CHEMISTRY ONLINE TUITION

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CHEMISTRY

PHYSICAL CHEMISTRY

Level & Board	AQA (A-LEVEL)
TOPIC:	AMOUNT OF SUBSTANCE
PAPER TYPE:	QUESTION PAPER - 4
TOTAL QUESTIONS	10
TOTAL MARKS	/35

Amount of Substance - 4

1. A student does an experiment to determine the percentage by mass of sodium chlorate(I), NaClO, in a sample of bleach solution.
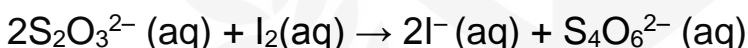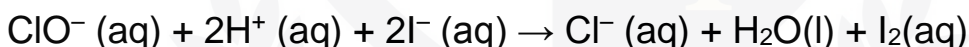Method:

- Dilute a 10.0 cm^3 sample of bleach solution to 100 cm^3 with distilled water.
- Transfer 25.0 cm^3 of the diluted bleach solution to a conical flask and acidify using sulfuric acid.
- Add excess potassium iodide to the conical flask to form a brown solution containing I_2(aq).
- Add 0.100 mol dm^{-3} sodium thiosulfate solution ($Na_2S_2O_3$) to the conical flask from a burette until the brown solution containing I_2(aq) becomes a colourless solution containing I$^-$ (aq).

The student uses 33.50 cm^3 of sodium thiosulfate solution.
The density of the original bleach solution is 1.20 g cm^{-3}
The equations for the reactions in this experiment are

ClO^- (aq) + $2H^+$ (aq) + $2I^-$ (aq) → Cl^- (aq) + H_2O(l) + I_2(aq)

$2S_2O_3^{2-}$ (aq) + I_2(aq) → $2I^-$ (aq) + $S_4O_6^{2-}$ (aq)

(a) Use all the information given to calculate the percentage by mass of NaClO in the original bleach solution.

Give your answer to 3 significant figures.

(7)

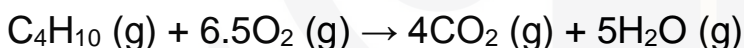**(b)** The total uncertainty from two readings and an end point error in using a burette is ± 0.15 cm^3

What is the total percentage uncertainty in using the burette in this experiment?

A. 0.45%
B. 0.90%
C. 1.34%
D. 1.99%

(1)

2. The equation below represents the complete combustion of butane.

C_4H_{10} (g) + 6.5O_2 (g) → 4CO_2 (g) + 5H_2O (g)

20 cm^3 of butane are completely burned in 0.20 dm^3 of oxygen.
Which statement is correct?

All volumes are measured at the same temperature and pressure.

A. 40 cm^3 of carbon dioxide are formed
B. 0.065 dm^3 of oxygen react
C. 70 cm^3 of oxygen remain
D. 0.50 dm^3 of steam are formed

(1)

3. This question is about sodium fluoride (NaF).

Some toothpastes contain sodium fluoride. The concentration of sodium fluoride can be expressed in parts per million (ppm).

1 ppm represents a concentration of 1 mg in every 1 kg of toothpaste.

(a) A 1.00 g sample of toothpaste was found to contain 2.88×10^{-5} mol of sodium fluoride.

Calculate the concentration of sodium fluoride, in ppm, for the sample of toothpaste.

Give your answer to 3 significant figures.

(4)

(b) Sodium fluoride is toxic in high concentrations.

Major health problems can occur if concentrations of sodium fluoride are greater than 3.19×10^{-2} g per kilogram of body mass.

Deduce the maximum mass of sodium fluoride, in mg, that a 75.0 kg person could swallow without reaching the toxic concentration.
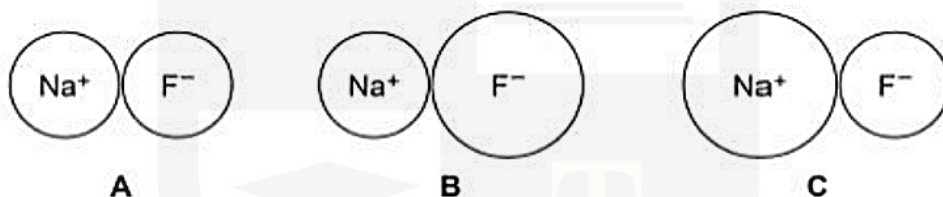
(1)

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(c) The concentration of sodium fluoride in a prescription toothpaste is 2800 ppm.

Use your answer to Question (b) to deduce the mass of toothpaste, in kg, that a 75.0 kg person could swallow without reaching the toxic concentration.

(1)

(d) Identify the diagram in the figure below that shows the correct relative sizes of the ions in sodium fluoride.

Justify your answer.

(3)

4. The heat released when 1.00 g of ethanol (Mr = 46.0) undergoes complete combustion is 29.8 kJ

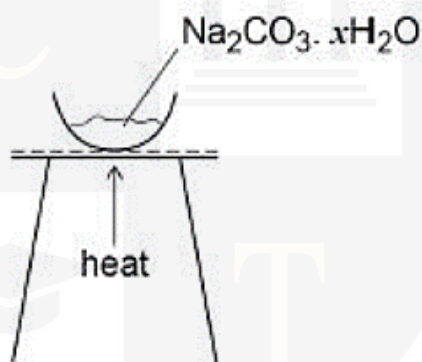What is the heat released by each molecule, in joules, when ethanol undergoes complete combustion?

(The Avogadro constant L = 6.022×10^{23} mol^{-1})

A. 2.28×10^{-18} J
B. 4.95×10^{-20} J
C. 2.28×10^{-21} J
D. 4.95×10^{-23} J

(1)

5. A student heated a solid sample of $Na_2CO_3 \cdot xH_2O$ for 1 minute to remove water and determine a value for x The diagram shows the apparatus used.

The table shows the results recorded.

Mass of empty evaporating basin	24.35 g
Mass of evaporating basin and solid before heating	25.47 g
Mass of evaporating basin and solid after heating for 1 minute	24.92 g

(a) Use the data in the table to calculate a value for x in the formula $Na_2CO_3 \cdot xH_2O$

Give your answer to 2 decimal places.

(5)

(b) The correct value for x is 10. Suggest a reason for the difference between the experimental value for x and the correct value.

(If you were unable to calculate an experimental value for x assume it was 8.05. This is not the correct experimental value.)

(1)

(c) Suggest how the procedure could be improved, using the same apparatus, to give a more accurate value for x Justify your answer.

(2)

6. How many protons are there in 6.0 g of nitrogen gas?
Avogadro constant, $L = 6.022 \times 10^{23}$ mol^{-1}

A. 1.3×10^{23}
B. 9.0×10^{23}
C. 1.8×10^{24}
D. 3.6×10^{24}

(1)

7. Calculate the minimum volume of hydrogen, in cm^3, at 298 K and 101.3 kPa, that is needed to form 5.00 g of hydrogen sulphide.

(3)

8. A 30 cm^3 sample of nitrogen was reacted with a 60 cm^3 sample of fluorine according to the equation

What is the volume of the gas mixture after the reaction, at constant temperature and pressure?

A. 20 cm^3
B. 30 cm^3
C. 40 cm^3
D. 50 cm^3

(1)

9. Calculate the maximum mass of sodium sulphide that can be obtained from 10.0 g of sulphur.

(2)

10. What is the volume occupied by 10.8 g of the freon CCl_2F_2 at 100 kPa and 273 K?

A. 2.02 dm^3
B. 2.05 dm^3
C. 2.02 cm^3
D. 2.05 cm^3

(1)

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