PRACTICE PROBLEMS FOR TEST 2 (March 11, 2009)

1) What is the overall order of the following reaction, given the rate law?

$$2NO(g) + H_2(g) \rightarrow N_2(g) + 2H_2O(g) \qquad \text{Rate} = k[NO]^2[H_2]$$

A) 1st order
B) 2nd order
C) 3rd order
D) 4th order
E) 0th order

Answer: C

2) Given the following rate law, how does the rate of reaction change if the concentration of Y is doubled?

$$\text{Rate} = k\,[X][Y]^2$$

A) The rate of reaction will increase by a factor of 2.
B) The rate of reaction will increase by a factor of 4.
C) The rate of reaction will increase by a factor of 5.
D) The rate of reaction will decrease by a factor of 2.
E) The rate of reaction will remain unchanged.

Answer: B

3) Determine the rate law and the value of k for the following reaction using the data provided.

$$S_2O_8^{2-}(aq) + 3\,I^-(aq) \rightarrow 2\,SO_4^{2-}(g) + I_3^-(aq)$$

$[S_2O_8^{2-}]_i$ (M)	$[I^-]_i$ (M)	Initial Rate ($M^{-1}s^{-1}$)
0.30	0.42	4.54
0.44	0.42	6.65
0.44	0.21	3.33

A) Rate = 120 $M^{-2}s^{-1}$ $[S_2O_8^{2-}]^2[I^-]$

B) Rate = 36 $M^{-1}s^{-1}$ $[S_2O_8^{2-}][I^-]$

C) Rate = 86 $M^{-2}s^{-1}$ $[S_2O_8^{2-}][I^-]^2$

D) Rate = 195 $M^{-3}s^{-1}$ $[S_2O_8^{2-}]^2[I^-]^2$

E) Rate = $23\ M^{-1/2}s^{-1}\ [S_2O_8^{2-}][I^-]^{1/2}$

4) Which of the following represents the integrated rate law for a first-order reaction?

A) $\ln\frac{[A]t}{[A]o} = -kt$

B) $\frac{1}{[A]t} - \frac{1}{[A]o} = kt$

C) $[A]t - [A]o = -kt$

D) $k = Ae^{\left(-\frac{Ea}{RT}\right)}$

E) $\ln\frac{k_2}{k_1} = \frac{Ea}{R}\left(\frac{1}{T}\right) + \ln A$

Answer: A

5) What data should be plotted to show that experimental concentration data fits a first-order reaction?

A) 1/[reactant] vs. time
B) [reactant] vs. time
C) ln[reactant] vs. time
D) ln(k) vs. 1/T
E) ln(k) vs. E_a

Answer: C

6) The first-order decay of radon has a half-life of 3.823 days. How many grams of radon remain after 7.22 days if the sample initially weighs 250.0 grams?

A) 4.21 g
B) 183 g
C) 54.8 g
D) 76.3 g
E) 67.5 g

Answer: E

7) The first-order decomposition of N_2O_5 at 328 K has a rate constant of $1.70\times10^{-3}s^{-1}$. If the initial concentration of N_2O_5 is 2.88 M, what is the concentration of N_2O_5 after

12.5 minutes?

A) 0.124 M
B) 0.805 M
C) 2.82 M
D) 0.355 M
E) 0.174 M

Answer: B

8) The second-order decomposition of HI has a rate constant of $1.80 \times 10^{-3} M^{-1}s^{-1}$. How much HI remains after 27.3 s if the initial concentration of HI is 4.78 M?

A) 4.55 M
B) 0.258 M
C) 3.87 M
D) 2.20 M
E) 2.39 M

Answer: C

9) The half-life for the second-order decomposition of HI is 15.4 s when the initial concentration of HI is 0.67 M. What is the rate constant for this reaction?

A) $1.0 \times 10^{-2} M^{-1}s^{-1}$
B) $4.5 \times 10^{-2} M^{-1}s^{-1}$
C) $9.7 \times 10^{-2} M^{-1}s^{-1}$
D) $2.2 \times 10^{-2} M^{-1}s^{-1}$
E) $3.8 \times 10^{-2} M^{-1}s^{-1}$

Answer: C

10) Derive an expression for a "1/3-life" for a first-order reaction.

A) $\dfrac{\ln \dfrac{[A]t}{[A]o}}{-k}$
B) $\dfrac{0.462}{k}$
C) $\dfrac{\ln \dfrac{[A]t}{[A]o}}{-3k}$

D) $\frac{1.099}{k}$

E) $\frac{3}{k}$

Answer: D

11) MIX AND MATCH

61) k	A) frequency factor
62) $t_{\frac{1}{2}}$	B) activation energy
63) E_a	C) half-life
64) A	D) reaction order
65) *n*, in Rate = k[A]^n	E) rate constant

Answer:

61 – E
62 – C
63 – B
64 – A
65 – D

12) Which of the following compounds will be most soluble in ethanol (CH_3CH_2OH)?

A) trimethylamine ($N(CH_3)_3$)
B) acetone (CH_3COCH_3)
C) ethylene glycol ($HOCH_2CH_2OH$)
D) hexane ($CH_3CH_2CH_2CH_2CH_2CH_3$)
E) None of these compounds should be soluble in methanol.

Answer: C

13) Determine the solubility of N_2 in water exposed to air at 25°C if the atmospheric pressure is 1.2 atm. Assume that the mole fraction of nitrogen is 0.78 in air and the Henry's law constant for nitrogen in water at this temperature is 6.1×10^{-4} M/atm.

A) 1.5×10^{-4} M
B) 6.5×10^{-4} M
C) 5.7×10^{-4} M
D) 1.8×10^{-4} M
E) 3.6×10^{-4} M

Answer: C
14) Which of the following concentration units are temperature dependent?

A) Mole fraction
B) Molality
C) Mass percent
D) Molarity
E) None of the above.

Answer: D
15) Calculate the molality of a solution formed by dissolving 27.8 g of LiI in 500.0 mL of water.

A) 0.254 *m*
B) 0.394 *m*
C) 0.556 *m*
D) 0.241 *m*
E) 0.415 *m*

Answer: E

16) Calculate the molality of a solution that is prepared by mixing 25.5 mL of CH_3OH (d= 0.792 g/mL) and 387 mL of $CH_3CH_2CH_2OH$ (d= 0.811 g/mL).

A) 0.630 *m*
B) 0.812 *m*
C) 1.57 *m*
D) 2.01 *m*
E) 4.98 *m*

Answer: D

17) Commercial grade HCl solutions are typically 39.0% (by mass) HCl in water. Determine the molality of the HCl, if the solution has a density of 1.20 g/mL.

A) 39.0 *m*
B) 17.5 *m*
C) 6.39 *m*
D) 10.7 *m*
E) 9.44 *m*

Answer: B

18) An aqueous solution is 0.387 M in HCl. What is the molality of the solution if the density is 1.23 g/mL?

A) 0.115 *m*
B) 0.387 *m*
C) 0.315 *m*
D) 0.411 *m*
E) 0.318 *m*

Answer: E

19) A solution is prepared by dissolving 38.6 g sucrose ($C_{12}H_{22}O_{11}$) in 495 g of water. Determine the mole fraction of sucrose if the final volume of the solution is 508 mL.

A) 4.09×10^{-3}
B) 7.80×10^{-2}
C) 1.28×10^{-3}
D) 7.23×10^{-2}
E) 2.45×10^{-3}

Answer: A

20) Calculate the mole fraction of total ions in an aqueous solution prepared by dissolving 0.400 moles of $MgCl_2$ in 850.0 g of water.

A) 0.00841
B) 0.0254
C) 0.00848
D) 0.0248
E) 0.0167

Answer: D

21) Determine the vapor pressure of a solution at 25°C that contains 76.6 g of glucose ($C_6H_{12}O_6$) in 250.0 mL of water. The vapor pressure of pure water at 25°C is 23.8 torr.

A) 70.8 torr
B) 72.9 torr
C) 23.1 torr
D) 22.9 torr
E) 7.29 torr

Answer: C

22) Determine the vapor pressure of a solution at 55°C that contains 34.2 g NaCl in 375 mL of water. The vapor pressure of pure water at 55°C is 118.1 torr.

A) 115 torr
B) 87.1 torr
C) 108 torr
D) 112 torr
E) 92.8 torr

Answer: D

23) Determine the freezing point depression of a solution that contains 30.7 g glycerin ($C_3H_8O_3$, molar mass = 92.09 g/mol) in 376 mL of water. Some possibly useful constants for water are K_f = 1.86°C/*m* and K_b = 0.512°C/*m*.

A) 0.887°C
B) -1.65°C
C) 3.33°C
D) -3.33°C
E) 0.654°C

Answer: B

24. When a solute such as ammonium sulfate is dissolved in a solvent like water, one of the observed effects is

    ! a. a decrease in the vapor pressure of the solvent
    b. an increase in the vapor pressure of the solute
    c. an increase in the melting point of the liquid
    d. a decrease in the boiling point of the liquid
    e. scattering of light beams by the solute particles in the solution

25. At 28.0 ^{o}C, the vapor pressure of *n*-propyl mercaptan, C_3H_7SH, is 175 torr, while that of acetonitrile, CH_3CN, is 102 torr. What is the vapor pressure, at 28.0 ^{o}C, of a solution made by mixing 100.0 g of C_3H_7SH and 100.0 g CH_3CN, if Raoult's Law is obeyed?

    a. 35.7 torr
    ! b. 128 torr
    c. 139 torr
    d. 149 torr
    e. 277 torr