CHEMISTRY ONLINE
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CHEMISTRY

PHYSICAL CHEMISTRY

Level & Board	AQA (A-LEVEL)
TOPIC:	AMOUNT OF SUBSTANCE
PAPER TYPE:	QUESTION PAPER - 1
TOTAL QUESTIONS	10
TOTAL MARKS	/42

Amount of Substance - 1

1. What is the empirical formula of a hydrocarbon that contains 90% carbon by mass?

A. C_2H_3
B. C_3H_2
C. C_3H_4
D. C_4H_3

(1)

2. Sodium chlorate(V), $NaClO_3$, contains 21.6% by mass of sodium, 33.3% by mass of chlorine and 45.1% by mass of oxygen.

(a) Use the above data to show that the empirical formula of sodium chlorate(V) is $NaClO_3$

(3)

(b) Sodium chlorate(V) may be prepared by passing chlorine into hot aqueous sodium hydroxide.

Balance the equation for this reaction below.

…… Cl_2 + …… NaOH → …… NaCl + $NaClO_3$ + $3H_2O$

(1)

3. A sample of hydrated nickel sulfate ($NiSO_4.xH_2O$) with a mass of 2.287 g was heated to remove all water of crystallisation.

The solid remaining had a mass of 1.344 g.

(a) Calculate the value of the integer x.
Show your working.

(4)

(b) Suggest how a student doing this experiment could check that all the water had been removed.

(2)

4. Which of these samples of gas contains the largest number of molecules?

The gas constant R = 8.31 J K^{-1} mol^{-1}.

A. 5.0×10^{-4} m^3 at 1.0×10^6 Pa and 300 K
B. 4.0×10^{-3} m^3 at 2.0×10^5 Pa and 400 K
C. 3.0×10^1 dm^3 at 3.0×10^4 Pa and 500 K
D. 2.0×10^2 dm^3 at 4.0×10^3 Pa and 600 K

(1)

5. Steel rods are cleaned before they are painted.

The rods are cleaned by passing them through a bath of dilute sulfuric acid.

This process produces large quantities of iron(II) sulfate.

(a) Write an equation for the reaction between iron and dilute sulfuric acid.

(1)

(b) State one chemical hazard in this process and suggest an appropriate safety precaution for this hazard.

(2)

6. A sample of 2.18 g of oxygen gas has a volume of 1870 cm^3 at a pressure of 101 kPa.

What is the temperature of the gas?

The gas constant is $R = 8.31\ J\ K^{-1}\ mol^{-1}$.

A. 167 K
B. 334 K
C. 668 K
D. 334 000 K

(1)

7. Zinc forms many different salts including zinc sulfate, zinc chloride and zinc fluoride.

(a) People who have a zinc deficiency can take hydrated zinc sulfate ($ZnSO_4.xH_2O$) as a dietary supplement.

A student heated 4.38 g of hydrated zinc sulfate and obtained 2.46 g of anhydrous zinc sulfate.

Use these data to calculate the value of the integer x in $ZnSO_4.xH_2O$
Show your working.

(3)

(b) Zinc chloride can be prepared in the laboratory by the reaction between zinc oxide and hydrochloric acid.

The equation for the reaction is

$ZnO + 2HCl \rightarrow ZnCl_2 + H_2O$

A 0.0830 mol sample of pure zinc oxide was added to 100 cm^3 of 1.20 mol dm^{-3} hydrochloric acid.

Calculate the maximum mass of anhydrous zinc chloride that could be obtained from the products of this reaction.

(4)

(c) Zinc chloride can also be prepared in the laboratory by the reaction between zinc and hydrogen chloride gas.

$Zn + 2HCl \rightarrow ZnCl_2 + H_2$

An impure sample of zinc powder with a mass of 5.68 g was reacted with hydrogen chloride gas until the reaction was complete.

The zinc chloride produced had a mass of 10.7 g.

Calculate the percentage purity of the zinc metal.

Give your answer to 3 significant figures.

(4)

(d) Predict the type of crystal structure in solid zinc fluoride and explain why its melting point is high.

(3)

8. A student carried out an experiment to find the mass of $FeSO_4.7H_2O$ in an impure sample, X.

The student recorded the mass of X.

This sample was dissolved in water and made up to 250 cm^3 of solution.

The student found that, after an excess of acid had been added, 25.0 cm^3 of this solution reacted with 21.3 cm^3 of a 0.0150 mol dm^{-3} solution of $K_2Cr_2O_7$

(a) Use this information to calculate a value for the mass of $FeSO_4.7H_2O$ in the sample of X.

(5)

(b) The student found that the calculated mass of $FeSO_4.7H_2O$ was greater than the actual mass of the sample that had been weighed out.

The student realised that this could be due to the nature of the impurity.

Suggest one property of an impurity that would cause the calculated mass of $FeSO_4.7H_2O$ in X to be greater than the actual mass of X.

Explain your answer.

(2)

9. The removal of silicon dioxide with limestone in the Blast Furnace can be represented by the following equation.

$CaCO_3(s) + SiO_2(s) \rightarrow CaSiO_3(l) + CO_2(g)$

The volume of carbon dioxide, measured at 298 K and 1.01×10^5 Pa, formed in this reaction during the removal of 1.00 tonne (1000 kg) of silicon dioxide is

A. 24.5 dm^3
B. 408 dm^3
C. 24.5 m^3
D. 408 m^3

(1)

10. Barium metal can be extracted from barium oxide, BaO, by reduction with aluminium.

$6BaO + 2Al \rightarrow 3Ba + Ba_3Al_2O_6$

Calculate the mass of barium metal that could be produced from reduction of 500 g of barium oxide using this method.

(4)

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