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 - 4
TOTAL QUESTIONS	10
TOTAL MARKS	/35

Amount of Substance - 4

1.

(a)

moles of $Na_2S_2O_3$ used in the titration:

$$n(Na_2S_2O_3) = \frac{33.50\ cm^3 \times 0.100\ mol\ dm^{-3}}{1000} = 0.00335\ mol$$

moles of I_2 reacted:

$n(I_2) = 0.00335\ mol / 2 = 0.001675\ mol$

moles of ClO^- in the 25.0 cm^3 of the diluted bleach solution:

$n(ClO^-) = n(I_2) = 0.001675\ mol$

moles of ClO^- in the 100 cm^3 flask (original 10 cm^3 sample):

$n(ClO^-)$ in original 10 cm^3 sample $= 0.001675\ mol \times 4 = 0.00670\ mol$

mass of NaClO in the original bleach solution:

Mass of NaClO $= 0.00670\ mol \times 74.5\ g\ mol^{-1} = 0.499\ g$

total mass of the 10.0 cm^3 bleach solution:

Mass of bleach solution $= 10.0\ cm^3 \times 1.20\ g\ cm^{-3} = 12.0\ g$

percentage by mass of NaClO in the original bleach solution:

Percentage by mass of NaClO $= (0.499\ g / 12.0\ g) \times 100 = 4.16\%$

(7)

(b)

A. 0.45%

(1)

2. C

(1)

3.

(a)

Molar mass of NaF= 42.0 g/mol

Moles of NaF =2.88×10^{-5}mol

The mass of NaF is:

Mass of NaF

=n(NaF)×Molar mass of NaF

=2.88×10^{-5} mol×42.0 g/mol=1.2096×10^{-3} g

Mass of NaF in mg=1.2096×10^{-3}g×1000=1.2096mg

Concentration of NaF in ppm
=1.2096mg / 0.001kg
=1209.6ppm

Concentration of NaF=1210ppm

(4)

(b)

Given toxic concentration:

3.19×10^{-2}g/kg

maximum mass for a 75.0 kg person:
3.19×10^{-2} g/kg×75.0 kg=2.3925 g

Convert to milligrams:

2.3925 g×1000=2392.5 mg

significant figures:
Maximum mass of NaF=2390 mg

(1)

(c)

Maximum mass of NaF=2390mg

Toothpaste concentration to mg/kg:

2800ppm=2800mg/kg

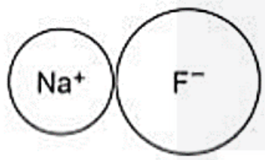
Mass of toothpaste:

Mass of toothpaste=2390 mg / 2800 mg/kg=0.854 kg

(1)

(d)

Correct relative sizes of the ions in sodium fluoride shown in B



B

Sodium ion (Na^+) and fluoride ion (F^-) have the same electron arrangement or are isoelectronic ($1s^2 2s^2 2p^6$).

Sodium ion (Na^+) has more protons than fluoride ion (F^-), which results in stronger attraction for outer electrons.

This stronger attraction results in sodium ion (Na^+) being less in size compared to fluoride ion (F^-) (Sodium (ion) has more protons so attracts (outer) electrons closer) due to higher charge density and stronger electrostatic forces.

(3)

4. A

(1)

5.

(a)

Mass of Na_2CO_3 after heating = 0.57 g
Mass of water lost = 0.55 g

Molar mass of Na_2CO_3 = 105.99 g/mol
Moles of Na_2CO_3 = Mass / Molar mass

$=0.57\ g / 105.99\ g/mol = 0.00538\ mol$

Moles of H_2O=mol0.55g / 18.015g = 0.03056mol
Ratio= Moles of H_2O / Moles of Na_2CO_3
=0.03056 / 0.00538 = 5.68

(5)

(b)

The difference between the experimental value of x (5.68) and the correct value (10) is due to:

Incomplete removal of water:

The experimental heating process did not completely remove all water molecules from the hydrated sodium carbonate ($Na_2CO_3 \cdot xH_2O$).

This incomplete dehydration led to a lower measured mass of water lost, resulting in a lower calculated value of x.

(1)

(c)

To improve the accuracy of determining xxx in $Na_2CO_3 \cdot xH_2O$ using the same apparatus:

Heat the sample to constant mass:
Ensure complete dehydration by heating until the mass remains unchanged, indicating all water has been driven off.
Use a smaller sample mass:
This allows for more uniform heating and reduces the risk of incomplete dehydration, leading to more accurate results.

(2)

6. C

(1)

7.

Given:

Mass of H_2S = 5.00 g
Molar mass of H_2S = 34.1 g/mol
Moles of H_2S:
Moles=Mass / Molar mass=5.00 g / 34.1 g/mol=0.1466 mol

$H_2+S \rightarrow H_2S$

Moles of H_2 needed = moles of H_2S = 0.1466 mol
PV=nRT

$$V = \frac{nRT}{p}$$

$$V = \frac{0.1466 \times 0.0821 \times \mathbf{298}}{1}$$

$V=3.59L \times 1000cm^3/L=3590cm^3$

(3)

8. D

(1)

9.

Moles of S=10.0g / 32 g/mol =0.312mol
From the balanced equation $S+2Na \rightarrow Na_2S$
Molar mass of Na_2S =78.042 g/mol

Mass of Na_2S=Moles of S×Molar mass of Na_2S

=0.312mol×78.04g/mol=24.37g

(2)

10. A

(1)

DR. ASHAR RANA

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

- Founder & CEO of Chemistry Online Tuition Ltd.
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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