Chem 1121
Spring 2012
Exam 5A

Name: KEY

Multiple Choice. Select the best answer, and record your response on a scantron sheet.

Q1. [4 pts] Which of the following equations is Avogadro's law?
a) $p \propto V$ b) $V \propto T$ c) $V \propto n$ d) $p \propto 1/V$ e) $p \propto 1/T$

Q2. [4 pts] The partial pressure of a substance above its liquid is known as:
a) vapor pressure b) barometric pressure c) ideal pressure
d) boiling point e) osmotic pressure

Q3. [4 pts] A reaction that absorbs heat is called:
a) dynamic b) catalyzed c) explosive d) endothermic e) non-ideal

Q4. [4 pts] A reaction with a high activation energy will be:
a) fast b) slow c) exothermic

Q5. [4 pts] What can you say about a reaction at equilibrium:
a) the molecules are no longer reacting
b) the activation energy has been reduced to zero
c) the rate of the forward reaction is zero
d) the rate of the forward reaction equals the rate of the reverse reaction
e) Le Chatelier's principle no longer applies

Q6. [4 pts] What is the Arrhenius definition of a base:
a) proton donor b) proton acceptor c) releases H^+ in solution
d) releases OH^- in solution e) turns litmus blue

Q7. [4 pts] Which of the following molecules is probably a triprotic acid?
a) HC_2H_2O b) H_2SO_4 c) H_3PO_4 d) HCO_2H e) H_2CO_3

Q8. [4 pts] An aqueous solution at 25 °C with $[H^+] = 1.0 \times 10^{-8}$ M is:
a) acidic b) neutral c) basic d) a buffer e) not enough information

pH = 8.00 (>7 means basic, <7 means acidic)

Q9. [4 pts] What is the pOH of a solution if $[H^+] = 1.0 \times 10^{-6}$
a) 5.00 b) 6.00 c) 7.00 d) 8.00 e) 9.00

$pH = -\log[H^+] = 6.00$
$pH + pOH = 14.00$

Q10. [4 pts] Which radioactive particle is strongly repelled by a negatively charged plate?
a) alpha b) beta c) gamma d) delta e) epsilon

$\beta = {}^{0}_{-1}e^-$ ← negative ⇒ will be repelled by -ve plate

Q11. [4 pts] Cobalt-60 ($^{60}_{27}Co$) undergoes beta decay. What is the identity of the daughter atom formed?
a) $^{60}_{29}Cu$ b) $^{64}_{29}Cu$ c) $^{56}_{25}Mn$ d) $^{61}_{27}Co$ e) $^{60}_{28}Ni$

20 years = 2 × half-lives!

⇒ 100% × $\frac{1}{2}$ × $\frac{1}{2}$ = 25%

Q12. [4 pts] Hydrogen-3 has a half life of approximately ten years. What percent of a sample of hydrogen-3 will remain after twenty years?

a) 100 % b) 50 % c) 25 % d) 10 % e) 0 %

Show all work to receive credit. You must use the factor-label (conversion-factor) method for all conversions. Be sure to show all units and write your answers using the correct number of significant figures or decimal places.

Q13. [10 pts] What volume will 23.4 g of $NH_3(g)$ occupy at a pressure of 1.20 atm and a temperature of –5 °C?

$PV = nRT \Rightarrow V = \frac{nRT}{P}$

NH_3

$1 \times N = 14.01$

$3 \times H = 3 \times 1.01$

17.04

$23.4\,g\ NH_3 \left| \frac{1\ mol\ NH_3}{17.04\,g\ NH_3} \right. = 1.37\ mol\ NH_3$ (n)

(T) $= 273 - 5 = 268\,K$

$\Rightarrow V = \frac{nRT}{P} = \frac{1.37\ mol \times 0.08206 \frac{atm \cdot L}{mol \cdot K} \times 268\,K}{1.20\ atm}$

$= 25.1\ L$ (3 s.f.)

Q14. [10 pts] Consider the following reaction at equilibrium:

$$2CH_4(g) + 2NO(g) \rightleftharpoons 2CO(g) + 2NH_3(g) + H_2(g) + \text{heat}$$

Which direction (left, right, or no change) will the equilibrium shift when:

a) The amount of NO(g) is decreased: LEFT (to make more NO!)

b) The pressure is increased: LEFT (to lower pressure by making fewer molecules!)

c) The amount of $H_2(g)$ is decreased: RIGHT (to make more H_2)

d) The temperature is increased: LEFT (to remove heat)

e) The amount of CO(g) is increased: LEFT (to make less CO)

Q15. [10 pts] Calculate the pH of the following solutions:

Be sure to show ALL work! Answers that do not show work will not receive any credit. ☹

a) 0.25 M $HNO_3(aq)$ ⟶ $H^+(aq)$ + $NO_3^-(aq)$

0.25M → 0.25M, 0.25M

(2s.f.) conc (2 d.p.) pH

$pH = -\log[H^+] = -\log[0.25] = \boxed{0.60}$

b) 0.35 M $Mg(OH)_2(aq)$ ⟶ $Mg^{2+}(aq)$ + $2OH^-(aq)$

0.35M → 0.35M, 0.70M

$pOH = -\log[OH^-] = -\log[0.70] = 0.15$

$\Rightarrow pH + pOH = 14.00$

$\Rightarrow pH = 14.00 - pOH = 14.00 - 0.15 = \boxed{13.85}$

c) 0.25 M $HC_2H_3O_2(aq)$, a weak acid that undergoes 3.0 % dissociation.

$HC_2H_3O_2(aq) \rightleftharpoons H^+(aq) + C_2H_3O_2^-(aq)$

0.25M ⟶ $\frac{3.0}{100} \times 0.25M$ ...

$\Rightarrow [H^+] = 0.0075M$

$\Rightarrow pH = -\log[H^+] = 2.12$

Q16. [10 pts] Write the balanced nuclear equation for the alpha-decay of Polonium-210. (Polonium is element number 84, Po)

$^{210}_{84}Po \longrightarrow {}^{206}_{82}Pb + {}^{4}_{2}He$

Q17. [5 pts] Carbonic acid, H_2CO_3 is a weak diprotic acid. What does diprotic mean? Write out chemical equations that show the dissociation reactions of carbonic acid in water.

diprotic means it can lose $2H^+$ / molecule.

weak ⇒ all rxns are equil!

$$H_2CO_3(aq) \rightleftharpoons H^+(aq) + HCO_3^-(aq)$$

$$HCO_3^-(aq) \rightleftharpoons H^+(aq) + CO_3^{2-}(aq)$$

Q18. [7 pts] What does a buffer do? How is it made?

A buffer is a solution that resists changes in pH when small amounts of acids/bases are added to them.

Buffers are made from solutions containing both a weak acid and its conjugate base.

BONUS Question:

Explain why liquids boil at a lower temperature when atmospheric pressure is reduced?

liquids boil when their vapor pressure equals atmospheric pressure. if atmospheric pressure is reduced, then the b.p. ↓ since a lower T generates a pressure equal to the new atmospheric pressure.