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Chemistry Olympiad Training for Secondary School Level – Part Five

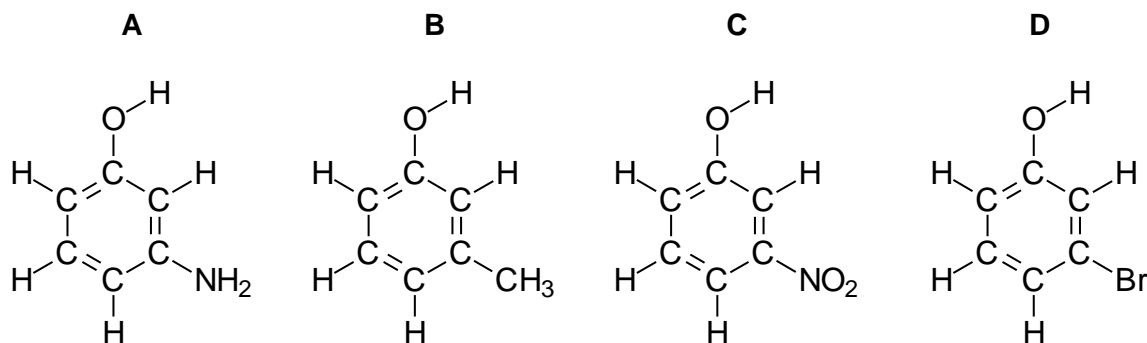
1. Which one of the following series of ions is arranged in order of increasing ionic radius?

- A $Mg^{2+} < S^{2-} < Cl^{-} < K^{+} < Ca^{2+}$
- B $Mg^{2+} < Ca^{2+} < K^{+} < Cl^{-} < S^{2-}$
- C $S^{2-} < Cl^{-} < K^{+} < Mg^{2+} < Ca^{2+}$
- D $S^{2-} < Mg^{2+} < Ca^{2+} < Cl^{-} < K^{+}$

2. Which one of the following compounds could **not** be obtained by oxidising phosphorus trifluoride, PF_3 ?

- A $Na_4P_2O_7 \cdot 10H_2O$
- B $H_4P_2O_6$
- C $(NH_4)_2HPO_3 \cdot H_2O$
- D $Ca_5(PO_4)_3F$

3. Ethanoic acid was heated with an unknown compound **X** and a catalytic amount of sulfuric acid. The reaction mixture was shown by mass spectrometry to contain a compound of molar mass 193 g mol^{-1} . Which one of the following could be compound **X**?



4. Equal masses of each of the following compounds were treated with excess hydrochloric acid. Which one produced the greatest volume of carbon dioxide?

- A Sodium carbonate
- B Magnesium carbonate
- C Potassium carbonate
- D Calcium carbonate

13. The enthalpy change of which reaction corresponds to ΔH_f° for $\text{Na}_2\text{CO}_3(\text{s})$ at 298 K?

- A $2 \text{Na}(\text{s}) + \text{C}(\text{s}) + \frac{3}{2} \text{O}_2(\text{g}) \rightarrow \text{Na}_2\text{CO}_3(\text{s})$
- B $\text{Na}_2\text{O}(\text{s}) + \text{CO}_2(\text{g}) \rightarrow \text{Na}_2\text{CO}_3(\text{s})$
- C $2 \text{Na}^+(\text{aq}) + \text{CO}_3^{2-}(\text{aq}) \rightarrow \text{Na}_2\text{CO}_3(\text{s})$
- D $2 \text{Na}^+(\text{aq}) + 2 \text{OH}^-(\text{aq}) + \text{CO}_2(\text{g}) \rightarrow \text{Na}_2\text{CO}_3(\text{s}) + \text{H}_2\text{O}(\text{l})$

14. A sample of oxygen gas and a sample of an unknown gas are weighed separately in the same evacuated flask. Use the data given to find the molar mass of the unknown gas. Assume that all experiments are conducted at the same temperature and pressure.

mass of evacuated flask	124.46 g
mass of flask + oxygen	125.10 g
mass of flask + unknown gas	125.34 g

- A 22 g mol^{-1}
- B 38 g mol^{-1}
- C 44 g mol^{-1}
- D 84 g mol^{-1}

15. What is the most effective way to condense a gas?

- A Decrease the temperature and increase the pressure.
- B Decrease the temperature and decrease the pressure.
- C Increase the temperature and decrease the pressure.
- D Increase the temperature and increase the pressure.

16. For a rate law of the form:

$$\text{rate} = k \times [\text{A}]^m \times [\text{B}]^n$$

the exponents m and n are obtained from:

- A Changes in the rate of reaction with changing temperature.
- B The coefficients of A and B in the balanced chemical equation.
- C The concentrations of A and B in a single experiment.
- D Changes in the rate of reaction for different concentrations of A and B.

17. Which reaction occurs with the greatest increase in entropy?

- A $2 \text{H}_2\text{O}(\text{l}) \rightarrow 2 \text{H}_2(\text{g}) + \text{O}_2(\text{g})$
- B $2 \text{NO}(\text{g}) \rightarrow \text{N}_2(\text{g}) + \text{O}_2(\text{g})$
- C $\text{C}(\text{s}) + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g})$
- D $\text{H}_2(\text{g}) + \text{Cl}_2(\text{g}) \rightarrow 2 \text{HCl}(\text{g})$

18. The rates of which reactions are increased when temperature is increased?

I exothermic

II endothermic

A I only.

B II only.

C Both I and II.

D Neither I nor II.

19. The boiling points of the halogens, F_2 , Cl_2 , Br_2 and I_2 , increase in that order. This is best attributed to differences in:

A Covalent bond strengths.

B Dipole forces.

C van der Waals forces.

D Hydrogen bonds.

20. Which statement is true for a reaction at equilibrium?

A All reactions cease.

B The reaction has reached completion.

C The rates of the forward and reverse reactions are equal.

D The amount of product equals the amount of reactant.

Answers

1. **B**
2. **C**
3. **A**
4. **B**
5. **C**
6. **B**
7. **C**
8. **A**
9. **C**
10. **C**
11. **B**
12. **D**
13. **A**
14. **C**
15. **A**
16. **D**
17. **A**
18. **C**
19. **C**
20. **C**