



CHEMISTRY ONLINE
— **TUITION** —

Phone: +442081445350

www.chemistryonlinetuition.com

Email: asherrana@chemistryonlinetuition.com

CHEMISTRY

PHYSICAL CHEMISTRY

Level & Board

AQA (A-LEVEL)

TOPIC:

AMOUNT OF SUBSTANCE

PAPER TYPE:

SOLUTION - 3

TOTAL QUESTIONS

10

TOTAL MARKS

/43

ChemistryOnlineTuition Ltd reserves the right to take legal action against any individual/ company/organization involved in copyright abuse.

Amount of Substance - 3

1.

(a)

Mass of X injected

= Mass of hypodermic syringe filled with X before injection - Mass of hypodermic syringe with left over X after injection

Given data:

Mass of hypodermic syringe filled with X before injection = 10.340 g

Mass of hypodermic syringe with left over X after injection = 10.070 g

Mass of X injected = $10.340\text{ g} - 10.070\text{ g} = 0.270\text{ g}$

Table 1

Mass of hypodermic syringe filled with X before injection / g	10.340
Mass of hypodermic syringe with left over X after injection / g	10.070
Mass of X injected / g	0.270 g

Volume of X:

Volume of X = Volume of X in gas syringe after injection - Volume reading on gas syringe before injection of X

Volume reading on gas syringe before injection of X = 0.0 cm^3

Volume of X in gas syringe after injection of X = 105.0 cm^3

Volume of X = $105.0\text{ cm}^3 - 0.0\text{ cm}^3 = 105.0\text{ cm}^3$

Table 2

Volume reading on gas syringe before injection of X / cm^3	0.0
Volume of X in gas syringe after injection of X / cm^3	105.0
Volume of X / cm^3	105.0

(1)

(b)

Using the Ideal Gas Law:

$PV = nRT$

Given:

$$P = 100 \text{ kPa} = 100 \times 10^3 \text{ Pa}$$

$$V = 105.0 \text{ cm}^3 = 105.0 \times 10^{-6} \text{ m}^3$$

$$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$$

$$T = 97^\circ \text{C} = 370.15 \text{ K}$$

Calculate $n = PV/RT$

$$n = \frac{100 \times 10^3 \times 105.0 \times 10^{-6}}{8.31 \times 370.15}$$

$$n = 10.5 / 3072.5465$$

$$n = 3.41 \times 10^{-3} \text{ mol}$$

Calculation of Mr:

Using the mass of X injected:

$$\text{Mr} = \text{mass of X injected} / n$$

$$\text{Mass of X injected} = 0.270 \text{ g}$$

$$n = 3.41 \times 10^{-3} \text{ mol}$$

$$\text{Mr} = 0.270 \text{ g} / 3.41 \times 10^{-3} \text{ mol}$$

$$\text{Mr} = 79.1 \text{ g/mol}$$

Identity of X:

Comparing the calculated Mr to the molar masses of the given chloroalkanes:

- CCl_4 Mr = 154 g/mol
- CHCl_3 Mr = 119.5 g/mol
- CH_2Cl_2 Mr = 85 g/mol
- CH_3Cl Mr = 50.5 g/mol

The calculated Mr of 79.1 g/mol is closest to the molar mass of CH_2Cl_2 (85 g/mol).

(5)

(c)

Air Leakage into the Syringe**Reason:**

The volume of the gas in the syringe (V) is greater than the true volume because some air leaked into the syringe.

Effect on Calculation:

If V is too large, the calculated $M_r = m \cdot RT / PV$ would be too small because the number of moles (n) would be overestimated.

(2)

(d)

Carry out the experiment in a fume cupboard.

Reason:

To avoid exposure to toxic vapors.

This precaution helps to ensure that harmful vapors are contained and safely vented away, protecting the student's health.

(2)

2. D

(1)

3.

(a)

mass of Ni = 2.0g

moles of Ni = $2.0/58.7 \text{ mol} = 0.0341 \text{ mol}$

(2)

(b)

Number of atoms of Ni = $6.02 \times 10^{23} \times 0.0341$

= 2.05×10^{22} atoms

(1)

4.

Pipette

Given:

Absolute error: $\pm 0.05 \text{ cm}^3$ **Measured volume:** 25.0 cm^3 (typical volume for a pipette)

Calculate the percentage error:

Percentage error for pipette = $(0.05 \text{ cm}^3 / 25.0 \text{ cm}^3) \times 100 = 0.2\%$ **Burette**

Given:

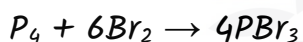
Absolute error: $\pm 0.15 \text{ cm}^3$ **Average titre (measured volume):** 24.25 cm^3

Calculate the percentage error:

Percentage error for burette = $(0.15 \text{ cm}^3 / 24.25 \text{ cm}^3) \times 100 = 0.618$

(2)

5.

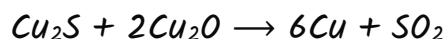
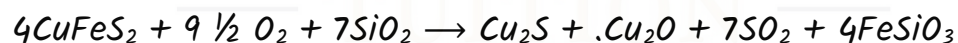


(1)

6.

(a)

Balanced equations:



(2)

(b)

Sulfur dioxide (SO_2) by-product is removed from the exhaust gases in copper production from CuFeS_2 to:

Prevents Acid Rain:

I am Sorry !!!!!

- SO_2 contributes to acid rain formation when it reacts with water vapor in the atmosphere, leading to environmental damage.

Health and Safety:

- SO_2 is toxic and can cause respiratory issues and exacerbate lung conditions in humans.

(2)

(c)

Calculate the percentage of copper in $CuFeS_2$:

The molar mass of copper (Ar Cu) is 63.5 g/mol.

The molar mass of $CuFeS_2$ (Mr $CuFeS_2$) is 183.5 g/mol.

Percentage of Cu in $CuFeS_2 = (63.5/183.5) \times 100 = 34.6\%$

Calculate the percentage of copper in the rock:

Given that the rock sample contains 1.25% $CuFeS_2$ by mass, we calculate the percentage of copper in the rock as follows:

Percentage of Cu in the rock = $(34.6/100) \times 1.25 = 0.4325\%$

Calculate the mass of rock needed:

We need 4050 kg of copper.

Mass of rock = $(4050 \times 100) / 0.4325$

Mass of rock = $405000 / 0.4325$

Mass of rock = 936416 kg

Convert mass of rock to tonnes:

Knowing 1 tonne = 1000 kg,

Mass of rock in tonnes = $936416 / 1000$

Mass of rock in tonnes = 936 tonnes

(4)

(d)

Atom economy

$$= (\text{Molar mass of useful products} / \text{Total molar mass of reactants}) \times 100$$

Total molar mass of reactants:

2 moles of CuO + 1 mole of C

$$\text{Total molar mass of reactants} = 2 \times 79.5 \text{ g/mol} + 12.0 \text{ g/mol} = 171 \text{ g/mol}$$

Molar mass of useful products:

2 moles of Cu

$$\text{Molar mass of useful products} = 2 \times 63.5 \text{ g/mol} = 127 \text{ g/mol}$$

Atom economy

$$= (127 \text{ g/mol} / 171 \text{ g/mol}) \times 100$$

$$\text{Atom economy} = 0.74269006 \times 100$$

$$= 74.3\%$$

(2)

7. B

(1)

8.

(a)

$$PV = nRT$$

$$R = 8.317 \text{ K}^{-1} \text{ mol}^{-1}$$

$$P = 102000 \text{ Pa}$$

$$V = 0.072 \text{ m}^3$$

$$T = 373 \text{ K}$$

$$n = 102000 \times 0.072 / 8.31 \times 373$$

$$n = 7344 / 3105.03$$

$$n = 2.3665 \times 10^{-3} \text{ mol}$$

$$M_r = \text{mass} / \text{moles}$$

$$M_r = 0.000194 \text{ kg} / 2.3665 \times 10^{-3} \text{ mol}$$

$$M_r = 0.000194 / 0.0023665$$

$$M_r = 82.08$$

(5)

(b)

Given:

- Carbon (C) is 83.7% by mass
- Hydrogen (H) is 16.3% by mass

Calculate the moles:

- Moles of carbon = $83.7/12.0 = 6.975$
- Moles of hydrogen = $16.3/1.018 = 16.3$
- Moles of carbon = $6.975/6.975 = 1$
- Moles of hydrogen $\approx 16.3/6.975 = 2.34$
- Carbon: C_3
- Hydrogen: H_7

So, the empirical formula of Y is C_3H_7

Ratio of Mr to EFM:

$$\text{Ratio} = \text{Mr} / \text{EFM} = 86.0 / 43.0 = 2$$

$$\text{Molecular formula} = \text{Empirical formula} \times \text{Ratio}$$

$$= C_3H_7 \times 2$$

$$\text{Molecular formula} = C_6H_{14}$$

(4)

9.

(a)

Volume of NaOH used = $25.30 \text{ cm}^3 = 25.30 \times 10^{-3} \text{ L}$ (converted from cm^3 to L)

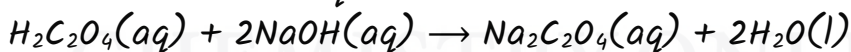
Concentration of NaOH (C) = $0.500 \text{ mol/dm}^3 = 0.500 \text{ mol/L}$

Amount of NaOH = Concentration \times Volume

$$\text{Amount of NaOH} = 0.500 \times 25.30 \times 10^{-3}$$

$$\text{Amount of NaOH} = 0.01265 \text{ mol}$$

From the balanced equation:



Moles of $H_2C_2O_4$ = Moles of NaOH / 2

$$\text{Moles of } H_2C_2O_4 = 0.01265 / 2$$

$$= 0.006325 \text{ mol}$$

$$\text{Molar mass of } H_2C_2O_4 = 90.04 \text{ g/mol}$$

$$\text{Mass of } H_2C_2O_4 = \text{Moles} \times \text{Molar mass} \text{ Mass of } H_2C_2O_4 = 0.006325 \times 90.04$$

$$= 0.5694 \text{ g}$$

$$\text{Or} = 569.4 \text{ mg}$$

(4)

(b)

Rinsing with deionised water ensures that all ethanedioic acid and sodium hydroxide are fully transferred into the reaction mixture, preventing residues on the flask's sides that could lead to incomplete reactions or inaccurate measurements.

Thus, it improves the accuracy of the titration by ensuring complete reaction and reliable endpoint detection.

(1)

(c)

Concordant titres refer to volume measurements in titration experiments that are within a narrow range of each other, typically within 0.1 cm^3 . This range accounts for the precision of the measuring apparatus, ensuring consistent and reliable results despite minor variations in individual readings.

(1)

10. D

(1)

CHEMISTRY ONLINE
— TUITION —

I am Sorry !!!!!



DR. ASHAR RANA



CHEMISTRY ONLINE
— TUITION —

Phone: +442081445350
www.chemistryonlinetuition.com
Email: asherrana@chemistryonlinetuition.com

- Founder & CEO of Chemistry Online Tuition Ltd.
- Tutoring students in UK and worldwide since 2008
- Chemistry, Physics, and Math's Tutor

CONTACT INFORMATION FOR **CHEMISTRY ONLINE TUITION**

- UK Contact: 02081445350
- International Phone/WhatsApp: 00442081445350
- Website: www.chemistryonlinetuition.com
- Email: asherrana@chemistryonlinetuition.com
- Address: 210-Old Brompton Road, London SW5 OBS, UK