

I Multiple choice (60%)

1. A nuclear reaction is shown as: ${}^{14}_7\text{N} + {}^4_2\text{He} \longrightarrow \text{X} + {}^1_1\text{H}$

What is the "X"? (A) ${}^{17}\text{O}$ (B) ${}^{18}\text{F}$ (C) ${}^{17}\text{F}$ (D) ${}^{17}\text{N}$ (E) ${}^{14}\text{C}$

2. Which of the following materials that are inorganic solids with high thermal stability, usually formed through three-dimensional network covalent bonding?

(A) quartz (B) polystyrene (C) ice (D) PVC (E) sodium carbonate

3. A solution is prepared with 0.5 M of an acid HA ($\text{p}K_a = 4.85$) and 0.05 M of its sodium salt NaA. What is the pH of this solution? (A) 3.85 (B) 4.75 (C) 4.85 (D) 4.95 (E) 5.85

4. Which of the following pair of compounds can form a homogeneous solution in any ratio?

(A) $\text{C}_6\text{H}_5\text{Cl}/\text{H}_2\text{O}$ (B) $\text{HOCH}_2\text{CH}_2\text{OH}/\text{H}_2\text{O}$ (C) n-hexane/ H_2O (D) $\text{C}_6\text{H}_5\text{CH}_3/\text{H}_2\text{O}$ (E) benzene/ H_2O

5. Which of the following substance will give a basic aqueous solution?

(A) CO_2 (B) SO_2 (C) P_2O_5 (D) $\text{Na}(\text{CH}_3\text{COO})$ (E) $\text{NH}_4(\text{CH}_3\text{COO})$

6. Which of the following is the monomer unit in both starch and cellulose?

(A) galactose (B) fructose (C) sucrose (D) glucose (E) glucose and sucrose

7. As the amount of organic material in a water system increases, what kind of biochemical oxygen demand (BOD) change would be observed in this system?

(A) decrease (B) increase (C) remain as constant (D) too complicate to correlate.

8. Which one is the correct formula for magnesium nitride?

(A) Mg_2N_3 (B) Mn_3N_2 (C) Mg_3N_2 (D) Mn_2N_3 (E) $\text{Mg}(\text{NO}_2)_2$.

9. The removal of silver tarnish from silverware can be achieved by using aluminum foil in the presence of aqueous sodium bicarbonate solution. What reaction (Not balanced) does this process involve?

(A) $\text{Ag}^+ + \text{Al} \rightarrow \text{Al}^{3+} + \text{Ag}$ (B) $\text{Ag} + \text{CO}_3^{2-} \rightarrow \text{Ag}_2\text{CO}_3$

(C) $\text{Ag}^+ + \text{HCO}_3^- \rightarrow \text{Ag} + \text{CO}_2 + \text{H}^+$ (D) $\text{Ag}^+ + \text{OH}^- \rightarrow \text{AgOH}$

(E) $\text{Al} + \text{OH}^- \rightarrow \text{Al}(\text{OH})_4$

10. Which of the following is not proper fuel source?

(A) H_2 (B) CH_4 (C) CCl_4 (D) $\text{C}_{20}\text{H}_{22}$ (E) benzene

11. In hair curling, the first step is to treat the hair with thioglycolic acid. What is the major function of this reagent?

(A) causes the hydrolysis of protein within hair

(B) bleaching hair

(C) causes the disulfide bond within hair to cleave

(D) removal of water on the hair surface

(E) destroy the hydrogen bonding within the hair

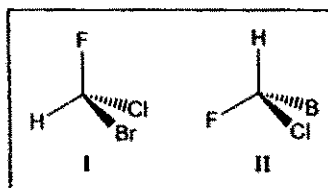
12. Using VSEPR theory to predict the bond angle (O-S-O) in sulfate anion?

(A) 60° (B) 90° (C) 109° (D) 120° (E) 180°

13. What is the monomer used to prepare poly(vinyl acetate)?

(A) $\text{CH}_2=\text{CHCl}$ (B) $\text{CH}_2=\text{CHOH}$ (C) $\text{CH}_2=\text{CHC}_6\text{H}_5$ (D) $\text{CH}_2=\text{CHOCOCH}_3$ (E) $\text{CH}_2=\text{CHOCH}_3$

14. What is the relationship for the compounds I and II on the left?



(A) identical compounds (B) optical isomers

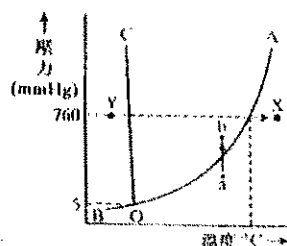
(C) allotropes

(D) geometrical isomers

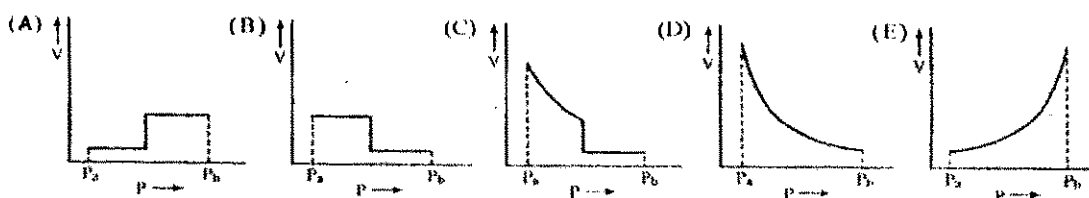
(E) isoelectronic

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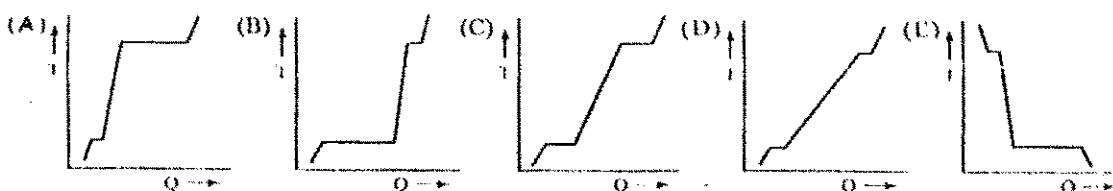
According to the phase diagram of water shown below, answer the questions 15-16



15 From a to b, which of the following plot properly illustrates the relationship between the pressure and the volume?



16 The ΔH_{liq} of ice is 6. kJ/mol and ΔH_{vap} of ice is 41 kJ/mol. From Y to X, which of the following plot properly illustrates the change of temperature (T) with respect to the supplied heat (Q)?

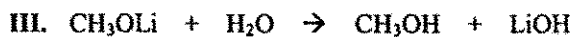
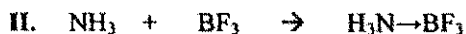
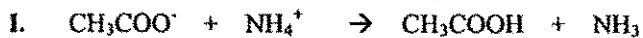


17. Which of the following molecules are polar?

(I) NH_3 (II) CO_2 (III) CH_4 (IV) CH_2Cl_2 (V) CH_3CH_3

(A) I, II and IV (B) I and IV (C) I, II, IV and V (D) II, IV and V (E) I only

18. Which are acid-base reactions according to Lewis acid-base theory?



(A) I, II, III and IV (B) I and III (C) I only (D) I, III and IV (E) II and IV

The urban air pollution is often due to the release of NO_x that is mainly consisted of NO and NO_2 by the vehicles or industrial production. NO_x may be catalytically converted into nitrogen and water with use of ammonia.

19 What role does ammonia play in this process?

(A) acid (B) base (C) oxidant (D) reductant (E) catalyst

20 In order to have complete conversion of 6.0 L NO_x in which the molar ratio of NO and NO_2 is 1:2 under the same temperature and atmospheric pressure, how many liters of ammonia will be needed at least?

(A) 3.0 (B) 6.0 (C) 12.0 (D) 20.0 (E) 30.0

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II Problems (40%)

- 1 (a) Draw the Lewis structures for (A) ozone (B) carbonate anion.
 (b) Could the single Lewis structure illustrate the real nature of these compounds? why?
 2 Fig I and II show the unit cells of sodium chloride and cesium chloride, respectively. (15%)

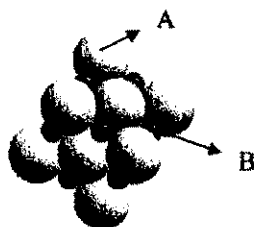


Fig I

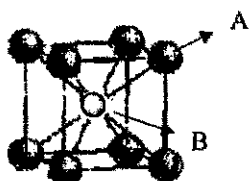


Fig II

- (a) Identify A and B and determine the number of the ions in each unit cell.
 (b) What are the coordination numbers for Na^+ and Cs^+ ?
 (c) Why the coordination numbers for Na^+ and Cs^+ are different?
 3 The reaction $\text{NO}_{(g)} + \text{O}_{3(g)} \rightarrow \text{NO}_{2(g)} + \text{O}_{2(g)}$ was studied by performing the flooding technique. When $[\text{O}_3] = 1.0 \times 10^{14}$ molecules/cm³, the change of $[\text{NO}]$ with time is shown in Table 1. When $[\text{NO}] = 2.0 \times 10^{14}$ molecules/cm³, the change of $[\text{O}_3]$ with time is shown in Table 2. (15%)

Table 1

Table 2

Time (ms)	[NO] (molecules/cm ³)	Time (ms)	[O ₃] (molecules/cm ³)
0	6.0×10^8	0	1.0×10^{10}
100	5.0×10^8	50	8.4×10^9
500	2.4×10^8	100	7.0×10^9
700	1.7×10^8	200	4.9×10^9
1000	9.9×10^7	300	3.4×10^9

- (a) Using the graphs to determine the rate order with respect to $[\text{NO}]$ and $[\text{O}_3]$?
 (b) Determine the rate law and evaluate the rate constant for this reaction.
 (c) Propose a mechanism and explain how it can match with the experimental data.

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