# Quiz (Instrumental Analytical Methods)

## Section A: Multiple-choice

- 1. In which of the following reactions the concentration of reactants or products can be determined by colorimetry?
  - (1)  $Fe^{3+}(aq) + SCN^{-}(aq) \longrightarrow FeSCN^{2+}(aq)$
  - (2)  $5Fe^{2+}(aq) + MnO_{4^{-}}(aq) + 8H^{+}(aq) \longrightarrow 5Fe^{3+}(aq) + Mn^{2+}(aq) + 4H_{2}O(I)$
  - (3)  $2I^{-}(aq) + S_2O_8^{2-}(aq) \longrightarrow I_2(aq) + SO_4^{2-}(aq)$
  - A. (1) and (2) only
  - C. (2) and (3) only

- B. (1) and (3) only
- D. (1), (2) and (3)
- 2. Iron(II) sulphate solution is added to 25.0 cm<sup>3</sup> 0.02 M acidified potassium permanganate solution in a conical flask. Which of the following statements is correct?
  - A. This is a redox reaction.
  - B. The reaction mixture changes from purple to colourless.
  - C. The progress of the reaction can be monitored by using a colorimeter.
  - D. The absorbance of the reaction mixture increases when acidified potassium permanganate solution has completely reacted.
- 3. Which of the following information obtained from the infrared spectrum can be used to distinguish between propan-2-ol and propanone?
  - (1) The presence of broad absorption peaks at 3230–3670 cm<sup>-1</sup>
  - (2) The presence of broad absorption peaks at 2500–3300 cm<sup>-1</sup>
    - (3) The presence of absorption peaks at 1680–1800 cm<sup>-1</sup>
  - A. (1) and (2) only
  - C. (2) and (3) only

- B. (1) and (3) only D. (1), (2) and (3)
- 4. The IR spectrum of an organic compound X ( $C_4H_8O_2$ ) is shown below:



What is organic compound X?

- A. Butanoic acid
- C. Ethyl ethanoate

- B. Butan-1-ol
- D. Methyl propanoate

- 5. Which of the following causes the separation of the ions in a mass spectrometer?
  - A. A vacuum pump
  - Β. An ionization chamber C. An electric field D. A magnetic field
- Which of the following methods can be used to distinguish between butanal 6. and butanone?
  - (1) Analysing their mass spectra
  - (2) Analysing their IR spectra
  - (3) Adding 2,4-dinitrophenylhydrazine
  - A. (1) and (2) only (1) and (3) only Β.
  - C. (2) and (3) only

- (1), (2) and (3) D.
- 7. Which of the following ions will be deflected to the least extent in a mass spectrometer?

Α.	<sup>12</sup> C+	В.	14C+
C.	$^{12}C^{2+}$	D.	$^{14}C^{2+}$

8. The mass spectrum of pentane is shown below.

43 100 80 60 Relative intensity (%) 40 29 57 20 72 0 10 20 30 50 60 40 70 m/e

Which of the following statements are correct?

- (1) The peak at m/e = 29 is due to the ion CH<sub>3</sub>CH<sub>2</sub><sup>+</sup>.
- (2) The peak at m/e = 43 is due to the ion CH<sub>3</sub>CHCH<sub>3</sub><sup>+</sup>.
- (3) The peak at m/e = 72 corresponds to the molecular ion.
- A. (1) and (2) only

(1) and (3) only Β.

C. (2) and (3) only

- D. (1), (2) and (3)

#### Section B: Structured questions

Compound X is an amino acid. It contains a carboxyl group (–COOH) and an amino group (–NH<sub>2</sub>). X has the following composition by mass: 40.4% carbon, 7.9% hydrogen, 36.0% oxygen and 15.7% nitrogen.

- (a) Suggest a chemical test to show the presence of carboxyl group in X.
- (b) Determine the empirical formula of X. (Relative atomic masses: H = 1.0, C = 12.0, N = 14.0, O = 16.0)
- (c) Some peaks found in the mass spectrum of X are tabulated below.

lons	m/e	Remarks
<i>X</i> <sub>1</sub>	89	The peak with the highest value of <i>m</i> /e
X <sub>2</sub>	44	The peak with the highest intensity

(i) Determine the relative molecular mass of X.

(ii) Write the structural formulae of  $X_1$  and  $X_2$  respectively.

## **Suggested Answer**

### Section A

1.	D	5.	D
2.	С	6.	A
3.	В	7.	В
4.	A	8.	В

#### Section **B**

(a) Add X to sodium carbonate solution. Colourless gas bubbles will be given out.

(b) Assume that there are 100 g of X.

	С	Н	0	Ν
Mass (g)	40.4	7.9	36.0	15.7
Number of moles (mol)	40.4/12.0	7.9/1.0	36.0/16.0	15.7/14.0
	= 3.37	= 7.90	= 2.25	= 1.12
Mole ratio	3.37/1.12	7.90/1.12	2.25/1.12	1.12/1.12
	= 3	= 7	= 2	= 1

 $\therefore$  empirical formula of X is C<sub>3</sub>H<sub>7</sub>O<sub>2</sub>N.

(c) (i) 89

(The peak with the highest value of m/e represents the signal generated by molecular ion.)

$$H_{3}C - C - COOH^{+}$$

X<sub>2</sub>:

$$H_{3}C - C^{+}$$

$$I$$

$$NH_{2}$$