1. Which of these is not true?
   (a) has critical temperature above room temperature
   (b) Substances with critical temperature above room temperature exist in the atmosphere as vapour
   (c) Nitrogen gas has critical temperature above room temperature [c]
   (d) Substances with critical temperature above room temperature are liquefiable by compression only

2. 27g of acetylene dissolves in 1L of acetone at 1.0 atm pressure. If the partial pressure of acetylene is increased to 12 atm, what is the solubility in acetone?
   (a) 3.24×10^2g   (b) 4.8g   (c) 2.25g   (d) 13.8g   [ ]

3. What is the partial vapour pressure of benzene in a solution containing 0.70 mole fraction benzene and 0.30 mole fraction of toluene? (vapour pressure of benzene and toluene are 75mmHg and 22mmHg respectively)
   (a) 6.6mmHg   (b) 52.5mmHg   (c) 59.1mmHg   (d) 2.6mmHg   [ ]

4. How many grams of glucose are required to lower the freezing point of 100cm^3 of water by 0.70°C? (k$_f$ of water= 1.86°C/m; density of water= 1.0g/cm^3; C=12; H=1; O=16)
   (a) 19.6g   (b) 1.96g   (c) 6.73g   (d) 1.8g   [ ]

5. Which of these is true of the effect of a solute that associates in solution?
   (a) the molecular weight increases   (b) the vapour pressure lowering increases
   (c) the freezing point depression increases   (d) the boiling point elevation increases   [ ]

6. Which of the following is true for free energy?
   (a) $\Delta A= 0$ (b) $\Delta G <0$ (c) $\Delta G=0$ (d) $\Delta A<0$ [ ]

7. Calculate the standard free energy change for the reaction: $CuO_{(s)} + C_{(s)} \rightarrow Cu_{(s)} + CO_{(g)}$ and predict the spontaneity of the reaction. ($\Delta \overline{G}_f^0$ (CO) = -137.3kJmol^{-1}; $\Delta \overline{G}_f^0$ (CuO)= -127.2kJmol^{-1})
   (a) -10.1 kJmol^{-1}; non-spontaneous   (b) $+ 10.1$ kJmol^{-1}; non-spontaneous
   (c) -101.1 kJmol^{-1}; spontaneous   (d) -10.1 kJmol^{-1}; spontaneous   [ ]

8. Which of the following is true for non spontaneous process at high temperature?
   (a) $\Delta G= -ve, \Delta H= +ve, \Delta S= +ve$ (b) $\Delta G= -ve, \Delta H= -ve, \Delta S= -ve$
   (c) $\Delta G= +ve, \Delta H= -ve, \Delta S= +ve$ (d) $\Delta G= +ve, \Delta H= -ve, \Delta S= -ve$ [ ]

9. Which of the following is true for change in internal energy at constant entropy and volume?
   (a) $\Delta E \geq 0$ (b) $\Delta E = 0$ (c) $\Delta E < 0$ (d) $\Delta E > 0$ [ ]

10. Calculate the standard entropy change for the reaction: $N_2+O_2 \rightarrow 2NO$, given that the standard molar entropies of $N_2= 191$JK^{-1}mol^{-1}, $O_2=205.0$ JK^{-1}mol^{-1}, NO=210.6 JK^{-1}mol^{-1}
   (a) +24.7 JK^{-1}mol^{-1} (b) +247kJmol^{-1} (c) +24.7kJmol-1   (d) -24JK-1mol^{-1} [ ]

11. Calculate K_x for the reaction: $N_2O_{4(g)} \rightleftharpoons 2NO_{2(g)}$ taking place at 300°C and 10atm, given that K_p is 0.571
    (a) 0.157   (b) 0.571   (c) 0.0571   (d) NOTA   [ ]

12. Consider the reaction.
    $$A + B \underset{k_2}{\overset{k_1}{\rightleftharpoons}} C$$
    ; if $K_2 =1.8 \times 10^{-3}$, find the inverse of K_1.
    (a) 1.8×10^{-3} (b) 555.6   (c) 1.8×10^3 (d) 3.2×10^{-6} [ ]

13. Which of the following is both a Bronsted-Lowry base as well as an acid.
    (a) NH_4^+ (b) H_2O (c) H_3O^+ (d) NH_3 [ ]

14. If the solubility of silver chromate in water at 25°C is 3.5×10^{-5}, calculate its solubility product
    (a) 1.3×10^{-9} (b) 4.9×10^{-9} (c) 4.3×10^{-14} (d) 1.7×10^{-13} [ ]

15. Which of the following is correct?

(a) $p^{kw} = p^{Kh} \cdot p^{kb}$ (b) $p^{kb} = p^{kw} + p^{kh}$ (c) $p^{kw} = p^{kh} - p^{kb}$ (d) $p^{kh} = p^{kw} - p^{kb}$ [ ]

16. Boyle's and Charles's laws are obeyed by gases at the following conditions:

(a) low temperature and low pressure   (b) high temperature and high pressure

(c) low temperature and high pressure   (d) high temperature and low pressure.   [ ]

17. What volume would 8.0g of hydrogen occupy at 2.0atm and 127^0C? ($R = 0.082 dm^3 atm mol^{-1} K^{-1}$).

(a) $60.0 dm^3$ (b) $62.1 dm^3$ (c) $63.0 dm^3$ (d) $65.6 dm^3$ [ ]

18. Calculate the temperature at which molecules of nitrogen gas would have same most probable speed as molecules of oxygen at 0^0C

(a) 240K   (b) 260K   (c) 300K   (d) 320K   [ ]

19. The negative deviation observed in compressibility chart is caused by:

(a) pressure effect   (b) volume effect   (c) temperature effect   (d) molar effect   [ ]

20. At what temperature would one mole of nitrogen gas contained in a 20 dm^3 vessel behave ideally, ($z = 1$) at pressure of 1 atm?

(a) 230K   (b) 244K   (c) 235K   (d) 240K   [ ]

21. For the reaction: $A \xrightarrow{\ k\ } B$, what is the differential equation for the formation of B

(a) $\dfrac{d[A]}{dt} = -K[A]$ (b) $\dfrac{d[B]}{dt} = K[A]$

(c) $\dfrac{-d[B]}{dt} = K[B]$ (d) $\dfrac{-d[B]}{dt} = -K[A]$ [ ]

22. Which of the following equations represent the equation of the first order reaction?

(a) $x_0 - x = k_1 t$ (b) $\log(a-x) = \dfrac{-K_1 t}{2.303} + \log a$

(c) $-\log(a-x) = \dfrac{K_1 t}{2.303} + \log a$ (d) $\log(x_0 - x) = k_1 t$ [ ]

23. The rate for the product P is represented as

(a) $\dfrac{d[p]}{dt} = K'[M][N]$ (b) $\dfrac{d[p]}{dt} = K^+ \dfrac{[MN^{\neq}]}{[M][N]}$

(c) $\dfrac{d[p]}{dt} = -K' \dfrac{[M][N]}{[MN^{\neq}]}$ (d) $\dfrac{d[p]}{dt} = k^+ K'[M][N]$ [ ]

24. The stoichiometry of the reaction describes

(a) A set of elementary reaction   (b) The rate of a chemical reaction   [ ]

(c) The mechanism of a reaction   (d) How many moles of each reactant needed to form each mole of product.

25. Which of the following is a first order reaction?

(a) $2NOCl_{(g)} \rightarrow 2NO_{(g)} + Cl_{2\,(g)}$ (b) $2HI_g \leftrightarrow H_{2(g)} + I_{2\,(g)}$

(c) $2N_2O_{5(g)} \leftrightarrow 4NO_{2(g)} + O_{2(g)}$ (d) $H_2 + I_2 \leftrightarrow 2HI_{(g)}$ [ ]

26. A system is confined by

(a) Closed metal can   (b) Volatile liquid

(c) Thermally isolated vessel   (d) Boundary   [ ]

27. When only P-V work is done, heat absorbed in a process at constant pressure is equal to the change in enthalpy. We can represent this statement as follows:

(a) $q_p = P\Delta V$ (b) $q_p = \Delta E$

(c) $q_p = \Delta H$ (d) $\Delta H = \Delta E + P\Delta V$ [ ]

28. Compute the energy in joules necessary to increase the volume of a gas by $10 cm^3$ against a pressure of 10 atmospheres. (Take $1atm = 1.0135 \times 10^5 \, Nm^{-2}$)

(a) 101J   (b) 0.101J   (c) 1.01J   (d) 10.1J   [ ]

29. What is the work done in kilojoules when 40 moles of a gas expands isothermally and irreversibly at 25^0C from 15 to $50 dm^3$? (Take $R = 8.314 J Mol^{-1} K^{-1}$)

(a) 119KJ   (b) 119.34KJ   (c) 1193.4KJ   (d) 11.9KJ   [ ]

30. For the same process, the heat absorbed at constant pressure and the heat absorbed at constant volume are related thus:

(a) $q_v = q_p + P\Delta V$ (b) $q_p = \Delta H$ (c) $q_p = q_v - P\Delta V$ (d) $q_p = q_v + P\Delta V$ [ ]

1. 2g of hydrogen and 28g of nitrogen gases were placed in an enclosed vessel. The pressure was 2.0 x $10^5 NM^{-2}$ and the temperature is 27°C. Calculate the volume of the container. (Hint: assume ideal behaviour, $R=8.314 NMmol^{-1}K^{-1}$)

(a) $0.0249m^3$ (b) $0.249m^3$ (c) $0.0249dm^3$

(d) $0.249dm^3$ $V_1 + V_2$ [   ]

2. The root-mean square (rms) speed of oxygen gas at 25°C is: (O=16; $R=8.314 NMmol^{-1}K^{-1}$)

(a) $5 \times 10^1 ms^{-1}$ (b) $4.8 \times 10^2 ms^{-1}$ (c) $6 \times 10^2 ms^{-1}$ (d) $4 \times 10^3 ms^{-1}$ [   ]

3. The excluded volume of non-ideal gases is more than the actual volume of the molecules by a factor of:

(a) 8   (b) 3   (c) 6   (d) 4   [   ]

4. The observed positive deviation in compressibility chart is caused by:

(a) pressure effect (b) volume effect (c) temperature effect (d) molar effect   [   ]

5. At what temperature would molecules of oxygen have the same arithmetic mean speed ($\bar{c}$) as molecules of hydrogen at 0°C ?

(a) 3000K   (b) 3500K   (c) 4000K   (d) 4400K   [   ]

6. Calculate K_p for the reaction: $N_2O_{4(g)} \rightleftharpoons 2NO_{2( )}$, taking place at 300°C and 10 atm, given that K_c is $6.38 \times 10^{-2} moldm^{-3}$.

(a) 2.98   (b) 3.0   (c) 1.57   (d) 1.6   [   ]

7. Consider the reaction:

$$R + S \underset{k_1}{\overset{k_2}{\rightleftharpoons}} T;$$

If K_1 is 2.0×10^{-4}. Calculate the square of K_2.

(a) 4.0×10^{-8} (b) 4.0×10^8 (c) 5.0×10^3 (d) 2.5×10^7 [   ]

8. Which of the following is a Lewis acid?

(a) BCl_3 (b) BCl_3^+ (c) NH_3^- (d) H_2^+ [   ]

9. If the solubility product constant of calcium carbonate in water is 6.25×10^{-12}, calculate its solubility.

(a) 2.5×10^{-6} (b) 1.8×10^{-4} (c) 1.2×10^{-4} (d) 1.6×10^{-12} [   ]

10. Which of these is out of place?

(a) $K_h + K_w = K_b$ (b) $K_w = K_h + K_b$ (c) $K_b = K_w/K_h$ (d) $K_h K_w = K_b$ [   ]

11. For the reaction: $A \xrightarrow{k} B$, with respect to B, what is the order of the reaction?

(a) zero order (b) half order (c) first order   (d) second order   [   ]

12. For a first order reaction, the slope is given as:

(a) $\dfrac{-K_1 l}{2.303}$ (b) $\dfrac{K_1}{2.303}$ (c) $\dfrac{K_1 l}{2.303}$ (d) $\dfrac{-K_1}{2.303}$ [   ]

13. Neither K^l nor k^l is experimentally measurable because:

(a) The concentrations of the transition state are too high
(b) The concentrations of the transition state are low
(c) The concentrations of the transition state is not measurable (d) NOTA   [   ]

14. The mechanism of the reaction describes:

(a) the molecularity of a reaction
(b) a set of elementary reactions consistent with the stoichiometric reaction
(c) the rate of a chemical reaction   (d) NOTA   [   ]

15. Which of the following is a first order reaction?

(a) $SO_2Cl_{2(g)} \rightarrow SO_{2(g)} + Cl_{2(g)}$ (b) $3KClO_{(aq)} \rightarrow 2KCl_{(aq)} + KClO_{3(aq)}$
(c) $NH_4^+{}_{(aq)} + CNO^-{}_{(aq)} \rightarrow CO(NH_2)_{2(aq)}$ (d) NOTA   [   ]

16. What separates the system from the surroundings?
    (a) thermally isolated vessel   (b) Boundary
    (c) closed metal can   (d) volatile liquid   [   ]

17. Assuming that only P-V work is done, heat absorbed in a process at constant pressure equals the change in enthalpy. This statement can be represented thus:
    (a) $q_v = P\Delta V$ (b) $q_p = \Delta E$ (c) $\Delta H = \Delta E + P\Delta V$ (d) $q_p = \Delta H$ [   ]

18. What amount of energy in joules is required to increase the volume of a gas by $10cm^3$ against a pressure of 10 atmospheres? (Take 1 atm $= 1.0135 \times 10^5 NM^{-2}$).
    (a) 1.01J   (b) 10.1J   (c) 0.101J   (d) 101J   [   ]

19. Compute the work done in kilojoules for the expansion of 40moles of nitrogen gas from 15 to 50 dm^3 in a thermally and irreversibly at 25°C. (R= 8.314 $Jmol^{-1} K^{-1}$).
    (a) 11.9kJ   (b) 1193.4kJ   (c) 119kJ   (d) 119.34kJ   [   ]

20. The relationship between the heat absorbed at constant volume for the same process can be stated as follows
    (a) $q_p = q_v + P\Delta V$ (b) $q_p = q_v + P\Delta V$ (c) $q_p = \Delta H$ (d) $q_v = q_p + P\Delta V$ [   ]

21. Which of these is not true?
    (a) Dipole-dipole attraction is strongly independent of temperature
    (b) Induction force is small and independent of the temperature
    (c) London forces is independent of temperature
    (d) H_2O has a higher boiling point than H_2Se [   ]

22. 27g of ethene dissolves in 1L of acetone at 1atm pressure. If the partial pressure is ethene is increased to 12 atm. What is its solubility in acetone?
    (a) 2.28g   (b) 4.8g   (c) 0.324×10^3g   (d) NOTA   [   ]

23. What is the partial vapour pressure of toluene in a solution containing 0.70 mole fraction of benzene and 0.30 mole fraction of toluene? (vapour pressure of benzene and toluene are 75mmHg and 22mmHg respectively.
    (a) 6.6mmHg   (b) 52.5mmHg   (c) 59.1mmHg   (d) 2.28mmHg   [   ]

24. What is the molar mass of the solute if the osmotic pressure of the solution containing 20.0g/dm^3 of solute is 20 atm at 25°C? (R= $0.08212 atmK^{-1}mol^{-1}$)
    (a) 6.02g/mol   (b) 24.47g/mol   (c) 47.48g/mol   (d) 14.48g/mol   [   ]

25. Which of these is not true?
    (a) acetic acid in benzene forms dimer due to hydrogen bond
    (b) increase in pressure decreases the melting point of water
    (c) solution of benzene and methylbenzene is ideal
    (d) NOTA   [   ]

26. Which of the following is true for free energy of a reversible process at constant temperature and volume?
    (a) $\Delta A < 0$ (b) $\Delta G < 0$ (c) $\Delta G = 0$ (d) $\Delta A = 0$ [   ]

27. Calculate the standard free energy change for the reaction: $Fe_3O_{4(s)} + 4C_{(s)} \rightarrow 3Fe_{(s)} + 4CO_{(g)}$ and predict whether the reaction is spontaneous or not. ($\Delta \bar{G}_f^0$ (Fe_3O_4) $= -1014.2 kJmol^{-1}$; $\Delta \bar{G}_f^0$ (CO)$= -137.3 kJmol^{-1}$)
    (a) +465kJmol-1; non-spontaneous   (b) – 465kJmol-1; spontaneous
    (c) – 4655kJmol-1; spontaneous   (d) + 4655kJmol-1; non-spontaneous   [   ]

28. Which of the following conditions of enthalpy and entropy is true for a spontaneous process at low temperature?
    (a) $\Delta H > T\Delta S$ (b) $T\Delta S = \Delta H$ (c) $\Delta H < T\Delta S$ (d) NOTA   [   ]

29. Which of the following is true for entropy change of the universe for a spontaneous process?
    (a) $\Delta S < 0$ (b) $\Delta S > 0$ (c) $\Delta S = 0$ (d) $\Delta S \leq 0$ [   ]

30. Calculate the standard entropy change for the reaction: $2SO_{2(g)} + O_{2(g)} \rightarrow 2SO_{3(g)}$, if the $\Delta \bar{S}^0$ (SO_3)= 256JK^{-1}mol^{-1}; $\Delta \bar{S}^0$ (SO_2) = 248JK^{-1}mol^{-1}; $\Delta \bar{S}^0$ (O_2) = 205JK^{-1}mol^{-1}
    (a) + 189   (b) + 189JK^{-1} mol^{-1} (c) – 189JK^{-1}mol^{-1} (d) – 189kJK-1mol^{-1} [   ]

University of Nigeria, Nsukka
Department of Pure & Ind Chemistry   S/N
CHM 112 Basic Principles of Physical Chemistry   DEPT
2012/2013 Second Semester Examination   REG NO
Instructions: Attempt all questions. Any answer written in pencil or mutilated/cancelled is voided   SIGN

1. If a certain reaction has a specific rate constant of 0.002/s at 27 °C and 0.0013 /s at 127 °C, what is the activation energy for the reaction?

   a)418 9kJ/mol   b)41.84 kJ/mol c)102kJ/mol   d)23kcal/mol   [ ]

2. For the reaction, $H_2O_2 = H_2 + O_2$, the concentration of H_2O_2 that remained after 65min was 9 50ml while the initial concentration was 57.90ml. Calculate the rate constant.

   a) -0.0078/min   b) 0.0726/h   c) 1.66/min   d) 0.0276/min [ ]

3. Which of the following is correct about Raoul"s law?

   (A) $\Delta P / X_2 = P^\circ$ (B) $\Delta P = P^\circ X_1$ (C) $\Delta P / P = X_1$ (D) $P^\circ / P = 1 - X_2$ [ ]

4. A solution contains 15.8g of glucose, $C_6H_{12}O_6$ dissolved in 125g of water. What is the normal boiling point of the solution, given that the ebullioscopic constant is 0.45°C.

   (A) 373.54K (B) 373.32K (C) 373.68K (D) 0.32K   [ ]

5. Which one of these is TRUE?
   A. $V = 0.921U$ B. $c = \frac{2}{3}u$ C. $u = \sqrt{\frac{3RT}{M}}$ D. AOTA   [ ]

6. Calculate the root mean square speed of nitrogen molecules in a tank at 21 °C and 15.7 atm? [R=8.31 $kg.m^2s^{-2} K^{-1}Mol^{-1}$; N= 14]

                                                                                [ ]

   A. 479 ms^{-1} B. 147 ms^{-1} C. 200 ms^{-1} D. 512 ms^{-1}

7. An isolated system under investigation is

   A. Made up of the system alone B. Made up of the surrounding and the universe C. Made up of the universe and the system   D. Made up of the system and the surrounding.   [ ]

8. Using the standard free energies, calculate the equilibrium constant (K_p) for the following reaction at 25°C given that the standard free energy formation of HCl is 92.27 kJ/mol. Take R to be 8.314 J/K mol
   $$2HCl_{(g)} \longleftrightarrow H_{2(g)} + Cl_{2(g)}$$

   A. 7×10^{-84} B. 190.54×10^{-84} C. 3.98×10^{-84} D. -3.98×10^{-84} [ ]

9. Which of the following is true of the effect of temperature on degree of dissociation?

   a) It always lowers the percent degree of dissociation. b) It always increases the degree of dissociation c) It does not affect the degree of dissociation if the dissolution process is not endothermic. d) None of the above   [ ]

10. Find the percent degree of dissociation for a solution of pOH 7.3 if the k_a is 7.2×10^{-10} [assume extreme dilution].

    a. 0.06   b. 0.60   c.6.0   d.6.70   [ ]

11. For a Pure gas, the number of degrees of freedom, F is equal to
    (a) 2   (b) 1   (c) 3   (d) 6   [ ]

12. The actual volume of 1 molecule of a gas is less than the excluded volume by a factor of
    (a) Four   (b) Ten   (c) Twelve   (d) Eight

13. Which of the following is true for work done by the system (expansion)?

    (A) dw<0 (B) dw>0 (C) dw=0 (D) NOTA   [ ]

14. How many Joules of heat would be required to vaporize one mole of ethanol at its boiling point (78.5°C)? Specific heat of ethanol is 2.431 Jg⁻¹deg⁻¹ (C=12, H=1, O=16)

    (A) 393.06 kJmol⁻¹ (B) 29.6kJmol⁻¹ (C) 2.96kJmol⁻¹ (D) 39.3kJmol⁻¹   [ ]

15. Suppose at 100°C and at equilibrium a chemical reaction is represented by the following equation

$$A(g) + 2B(g) \rightleftharpoons 3C(g) + 4D(g)$$

If the equilibrium concentration, (A), (B), (C), and (D) are 1.5, 2.0, 2.5 and 3.0 moles/dm³ respectively, calculate the equilibrium constant.

    A. 210.94 B. 0.21   C. 2.11   D. 21.09   [ ]

16. The following equilibrium reactions,

$$A \underset{K_1}{\rightleftharpoons} B; \quad C \underset{K_2}{\rightleftharpoons} D; \quad A+C \underset{K_3}{\rightleftharpoons} B+D,$$

gave $K_1 = 1.6 \times 10^{-4}$ and $K_2 = 1.2 \times 10^5$; what is the value of K_3?

    A. 19.2   B. 1.92   C. 1.9   D. 192   [ ]

17. The equation that shows how the rate of reaction varies with the concentration of reactants ad products is the --- equation. a) elementary b) order c) rate law d) integral rate law   [ ]

18. The osmotic pressure of a solution made by dissolving 0.75g of a solute in 80cm³ of a solvent at 27°C is 2.85atm. Calculate the molecular weight of the solute

    (A) 88   (B) 78   (C) 81.8   (D) 150   [ ]

19. How many gram of oxygen molecule are there in a 25 litre tank at 100 °C when the oxygen pressure is 15 atm? [R=0.082 dm³ atm K⁻¹Mol⁻¹; O = 16]

    A. 104 g B. 200 g C. 143 g D. 392 g   [ ]

20. From the reaction $H_{2(g)} + Br_{2(g)} = 2HBr_{(g)}$, the entropy change of the system is
A. Zero B. Negative   C. Positive   D. None of the above   [ ]

21. Given a solution of molality 20.0moles/Kg, calculate the number of moles of dissociated solute contained in 50g of solution if the percent degree of dissociation is 0.1%.

    a. 1.0×10^{-3} b. 2.0×10^{-3} c. 1.0×10^{-4} d. 2.0×10^{-4} [ ]

22. Which of the following is true about phase rule.
(a) $C = S - n - m$ (b) $S = C - n - m$ (c) $m = C - S - n$ (d) $n = C - S - n$ [ ]

23. Which of the following explains a closed system?
(A) Mass remains constant but energy may change (B) Exchanges both matter and energy (C) Energy and matter cannot be exchanged (D) NOTA   [ ]

24. At 100°C the chemical reaction $A(g) + 2B(g) = 3C(g) + 4D(g)$ has the equilibrium concentrations of A, B, C, and D as 1.5, 2.0, 2.5 and 3.0 moleS/dm³ respectively. Calculate the equilibrium constant

    A. 0.21   B. 21.09   C. 210.94   D. 2.11   [ ]

Instructions: Attempt all questions. Any answer written in pencil or mutilated/cancelled is voided

1. For a certain zero order reaction, the rate constant was 1.76×10^{-3} mol/dm^3 per h. If the half life was found to be 244min, calculate the initial concentration of the reactant

a) 1.4×10^{-3} mol/dm^3/h b) 1.4×10^{-3} mol/dm^4/min c) 1.76×10^{-3} mol/dm^3/h d) 1.39×10^{-4} mol/dm^3/h   [ ]

2. A certain reaction was first order. After 19min, 42% of the reactant remained. Calculate the specific rate constant for the reaction

a) 4.6×10^{-3} b) 0.096/min c) 9.6×10^{-3} d) 0.046   [ ]

3. The half-life of a which reaction order reaction is directly dependent on the initial concentration of reactants.
   a) zero   b) first c) second d) NOTA   [ ]

4. Calculate the root mean square speed of carbon monoxide gas in a tank at 21 °C and 20 atm?
   [R=8.31 kg m^{2}s^{-2} K^{-1}Mol^{-1}; C=12, O = 16]

   A. 420 ms^{-1} B. 147 ms^{-1} C. 512 ms^{-1} D. 138 ms^{-1} [ ]

5. How many gram of oxygen molecule are there in a 25 litre tank at 100 °C when the oxygen pressure is 15 atm? [R=0.082 dm^3 atm K^{-1}Mol^{-1}; O = 16]

   A. 104 g   B. 200 g   C. 143 g   D. 392 g   [ ]

6. Which one of these is FALSE?
   A. $U = 0.921V$ B. $c = \frac{2}{3} U$ C. $u = \sqrt{\frac{3RT}{M}}$ D. $c = \sqrt{\frac{2RT}{M}}$ [ ]

7. Calculate the quantity of heat liberated if temperature of 250g of aluminum is changed from 22°C to 48°C. Specific heat of aluminum is 0.8954 Jg^{-1}deg^{-1}

   (A) 69631kJ.   (B) 66931J   (C) 65.6141   (D) 66931kJ   [ ]

8. Which of the following statements explains an isolated system?
   (A) Enclosed by an adiabatic wall   (B) Neither energy nor mass can be exchanged
   (C) dq=0   (D) AOTA   [ ]

9. Which of the following is true for an isothermal process?
   (A) dT>0 (B) dT=0 (C) dT<0 (D) NOTA   [ ]

10. A concentrated solution of HCl in water has a concentration of 43% by weight of the acid. If the density of the solution is 2.735gcm^{-3}, calculate the normality of the acid.

   (A) 27 (B) 32.22 (C) 0.80 (D) 0.48   [ ]

11. Which of the following expresses a colligative property
   (A) $\Delta T_f = K_f \times w_2/M_2 \times w_1/1000$ (B) $\Delta T_f = K_f \times 1000m$ (C) $\Delta P = w_2/w_1 \times M_1/M_2 \times P^o$ (D) $\Delta T_f = K_f m$ [ ]

12. A solution contains 21.8g of glucose, $C_6H_{12}O_6$ dissolved in 120g of water. What is the normal boiling point of the solution, given that the ebullioscopic constant is 0.57°C.

   (A) 373.42K (B) 0.58K (C) 373.54K (D) 373.58K   [ ]

13. How does the entropy change in evaporating a beaker of liquid bromine at room temperature?

   A. $\Delta S = 25°C$ B. $\Delta S = 0$ C. $\Delta S < 0$ D. $\Delta S > 0$ [ ]

14. From the reaction $N_{2(g)} + O_{2(g)} \longrightarrow 2NO_{(g)}$, the entropy change of the system is

   A. Zero   B. Negative   C. Positive   D. None of the above   [ ]

15. Using the standard enthalpies of formation (H⁺=0, OH⁻ = -230, and H_2O = -285.8) and standard entropies (H⁺=0, OH⁻ = -10.9, and H_2O = 70) of the following reactants and products, calculate the equilibrium constant (K_c) for the reaction at 25°C taking R to be 8.314 J/K mol.

   $H^+_{(aq)} + OH^-_{(aq)} \longrightarrow H_2O_{(l)}$
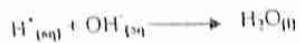
   A. 2.01×10^{14} B. -2.01×10^{14} C. -1.01×10^{14} D. 1.01×10^{14} [ ]

16. Calculate the volume of 2 moles of oxygen gas at a temperature of 40°c and 2 atm pressure using the ideal gas equation. $R = 0.082$ atmdm³k⁻¹mol⁻¹

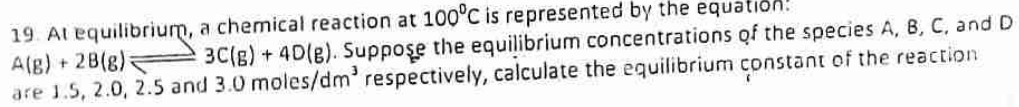   (a) 312 dm³   (b) 25 dm³   (c) 36dm³   (d) 405dm³   [ ]

17. Which of the following is not true?
(a) Induction force is small and independent of temp (b) Dipole –Dipole attraction is strongly independent of temp (c) London forces is independent of Temp (d) H_2O has a higher boiling point than H_2Se [ ]

18. All of the following are modes of cooling a gas except
(a) Expansion against a pressure gradient (b) Free expansion involving no external work
(c) Increase in volume of the gas (d) Lowering the temperature of the gas   [ ]

19. At equilibrium, a chemical reaction at 100°C is represented by the equation:
$A(g) + 2B(g) \rightleftharpoons 3C(g) + 4D(g)$. Suppose the equilibrium concentrations of the species A, B, C, and D are 1.5, 2.0, 2.5 and 3.0 moles/dm³ respectively, calculate the equilibrium constant of the reaction

   A 21.09   B 210.94   C 0.21   D 2.11   [ ]

20. The chemical reaction $N_2O(g) \rightleftharpoons 2NO_2(g)$ gave $K_c = 7.65 \times 10^{-3}$ mol⁻³, T = 500K at 1 atm. What is the K_p of the reaction? ($R = 0.082$ dm³ atm mol⁻¹k⁻¹)

   A. 0.313   B. 31.13   C. 3.13   D. 313.65   [ ]

21. For a certain zero order reaction, the initial concentration of the reactant was 0.860 mol/dm³. If the half life was found to be 244min, calculate the rate constant for the reaction.

   a) 1.39×10^{-4} mol/dm³/h b) 1.76×10^{-3} mol/dm³/min c) 1.76×10^{-3} mol/dm³/h d) 1.39×10^{-3} mol/dm³/min [ ]

22. A certain reaction was first order. After 9min, 24% of the reactant remained. Calculate the specific rate constant for the reaction.

   a) 0.1586   b) 0.046/min   c) 0.096/min   d) 0.0264/min   [ ]

23. What is the molecular weight of halothane which the density at 100 °C and 2 atm is 5.12 g/l? [R=0.0821 dm³ atm K⁻¹Mol⁻¹]

   A 116 g/mol   B. 78 g/mol   C. 197 g/mol   D. 147 g/mol   [ ]

24. Which of the following statements is true for a permeable wall?
(A) Neither energy nor mass can be exchanged (B) encloses an open system
(C) encloses an isolated system   (D) NOTA   [ ]

DEPARTMENT OF PURE AND IND.CHEMISTRY
CHM 112; BASIC PRIN. OF PHY. CHEM.
2009/2010 SECOND SEMESTER EXAMINATION
TIME ALLOWED : 1 HR 30 MINS
INSTRUCTION: DO NOT WRITE WITH PENCIL. ANY CANCELLATION VOIDS THE ANSWER.
NOTA = NONE OF THE ABOVE

DEPT -----------------
S/N-----------------
SIGN:........................

1. Every system must have a ----------
   (a) volatile liquid (b) Close metal can (c) Boundary (d) Thermally isolated vessel ( )

2. Heat absorbed in a process at constant pressure is equal to the change in enthalpy if only P-V work is done. This can be represented thus:
   (a) $\Delta H = \Delta E + P\Delta V$ (b) $q_p = \Delta H$ (c) $q_p = \Delta E$ (d) $q_p = P\Delta V$ ( )

3. Assuming that only P-V work is done, heat absorbed in a process at constant pressure equals the change in enthalpy this statement can be represented thus.
   (a) $qp = P\Delta V$ (b) $q_p = \Delta E$ (c) $\Delta H = \Delta E + P\Delta V$ (d) $q_p = \Delta H$ ( )

4. Calculate the work done in kilojoules when 40 moles of nitrogen expands isothermally and irreversibly at 25°C from 15 to 50 dm³ (Take R=8.314Jmol⁻ᴷk⁻¹)
   (a) 11.9kJ (b) 1193.4kJ (c) 119.34kJ (d) 119kJ . ( )

5. What is the relationship between the heat absorbed at constant pressure and the heat absorbed at constant volume for the same process?
   (a) $q_c = E_P + P\Delta V$ (b) $E_P = E_V + P\Delta V$ (c) $E_P = E_V - P\Delta V$ (d) $E_P = \Delta H$ ( )

6. Which of the following is true for free energy of an irreversible process at constant temperature and volume?
   (a) $\Delta A < 0$ (b) $\Delta G = 0$ (c) $\Delta A = 0$ (d) $\Delta G < 0$ ( )

7. Calculate the standard free energy change for the reaction $CH_{4(g)} + 2O_{2(g)} \rightarrow CO_{2(g)} + 2H_2O_{(l)}$ and predict the spontaneity of the reaction.
   $[\Delta \overline{G}_f^\circ (CH_4) = -50.8 kJmol^{-1}; \Delta \overline{G}_f^\circ (CO_2) = -394.4 kJmol^{-1}; \Delta \overline{G}_f^\circ (H_2O) = -237.2 kJmol^{-1}]$
   (a) -81.80kJmol⁻¹; spontaneous (b) + 8180.0kJmol⁻¹; non-spontaneous (c) -818.0kJmol⁻¹; spontaneous (d) 818.0kJmol⁻¹; non-spontaneous ( )

8. Which of following conditions of enthalpy and entropy is true for a spontaneous process at high temperature?
   (a) $\Delta H = T\Delta S$ (b) $\Delta H < T\Delta S$ (c) $T\Delta S < \Delta H$ (d) NOTA ( )

9. Which of following is true for entropy change of universe for a reversible process?
   (a) $\Delta S > 0$ (b) $\Delta S = 0$ (c) $\Delta S \leq 0$ (d) $\Delta S < 0$ ( )

10. Calculate the standard entropy change for the reaction $4Fe_{(s)} + 3O_{2} \rightarrow 2Fe_2O_{3(s)}$ given that the standard molar entropies of Fe = 27Jk⁻¹; Fe₂O₃ = 90Jk⁻¹
    (a) +543JK⁻¹ (b) -0.543JK⁻¹ (c) -543JK⁻¹ (d) -0.543JK⁻¹ ( )

11. Which one of these is not true
    (a) for two miscible liquids, C = 2, and P = 1
    (b) For saturated solution of a gas in a liquid, C = 2, P = 3
    (c) For the reaction $CaCO_{3(s)} \rightleftharpoons CaO_{(s)} + CO_{2(g)}$, P = 3 C = 2
    (d) The number of components in a system is given by the expression, C = S-n-m. ( )

12. 27g of methane dissolves in 1L of acetone at 1.0 atm pressure. If the partial pressure of methane is increased to 12 atm; what is its solubility in acetone.
    (a) 3.7g (b) 4.8g (c) 2.25g (d) 324g ( )

13. What is total vapour pressure of the solution containing 0.70mole fraction of benzene and 0.30mole fraction of toluene (vapour pressure of benzene and toluene are 75mmHg and 22mmHg respectively)
    (a) 59.1mmHg (b) 52.5mmHg (c) 6.6mmHg (d) 2.89mmHg ( )

14. What is the boiling point of the solution containing 6.78g of glucose in 100cm³ of water? K_b of water = 0.52°C/m; density of water = 1.0g/cm³ (C = 12, H = 1, O = 16)
    (a) 0.196°C (b) 99.80°C (c) 100.196°C (d) 100°C ( )

15. Which of these is not true of the effect of a solute that dissociate in solution?
    (a) The vapour pressure lowering increases (b) the molecular weight estimation increases (c) the freezing point depression increases (d) the boiling point elevation increases ( )

16. Magnesium hydroxide has solubility product of 9.8 x 10⁻¹⁰ .calculate its solubility in water.
    (a) 3.6 x 10⁴ (b) 6.3 x 10⁻⁴ (c) 6.3 x 10⁴ (d) 3.1 x 10⁻⁵. ( )

17. Which of the following is not correct?
    (a) $k_w = k_h k_b$ (b) $k_w = k_h / k_b$ (c) $k_h = k_h / k_b$ (d) NOTA ( )

18. Calculate Kx for the reaction: $N_2O_4 (g) \rightleftharpoons 2NO_2 (g)$ taking place at 300°C and 10atm, given that 14 is 0.571.

(a) 0.157   (b) 0.571   (c) 0.0571   (d) NOTA   ( )

19. Consider the reaction:

$$X + Y \xrightarrow[k_2]{k_1} Z$$, if k_1 is 2.5×10^{-5}, find the reciprocal of k_2:
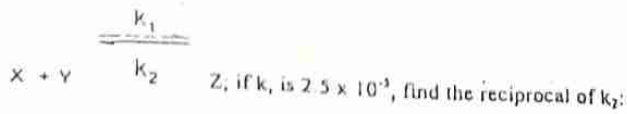
(a) 4.0×10^4 (b) 6.25×10^{-10} (c) 2.5×10^{-5} (d) 2.5×10^5 ( )
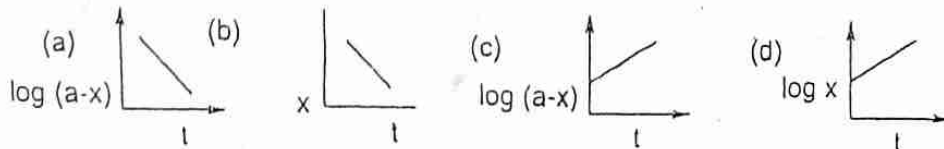
20. Which of the following is not a classical base?

(a) Na_2S (b) NH_3 (c) NH_4Cl (d) NH_4OH ( )

21. For the reaction $A \xrightarrow{k} B$ What is the differential equation for the formation of A. (a) $\frac{d[A]}{dt} = -k[A]$ (b) $\frac{d[B]}{dt} = k[A]$ (c) $\frac{-d[B]}{dt} = -k[A]$ (d) $\frac{-d[A]}{dt} = -k[A]$ ( )
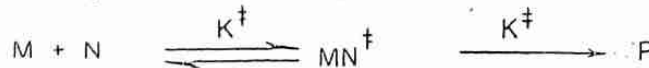
22. Which of the following graphs represent the graph of a first order reaction

( )

23. Molecularity of a chemical reaction is:
(a) A set of elementary reaction consistent with the stoichiometric reaction
(b) The way in which the rate of the reaction depends on the concentration.
(c) The number of reactant entities that group together to form the activated complex.
(d) The mechanism of a reaction   ( )

24. In the transition state theory, elementary reaction is represented as

$$M + N \xrightleftharpoons{K^{\ddagger}} MN^{\ddagger} \xrightarrow{K^{\ddagger}} P$$

The value of equilibrium constant is represented as (a) $\frac{d[k]}{dt} = \frac{k[MN^{\ddagger}]}{[M][N]}$ (b) $\frac{d[p]}{dt} = k^{\ddagger}[MN^{\ddagger}]$

(c) $k^{\ddagger} = \frac{[MN^{\ddagger}]}{[M][N]}$ (d) $k^{\ddagger} = \frac{[M][N]}{[MN^{\ddagger}]}$ ( )

25. Which of the following reaction is a first order reaction?
(a) $2HI_{(g)} \to H_{2(g)} + I_{2(g)}$ (b) $2N_2O_{5(g)} \leftrightarrow 4NO_{2(g)} + O_2(g)$
(c) $2NO_{(g)} \to 2NO_{(g)} + Cl_{2(g)}$ (d) NOTA   ( )

26. The following properties can be used to distinguish the three states of matter except:
(a) Diffusivity (b) Compressibility (c) Density (d) Odour   ( )

27. What is the density of a gas which exerts a pressure of 2 atm in a vessel at temperature of 100°C?
(Hints: molar weight of the gas = 46g.mol⁻¹; R = 0.082dm³atm.mol⁻¹kg⁻¹)
(a) 1.5gdm⁻³   (b) 1.5g.cm⁻³   (c) 3.0g.dm⁻³   (d) 3.0g.cm⁻³   ( )

28. What is the maximum temperature to which 20dm² flask containing 160g of oxygen can be heated, if the highest allowed pressure is 15.0atm?
(a) 720K   (b) 732K   (c) 738K   (d) 740K   ( )

29. The molecular speeds distribution of a gas at certain temperature (m.s⁻¹) is given by: f(c) dc= $10^{12}C^2$. e^{-6c2}. dc. estimate the value of the most probable speed (cp) of the gas from the molecular speeds distribution.
(a) 10^{-3}m.s⁻¹   (b) 10^{-4}m.s⁻¹   (c) 10^{-2}m.s⁻¹   (d) 10^{-6}m.s⁻¹   ( )

30. Which of the following is the correct expression for the average molar kinetic energy of a gas at temperature, t°C?
(a) $\overline{kE} = \frac{1}{2}Rt$ (b) $\overline{kE} = \frac{3}{2}Rt$ (c) $\overline{kE} = 3Rt$ (d) $\overline{kE} = \frac{3}{2}R(t+273)$ ( )

University of Nigeria, Nsukka
Department of Pure & Ind. Chemistry
CHM 112: Basic Principles of Physical Chemistry
2012/2013 Second Semester Examination

S/N
DEPT
REG NO
SIGN

Instructions: Attempt all questions. Any answer written in pencil or mutilated/cancelled is voided.

1. Calculate the half life of a zero order reaction with a specific rate constant of 8.2×10^{4} mol/dm^3/ hour and initial concentration of 0.470 mol/dm^3.

a) 2.866×10^{3}h   b) 2.866×10^{2}min   c) 0.286×10^{2} d) 5.73×10^{2}h   [ ]

2. A solution contains 19.5g of glucose, $C_6H_{12}O_6$ dissolved in 120g of water. What is the normal boiling point of the solution , given that the ebullioscopic constant is 0.75°C.

[ ]

(A) 0.68K   (B) 372.32K (C) 373.68K   (D) 273.68K

3. Calculate the root mean square speed of oxygen molecules in a tank at 21 °C and 15.7 atm? [R=8.31 kg m^{2}s^{-2} K^{-1}Mol^{-1}; O = 16]

[ ]

A. 280 ms^{-1} B. 479 ms^{-1} C. 183 ms^{-1} D. NOTA

4. How does the entropy of a system change forming sucrose crystals from a supersaturated solution?   [ ]
   A. $\Delta S<0$ B. $\Delta S>0$ C. $\Delta S=0$ D. None of the above

5. Which of the following equation is correct for compressibility factor   [ ]
   (a) $Z = V_m/_{RT}$ (b) $Z = V^o_m/_{PVM}$ (c) $Z = V_m/V^o_m$ (d) $Z = V^o_m/_{V_m}$

6. Calculate K$_c$ for the reaction $N_2O(g) \rightleftharpoons 2NO_2(g)$ with K_p = 0.357 at 400K and 1 atm (R = 0.082 dm^3 atm mol^{-1}K^{-1})

A. 1.088×10^{-5} mol.dm^{-3} B. 1.08×10^{-4} mol.dm^{-3} C. 1.09×10^{-3} mol.dm^{-3} B. 1.09×10^{-2} mol.dm^{-3} [ ]

7. Which of the following is true for heat absorbed by a system?   [ ]

(A) dq=0   (B) dq>0   (C) dq<0   (D) NOTA

8. Calculate the degree of dissociation of a 0.010M solution of A$_2$B, given that the freezing point depression is 0.0193°C and the molal freezing point constant K_f of water is 1.86°C.

3.76 x 10^{-2} b. 1.88 x 10^{-2} c. 5.64 x 10^{-2} d. 1.25 x 10^{-2} [ ]

9. The nature of a reaction is not fully understood until its' ---- is known

a) molecularity   b) rate constant   c) mechanism   d) activation energy   [ ]

10. Which of the following equation is correct about a very dilute solution?

(A) W_1/w_2 is large (b) w_2/w_1 is small (C) w_2+w_1 is small (D) $W_2 = W_1$ [ ]

11. Which one of these is TRUE?

A) All forms of matter obey the ideal gas laws B) All gases obey Boyle's law at very high pressure   C) All gases obey Boyle's law at high temperature D) All gases obey Boyle's law at very low pressure and very low temperature   [ ]

12. Using the standard free energies, calculate the equilibrium constant (K_P) for the following reaction at 25°C given that the standard free energy formation of water is 237.2 kJ/mol. Take R to be 8.314 J/K mol. $2H_2O_{(l)}$
$2H_{2(g)} + O_{2(g)}$

A. 7×10^{84} B. -7×10^{84} C. 10×10^{84} D. 12×10^{84}

13. Calculate the pressure for 2 moles of CO_2 gas in a $25dm^3$ vessel, using the ideal gas equation $R=0.082\ atmdm^3k^{-1}mol^{-1}$

     (a) 16 atm   (b) 2 atm   (c) 25 atm   (d) 16 atm   [   ]

14. The chemical reaction $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ at 740K has equilibrium constant, $K_p = 1.90 \times 10^{-4}$. Calculate ΔG^0 for the reaction (R = 8.314 J $mol^{-1}K^{-1}$)

    A. 52.73 kJ.mol^{-1} B. 5.27 kJ.mol^{-1} C. 527.25 kJ.mol^{-1} D. 0.53 kJ.mol^{-1} [   ]

15. Which of the following statements explains an open system?

(A) Prevents the passage of matter and energy (B) Enclosed by a permeable wall. (C)Allows the passage of energy but prevents the passage of matter   (D) AOTA   [   ]

16. If the solubility product constant of MX_2 is 1.2 x 10-14, calculate the solubility in distilled de-ionized water.

    3.00×10^{-5} b. 7.80×10^{-2} c. 4.80×10^{-4} d. 3.10×10^{-2} [   ]

17. The rate constant for the decomposition of 5-hydroxymethylfurfural at 120 °C is 1.173/h and 4.860/h at 140 °C. What is the activation energy in kcal/mol?

    a) 23cal/mol   b) 17.8kcal/mol   c) 23kcal/mol d) 23kJ/mol   [   ]

18. The osmotic pressure of a solution made by dissolving 0.83g of a solute in $75cm^3$ of a solvent at 25°C is 2.75atm. Calculate the molecular weight of the solute.

    (A) 147.5   (B) 98.3   (C) 3.85   (D) 40   [   ]

19. What is the molecular weight of halothane which the density at 71°C and 1.01 atm is 7.05 g/l? [R=0.0821 dm^3 atm $K^{-1}Mol^{-1}$]

    A. 197 g/mol   B. 179 g/mol   C. 147 g/mol D. NOTA   [   ]

20. From the reaction $2H_2(g) + O_{2(g)} \longrightarrow 2H_2O_{(l)}$, the entropy change of the system is

    A. Positive B. Negative   C. Zero   D. Greater than zero   [   ]

21. The excluded volume for a molecule of a gas is greater than the actual volume of the molecule of that gas by a factor of

    (a) 10   (b) 4   (c) 8   (d) 2   [   ]

22. Given the heat of combustion of ethane is -1559.88kJ and the heats of formation of liquid water and carbondioxide is -285kJ and - 393.5kJ respectively. Calculate the heat of formation of ethane

    (A) 1630.32J   (B) 8.45k J   (C) 84500J   (D) -1630.32kJ   [   ]

23. Which of the following represents the value of K_a for which the acids are 100 percent dissociated in solution?

    a. $k_a \geq 10$ b. $k_a \leq 10$ c. $k_a \geq 1$ d. $k_a > pk_a$ [   ]