



CHEM · CHEMISTRY

15. Alkyl Halides

Official PMDC Solved Past Paper Topical Booklet · High-Yield Examination Series

🕒 13 Solved Questions

📅 2023 to 2024 Archive

📋 Boards: BUMHS, DUHS, KMU, SZABMU, UHS

📄 Weightage: 27% of MDCAT (54 MCQs)

Curated by Ibrahim for fellow bees. Every question in this chapter has been verified against official UHS, NUMS, SZABMU, DUHS, and KMU answer keys. Propolis cognitive autopsies are provided at the end of this booklet to explain core concepts and break down common distractor traps.

OFFICIAL SOLVED EDITION**Q1.**

UHS 2024

Identify correct ascending order of reactivity of alkyl halides: [UHS (2024)]

- (A) Cl, Br, I, F
- (B) Br, I, F, Cl
- (C) F, Cl, Br, I
- (D) I, F, Cl, Br

Q2.

UHS 2024

Identify the correct statement related to substitution and elimination of alkyl halides: [UHS (2024)]

- (A) Strong bases cause substitution in preference to elimination
- (B) Role of leaving groups in elimination is similar to substitution
- (C) Substitution is favoured more than elimination by decreasing solvent polarity
- (D) Decrease in temperature will favor elimination more than substitution

Q3.

UHS 2024

Alkyl halides involving -C-X bond breakage and -C-Nu bond formation simultaneously would follow which one of the following mechanisms: [UHS (2024)]

- (A) S_N1
- (B) E_1
- (C) S_N2
- (D) E_2

Q4.

SZABMU 2024

When CO_2 reacts with propyl magnesium chloride followed by acid hydrolysis, the product formed is ____ [SZABMU (2024)]

- (A) Butanoic acid
- (B) Pentanoic acid
- (C) Ethanoic acid
- (D) Propanoic acid

Q5.

SZABMU 2024

Unimolecular nucleophilic substitution reaction involves _____. [SZABMU (2024)]

- (A) 1st order kinetics
- (B) 3rd order kinetics
- (C) 2nd order kinetics
- (D) zero order kinetics

Q6.

KMU 2024

Dehydrohalogenation of alkyl halide is carried out in presence of: [ETEA (2024)]

- (A) Alcoholic KOH
- (B) Conc. H_2SO_4
- (C) Aqueous KOH
- (D) Zn dust

Q7.

DUHS 2024

The rate of S_N1 mechanism depends upon: **[SINDH (2024)]**

- (A) Concentration of nucleophile
- (B) Concentration of both substrate and nucleophile
- (C) Polar non-polar solvent
- (D) Concentration of substrate only

Q8.

BUMHS 2024

The procedure for the preparation of ethers in which an alcohol is first allowed to react with metallic sodium is called: **[BUMHS (2024)]**

- (A) Tollen's synthesis
- (B) Fehling's synthesis
- (C) Williamson's synthesis
- (D) Grignard's synthesis

Q9.

BUMHS 2024

Having knowledge of the bond energies of alkyl halides; the most reactive one is the: **[BUMHS (2024)]**

- (A) Iodo-compound
- (B) Bromo-compound
- (C) Chloro-compound
- (D) Fluoro-compound

Q10.

BUMHS 2024

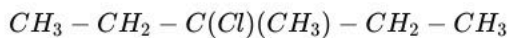
In organic chemistry, a nucleus liking agent, rich in electrons, is defined as: **[BUMHS (2024)]**

- (A) A nucleotide
- (B) A nucleophile
- (C) An electrophile
- (D) Electron affluent

Q11.

BUMHS 2024

Alkyl halides IUPAC name of the following compound is: **[BUMHS (2024)]**



- (A) Hexylchloride
- (B) 3-Chloromethylhexane
- (C) 3-Chloro-3-ethylbutane
- (D) 3-Chloro-3-methylpentane

Q12.

BUMHS 2024

Alkyl halides can yield ethers when heated in the presence of the metallic compound: **[BUMHS (2024)]**

- (A) Ag_2O
- (B) CuO
- (C) Cu_2O_2
- (D) Fe_2O_3

Q13.

BUMHS 2023

Which of the following statement is true about Grignard reagent ($RMgX$)? **[BUMHS (2023)]**

- (A) $RMgX$ is prepared in aqueous medium
- (B) $RMgX$ is prepared in ether
- (C) $RMgX$ does not react with water
- (D) $RMgX$ inactive in ethanol

RAPID 5-COLUMN ANSWER KEY

Official PMDC verified answer keys for 15. Alkyl Halides.

beambeprep.com

Q#	KEY	BOARD	Q#	KEY	BOARD	Q#	KEY	BOARD	Q#	KEY	BOARD	Q#	KEY	BOARD
1	C	UHS 2024	4	A	SZABMU 2024	7	D	DUHS 2024	10	B	BUMHS 2024	13	B	BUMHS 2023
2	B	UHS 2024	5	A	SZABMU 2024	8	C	BUMHS 2024	11	D	BUMHS 2024			
3	C	UHS 2024	6	A	KMU 2024	9	A	BUMHS 2024	12	A	BUMHS 2024			

TOTAL
MCQS
13

CORRECT

INCORRECT

BLANK

ACCURACY

%

Scan the booklet QR code to enter answers in
BeambePrep Grind Mode for automated error
autopsies.

PROPOLIS COGNITIVE ERROR AUTOPSIES

Step-by-step conceptual derivations, formula working, and distractor autopsies for every question.

Question #1 Key: (C)

UHS 2024

Identify correct ascending order of reactivity of alkyl halides: [UHS (2024)]

CORE CONCEPT AND DERIVATION

The reactivity of an alkyl halide primarily depends on the bond dissociation energy of the carbon-halogen (C-X) bond.

Solution:

- "Ascending order" means from least reactive to most reactive.
- Reactivity is inversely proportional to bond strength. A stronger bond is harder to break, making the molecule less reactive.
- As halogen size increases down Group 17, the C-X bond length increases, and the bond energy decreases.
- Bond Energy Order: $\text{C-F} > \text{C-Cl} > \text{C-Br} > \text{C-I}$.
- Therefore, the Reactivity Order is: $\text{R-F} < \text{R-Cl} < \text{R-Br} < \text{R-I}$.

Why other options are incorrect:

- **Options A, B, & D:** Do not correctly reflect the inverse relationship between atomic radius/bond length and bond dissociation energy.

Question #2 Key: (B)

UHS 2024

Identify the correct statement related to substitution and elimination of alkyl halides: [UHS (2024)]

CORE CONCEPT AND DERIVATION

Substitution and elimination are competing pathways that share fundamental kinetic requirements, such as the need for the leaving group to detach.

Solution:

- In both substitution (S_N1/S_N2) and elimination (E_1/E_2), the carbon-halogen bond must break, and the halide ion must depart with the electron pair.
- Therefore, a good leaving group (like I^-) accelerates both reaction types equally. The role and requirement of the leaving group are identical across both mechanisms.

Why other options are incorrect:

- **Option A:** Strong bases heavily favor elimination (by abstracting a proton) over substitution.
- **Option C:** Decreasing solvent polarity favors elimination (e.g., alcoholic KOH vs aqueous KOH).
- **Option D:** Elimination reactions have higher activation energies and are entropically favored (creating more product molecules), so an **increase** in temperature favors elimination, not a decrease.

Question #3 Key: (C)

UHS 2024

Alkyl halides involving C-X bond breakage and C-Nu bond formation simultaneously would follow which one of the following mechanisms?

CORE CONCEPT AND DERIVATION

A concerted mechanism occurs when all bond-breaking and bond-forming steps happen in a single coordinated motion without forming an intermediate.

Solution:

- The term "simultaneously" indicates a one-step reaction passing through a single transition state.
- Because it specifies the formation of a Carbon-Nucleophile (C-Nu) bond, this is a substitution reaction, not an elimination.
- The single-step, concerted substitution mechanism is S_N2 (Substitution Nucleophilic Bimolecular).

Why other options are incorrect:

- Option A:** S_N1 is step-wise (breakage first, formation second).
- Options B & D:** E_1 and E_2 are elimination reactions that form π bonds, not C-Nu substitution bonds.

Question #4 Key: (A)

SZABMU 2024

When [Formula] reacts with propyl magnesium chloride followed by acid hydrolysis, the product formed is ____ [...]

CORE CONCEPT AND DERIVATION

The reaction of a Grignard reagent with carbon dioxide (carboxylation) extends the carbon chain by exactly one carbon, forming a carboxylic acid.

Solution:

- The Grignard reagent is propyl magnesium chloride ($\text{CH}_3\text{CH}_2\text{CH}_2\text{MgCl}$), which contains a **3-carbon** chain.
- Carbon dioxide (CO_2) provides exactly **1 carbon** atom.
- The nucleophilic propyl group attacks the electrophilic carbon of CO_2 , forming a carboxylate salt.
- Acid hydrolysis protonates the salt: $\text{C}_3\text{H}_7 - \text{C}(=\text{O})\text{O}^- \xrightarrow{\text{H}^+} \text{C}_3\text{H}_7\text{COOH}$.
- The final product has $3 + 1 = 4$ carbons. A 4-carbon carboxylic acid is Butanoic acid.

Why other options are incorrect:

- Option D:** Propanoic acid would form if ethyl magnesium chloride (2 carbons) was used.
- Option B:** Pentanoic acid would require a butyl Grignard (4 carbons).

Question #5 Key: (A)

SZABMU 2024

Unimolecular nucleophilic substitution reaction involves _____. [SZABMU (2024)]

CORE CONCEPT AND DERIVATION

The molecularity of a reaction corresponds to the number of species involved in the rate-determining step.

Solution:

- "Unimolecular nucleophilic substitution" is the formal name for the S_N1 mechanism.
- In this mechanism, the rate-determining (slowest) step is the spontaneous ionization of the alkyl halide to form a carbocation.
- The nucleophile is not involved in this slow step.
- Because the rate depends strictly on the concentration of only one reactant (the alkyl halide), the reaction follows 1st order kinetics.

$$\text{Rate} = k[\text{Alkyl Halide}]^1$$

Why other options are incorrect:

- Option C:** 2nd order kinetics apply to bimolecular reactions (S_N2 and E_2), where both the substrate and nucleophile/base are in the rate equation.

Question #6 Key: (A)

KMU 2024

Dehydrohalogenation of alkyl halide is carried out in presence of: [ETEA (2024)]

CORE CONCEPT AND DERIVATION

Dehydrohalogenation is the elimination of a hydrogen atom and a halogen atom from an alkyl halide to form an alkene. This requires a strong base.

Solution:

- Potassium hydroxide dissolved in an alcohol (like ethanol) generates alkoxide ions (e.g., ethoxide, $\text{C}_2\text{H}_5\text{O}^-$).
- Alkoxide ions are extremely strong bases. Because they are not strongly hydrated by the alcoholic solvent, their basicity dominates over their nucleophilicity.
- They successfully abstract a β -hydrogen, triggering the elimination of the halogen to form a double bond.

Why other options are incorrect:

- Option B:** Concentrated sulfuric acid is a dehydrating agent used to remove water from alcohols, not hydrohalic acids from alkyl halides.
- Option C:** Aqueous KOH acts as a nucleophile, leading to substitution (forming an alcohol) instead of elimination.
- Option D:** Zinc dust is used for dehalogenation (removing two halogens from vicinal dihalides), not dehydrohalogenation.

Question #7 Key: (D)

DUHS 2024

The rate of [Formula] mechanism depends upon: [SINDH (2024)]

CORE CONCEPT AND DERIVATION

The kinetics of a multi-step reaction are determined solely by the slowest step in the sequence (the rate-determining step).

Solution:

- The S_N1 reaction occurs in two steps.
- The first step is the slow cleavage of the carbon-halogen bond to form a carbocation. The only molecule involved in this step is the alkyl halide (the substrate).
- Because the nucleophile only attacks in the fast second step, its concentration has zero effect on the overall speed of the reaction.
- Therefore, the rate law is: $\text{Rate} = k[\text{Substrate}]$. It depends on the concentration of the substrate only.

Why other options are incorrect:

- **Options A & B:** The nucleophile concentration dictates the rate of S_N2 reactions, not S_N1 .

Question #8 Key: (C)

BUMHS 2024

The procedure for the preparation of ethers in which an alcohol is first allowed to react with metallic sodium...

CORE CONCEPT AND DERIVATION

The standard laboratory method for creating asymmetrical or symmetrical ethers involves an S_N2 reaction between an alkoxide ion and an alkyl halide.

Solution:

- **Step 1:** An alcohol ($R-OH$) is reacted with an active metal like sodium (Na) to produce sodium alkoxide ($R-O^-Na^+$), releasing hydrogen gas.
- **Step 2:** This strong nucleophile (alkoxide) is then reacted with a primary alkyl halide ($R'-X$).
- The alkoxide attacks the alkyl halide, displacing the halogen to form an ether ($R-O-R'$).
- This two-step protocol was developed by Alexander Williamson and is universally known as the Williamson ether synthesis.

Why other options are incorrect:

- **Options A & B:** Tollen's and Fehling's reagents are used to test for the presence of aldehydes.
- **Option D:** Grignard synthesis uses magnesium to create organometallic reagents for carbon-carbon bond formation.

Question #9 Key: (A)

BUMHS 2024

Having knowledge of the bond energies of alkyl halides; the most reactive one is the: [BUMHS (2024)]

CORE CONCEPT AND DERIVATION

Chemical reactivity in haloalkanes requires breaking the carbon-halogen bond. A weaker bond requires less activation energy to break, resulting in a faster, more reactive molecule.

Solution:

- The size of the halogen atom increases down the periodic table: $F < Cl < Br < I$.
- As the atomic radius increases, the orbital overlap with the small carbon atom becomes much poorer, making the bond longer and weaker.
- The C-I bond has the lowest bond dissociation energy (weakest bond) among all alkyl halides.
- Because it breaks so easily, iodo-compounds are highly unstable and exceptionally reactive compared to the other halogens.

Why other options are incorrect:

- **Option D:** Fluoro-compounds have the shortest and strongest bonds, making them incredibly stable and generally unreactive under normal conditions.

Question #10 Key: (B)

BUMHS 2024

In organic chemistry, a nucleus liking agent, rich in electrons, is defined as: [BUMHS (2024)]

CORE CONCEPT AND DERIVATION

Chemical species are named based on the etymology of what they "seek" or "love" during a reaction.

Solution:

- The suffix "-phile" comes from the Greek *philos*, meaning "loving" or "seeking".
- A nucleus is positively charged.
- Therefore, a "nucleus-liking" or "nucleus-seeking" agent is called a **nucleophile**.
- Because opposites attract, a nucleophile must be rich in electrons (either an anion or possessing lone pairs) in order to be attracted to a positive nucleus.

Why other options are incorrect:

- **Option A:** A nucleotide is a biological building block of DNA/RNA, not a general reaction mechanism term.
- **Option C:** An electrophile is an "electron-liking" agent, meaning it is electron-deficient.
- **Option D:** "Electron affluent" is simply an English description, not a recognized chemical term.

Question #11 Key: (D)

BUMHS 2024

Alkyl halides IUPAC name of the following compound is: [BUMHS (2024)] [Formula]

CORE CONCEPT AND DERIVATION

IUPAC naming requires identifying the longest continuous carbon chain, numbering it to give the lowest locants to substituents, and listing substituents alphabetically.

Solution:

- **Step 1: Identify the longest chain.**
The longest continuous horizontal chain consists of 5 carbon atoms: $CH_3 - CH_2 - C - CH_2 - CH_3$. A 5-carbon chain is a **pentane**.
- **Step 2: Number the chain.**
Numbering from either the left or the right places the central carbon at position 3.
- **Step 3: Identify substituents.**
On Carbon 3, there is a chlorine atom (**chloro**) and a methyl group (**methyl**).
- **Step 4: Assemble alphabetically.**
"Chloro" comes before "methyl". Both are at position 3.
- Therefore, the full IUPAC name is **3-Chloro-3-methylpentane**.

Why other options are incorrect:

- **Option C:** Identifying the chain as "butane" means a 4-carbon chain was incorrectly selected instead of the longest 5-carbon chain.
- **Option B:** Hexane implies a 6-carbon continuous chain, which does not exist in this molecule.

Question #12 Key: (A)

BUMHS 2024

Alkyl halides can yield ethers when heated in the presence of the metallic compound: [BUMHS (2024)]

CORE CONCEPT AND DERIVATION

Alkyl halides can undergo substitution reactions with metal oxides to form oxygen-containing functional groups.

Solution:

- When an alkyl halide is heated with **dry silver oxide** (Ag_2O), two molecules of the alkyl halide couple with the oxygen atom.
- The reaction proceeds as follows: $2R - X + Ag_2O \xrightarrow{\Delta} R - O - R + 2AgX \downarrow$.
- The resulting product is an ether ($R-O-R$).
- **Note:** If **moist** silver oxide is used, it behaves as $AgOH$ and yields an alcohol instead. The question implies the use of dry Ag_2O .

Why other options are incorrect:

- **Options B, C, & D:** Copper and iron oxides are not standard reagents used for ether synthesis via nucleophilic substitution of alkyl halides. Silver's strong affinity for halogens (driving the precipitation of AgX) makes Ag_2O uniquely effective.

Question #13 Key: (B)

BUMHS 2023

Which of the following statement is true about Grignard reagent ($RMgX$)? [BUMHS (2023)]

CORE CONCEPT AND DERIVATION

Grignard reagents ($RMgX$) contain a highly nucleophilic and strongly basic carbanion-like carbon atom.

Solution:

- Because they are incredibly strong bases, they will immediately react with any source of acidic protons (like water or ethanol) in a violent acid-base reaction, destroying the reagent to form an alkane.
- To prevent this, they must be synthesized and stored in completely anhydrous (moisture-free) aprotic solvents.
- Dry diethyl ether is the standard solvent because it lacks acidic protons and its oxygen lone pairs help stabilize the magnesium atom via coordination.

Why other options are incorrect:

- **Options A, C, & D:** Aqueous mediums and ethanol provide acidic protons that will instantly quench (destroy) the Grignard reagent, forming an alkane. Therefore, it is highly reactive with water and ethanol, not inactive.