Chapter test with answers

Chapter 4 Volumetric analysis

Time permitted: 50 minutes

	Section	Number of questions	Marks available	Marks achieved
A	Multiple choice	15	15	
B	Short answer	5	15	
	Total	**20**	**30**	

Scale:

A+	29–30	**A**	26–28	**B**	23–25	**C**	19–22	**D**	15–18	**E**	9–14	**UG**	0–8

Section A Multiple choice (15 marks)

Section A consists of 15 questions, each worth one mark. Each question has only one correct answer. Circle the correct answer. Attempt all questions. Marks will not be deducted for incorrect answers. You are advised to spend no more than 15 minutes on this section.

1 A 50 mL 0.2 mol L^{-1} solution of NaOH is diluted to 500 mL with water. What is the final concentration of the NaOH?

A 0.01 mol L^{-1}

B *0.02 mol L^{-1}*

C 0.1 mol L^{-1}

D 0.2 mol L^{-1}

2 A sample of oxalic acid is pipetted into a small conical flask and titrated with NaOH solution from a burette. Which of the following lists the correct rinsing procedure?

A Rinse the pipette and flask with oxalic acid solution and the burette with NaOH.

B Rinse pipette and flask with oxalic solution and the burette with distilled water.

C Rinse the pipette and flask with distilled water and the burette with NaOH.

D *Rinse the pipette with oxalic acid, the flask with distilled water and the burette with NaOH.*

3 What is a standard solution?

A A solution whose concentration is to be determined

B A solution made from a standard compound

C A solution of an unknown substance

D *A solution whose concentration is accurately known*

4 A primary standard is:

A *a solution whose concentration is accurately known.*

B a solid suitable for making a standard solution.

C a compound with a large molecular mass.

D a simple substance.

5 An indicator:

A determines an equivalence point.

B approximates an endpoint.

C *changes colour at the endpoint.*

D changes colour at various pH values.

6 Which of the following is not a unit of concentration?

A mol L^{-1}

B *g mol^{-1}*

C g L^{-1}

D ppm

7 When titrating:

A rinse all glassware with distilled water.

B rinse only the burette with distilled water.

C rinse the pipette and titre flasks with distilled water.

D *rinse the pipette with solution being used in it.*

8 What volume should be used in calculations from these results?

Initial reading (mL)	0.45	16.00	31.40	1.40
Final reading (mL)	16.00	31.40	46.75	16.80

A 15.43

B *15.38*

C 15.40

D 15.39

9 Acid–base titrations are always used for determining concentrations with:

A strong acids/strong bases and weak acid/weak base solutions.

B *strong acid/weak base and weak acid/strong base solutions.*

C strong acids/weak base solutions only.

D strong acid/strong base solutions only.

10 Equivalence point and endpoint:

A *are determined by stoichiometry and indicators respectively.*

B are the same thing.

C change depending on indicator used.

D are never the same.

11 A good primary standard:

A must be a solution.

B must have a low molecular mass.

C *must be obtainable as a pure solid substance.*

D must be insoluble.

12 A weak base:

A only partially dissociates to release OH^- ions

B only accepts a few protons

C *only partially dissociates to produce a low percentage of OH^- ions*

D is not very soluble in water.

13 Parallax error:

A *never occurs if reading volume at eye level.*

B occurs at all times unless you wear glasses.

C occurs when reading volumes at an angle.

D only occurs with solutions that have a meniscus.

14 To make up a standard solution:

A make the solution up to the mark in a measuring cylinder.

B make the solution up to the mark in a burette.

C *make the solution up to the mark in a volumetric flask.*

D make the solution up to the mark in a beaker.

15 A successful titration will have three concordant results, which means:

A *the concentration of the solution varies within 0.1 mol L^{-1}*.

B the volume of the titres agree to 0.1 mL of each other.

C the average of the titres agree within 0.01 mL each time it is calculated.

D the indicator changes colour at the same volume each time.

Section B Short answer (15 marks)

Section B consists of five questions. Write your answers in the spaces provided. You are advised to spend 20 minutes on this section.

1 a Explain the difference between endpoint and equivalence point in titrations.

Answer: Endpoint is determined by colour change of an indicator. Equivalence point is when an acid is completely neutralised by an acid.

(2 marks)

b Name a suitable indicator for a strong acid strong base titration.

Answer: Any of methyl orange, methyl red, bromothymol blue or phenolphthalein (1 mark)

(= 3 marks total)

2 Name three requirements for a primary standard.

Answer: Any three of:

Easy to purify, able to be stored dry

Does not easily absorb moisture in the air

Have a relative high molecular mass to minimise weighing errors

Soluble in water

(= 3 marks total)

3 **a** You need 64 mL of 0.5 mol L^{-1} NaOH to neutralise 123 mL of an HCl solution. Calculate the concentration of the acid.

$$C_1V_1 = C_2V_2$$

$$C_2 = \frac{C_1V_1}{V_2}$$

$$C_2 = \frac{0.5 \times 64}{123}$$

Answer: $C_2 = 0.26 \text{ mol L}^{-1}$ (1 mark)

b It takes 55 mL of 0.1 mol L^{-1} KOH to neutralise 245 mL HNO_3. Determine the nitric acid concentration.

Answer:

$$C_1V_1 = C_2V_2$$

$$C_2 = \frac{C_1V_1}{V_2}$$

$$C_2 = \frac{55 \times 0.1}{245}$$

$$C_2 = 0.222 \text{ mol L}^{-1}$$

(1 mark)

c A 222 mL solution of H_2SO_4 is neutralised by77 mL of 0.2 mol L^{-1} of NaOH. What is the concentration of the sulfuric acid?

Answer:

$$2C_1V_1 = C_2V_2$$
$$C_2 = \frac{2C_1V_1}{V_2}$$
$$C_2 = \frac{2 \times 77 \times 0.2}{222}$$
$$C_2 = 0.14 \text{ mol L}^{-1}$$

(1 mark)

(= 3 marks total)

4 **a** Explain why phenolphthalein can be used as an indicator for both a weak acid and a strong acid being titrated against a strong base, while methyl red could be used for the strong acid/strong base but not for the weak acid/strong base?

Answer: Phenolphthalein changes colour over a pH range of 8.2–10. Methyl red's pH range is 4.8–6.0. Strong acid/strong base slope is very steep and changes quickly over a wide pH range from 3–11; both indicators will change colour here. (2 marks)

b Which indicator would you use for the titration of KOH with CH_3COOH? Explain.

Answer: Weak acid/strong base pH ranges from 6–12; only phenolphthalein will change colour here. (1 mark)

(= 3 marks total)

5 A titration was done to standardise a solution of approximately 0.1 mol L^{-1} NaOH, using oxalic acid. 0.18 g of oxalic acid was completely dissolved in 20 mL of distilled water and titrated with the base. Using the results below, determine the concentration of the base.

Molar mass of oxalic acid, HOOCCOOH, is 126 g mol^{-1}

$$2NaOH + HOOCCOOH \rightarrow NaOOCCOONa + 2H_2O$$

Initial reading (mL)	0.00	0.10	0.10	0.10
Final reading (mL)	22.00	20.10	20.20	20.00
	22.00	20.00	20.10	19.90

Answer: Closest 3 titres and averaged gives a 20.00 mL reading.

$$n(\text{oxalic acid}) = \frac{m}{M}$$
$$= \frac{0.18}{126}$$
$$n = 1.43 \times 10^{-3} \text{ mol}$$

This amount reacts with the 20.00 mL of NaOH. From the balanced equation above we know that for every mol of oxalic acid, 2 mol of NaOH react therefore there must be 2 × 1.43 × 10^{-3} mol of NaOH.

$$[\text{NaOH}] = \frac{2.86 \times 10^{-3} \text{ mol}}{20 \times 10^{-3} \text{ L}}$$
$$= 0.14 \text{ mol L}^{-1}$$

(=3 marks total)