

單選題 每題兩分 不倒扣 總分一百分

1. The element rhenium (Re) exists as two stable isotopes and 18 unstable isotopes. Rhenium-185 has in its nucleus.  
(A) 75 protons, 75 neutrons. (B) 75 protons, 130 neutrons. (C) 130 protons, 75 neutrons. (D) 75 protons, 110 neutrons. (E) not enough information is given.
2. What is the correct formula for iron(II) sulfate?  
(A)  $\text{Fe}_2\text{SO}_4$  (B)  $\text{FeSO}_4$  (C)  $\text{Fe}(\text{SO}_4)_2$  (D)  $\text{FeSO}_3$  (E)  $\text{Fe}_2\text{SO}_3$
3. Which of the following formulas is not the correct?  
(A)  $\text{Al}(\text{OH})_3$  (B)  $\text{MgCl}_2$  (C)  $\text{K}_2\text{CrO}_4$  (D)  $(\text{NH}_4)_2\text{PO}_4$  (E)  $\text{Li}_2\text{CO}_3$
4. Consider the element indium, atomic number 49, atomic mass 114.8 g. The nucleus of an atom of indium-112 contains  
(A) 49 protons, 63 neutrons, 49 electrons. (B) 49 protons, 49 neutrons. (C) 49 protons, 49 alpha particles. (D) 49 protons, 63 neutrons. (E) 49 protons, 112 neutrons.
5. A metal M forms an oxide  $\text{M}_2\text{O}_3$ , containing 68.4% metal by mass. Calculate the atomic mass of the metal.  
(A) 51.9 g/mol (B) 68.4 g/mol (C) 106 g/mol (D) 23.9 g/mol (E) 45.6 g/mol
6. What mass of styrene (molar mass 104.1 g/mol) contains  $4.50 \times 10^{20}$  molecules of styrene?  
(A)  $7.48 \times 10^{-4}$  g (B)  $7.48 \times 10^{-3}$  g (C)  $7.78 \times 10^{-2}$  g (D) 0.00778 g (E)  $7.48 \times 10^4$  g
7. Which of the following solutions contains the greatest total ion concentration?  
(A) One mole of potassium chloride dissolved in 1.0 L of solution. (B) One mole of iron(II) nitrate dissolved in 1.0 L of solution. (C) One mole of potassium hydroxide dissolved in 1.0 L of solution. (D) One mole of sodium phosphate dissolved in 1.0 L of solution. (E) At least two of the above solutions have an equal number of ions, and these contain the greatest total ion concentration.
8. You have 100.0 mL of a 0.2500M solution of NaCl sitting in a beaker. After several days you test the solution and find that it has a concentration of 0.3125 M. How much water must have evaporated?  
(A) 10.0 mL (B) 20.0 mL (C) 80.0 mL (D) 90.0 mL (E) The concentration will not change due to evaporation.
9. In the reaction  $\text{Cu (s)} + \text{AgNO}_3 \text{ (aq)} \rightarrow \text{Cu(NO}_3)_2 \text{ (aq)} + \text{Ag (s)}$ , identify the oxidizing agent.  
(A) Cu (B)  $\text{AgNO}_3$  (C)  $\text{Cu(NO}_3)_2$  (D) Ag (E) none of these
10. The volume of a balloon is 1.20 liters at  $24.0^\circ\text{C}$ . The balloon is heated to  $48.0^\circ\text{C}$ . Calculate the new volume of the balloon.  
(A) 1.20 L (B) 1.30 L (C) 1.70 L (D) 2.10 L (E) 2.40 L
11. Which of the following relationship is not true?  
(A)  $PV = \text{constant}$  when temperature and moles of gas are held constant. (B)  $V/T = \text{constant}$  when pressure and moles of gas are held constant. (C)  $nT = \text{constant}$  when pressure and volume are held constant. (D)  $P/n = \text{constant}$  when volume and temperature are held constant. (E) All of the above are true.
12. A container fitted with a piston contains oxygen gas and is heated slightly. As it is heated, the density of the oxygen gas  
(A) increases. (B) decreases. (C) stays the same. (D) all of above are possible. (E) none of these.

13. The value of the equilibrium constant,  $K$ , is dependent on I. The temperature of the system. II. The nature of the reactants and products. III. The concentration of the reactants. IV. The concentration of the products.  
(A) I, II (B) II, III (C) III, IV (D) It is dependent on three of the above choices. (E) It is not dependent on any of the above choices.
14. If  $x$  mole of  $\text{NOCl}$  react, what is the equilibrium concentration of  $\text{NO}$ ?  
(A)  $+x$  (B)  $+2x$  (C)  $-x$  (D)  $-2x$  (E)  $x^2$
15. Given the equation  $\text{A(aq)} + 2\text{B(aq)} \rightleftharpoons 3\text{C(aq)} + 2\text{D(aq)}$ . 45.0 mL of 0.050M A is mixed with 25.0 mL 0.100M B. At equilibrium the concentration of C is 0.0410 M. Calculate  $K$ .  
(A) 7.3 (B) 0.34 (C) 0.040 (D) 0.14 (E) none of these
16. Which of the following is a conjugate acid/base pair?  
(A)  $\text{HCl}/\text{OCl}^-$  (B)  $\text{H}_2\text{SO}_4/\text{SO}_4^{2-}$  (C)  $\text{NH}_4^+/\text{NH}_3$  (D)  $\text{H}_3\text{O}^+/\text{OH}^-$  (E) none of these
17. At  $0^\circ\text{C}$ , the ion-product constant of water,  $K_w$ , is  $1.2 \times 10^{-15}$ . What is the pH of pure water at  $0^\circ\text{C}$ ?  
(A) 7.00 (B) 6.88 (C) 7.56 (D) 7.46 (E) none of these
18. Calculate the pH of a solution prepared by mixing 50 mL of a 0.10 M solution of HF with 25 mL of a 0.20 M solution of NaF.  $\text{p}K_a$  of HF is 3.14.  
(A) 3.14 (B) 10.80 (C) 5.83 (D) 7.35 (E) 12.00
19. How many mmoles of HCl must be added to 100 mL of a 0.100 M solution of methylamine ( $\text{p}K_b = 3.36$ ) to give a buffer having a pH of 10.0?  
(A) 8.1 (B) 18.7 (C) 20.0 (D) 41.5 (E) 12.7
20. Of energy, work, enthalpy, and heat, how many are state functions?  
(A) 0 (B) 1 (C) 2 (D) 3 (E) 4
21. The  $\Delta H$  value for the reaction  $(1/2)\text{O}_2(\text{g}) + \text{Hg}(\text{l}) \rightarrow \text{HgO}(\text{s})$  is  $-90.8\text{ kJ}$ . How much heat is released when 32.5 g Hg is reacted with oxygen?  
(A) 9.32 kJ (B) 90.8 kJ (C) 14.7 kJ (D) 40.0 kJ (E) none of these
22. For which process is  $\Delta S$  negative?  
(A) evaporation of 1 mol of  $\text{CCl}_4(\text{l})$  (B) mixing 5 mL ethanol with 25 mL water (C) compressing 1 mol Ne at constant temperature from 1.5 atm to 0.5 atm (D) raising the temperature of 100 g Cu from 275 K to 295 K (E) grinding a large crystal of KCl to powder
23. For the vaporization of a liquid at a given pressure: (Note: Answers C and D imply that  $\Delta G$  is zero at some temperature.)  
(A)  $\Delta G$  is positive at all temperatures. (B)  $\Delta G$  is negative at all temperatures. (C)  $\Delta G$  is positive at low temperatures, but negative at high temperatures. (D)  $\Delta G$  is negative at low temperatures, but positive at high temperatures.
24. When the equation for the following reaction in basic solution is balanced, what is the sum of the coefficients?  $\text{MnO}_2 + \text{HO}_2^- \rightarrow \text{MnO}_4^-$   
(A) 11 (B) 31 (C) 14 (D) 9 (E) 18
25. For a reaction in a voltaic cell both  $\Delta H^\circ$  and  $\Delta S^\circ$  are positive. Which of the following statements is true?  
(A)  $E^\circ_{\text{cell}}$  will increase with an increase in temperature. (B)  $E^\circ_{\text{cell}}$  will decrease with an increase in temperature. (C)  $E^\circ_{\text{cell}}$  will not change when the temperature increases. (D)  $\Delta G^\circ > 0$  for all temperatures. (E) None of the above statements is true.
26. Which form of electromagnetic radiation has the longest wavelengths?  
(A) gamma rays (B) microwaves (C) radio waves (D) infrared radiation (E) x-rays

27. What is the wavelength of a photon of red light (in nm) whose frequency is  $4.60 \times 10^{14}$  Hz?  
 (A) 652 nm (B)  $153 \times 10^6$  nm (C) 153 nm (D) 460 nm (E) none of these
28. Which of the following atoms or ions has 3 unpaired electrons?  
 (A) N (B) O (C) Al (D)  $S^{2-}$  (E)  $Zn^{2+}$
29. Choose the compound with the most ionic bond.  
 (A) LiCl (B) KF (C) NaCl (D) LiF (E) KCl
30. Which of the following is non-polar?  
 (A)  $H_2O$  (B)  $CO_2$  (C)  $SCl_2$  (D)  $NH_3$  (E) All of the above are non-polar.
31. As indicated by Lewis structure, which of the following species could probably not exist as a stable molecule?  
 (A)  $NH_3$  (B)  $N_2H_2$  (C)  $N_2H_4$  (D)  $N_2H_6$  (E)  $N_2O_4$
32. What is the hybridization of each N atom in the molecule  $N_2H_4$ ?  
 (A) sp (B)  $sp^2$  (C)  $sp^3$  (D)  $dsp^3$  (E)  $d^2sp^3$
33. Order the following from shortest to longest bond :  $C_2$ ,  $B_2$ ,  $H_2$ ,  $N_2$   
 (A)  $H_2$ ,  $N_2$ ,  $C_2$ ,  $B_2$  (B)  $N_2$ ,  $C_2$ ,  $B_2$ ,  $H_2$  (C)  $C_2$ ,  $N_2$ ,  $H_2$ ,  $B_2$  (D)  $C_2$ ,  $B_2$ ,  $H_2$ ,  $N_2$  (E) none of these
34. Which of the following has the shortest N-O bond?  
 (A)  $NO_3^-$  (B)  $NO^+$  (C)  $N_2$  (D)  $NO_2^-$  (E) none of the above
35. The rate expression for a particular reaction is  $rate = k[A][B]^2$ . If the initial concentration of B is increased from 0.1 M to 0.3 M, the initial rate will increase by which of the following factors?  
 (A) 2 (B) 6 (C) 12 (D) 3 (E) 9
36. Consider the second order reaction  $aA \rightarrow \text{Products}$  (which has a first half-life of 25s). If the concentration of A after 10.0 s is 0.45M, determine the initial concentration of A.  
 (A) 0.50 M (B) 0.53 M (C) 0.55 M (D) 0.60 M (E) 0.63 M
37. Which one of following decreases as the strength of the attractive intermolecular forces increases?  
 (A) The heat of vaporization. (B) The normal boiling temperature. (C) The extent of deviations from the ideal gas law. (D) The sublimation temperature of a solid. (E) The vapor pressure of a liquid.
38. On a relative basis, the weaker the intermolecular forces in a substance,  
 (A) the greater its heat of vaporization. (B) the more it deviates from ideal gas behavior. (C) the greater its vapor pressure at a particular temperature. (D) the higher its melting point. (E) none of these.
39. How many milliliters of 18.4 M  $H_2SO_4$  are needed to prepare 600.0 mL of 0.10 M  $H_2SO_4$ ?  
 (A) 1.8 mL (B) 2.7 mL (C) 3.3 mL (D) 4.0 mL (E) 4.6 mL
40. Rank the following compounds according to increasing solubility in water.  
 I.  $CH_3-CH_2-CH_2-CH_3$   
 II.  $CH_3-CH_2-O-CH_2-CH_3$   
 III.  $CH_3-CH_2-OH$   
 IV.  $CH_3-OH$   
 (A) I < III < IV < II  
 (B) I < II < IV < III  
 (C) III < IV < II < I  
 (D) I < II < III < IV  
 (E) No order is correct.

41. Choose the element that is the strongest reducing agent in the gas phase.  
(A) Li (B) Na (C) K (D) Rb (E) Cs
42. Order the following bonds from highest to lowest bond energy : carbon-carbon, silicon-silicon, silicon-oxygen.  
(A) C-C, Si-Si, Si-O (B) Si-O, C-C, Si-Si (C) Si-Si, Si-O, C-C (D) Si-O, Si-Si, C-C (E) C-C, Si-O, Si-Si
43. Choose the most metallic element.  
(A) N (B) P (C) As (D) Sb (E) Bi
44. Choose the species with the largest radius.  
(A) F (B) F<sup>-</sup> (C) Cl (D) Cl<sup>-</sup> (E) All are the same.
45. How many isomers of C<sub>4</sub>H<sub>10</sub> are there?  
(A) 1 (B) 2 (C) 3 (D) 5 (E) 6
46. Which of the following has the highest boiling point?  
(A) methane (B) butane (C) ethane (D) propane (E) All of the above have the same boiling point.
47. Identify the type of organic compound shown :
- $$\begin{array}{ccccccc}
 & \text{H} & & \text{H} & & & \\
 & | & & | & & & \\
 \text{H} & - \text{C} & - & \text{C} & - & \text{C} = \text{O} \\
 & | & & | & & | & \\
 & \text{H} & & \text{H} & & \text{H} & 
 \end{array}$$
- (A) aldehyde (B) ester (C) amine (D) ketone (E) none of these
48. The structures of proteins are partially determined by the order of various amino acids in the macromolecule. This level of structural determination is known as  
(A) primary structure. (B) secondary structure. (C) tertiary structure. (D) quaternary structure. (E) order of bases.
49. A polypeptide is  
(A) an addition polymer of amino acids. (B) a condensation polymer of amino acids. (C) a polymer of sugar molecules. (D) a part of nucleic acids. (E) none of these
50. The overall shape of a protein is maintained of  
(A) hydrogen bonding. (B) ionic bonds. (C) dipole-dipole bonding. (D) covalent bonds. (E) all of these