm^3 standard solution for the titration outlined in part (a). Using section 6 of the data booklet, prove that the unknown carbonate is potassium carbonate, K_2CO_3.

Calculate the amount, in moles, of K_2CO_3 ……

Calculate the concentration in, mol dm^{-3}, of K_2CO_3 solution ……

[4 marks]

Question 3a

a)
3.75 g of zinc oxide, ZnO (s), was added to 150 cm^3 of 1.00 mol dm^{-3} of sulfuric acid (aq) producing a salt. Write a balanced symbol equation for this reaction.

[1 mark]

Question 3b

b)
Using the equation in part (a) and section 6 of the data booklet, calculate the limiting reagent in the reaction. Give your answer to 2 significant figures.

[3 marks]

Question 3c

c)
Use your answer to part (b) and section 6 of the data booklet to calculate the amount, in grams, of the salt produced. Give your answer to 3 significant figures.

[1 mark]

Question 3d

d)
Calculate the amount, in moles, of the excess reactant left over at the end of the reaction. Give your answer to 2 decimal places.

[1 mark]

Question 4a

A sample of pure magnesium nitrate, $Mg(NO_3)_2$, was decomposed by heating as shown in the equation below

$$2Mg(NO_3)_2(s) \rightarrow 2MgO(s) + 4NO_2(g) + O_2(g)$$

A 0.75 g sample of $Mg(NO_3)_2$ was completely decomposed by heating.

a)
Calculate the amount, in moles, of magnesium nitrate that was decomposed. Give your answer to 2 decimal places.

[2 marks]

Question 4b

b)
Calculate the total amount, in moles, of gas produced in the reaction. Give your answer to 2 decimal places.

[2 marks]

Question 4c

c)
Calculate the total volume, in m^3, of gas produced at 333 K and 100 kPa.

[2 marks]

Question 5a

a)

90 cm^3 ammonia gas, $NH_3(g)$, is combusted in oxygen, $O_2(g)$, to produce nitrogen oxide and water, $H_2O(l)$. What is the total volume of gases remaining when 90 cm^3 of ammonia is combusted completely with 50 cm^3 of oxygen according to the equation shown?

$$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(l)$$

Deduce the limiting reagent for the combustion of ammonia, 90 cm^3 ammonia gas, $NH_3(g)$, is combusted in oxygen.

[1 mark]

Question 5b

b)

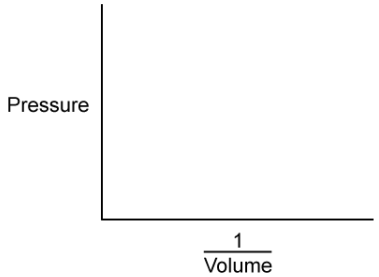
Calculate the total volume, in cm^3, of gases remaining for the reaction in part (a).

[4 marks]

Question 5c

c)

Sketch a line on the graph below that shows the correct relationship between pressure and $\frac{1}{\text{volume}}$



[1 mark]

Question 5d

d)

At 25 °C and 100 kPa a gas occupies a volume of 35 dm^3. Using the equation $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$, calculate the new temperature, in °C, of the gas if the volume is decreased to 15 dm^3 at **constant** pressure.

[2 marks]