Exam 3
Chem 1121
Fall 2009

Name: KEY

Show all work to receive credit.

Q1. [10 pts.] Balance the following equations using the lowest whole-number coefficients:

a) The oxidation of ethyl alcohol to acetic acid:

$$2\,C_2H_6O(l) + 1\,O_2(g) \longrightarrow 2\,C_2H_6O_2(l)$$

b) The combustion of butane:

$$2\,C_4H_{10}(g) + 13\,O_2(g) \longrightarrow 8\,CO_2(g) + 10\,H_2O(l)$$

c) The anaerobic fermentation of sugar:

$$1\,C_6H_{12}O_6(s) \longrightarrow 2\,C_2H_6O(l) + 2\,CO_2(g)$$

Q2. [9 pts.] Convert the following masses to moles. Show ALL work!

a) 34.5 g urea, N_2H_4CO

N_2H_4CO

$2\times N = 2\times 14.01$
$4\times H = 4\times 1.01$
$1\times C = 1\times 12.01$
$1\times O = 1\times 16.00$
60.07

$$34.5\,g\ N_2H_4CO \times \frac{1\ mol\ N_2H_4CO}{60.07\,g\ N_2H_4CO} = 0.574\ mol\ N_2H_4CO\ (3\ s.f.)$$

b) 24.4 g vitamin C, $C_6H_8O_6$

$C_6H_8O_6$

6×12.01 (C)
8×1.01 (H)
6×16.00 (O)
176.14

$$24.4\,g\ C_6H_8O_6 \times \frac{1\ mol\ C_6H_8O_6}{176.14\,g\ C_6H_8O_6} = 0.139\ mol\ C_6H_8O_6$$

Q3. [5 pts.] How many moles of formaldehyde are in 24.5 mL of a solution whose molar concentration is 0.350 M? Show all work.

$$0.350\,M = \frac{0.350\ mol}{1\,L} \Rightarrow 24.5\,mL \times \frac{1\,L}{1000\,mL} \times \frac{0.350\ mol}{1\,L} = 0.00858\ mol\ formald$$
(3 s.f.)

Q4. [8 pts.] A sample of gas with a pressure of 452 mmHg and a volume of 3.2 L is compressed until its new volume is 0.89 L. What will its pressure become? (Assume the temperature does not change.)

$$P_1V_1 = P_2V_2 \Rightarrow P_2 = \frac{P_1V_1}{V_2} = \frac{452\,mmHg \times 3.2\,L}{0.89\,L} = 1600\,mmHg \quad (2\ s.f.)$$

Q5. [8 pts.] A cylinder of hairspray with a pressure of 1.01 atm at a temperature of 15 °C is thrown onto a fire whose temperature is 581 °C. What will the pressure of the hairspray change to?

$$\frac{P_1}{T_1} = \frac{P_2}{T_2} \Rightarrow P_2 = \frac{P_1 \times T_2}{T_1} = \frac{1.01\,atm \times 854\,K}{288\,K} = 2.99\,atm.$$

$15 + 273 = 288\,K$

$581 + 273 = 854\,K$

Q6. Urea breaks down via the following unbalanced chemical equation:

$$1\,N_2H_4CO + 1\,H_2O \longrightarrow 2\,NH_3 + 1\,CO_2$$

a) [4 pts.] Balance the chemical equation using the lowest set of whole number coefficients.

b) [4 pts.] How many moles of NH_3 are formed from the complete reaction of 3.4 mol urea, N_2H_4CO? Show all work. Be sure to use the conversion-factor (factor-label) method.

$$3.2\,mol\ N_2H_4CO \times \frac{2\,mol\ NH_3}{1\,mol\ N_2H_4CO} = 6.4\,mol\ NH_3 \quad (2\,s.f.)$$

c) [8 pts.] How many grams of NH_3 can be formed from the complete break-down of 15.1 g urea, N_2H_4CO? Show all work. Be sure to use the conversion-factor (factor-label) method.

NH_3

$1 \times N = 1 \times 14.01$
$3 \times H = 3 \times 1.01$
17.04

N_2H_4CO

$2 \times N = 2 \times 14.01$
$4 \times H = 4 \times 1.01$
$1 \times C = 1 \times 12.01$
$1 \times O = 1 \times 16.00$
60.07

(1) $15.1\,g\ N_2H_4CO \times \frac{1\,mol\ N_2H_4CO}{60.07\,g\ N_2H_4CO} = 0.251\,mol\ N_2H_4$

(2) $0.251\,mol\ N_2H_4CO \times \frac{2\,mol\ NH_3}{1\,mol\ N_2H_4CO} = 0.502\,mol\ NH_3$

(3) $0.502\,mol\ NH_3 \times \frac{17.04\,g\ NH_3}{1\,mol\ NH_3} = 8.55\,g\ NH_3$

Q7. [8 pts.] Define the following terms:

a) Saturated solution

Max solute dissolved for given amount of solvent.

b) Unsaturated solution

Less than " ——————————— "

c) Supersaturated solution

More than " ——————————— " (unstable!)

d) Aqueous solution

Water is the solvent.

Q8. [4 pts.] How does adding an ionic compound, such as ammonium nitrate, NH_4NO_3, to water affect its boiling point and freezing point?

a) Effect upon boiling point

increases

b) Effect upon freezing point

decreases

Q9. [10 pts.] Using the ideal gas equation, calculate the pressure that 1.4 g of CH_4 will exert at a temperature of 0 °C and a volume of 1.03 L.

$pV = nRT \Rightarrow p = \frac{nRT}{V}$

CH_4

$1 \times C = 1 \times 12.01$

$4 \times H = 4 \times 1.01$

16.05

$1.4\,g\ CH_4 \times \frac{1\,mol\ CH_4}{16.05\,g\ CH_4} = 0.087\,mol\ CH_4$ (n)

$T = 0 + 273 = 273\,K$

$\Rightarrow p = \frac{0.087\,mol \times 0.08206\,\frac{atm \cdot L}{mol \cdot K} \times 273\,K}{1.03\,L}$

$= 1.9\,atm.$ (2 s.f.)

RBC

Q10. [1 pt.] What will happen if a red blood cell is added to a *hypotonic* solution?

It will swell, and possibly explode! (Hemolysis)

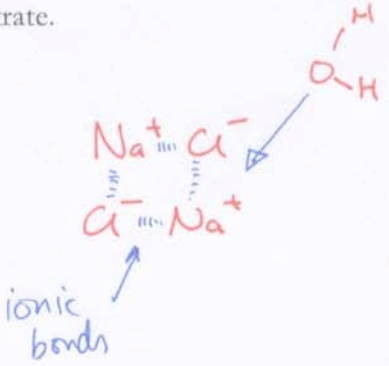
[4 pts.] Explain why.

Hypotonic = lower solute conc than inside of cell
⇒ higher water conc " " "

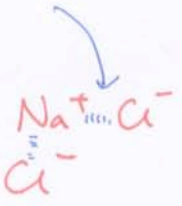
RBC has a cell wall (membrane) that is semi-permeable. Only H_2O can diffuse through it ⇒ H_2O diffuses inwards (OSMOSIS!) since conc is higher outside.

Q11. [9 pts.] What are the three steps involved in the dissolving of an ionic compound, such as NaCl? Draw pictures to illustrate.

i) Collision

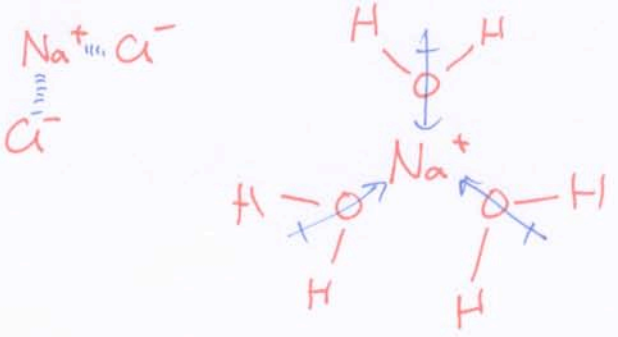


ii) Dissociation



Na^+

iii) Solvation



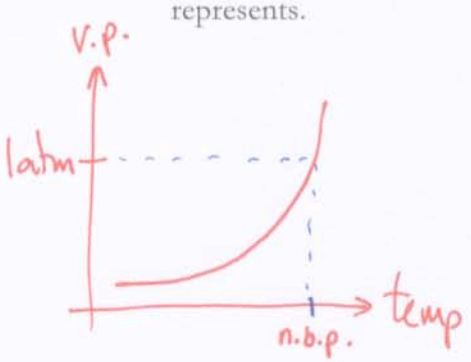
negative end of H_2O solvates positive Na^+ cation.

Q12. (i) [2 pts.] What is meant by the term: vapor pressure?

pressure of gas above liquid.

ii) [6 pts.] Sketch a graph of vapor pressure vs. temperature. Label your axes. Explain how you can use your graph to determine the *normal boiling point* of the substance it represents.

n.b.p.



n.b.p. is when v.p. equals normal atmospheric pressure (1atm.)

ex: Autoclave / pressure cooker

note: as atmospheric pressure ↑, b.p. ↑

and as atmospheric pressure ↓, b.p. ↓

ex: extended cooking times at high elevations.

BONUS QUESTION:

Ringer's solution, used in the treatment of burns and wounds, is prepared by dissolving 8.6 g NaCl, 0.3 g KCl, and 0.33g $CaCl_2$ in water and diluting to a volume of 1.00 L.

What is the molarity of each component?

$$\text{molarity} = \frac{\#\text{mol solute (mol)}}{\text{volume solution (L)}}$$

NaCl

$1\times Na = 1\times 22.99$

$1\times Cl = 1\times 35.45$

58.44

$$\Rightarrow \#\text{mol NaCl} = 8.6\text{g NaCl} \times \frac{1\text{mol NaCl}}{58.44\text{g NaCl}} = 0.15\text{mol NaCl (2s.f)}$$

$$\Rightarrow \#\text{mol KCl} = 0.3\text{g KCl} \times \frac{1\text{mol KCl}}{74.55\text{g KCl}} = 0.004\text{mol KCl}$$

$$\Rightarrow \#\text{mol } CaCl_2 = 0.33\text{g } CaCl_2 \times \frac{1\text{mol } CaCl_2}{110.98\text{g } CaCl_2} = 0.0030\text{mol } CaCl_2$$

KCl

$1\times K = 1\times 39.10$

$1\times Cl = 1\times 35.45$

74.55

$$\Rightarrow [NaCl] = \frac{\#\text{mol}}{\#\text{L}} = \frac{0.15\text{mol}}{1.00\text{L}} = 0.15\ \frac{\text{mol}}{\text{L}} \text{ or } M$$

$$[KCl] = \frac{0.004\text{mol}}{1.00\text{L}} = 0.004\,M$$

$CaCl_2$

$1\times Ca = 1\times 40.08$

$2\times Cl = 2\times 35.45$

110.98

$$[CaCl_2] = \frac{0.0030\text{mol}}{1.00\text{L}} = 0.0030\,M$$