CHEMISTRY

Unit 16

LAB SAFETY & PRACTICAL SKILLS

MCQs • Short Questions • Long Questions

Complete Study Booklet with Answer Keys

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Section 1 | Multiple Choice Questions

Tick the correct option. Correct answers are highlighted in green with a check mark.

1. While taking a reading with a burette, why it is always advisable to read the lower meniscus for the colorless liquids and the upper meniscus for the coloured liquids?

(a) Because it is more convenient
(b) Because colorless liquids have more surface tension than colored liquids
(c) Because lower meniscus does not exist for colored liquids
✓ (d) Because of the parallax effect

2. Why phenolphthalein indicator is more appropriate to use during the titrations which involve a strong acid and a strong base?

(a) Because it is itself weakly acidic
✓ (b) Because the pH at the equivalence point as well as the pH over where the colour of phenolphthalein changes match each other
(c) Because the solution at the end of titration is acidic
(d) Because the solution at the end of titration is basic

3. Which cation gives a white gelatinous precipitate upon the addition of aqueous ammonia?

✓ (a) Cr^{3+}
(b) Cr^{2+}
(c) Zn^{2+}
(d) Al^{3+}

4. Addition of NH_4OH to an aqueous solution of cation gives a green precipitate which turns brown upon standing. Which basic radical is indicated?

(a) Cu^{2+}
(b) Cr^{3+}
✓ (c) Fe^{2+}
(d) Fe^{3+}

5. On dry heating test for salt analysis, the evolution of colorless, odourless gas that turns limewater milky suggests the presence of:

(a) Chloride ion (Cl^-)
(b) Sulfate ion (SO_4^{2-})
✓ (c) Carbonate ion (CO_3^{2-})
(d) Nitrate ion (NO_3^-)

6. The chromyl chloride test is a specific confirmatory test for:

(a) Bromide ions (Br^-)
(b) Iodide ions (I^-)
✓ (c) Chloride ions (Cl^-)
(d) Sulfate ions (SO_4^{2-})

7. The brown ring test is a confirmatory test for which acid radical?

(a) Chloride (Cl^-)
✓ (b) Nitrate (NO_3^-)
(c) Sulfate (SO_4^{2-})
(d) Carbonate (CO_3^{2-})

8. Which of the following is not a component of titration?

(a) Pipette

(b) Burette
✓ **(c) Test tube**
(d) Conical flask

9. Which of the following is the most suitable indicator for the titration of a strong acid and a strong base?

✓ **(a) Phenolphthalein**
(b) Methyl orange
(c) Universal indicator
(d) Litmus

10. Why is it important to use a pipette in titration?

(a) To hold the acid
✓ **(b) To measure a fixed volume of the solution accurately**
(c) To detect the end point
(d) To mix the acid and alkali

11. A white precipitate that dissolves in excess ammonia is likely to be:

✓ **(a) Zinc hydroxide**
(b) Calcium carbonate
(c) Lead (II) iodide
(d) Barium sulphate

12. Which of the following is a primary standard solution?

(a) NaOH
✓ **(b) Na2CO3**
(c) KOH
(d) HCl

13. Which apparatus is used to deliver a variable volume of solution in titration?

✓ **(a) Burette**
(b) Pipette
(c) Beaker
(d) Measuring cylinder

14. The end point of a titration is indicated by:

(a) Formation of a gas
(b) Change in temperature
✓ **(c) Colour change of the indicator**
(d) Change in pressure

15. What is the typical volume of solution a pipette delivers in titration?

(a) 10 mL
✓ **(b) 25 mL**
(c) 50 mL
(d) 100 mL

16. Before starting a titration, the burette should be:

(a) Heated
(b) Dried completely
(c) Washed with distilled water only
✓ **(d) Rinsed with the solution it will contain**

17. Which of the following pairs would require methyl orange as an indicator?

(a) Strong acid and strong base

(b) Weak acid and strong base
✓ **(c) Strong acid and weak base**
(d) Weak acid and weak base

18. A gas with a pungent smell turns moist red litmus paper blue. The gas is likely:
(a) HCl
✓ **(b) NH3**
(c) CO2
(d) SO2

19. Which cation forms a white precipitate with NaOH that dissolves in excess NaOH?
(a) Mg2+
✓ **(b) Zn2+**
(c) Ca2+
(d) Ba2+

20. A salt solution gives a brick-red flame test. The cation present is likely:
(a) Na+
(b) K+
✓ **(c) Ca2+**
(d) Sr2+

21. The addition of HCl to a carbonate salt leads to:
✓ **(a) Effervescence**
(b) Blue colour formation
(c) White precipitate
(d) No visible reaction

22. Which reagent is used to test for chloride ions?
(a) Barium chloride
✓ **(b) Silver nitrate**
(c) Sodium hydroxide
(d) Lead nitrate

23. In case of a chemical spill on the skin, the first step is to:
(a) Wipe it with tissue
(b) Apply alcohol
✓ **(c) Wash with plenty of water**
(d) Ignore it

24. Which is the proper way to smell a chemical?
(a) Inhale deeply
(b) Sniff directly
✓ **(c) Waft the vapour toward your nose**
(d) Open the bottle under your nose

25. Lab coats are important because they:
(a) Are fashionable
(b) Make you feel like a scientist
✓ **(c) Prevent contamination and protect clothing**
(d) Keep you warm

26. A student forgets to label a beaker with an unknown liquid. What should they do?
(a) Taste it to identify
(b) Pour it down the sink

✓ **(c) Ask the teacher for advice**

(d) Ignore it

27. Eating and drinking in the lab is:

(a) Allowed during breaks

(b) Allowed if you're careful

(c) Allowed in the chemistry lab but not physics

✓ **(d) Strictly prohibited**

Section 2 | Short Questions

Q9. What precautions must you observe while diluting a concentrated acid?

Always add acid to water slowly, never the reverse, while stirring continuously - this prevents violent splashing due to the exothermic nature of dilution.

Q10. Why does an aqueous solution of Na_2CO_3 behave like a base?

The carbonate ion (CO_3^{2-}) hydrolyzes in water to form OH^- ions, making the solution basic: $CO_3^{2-} + H_2O \rightarrow HCO_3^- + OH^-$

Q11. If an aqueous solution of NaOH is kept in an open container, what changes occur over time?

NaOH absorbs carbon dioxide (CO_2) from air, forming sodium carbonate (Na_2CO_3), reducing the concentration of hydroxide ions over time: $2NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$

Q12. What is titration?

A volumetric analysis technique used to determine the concentration of a solution by reacting it with a standard solution of known concentration until the reaction reaches completion.

Q13. What is the role of an indicator in titration?

An indicator is a substance that shows the completion of a reaction by changing its colour.

Q14. Name the indicator used in acid-base titration.

Phenolphthalein.

Q15. Why is the funnel removed after filling the burette?

To prevent any extra drops of solution from entering the burette, which could affect the accuracy of the initial reading.

Q16. Why is a white paper placed under the conical flask during titration?

To clearly observe the colour change of the indicator.

Q17. Which solution is taken in the burette and which in the conical flask?

HCl solution is taken in the burette and NaOH solution in the conical flask.

Q18. What precautions must be taken during an acid-base titration to ensure accurate results?

Use clean, rinsed apparatus with the appropriate solution; ensure no air bubbles in the burette nozzle; remove the funnel before starting; add the titrant slowly near the endpoint; swirl the flask continuously; read the burette at eye level using an anti-parallax card; repeat to get concordant readings.

Q19. What is a chemistry laboratory?

A chemist's workshop where students learn to observe the physical and chemical properties of substances by following definite procedures.

Q20. How is the chromium radical (Cr^{3+}) test identified?

Dissolve a sample in distilled water, split into two parts, and test.

Reaction: $Cr^{3+}(aq) + 3OH^-(aq) \rightarrow Cr(OH)_3(s)$ (green precipitate).

Q21. Discuss identification of the ammonium (NH_4^+) radical.

Reaction: $NH_4^+(aq) + OH^-(aq) \rightarrow NH_3(g) + H_2O(l)$. Ammonia gas is evolved with a distinct smell and turns moist red litmus blue.

Q22. How is the calcium (Ca^{2+}) radical test performed?

Dissolve a solid sample in distilled water, split into two parts, and test.

Reaction: $Ca^{2+}(aq) + 2OH^-(aq) \rightarrow Ca(OH)_2(s)$ (white precipitate).

Section 3 | Descriptive Questions

Q3 (Descriptive). Describe common types of chemistry lab hazards, with two examples of each.

Physical hazards: slips/falls (wet floors, tripping over equipment), handling broken glassware (cuts, abrasions).

Chemical hazards: exposure to toxic/corrosive/flammable substances, chemical spills (acid/base spills, solvent leaks).

Biological hazards: infectious/zoonotic diseases from animals, allergens causing allergic reactions to biological materials.

Q4 (Descriptive). What are common accidents in the chemistry lab, and how are they managed with first aid?

Cuts: minor cuts - apply methylated spirit or tincture iodine as disinfectant; serious cuts - apply pressure for 10 minutes and consult a doctor.

Eye injuries: acid in the eye - wash with water then 1% sodium bicarbonate; alkali in the eye - wash with water then 1% boric acid; foreign particle - do not rub, remove carefully then wash; soreness - put a drop of olive oil and keep eyes closed.

Burns: dry heat - apply burnol/mustard oil; acid burns - wash with ice-cold water then sodium bicarbonate; alkali burns - wash with water then 1% acetic acid then burnol; phenol burns - wash with 2% ammonia solution and apply glycerine.

Q5 (Descriptive). How are the following acid radicals indicated and confirmed in salt analysis: (i) CO_3^{2-} (ii) Cl^- (iii) NO_3^- (iv) SO_4^{2-}?

CO_3^{2-}: dilute HCl gives effervescence, and the gas turns limewater milky.

Cl^-: $AgNO_3$ + dilute HNO_3 gives a white precipitate (AgCl); Br^- gives cream-yellow (AgBr); I^- gives bright yellow (AgI).

NO_3^-: NaOH + aluminium metal releases NH_3 gas with a pungent smell that turns red litmus blue.

SO_4^{2-}: $Ba(NO_3)_2$ + dilute HNO_3 gives a heavy white precipitate of $BaSO_4$.

Q6 (Descriptive). How are the following basic radicals indicated and confirmed in salt analysis: (i) Cu^{2+} (ii) Al^{3+} (iii) Fe^{3+} (iv) Zn^{2+}?

Cu^{2+}: NaOH gives a light-blue precipitate; aqueous ammonia gives a deep blue solution.

Fe^{3+}: NaOH or aqueous ammonia gives an orange-brown precipitate of $Fe(OH)_3$.

Zn^{2+}: NaOH gives a white precipitate that is soluble in excess NaOH; aqueous ammonia gives a white precipitate that dissolves in excess ammonia.

(Al^{3+} testing follows a similar pattern to Cr^{3+}/Zn^{2+} - a white gelatinous precipitate with NaOH/ammonia, soluble in excess of either reagent.)

Section 4 | Long Questions

Q1. Explain the instructions a student should follow when working in a chemical laboratory.

Working in a Chemical Laboratory

A chemistry laboratory is a chemist's workshop - a place where students are trained to observe the physical and chemical characteristics of substances. Students should familiarize themselves with the laboratory layout and the fittings on the lab table and side shelves.

General Instructions to Students

Conduct yourself responsibly at all times in the lab; never work alone - experiments should be performed in the presence of a lab instructor or staff.

Always wear a lab coat and safety goggles; girls must tie up scarves and hair before starting work.

Determine potential hazards related to any equipment or experiment before starting, and observe appropriate safety precautions.

Avoid crowding in the lab; stick to your workspace at a safe distance from others.

Never bring food into the lab, and never taste or smell any compound or gas.

Report any accident or broken glassware to the lab in-charge immediately.

Seek help from the instructor if you cannot handle equipment properly.

Never pour chemicals down drains or use the sewer for chemical waste disposal.

Always follow the warning signs displayed in the lab.

Q2. Describe common types of chemistry lab hazards, with two examples for each.

Types of Laboratory Hazards

Laboratory hazards are generally divided into three main categories: physical, chemical, and biological.

(i) Physical Hazards

Examples: slips/falls (wet floors, tripping over equipment), and injuries from handling broken glassware (cuts, abrasions).

Precautions: take care to prevent slipping/tripping/falling; wear cut-resistant gloves when handling broken glass; dispose of broken glassware in a designated container.

(ii) Chemical Hazards

Examples: exposure to toxic, corrosive, or flammable substances; chemical spills (acid/base spills, solvent leaks).

Precautions: always use chemicals according to standard procedures; be aware of each chemical's hazards and required safety precautions; follow proper handling and storage procedures.

(iii) Biological Hazards

Examples: infectious/zoonotic diseases transmitted from animals, plants, water, or air; allergens causing allergic reactions to biological materials.

Precautions: follow proper safety measures to prevent the spread of these diseases.

Q3. Explain how chemicals are disposed of by the waste disposal system.

Waste Disposal System for Chemicals

Chemical waste cannot be disposed of in ordinary bins or the sewer system. Most chemical wastes must be disposed of according to the rules and regulations of the Environmental Protection Agency (EPA):

Store chemical wastes in proper containers; label the containers with the type of waste, date, and place of origin; these containers are then transferred to an allocated site for appropriate treatment.

Chemical Treatment of Wastes

Involves: neutralization, precipitation, ion exchange, and oxidation or reduction.

Q4. What are common accidents in the chemistry lab, and how are they managed with first aid?

First Aid in the Laboratory

Every laboratory must have a first aid box.

Cuts

Minor cuts: remove any glass fragment, apply methylated spirit or tincture of iodine with cotton (both act as disinfectants).

Serious cuts: apply pressure on the cut for about 10 minutes to stop bleeding, then consult a doctor.

Eye Injuries

Acid in the eye: wash thoroughly with water, then with 1% sodium bicarbonate solution.

Alkali in the eye: wash with water, followed by 1% boric acid solution.

Foreign particle in the eye: do not rub the eye; carefully remove the particle with a soft handkerchief, then wash with water.

Soreness in the eye: put a drop of olive oil in the eye and keep it closed for some time.

Burns

Dry heat (flame/hot object): apply burnol or mustard oil.

Acid burns: wash with ice-cold water, then sodium bicarbonate solution.

Alkali burns: wash with water, then 1% acetic acid, then apply burnol.

Phenol burns: wash with 2% ammonia solution, then apply glycerine.

Quick Check 16.1

Types of burns: thermal burns (heat or fire), chemical burns (acids or bases), and electrical burns (electric shock).

Q5. Describe the complete procedure of an acid-base titration between NaOH and HCl using phenolphthalein.

Acid-Base Titration

Volumetric analysis finds the concentration of solutions using titration - a solution of unknown concentration is combined slowly and carefully with a known volume of a standard solution until a colour change shows the reaction is complete.

Key terms: Indicator - the substance that shows completion of the reaction by a colour change. End point - the moment the indicator changes colour.

How Phenolphthalein Works

Prepared by dissolving 1 g of indicator in 500 cm3 of 50% ethanol; use only 1-2 drops per 10 cm3 of solution being titrated. Colour changes from pink to colourless as pH decreases. The light pink endpoint colour tends to fade gradually due to atmospheric CO2 dissolving in the solution.

Materials Required

Burette, pipette, funnel, conical flask, HCl solution, NaOH solution, and phenolphthalein indicator.

Procedure

Step 1: rinse the pipette with distilled water and NaOH solution.

Step 2: rinse the conical flask with distilled water.

Step 3: pipette 10 cm3 of NaOH into the conical flask, add 1-2 drops of phenolphthalein - the solution turns pink.

Step 4: rinse the burette with distilled water then HCl solution.

Step 5: fill the burette with HCl using a funnel, then remove the funnel.

Step 6: release some acid to remove air bubbles and note the initial burette reading.

Step 7: place the flask on white paper under the burette, and perform a rough titration by adding acid dropwise while swirling the flask.

Step 8: when the pink colour just disappears (solution becomes colourless), note the final reading.

Step 9: repeat the titration to get concordant readings, agreeing within 0.1 cm3 of each other.

Chemical Equation and Calculation

NaOH(aq) + HCl(aq) -> NaCl(aq) + H2O(l), so n1 = n2 = 1.

Molarity equation: M1V1/n1 = M2V2/n2, where M1/V1/n1 relate to the acid and M2/V2/n2 to the base.

Rearranged: M2 = (M1V1/n1) x (n2/V2), giving the molarity of the unknown base solution.

Quick Check 16.2

Indicator: a chemical that changes colour at a specific pH, showing when a titration reaction is near completion. Endpoint: the stage when the indicator changes colour, signalling the reaction is complete.

Concordant readings: repeated titration results agreeing within about 0.1 cm3.

Volume of titrant used = final burette reading minus initial burette reading.

Q6. How are acid radicals indicated and confirmed in salt analysis?

(i) Carbonate (CO_3^{2-}) Radical

$CO_3^{2-}(aq) + 2H^+(aq) \rightarrow H_2O(l) + CO_2(g)$; $Ca(OH)_2(aq) + CO_2(g) \rightarrow CaCO_3(s) + H_2O(l)$ (limewater turns milky).

Test: add dilute HCl to the solid sample - effervescence occurs, and passing the gas through limewater turns it milky.

(ii) Chloride, Bromide, and Iodide Radicals

$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$ (white precipitate); $Ag^+(aq) + Br^-(aq) \rightarrow AgBr(s)$ (cream-yellow precipitate); $Ag^+(aq) + I^-(aq) \rightarrow AgI(s)$ (bright yellow precipitate).

Dilute HNO_3 is added before $AgNO_3$ to prevent carbonate ions from also precipitating and interfering with the halide test.

(iii) Nitrate (NO_3^-) Radical

Aluminium metal reduces nitrate ions to ammonium ions, which then react with aqueous NaOH to evolve ammonia gas:

$3NO_3^-(aq) + 8Al(s) + 5OH^-(aq) + 18H_2O(l) \rightarrow 3NH_3(aq) + 8[Al(OH)_4]^-(aq)$

Test: add NaOH and powdered aluminium to the sample - the characteristic pungent smell of NH_3 is detected, and it turns moist red litmus paper blue.

(iv) Sulphate (SO_4^{2-}) Radical

$SO_4^{2-}(aq) + Ba^{2+}(aq) \rightarrow BaSO_4(s)$ (white precipitate).

Dilute HNO_3 is added to destroy any carbonate ions present as impurities before testing with barium nitrate solution.

Q7. How are basic radicals indicated and confirmed in salt analysis?

(i) Ammonium (NH_4^+) Radical

$NH_4^+(aq) + OH^-(aq) \rightarrow NH_3(g) + H_2O(l)$. Test: add NaOH and heat gently - ammonia gas with a distinct smell is evolved, turning moist red litmus paper blue.

(ii) Calcium (Ca^{2+}) Radical

$Ca^{2+}(aq) + 2OH^-(aq) \rightarrow Ca(OH)_2(s)$ (white precipitate). Test: NaOH gives a white precipitate insoluble in excess; aqueous ammonia gives only slight turbidity or no precipitate.

(iii) Chromium (Cr^{3+}) Radical

$Cr^{3+}(aq) + 3OH^-(aq) \rightarrow Cr(OH)_3(s)$ (green precipitate). Test: NaOH gives a green precipitate that dissolves in excess NaOH; aqueous ammonia gives a green precipitate insoluble in excess ammonia.

(iv) Copper (Cu^{2+}) Radical

$Cu^{2+}(aq) + 2OH^-(aq) \rightarrow Cu(OH)_2(s)$ (blue precipitate). Test: NaOH gives a light-blue precipitate; aqueous ammonia gives a deep blue solution.

(v) Ferrous (Fe^{2+}) Radical

$Fe^{2+}(aq) + 2OH^-(aq) \rightarrow Fe(OH)_2(s)$ (green precipitate). Test: NaOH gives a green precipitate that turns orange-brown on standing; aqueous ammonia gives a white gelatinous $Fe(OH)_2$ precipitate that quickly oxidizes to red-brown $Fe(OH)_3$.

(vi) Ferric (Fe^{3+}) Radical

$Fe^{3+}(aq) + 3OH^-(aq) \rightarrow Fe(OH)_3(s)$ (orange-brown precipitate). Test: both NaOH and aqueous ammonia give an orange-brown precipitate.

(vii) Zinc (Zn^{2+}) Radical

$Zn^{2+}(aq) + 2OH^-(aq) \rightarrow Zn(OH)_2(s)$ (white precipitate). Test: NaOH gives a white precipitate soluble in excess NaOH; aqueous ammonia gives a white precipitate that dissolves in excess ammonia.

Section 5 | Answer Key & Formula Summary

MCQ Answer Key (Q1-Q27)

Q.No	Ans	Q.No	Ans	Q.No	Ans	Q.No	Ans
1	D	8	C	15	B	22	B
2	B	9	A	16	D	23	C
3	A	10	B	17	C	24	C
4	C	11	A	18	B	25	C
5	C	12	B	19	B	26	C
6	C	13	A	20	C	27	D
7	B	14	C	21	A		

Important Formulas

Formula	Description
$M_1V_1/n_1 = M_2V_2/n_2$	Titration molarity equation (acid-base)
$NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$	Acid-base neutralization (titration reaction)
$CO_3^{2-}(aq) + 2H^+(aq) \rightarrow H_2O(l) + CO_2(g)$	Carbonate radical test reaction
$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$	Chloride test (white precipitate)
$Ag^+(aq) + Br^-(aq) \rightarrow AgBr(s)$	Bromide test (cream-yellow precipitate)
$Ag^+(aq) + I^-(aq) \rightarrow AgI(s)$	Iodide test (bright yellow precipitate)
$SO_4^{2-}(aq) + Ba^{2+}(aq) \rightarrow BaSO_4(s)$	Sulfate test (white precipitate)
$NH_4^+(aq) + OH^-(aq) \rightarrow NH_3(g) + H_2O(l)$	Ammonium radical test

Key Constants & Notes

Constant/Note	Value
Typical pipette volume in titration	25 mL
Concordant reading agreement tolerance	within 0.1 cm^3
Phenolphthalein preparation	1 g indicator in 500 cm^3 of 50% ethanol
Phenolphthalein colour change	pink (base) to colorless (acid)
Eye wash for acid	water, then 1% sodium bicarbonate solution
Eye wash for alkali	water, then 1% boric acid solution
Reagent for HNO_3 addition in halide test	prevents/destroys interfering carbonate precipitation

Acid Radical Identification Summary

Radical	Test Reagent	Observation

CO_3^{2-}	Dilute HCl	Gas turns limewater milky
Cl^-	$AgNO_3$ + dilute HNO_3	White precipitate
Br^-	$AgNO_3$ + dilute HNO_3	Cream-yellow precipitate
I^-	$AgNO_3$ + dilute HNO_3	Bright yellow precipitate
NO_3^-	NaOH + Al metal	NH_3 gas (pungent smell)
SO_4^{2-}	$Ba(NO_3)_2$ + dilute HNO_3	White precipitate ($BaSO_4$)

Basic Radical Identification Summary

Radical	Test Reagent	Observation
NH_4^+	NaOH + heat	NH_3 gas (pungent, turns red litmus blue)
Ca^{2+}	NaOH	White precipitate (insoluble in excess)
Cr^{3+}	NaOH	Green precipitate (soluble in excess)
Cu^{2+}	NaOH	Light-blue precipitate
Fe^{2+}	NaOH	Green precipitate (turns orange-brown)
Fe^{3+}	NaOH	Orange-brown precipitate
Zn^{2+}	NaOH	White precipitate (soluble in excess)

First Aid for Burns

Type of Burn	First Aid Treatment
Dry heat (flame/hot object)	Apply burnol or mustard oil
Acid burns	Wash with ice-cold water, then sodium bicarbonate solution
Alkali burns	Wash with water, then 1% acetic acid, then burnol
Phenol burns	Wash with 2% ammonia solution, apply glycerine

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