Solutions to Chm139 Exam April 2006

PART A: Multiple Choice Questions

1. B
2. A
3. D
4. Based on PV = nRT in which P = 12.8/760 atm, V = 5 L, R = 0.08206, T = 288 K. Sub the numbers into the equation, n = 0.003563 mol. The mass of water vapour = 18n = 0.064 g. The mass of water remains in the liquid phase should be 10 g – 0.064 g = 9.936 g, this answer is not in the list.
5. The energy of the photon with a wavelength of $5x10^{-7}$ m= $E_{photon} = h\nu = hc/\lambda = 6.626x10^{-34}$ $x3x10^{8}$ / $5x10^{-7}$ = $3.9756x10^{-19}$ J.
The total energy emitted by a 60-watt source = E_{total} = 60x12x60x60 = 2592000 J
The number of photons produced = E_{total} / E_{photon} = $6.520x10^{24}$
6. C.
7. the rate law should be: rate = k $[A]^2$. The answer is D.
8. D
9. B
10. A
11. B
12. B
13. E
14. E
15. A
16. E
17. B
18. C
19. E
20. D
21. B
22. A
23. B
24. A
25. E
26. B
27. C
28. E
29. D
30. D

Part B – Short Answer Questions

Summary of the Three Kinds of Packing for Spheres

Unit cell	Primitive cubic	Body centered cubic	Face centered cubic
Structure	Simple cubic	Body centered cubic	Cubic closest packed
Stacking pattern	a-a-a-a-a-	a-b-a-b-	a-b-c-a-b-c-
Coordination number	6	8	12
Atom(s) per unit cell	1	2	4
Atomic radius (r) and length of unit cell (a)	2r = a	$4r = \sqrt{3}a$	$4r = \sqrt{2}a$
Packing efficiency calculation	$\frac{4\pi r^3}{3} \div a^3 = 52\%$	$2 \times \frac{4\pi r^3}{3} \div a^3 = 68\%$	$4 \times \frac{4\pi r^3}{3} \div a^3 = 74\%$
Density Calculation	$\frac{MM}{N_A} \div a^3$	$2 \times \frac{MM}{N_A} \div a^3$	$4 \times \frac{MM}{N_A} \div a^3$

Calculate the a value for three different kinds of packing

Unit cell	Primitive cubic	Body centered cubic	Face centered cubic
Atomic radius (r) and length of unit cell (a)	2r = a	$4r = \sqrt{3}a$	$4r = \sqrt{2}a$
Density Calculation	$\frac{MM}{N_A} \div a^3$	$2 \times \frac{MM}{N_A} \div a^3$	$4 \times \frac{MM}{N_A} \div a^3$
R = 197×10^{-12} m, a =	3.94×10^{-10} m	4.55×10^{-10} m	5.57×10^{-10} m
MM = 40.08 g, d =	1.09 g/cm^3	1.41 g/cm^3	1.54 g/cm^3

It is cubic closest packed structure and the unit cell is face centered cubic

2. a) $NH_4^+ + H_2O \leftrightarrow NH_3 + H_3O^+$

b) This is a buffer solution and the pH equation can be directly used.

$PH = pKa + \log (n_{base} / n_{acid})$

$8.9 = (14 - pKb) + \log (1.25 \times 0.25 / n_{acid})$

$8.9 = 9.255 + \log (0.3125 / n_{acid})$

$n_{acid} = 0.708$ mol

MM of NH_4Cl = 18 + 35.45

M = 37.8 g

c) The buffer solution prepared in part (b) has 0.25 x1.25 = 0.3125 mol base NH_3

$HCl + NH_3 = NH_4Cl$

0.3125 mol base NH_3 would require 0.3125 mol HCl

because the concentration of HCl = 2.0 M

the volume = 0.15625 L = 160 mL

d) the solution is acidic at the equivalence point because the solution is purely NH_4Cl at the equivalence point. NH_4Cl will ionize completely to form NH_4^+ . This is a weak acid and it ionizes in water to make the solution acidic.

$NH_4^+ + H_2O \leftrightarrow H_3O^+ + NH_3$

3. a) $\Delta H^o = 31$ kJ
$\Delta S^o = 0.06645$ kJ/K
$\Delta G^o = 11.2$ kJ
Because ΔG^o is positive at this temperature, the reaction is not spontaneous. There is no point to look for a catalyst because catalyst can't make a non spontaneous reaction become spontaneous. It can only make a spontaneous reaction go faster.
b) at equilibrium $\Delta G^o = \Delta H^o - T\,\Delta S^o = 0$
$T = \Delta H^o / \Delta S^o = 467$ K $= 194^oC$
c) $\Delta G^o = -RT\ln K$
$11200 = -8.314\,(298)\ln K$
$\ln K = -4.52$
$K = 0.0109$

4. a) Anode reaction: $Fe \rightarrow Fe^{2+} + 2e$
cathode reaction: $Fe^{3+} + e \rightarrow Fe^{2+}$
cell reaction: $Fe + 2\,Fe^{3+} \rightarrow 3\,Fe^{2+}$
b) i) anode used Fe and cathode used Pt
ii) electrons flow from anode to cathode through the wire
iii) the positive ions flow toward cathode and negative ions flow toward anode in the salt bridge
iv) $Fe(NO_3)_2$ is in the beaker where Fe bar is used as the electrode;
$Fe(NO_3)_2$ and $Fe(NO_3)_3$ are in the beaker where Pt is used as the electrode.