

Name: _____ Date: _____

Answer Key: Complex Lab Risk Assessment for Undergraduates

Evaluate high-stakes chemical interactions and justify emergency mitigation strategies through rigorous scenario-based analysis of non-routine laboratory failures.

1. When scaling up a Grignard reaction from 10 mmol to 500 mmol, which thermodynamic factor represents the most significant safety risk enhancement?

Answer: B) Surface area-to-volume ratio decrease affecting heat dissipation

In scale-ups, volume increases cubically while surface area increases quadratically; this leads to inefficient cooling of exothermic reactions, potentially causing thermal runaways.

2. A standard nitrile glove (approx. 4-5 mil thickness) provides a sufficient permeation barrier for handling dichloromethane (DCM) for extended periods exceeding 30 minutes.

Answer: B) False

Dichloromethane fast-permeates nitrile; breakthrough times are often under 5 minutes, requiring Silver Shield or Viton gloves for prolonged exposure.

3. In the event of a significant alkali metal fire (e.g., bulk Sodium), which extinguishing agent must be used to avoid a violent explosive reaction?

Answer: C) Class D Dry Powder

Lithium, Sodium, and Potassium react violently with water and can even react with CO₂; only Class D agents like Met-L-X or graphite powder are appropriate.

4. You discover an old bottle of Diethyl Ether that has developed visible crystalline solids around the cap. What is the most appropriate first action?

Answer: C) Place the bottle in a secondary container and contact EHS/Bomb Squad

Visible crystals indicate advanced peroxide formation; these are shock-sensitive explosives, and any friction from opening the cap can trigger a detonation.

5. Perchloric acid digestions are permissible in any standard laboratory fume hood provided the sash is kept at the appropriate working height.

Answer: B) False

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Perchloric acid requires a specialized 'wash-down' hood to prevent the accumulation of explosive perchlorate salts in the ductwork.

6. When working with Pyrophoric reagents like tert-Butyllithium (t-BuLi), the primary engineering control utilized to maintain an inert atmosphere in the reaction vessel is the _____.

Answer: B) Schlenk Line

A Schlenk line allows for the simultaneous evacuation of air and the introduction of inert gases (Nitrogen or Argon) to handle air-sensitive chemicals.

7. Which specific physiological effect makes Hydrofluoric Acid (HF) uniquely dangerous compared to stronger acids like HCl?

Answer: C) Decalcification of bone and induction of hypocalcemia

HF penetrates deeply into tissues, sequestering calcium ions to form CaF_2 , leading to systemic bone destruction and potentially fatal cardiac arrhythmias.

8. In the Hierarchy of Controls, the use of Personal Protective Equipment (PPE) is considered the most effective method for mitigating laboratory hazards.

Answer: B) False

PPE is the 'last line of defense.' Elimination, substitution, and engineering controls are more effective as they address the hazard at the source.

9. To satisfy the 'Prudent Practices' standard for chemical storage, incompatible materials like concentrated Nitric Acid and _____ must be physically separated.

Answer: C) Glacial Acetic Acid

Nitric acid is a strong oxidizer that reacts violently or explosively when in contact with organic acids like acetic acid or flammable solvents.

10. Under the OSHA Laboratory Standard, which document must be present and detail specific work practices for particularly hazardous substances (PHS)?

Answer: B) Chemical Hygiene Plan (CHP)

The Chemical Hygiene Plan is a mandatory, site-specific document that outlines the safety procedures and policies used to protect employees from laboratory hazards.