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## SECTION A / MULTIPLE-CHOICE QUESTIONS

### INSTRUCTIONS FOR SECTION A

Answer **all** questions in pencil on the answer sheet provided for the multiple-choice questions. Choose the response that is **correct** or that **best answers** the questions. 1 mark will be awarded for a correct answer; no marks will be awarded for an incorrect answer. Marks are **not** deducted for incorrect answers. No marks will be awarded if more than one answer is complete for any question.

#### Question 1

Aspirin is an organic compound used widely in headache preparations. The concentration of aspirin in a particular tablet is best determined by

- A. flame tests
- B. atomic absorption spectroscopy
- C. paper chromatography
- D. high performance liquid chromatography

#### Question 2

In which of the following species does sulfur have the lowest oxidation number?

- A.  $\text{SO}_4^{2-}$
- B.  $\text{SO}_2$
- C.  $\text{SO}_3$
- D.  $\text{H}_2\text{SO}_4$

#### Question 3

1.50 g of calcium carbonate reacts with 20.0 mL of 1.0 M HCl according to the equation



In a second reaction mixture, the volume of HCl is increased to 50.0 mL. Which of the following best describes the difference between the first and second reaction mixtures?

- A. The increased amount of HCl in the second reaction will cause it to proceed at a greater rate than the first.
- B. A shorter period of bubbling will be observed in the second reaction mixture.
- C. Equal volumes of carbon dioxide will be produced by the first and second reaction mixtures.
- D. A greater amount of  $\text{CaCl}_2$  will be produced in the second reaction.

#### Question 4

The number of carbon atoms present in 5.00 g of butane is

- A. 0.345
- B.  $5.19 \times 10^{22}$
- C.  $2.08 \times 10^{23}$
- D.  $2.73 \times 10^{23}$

#### Question 5

A colorimeter is used to determine the concentration of phosphate in a detergent. A blue solution is prepared for analysis by treating detergent solution with sodium molybdate. Which of the following best describes the colour of the light source used?

## PRACTICE EXAM 1 / SECTION A MULTIPLE-CHOICE QUESTIONS

### Question 1: C

- **C is correct.** HPLC allows the separation of organic compounds such as esters. NMR spectroscopy allows the estimation of the structure of organic compounds based on their  $^{13}\text{C}$  and  $^1\text{H}$  spectra.
- A is incorrect because neither UV-visible spectroscopy nor NMR spectroscopy allow the separation of compounds.
- B is incorrect because thin-layer chromatography is not precise enough to reliably separate esters for collection. IR spectroscopy will enable the identification of functional groups and can be used as a fingerprint for a structure.
- D is incorrect because UV-visible spectroscopy does not give any information about the structure of the compound being analysed. GC will separate the components if they can be easily vaporised without decomposing.

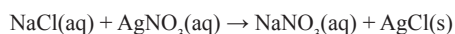
### Question 2: B

- **B is correct** according to the calculations below.

Step 1: Calculate the amount, in mol, of precipitate formed.

$$\begin{aligned} n(\text{AgCl}) &= \frac{m}{M} \\ &= \frac{0.241}{107.9 + 35.5} \\ &= \frac{0.241}{143.4} \\ &= 1.17 \times 10^{-3} \text{ mol} \end{aligned}$$

Step 2: Write a balanced chemical equation for the reaction between the sodium chloride in the biscuit sample and the silver nitrate that was added.



Step 3: Calculate the amount, in mol, of NaCl in the biscuit sample.

The coefficients in a balanced chemical equation provide the ratio of amounts, in mol, of reactants and products consumed or produced in the reaction.

According to the equation:

$$n(\text{NaCl}) : n(\text{AgCl})$$

$$1 : 1$$

$$\begin{aligned} \text{So, } n(\text{NaCl}) &= \frac{1}{1} \times n(\text{AgCl}) \\ &= 1.17 \times 10^{-3} \text{ mol} \end{aligned}$$

Step 4: Calculate the amount, in mol, of  $\text{Na}^+$  ions.

According to the ionic formula there is one  $\text{Na}^+$  ion in NaCl.

$$\begin{aligned} \text{So, } n(\text{Na}^+) &= n(\text{NaCl}) \\ &= 1.17 \times 10^{-3} \text{ mol} \end{aligned}$$

Step 5: Calculate the mass of  $\text{Na}^+$  ions.

$$\begin{aligned} m(\text{Na}^+) &= nM \\ &= 1.17 \times 10^{-3} \times 23.0 \\ &= 0.0387 \text{ g} \end{aligned}$$

Step 6: Calculate the percentage by mass of  $\text{Na}^+$  ions in the biscuit.

$$\begin{aligned} \text{Percentage by mass} &= \frac{\text{Mass of Na}^+}{\text{Mass of biscuits}} \times 100 \\ &= \frac{0.0387}{3.65} \times 100 \\ &= 1.06\% \end{aligned}$$

- A is incorrect because 0.0387 g is the mass of  $\text{Na}^+$  ions present and must be divided by the mass of the biscuit and multiplied by 100 to determine the percentage by mass.

- C is incorrect because the ratio of  $n(\text{NaCl}) : n(\text{AgCl})$  is 1 : 1, not 2 : 1.
- D is incorrect because the percentage by mass of  $\text{Na}^+$  ions is being calculated, not the percentage by mass of NaCl.

### TIPS

Students must know the valencies of common ions and be confident in writing balanced chemical equations. The periodic table is useful for remembering valencies. For example, all ions formed from Group 1 elements have a valency of +1 and ions formed from Group 2 elements have a valency of +2. Ions formed from Group 15 elements have a valency of -3, ions formed from Group 16 elements have a valency of -2, ions formed from Group 17 have a valency of -1 and the Group 18 elements are the noble gases and exist as atoms. Students must also learn polyatomic ions such as  $\text{NO}_3^-$ ,  $\text{SO}_4^{2-}$ ,  $\text{CO}_3^{2-}$  and  $\text{OH}^-$ .

### Question 3: A

- **A is correct** because if not all of the chloride ions were precipitated the mass of AgCl would be decreased, resulting in a lower percentage by mass of  $\text{Cl}^-$  and, therefore, NaCl.
- B is incorrect because any remaining solids would have added to the mass of the filtered precipitate and increased the percentage by mass.
- C is incorrect because any remaining water would contribute to a higher mass of precipitate, hence, an increased percentage by mass.
- D is incorrect because the precipitation of any additional ions would result in a higher mass of precipitate, and increase the percentage by mass.

### Question 4: C

- **C is correct** according to the calculations below.

Step 1: Calculate the amount, in mol, of propane gas undergoing combustion.

$$\begin{aligned} n(\text{C}_3\text{H}_8) &= \frac{m}{M} \\ &= \frac{100}{(3 \times 12.0) + (8 \times 1.0)} \\ &= \frac{100}{44.0} \\ &= 2.27 \text{ mol} \end{aligned}$$

Step 2: Calculate the amount, in mol, of  $\text{CO}_2$  produced.

The coefficients in a balanced chemical equation provide the ratio of amounts, in mol, of reactants and products consumed or produced in the reaction.

According to the equation:

$$\begin{aligned} n(\text{C}_3\text{H}_8) : n(\text{CO}_2) \\ 1 : 3 \\ \text{So, } n(\text{CO}_2) &= \frac{3}{1} \times n(\text{C}_3\text{H}_8) \\ &= \frac{3}{1} \times 2.27 \\ &= 6.82 \text{ mol} \end{aligned}$$

Step 3: Calculate the volume of  $\text{CO}_2$  produced at the specified conditions.

Temperature must be expressed in K.

$$\begin{aligned} T \text{ in K} &= T \text{ in } ^\circ\text{C} + 273 \\ &= 5.0 + 273 \\ &= 278 \text{ K} \end{aligned}$$

Pressure must be expressed in kPa.

$$1 \text{ atm} = 101.3 \text{ kPa}$$