① $\Delta G_R^\circ = \left(\cancel{230.3}^{203,3} + 105.7 + 1312 - 349\right)_{kJ/mol} + \Delta G^\circ_{solv.}(Cl^-, aq)$

$-131.2 \frac{kJ}{mol} = \cancel{1279}^{1272} \frac{kJ}{mol} + \Delta G^\circ_{solv}(Cl^-, aq)$

$\Delta G^\circ_{solv}(Cl^-, aq) = -\cancel{1430}^{1403.2}\ kJ/mol$

Ⓓ ✓ ok

② E emf at reversible work Ⓔ ✓ ok

③ $HAc \rightleftharpoons H^+ + Ac^-$

$K = \frac{\gamma_\pm [H^+] \gamma_\pm [Ac^-]}{[HAc]}$ $\quad x = [H^+]$

$= \frac{\gamma_\pm \cdot (0.1\,M + x)\,\gamma_\pm}{(0.105\,M - x)}$

$0.1M + x \approx 0.1M$

$0.105M - x \approx 0.105M$

$K = \frac{0.1\,M\,x}{0.105\,M}\,\gamma_\pm^2$ $\quad$ assume $\gamma_\pm = 1$

$= 0.9524\,x \quad x = \frac{1.75 \cdot 10^{-5}}{0.9524} = 1.8375 \cdot 10^{-5}$

$\log \gamma_I = -z_+ |z_-| B \sqrt{I}$ $\quad Na^+$

$I = \frac{1}{2}\left(1.8375 \cdot 10^{-5} + 0.1\right) M = \cancel{0.105}^{+0.1}{}_{0.1}\,M$

$\log \gamma_I = -11 \cdot 11 \cdot 0.51 \frac{1}{\sqrt{M}} \sqrt{\frac{\cancel{0.105}\,M}{0.1}}$

$= -\cancel{0.1110}\ 0.1613$

$\gamma_\pm = 10^{-0.\overset{1613}{\cancel{1110}}} = \cancel{0.7691}\ 0.6898$

$x = \frac{K}{0.9524 \cdot \gamma_I^2} = \frac{1.75 \cdot 10^{-5}}{0.9524 \cdot (\underset{0.6898}{\cancel{0.7691}})^2} = 3,\overset{8616}{\cancel{1064}} \cdot 10^{-5}$

$pH = -\log_{10} x = -\log_{10} 3.8616 \cdot 10^{-5}$

$= 4.41$ (C) ✓ ok

(4)

$\Delta G^\circ_{solv} = const. \left(\frac{1}{\varepsilon_r} - 1\right) < 0$ when $\varepsilon_r > 1$

(A) (E) ✓ ok $\varepsilon_r > 1 \Rightarrow \Delta G^\circ_{solv} < 0$

(5) $s(MgF_2) = 1.34 \cdot 10^{-3}\ m = x$ → ions are solvated

$\ln \gamma_I = -z_+ |z_-| B \sqrt{I}$

$I = \frac{1}{2}\left(x\, 2^2 + 2 \times (-1)^2\right)$

Mg^{2+} $2F^-$

$= \frac{1}{2}\left(1.34 \cdot 10^{-3} \cdot 4 + 2 \cdot 1.34 \cdot 10^{-3}\right)$

$= \frac{1}{2} \cdot 1.34 \cdot 10^{-3}(4+2) = 3 \cdot 1.34 \cdot 10^{-3}\ m$

$= 4.02 \cdot 10^{-3}$

$\log \ln \gamma_\pm = -2 \cdot 0.51 \sqrt{\frac{2.01}{4.02} \cdot 10^{-3}} = -0.06467$

$\gamma_\pm = 10^{-0.06467} = 0.8616$

$= 0.862$

(B) ✓ ok

(6) $f_{O_2} = 1$, $n = 4$

$$E = E^\circ - \frac{RT}{nF} \ln \frac{a_{OH^-}^4}{f_{O_2}} = E^\circ - \frac{4RT}{4F} \ln a_{OH^-}$$

$\frac{RT}{F} = 25.7\ mV$ at 298 K

$$E = E^\circ - \frac{25.7\ mV}{4} \ln a_{OH^-}$$

$E - E^\circ$ (0.607 − 0.401) V = 0.206 V $\ln a_{OH^-} = \frac{E - E^\circ}{25.7\ mV}$

$$\ln a_{OH^-} = -\frac{0.206\ V}{25.7 \cdot 10^{-3}\ V} = -8.015564$$

$a_{OH^-} = 3.30 \cdot 10^{-4}$ ✓ ok

CR $(3.29 \cdot 10^{-4})$

(7) (E) increase $I \rightarrow$ increase s

where DHL ✓ ok

(8) $E - \frac{RT}{2.303F} \log \frac{m}{m_0} = E^0_{Ag^+/Ag} - \frac{RT}{2.303F} \cdot 0.5090 \sqrt{\frac{m}{m_0}}$

intercept $= E^0_{Ag^+/Ag} = 0.8\ V$

$$E = 0.8\ V + \frac{25.7\ mV}{2.303} \log 0.112 - \frac{25.7\ mV}{2.303} \cdot 0.5091 \sqrt{0.112}$$

$$= 0.8V + 0.01116\ V \cdot \log 0.112 - 5.6812 \cdot 10^{-3} V \sqrt{0.112}$$

$$= 0.8\ V - 0.01061\ V - 1.9013 \cdot 10^{-3}$$

$$= 0.78749\ V = 0.787\ V \quad (B)\ \checkmark\ ok$$

(9) $E^0 = 0.22233\ V \quad E^0(H_2|H^+) = 0$

left Oxid. $\frac{1}{2} H_2 \rightarrow H^+ + e^-$

right Red. $AgCl + e^- \rightarrow Ag + Cl^-$

$$\frac{1}{2} H_2 + AgCl \rightarrow Ag + H^+ + Cl^- \qquad n = 1$$

$$E = E^0 - \frac{RT}{F} \ln a_{H^+} a_{Cl^-} \qquad a_{H^+} = a_{Cl^-}$$

$$= E^0 - \frac{RT}{F} \ln a^2_{H^+}$$

$$= E^0 - 2\frac{RT}{F} \ln a_{H^+}$$

$$\ln a_{H^+} = (E^0 - E) \cdot \frac{2F}{2RT} = (0.22233 - 0.517)\ V \cdot \frac{2F}{RT}$$

$$= -0.29467 \cdot \frac{F}{2RT}$$

(9) left: $H_2 \rightarrow 2H^+ + 2e^-$ oxidation

right: $AgCl + e^- \rightarrow Ag + Cl^-$ | · 2 reduction

$$H_2 + 2AgCl \rightarrow 2H^+ + 2Ag + 2Cl^-$$

$$E = E^\circ - \frac{RT}{2F} \ln a_{H^+}^2 a_{Cl^-}^2 \qquad a_{H^+} = a_{Cl^-}$$

$$= E^\circ - \frac{RT}{2F} \cdot 4 \ln a_{H^+}$$

$$= E^\circ - \frac{4RT}{2F} \ln a_{H^+}$$

$$= E^\circ - \frac{2RT}{F} \ln a_{H^+}$$

$$E^\circ = E^\circ_{AgCl|Ag} = 0,22233\ V$$

$$\ln a_{H^+} = (E^\circ - E) \frac{F}{2RT} \qquad E^\circ_{H_2^+|H_2} = 0$$

$$= (0,22233 - 0.517)\ V \frac{F}{2RT}$$

$$= -\frac{0,29467\ V}{25.7 \cdot 10^{-3} V} \cdot \frac{1}{2}$$

$$= -\frac{1}{2} \cdot 11.46576 = -5,73288$$

$$a_{H^+} = 3,27774 \cdot 10^{-3}$$

$$pH = -\log_{10} a_{H^+} = -\log_{10} 3.27774 \cdot 10^{-3}$$

$$= 2.4898 = 2.49$$

(B) ✓ ok

(10) small concentration (0.0062 M)

$\rightarrow \rho_{soln} \approx \rho_{solvent}$

$= 1 \frac{g}{cm^3} = 1 \frac{10^{-3} kg}{10^{-6} m^3} = 10^3 \frac{kg}{m^3}$

$\varepsilon_r = 78$ at 25°C

$0.0062\ M\ K_3PO_4$: $I = \frac{1}{2} \cdot 0.0062\ M\ (3 + (-3)^2)$

$= 12 \cdot 0.0031\ M$

$= 0.0372\ M$

$I = 0.0372 \frac{mol}{L} = 0.0372 \frac{mol}{1L \cdot \rho_{sol}}$

$1L \cdot \rho_{soln} = 1L \cdot 1 \frac{g}{cm^3} = 1L \cdot \frac{10^{-3} kg}{10^{-3} L}$

$= 1\ kg$

$\rightarrow I = 0.0372 \frac{mol}{kg}\ (m)$

$\sqrt{\frac{\rho_{sol} I}{\varepsilon_r}} = \sqrt{\frac{10^3 \frac{kg}{m^3} \cdot 0.0372 \frac{mol}{kg}}{78}}$

$= \sqrt{0.47692 \frac{mol}{m^3}}$

$= 0.6906 \sqrt{\frac{mol}{m^3}}$

$$1000\,\frac{L}{m^3} = 1000\,\frac{dm^3}{m^3} = 1000\,\frac{10^{-3}\,m^3}{m^3} = 1$$

$$\frac{2e^2 N_A}{\varepsilon_0 k_B T} = \frac{2 \cdot (1.602 \cdot 10^{-19}\,As)^2 \cdot 6.022 \cdot 10^{23}\,\frac{1}{mol}}{8.854 \cdot 10^{-12}\,\frac{A^2 s^2}{Nm^2} \cdot 1.38 \cdot 10^{-23}\,\frac{J}{K} \cdot 298\,K}$$

$$= 8.4891 \cdot 10^{17}\,\frac{Nm^2}{mol \cdot J} \qquad 1J = 1Nm$$

$$= 8.4891 \cdot 10^{17}\,\frac{m}{mol}$$

$$\sqrt{\frac{2e^2 N_A}{\varepsilon_0 k_B T}\,1000\,\frac{L}{m^3}} = 9.2136 \cdot 10^8 \sqrt{\frac{m}{mol}}$$

$$\kappa = 9.2136 \cdot 10^8 \sqrt{\frac{m}{mol}} \cdot 0.6906 \sqrt{\frac{mol}{m^3}}$$

$$= 6.3629 \cdot 10^8\,\frac{1}{m}$$

$$\frac{1}{\kappa} = 1.572 \cdot 10^{-9}\,m = 1.6\,nm$$

(c) ✓ ok

(11) $E = E^\circ_{Cr_2O_7^{2-}/Cr^{3+}} - E^\circ_X$

$Ag^+ \quad = 1.33\,V - 0.799\,V = 0.5301\,V > 0$

$\Rightarrow$ Ag dissolves

$Zn^{2+} \quad = 1.33\,V + 0.762\,V = 2.092\,V > 0$

$\Rightarrow$ Zn dissolves

$Au^+ \quad = 1.33\,V - 1.692\,V = -0.362\,V$

$\Rightarrow$ Au does not dissolve (D) ✓ ok

(12) $Hg \mid Hg_2^{2+} \mid Hg_2Cl_2 \mid Hg$

left oxid.: $2Hg \rightarrow Hg_2^{2+} + 2e^- \quad E^\circ = 0.7973\,V$

right red.: $Hg_2Cl_2 + 2e^- \rightarrow 2Hg + 2Cl^- \quad E^\circ = 0.2681\,V$

$Hg_2Cl_2 \rightarrow Hg_2^{2+} + 2Cl^-$

$E^\circ = 0.2681\,V - 0.7973\,V$ (right − left)

$= -0.5292\,V$

$E^\circ = \frac{RT}{2F} \ln \frac{1}{K} = -\frac{RT}{2F} \ln K$

$\ln K = -\frac{E^\circ 2F}{RT} = \frac{0.5292\,V \cdot 2}{25.7 \cdot 10^{-3}\,V} = 41.1829$

$K = \exp(41.1829)$ ✓ ok

$= 7.68 \cdot 10^{17}$ (B) ✓ ($7.79 \cdot 10^{17}$)

(13) $I = \frac{1}{2} \cdot 0.0210\,m\,(3 + 9) = \cancel{6} \cdot 0.0210\,m$

$= 0.126\,m$

$\log \gamma_\pm = -\cancel{0}.1 - 3 \cdot B \left(\dfrac{\sqrt{0.126}}{1 + \sqrt{0.126}} - 0.3 \cdot 0.126 \right)$

$B = 0.51/M$

$= -1.53\,(0.2242) = -0.3430$

$\gamma_\pm = 0.4539$

$= 0.454$ (D) ✓ ok

(14)

$$\frac{\partial E}{\partial T} = 56.1 \cdot 10^{-6} + 2.108 \cdot 10^{-8}\, T$$

$$= 56.1 \cdot 10^{-6} + 216 \cdot 10^{-8}\, T(°C)$$

$$= 56.1 \cdot 10^{-6} + 216 \cdot 10^{-8} \cdot 30\,°C$$

$$= 1.209 \cdot 10^{-4}$$

$$\Delta S_R = n F \frac{\partial E}{\partial T} \qquad n = 2$$

$$= 2 \cdot 96500 \frac{As}{mol} \cdot 1.209 \cdot 10^{-4} \frac{V}{K}$$

$$= 23,3 \frac{J}{K\,mol}$$

(D) ✓ ok

(15) $Al_2(SO_4)_3 \longrightarrow 2Al^{3+} + 3\,SO_4^{2-}$

$$\mu_{\pm} = \frac{\nu_+ \mu_+ + \nu_- \mu_-}{\nu} \qquad \nu = \nu_+ + \nu_- = 5$$

$$= \frac{2\mu_+ + 3\mu_-}{5} \qquad \nu_+ = 2,\ \nu_- = 3$$

(D) ✓ ok

(16) $E^0 = E^0_{right} - E^0_{left}$

$= E^0_{Ti^{2+}/Ti} - E^0_{Sc^{3+}/Sc}$

$= -1.63\,V + 2.08\,V$

$= 0.45\,V$

~~E2~~

left Oxid. $Sc \rightarrow Sc^{3+} + 3e^-$ | · 2

right Red. $Ti^{2+} + 2e^- \rightarrow Ti$ | · 3

$2\,Sc + 3\,Ti^{2+} \rightarrow 2\,Sc^{3+} + 3\,Ti$

$n = 6$

$E = E^0 - \frac{RT}{6F} \ln \frac{[Sc^{3+}]^2}{[Ti^{2+}]^3}$

$= 0.45\,V - \frac{25.7 \cdot 10^{-3}\,V}{6} \ln \frac{0.014^2}{1.3^3}$

$= \sout{0.45\,V} = 0.4899\,V$

$= 0.490\,V$ (C) ✓ ok

CHEM 311 (151) **First Major Exam** 2 HOURS

Wednesday, Oct. 01, 2015

STUDENT NAME: .....

STUDENT ID NUMBER: .....

Test Code (001)

(16 Questions)

Dr. M. Morsy	Section 1
Dr. H. Badawi	Section 2
Dr. W Forner	Section 3
Dr. G. Oweimreen	Section 4

Useful Physical constants and Formula

PHYSICAL CONSTANTS:	Useful Equations:
1 atm = 1.101325 x 10^5 Pa 1 bar = 10^5 Pa; 1 Torr = 1 mmHg = 133.322 Pa 1 J = 1 kg m^2 s^{-2} 0 °C = 273.15 K	DHLL: $\log \gamma_{\pm} = -z_+ \lvert z_- \rvert B\sqrt{I}$ Davies Eq.: $\log \gamma_{\pm} = -z_+ \lvert z_- \rvert B\left(\frac{\sqrt{I}}{1+\sqrt{I}} - 0.3\, I\right)$ in water at 25 °C: B = 0.51 (mol/Liter)$^{-½}$
k_B = 1.381 x 10^{-23} J K^{-1} N_A= 6.022 x 10^{23} mol^{-1}	$I = \frac{1}{2}\sum_i c_i z_i^2$
h = 6.626 x 10^{-34} J s ε_o = 8.854x10^{-12} $C^2N^{-1}m^{-2}$	$\kappa = \sqrt{\frac{2e^2 N_A}{\varepsilon_o k_B T}(1000\ L\,m^{-3})}\sqrt{\left(\frac{\rho_{sol}\, I}{\varepsilon_r}\right)}$
ε = 78 at 25°C ρ_{sol} = 1 g cm^{-3}	$\Delta G^o_{solvation} = \frac{z^2 e^2 N_A}{8\pi\varepsilon_o r}\left(\frac{1}{\varepsilon_r} - 1\right)$
e = 1.602x10^{-19} C	$\gamma_{\pm}^{(\nu_+ + \nu_-)} = \gamma_+^{\nu_+}\gamma_-^{\nu_-}$
c = 2.998 x 10^8 m s^{-1} g = 9.81 m s^{-2} pH = - Log [H^+]	$m_{\pm} = \left(m_+^{\nu} + m_-^{\nu}\right)^{1/\nu}$ $\nu = \nu_+ + \nu_-$
ΔG = - zFE ΔS = z F $(\partial E/\partial T)_p$ $\Delta G = \Delta H - T\Delta S$	$a_{\pm} = \left(\frac{m_{\pm}}{m^o}\right) g_{\pm}$
K_w= [OH^-] [H^+]	$\tilde{\mu}_2 - \tilde{\mu}_1 = z(\phi_2 - \phi_1)F$
R = 8.314 J mol^{-1} K^{-1} R = 0.08314 L bar K^{-1} mol^{-1} F = 96500 C mol^{-1}	E = E° – (RT/z F) ln(Q) E° = (RT/z F) ln(K) RT/F= 0.0257 at 298 K

Hydrogen Electrode: H^+ (aq) + e^- (g) → ½H_2 E° = 0 V

Silver-Silver Chloride: e^- + AgCl (s) → Ag (s) + Cl^- (aq) E° = 0.22233 V

Calomel Electrode: e^- + ½Hg_2Cl_2(s) → Cl^- (aq) + Hg (l) E° = 0.13337 V

1. The process of the formation of solvated H^+ and Cl^- ions is given by:

$\frac{1}{2} H_2(g) \rightarrow H(g)$ $\quad \Delta G^\circ = 203.3 \text{ kJ mol}^{-1}$

$\frac{1}{2} Cl_2(g) \rightarrow Cl(g)$ $\quad \Delta G^\circ = 105.7 \text{ kJ mol}^{-1}$

$H(g) \rightarrow H^+(g) + e^-$ $\quad \Delta G^\circ = 1312 \text{ kJ mol}^{-1}$

$Cl(g) \rightarrow Cl^-(g) + e^-$ $\quad \Delta G^\circ = -349 \text{ kJ mol}^{-1}$

$H^+(g) \rightarrow H^+(aq)$ $\quad \Delta G^\circ = \Delta G^\circ_{solvation}(H^+, aq)$

$Cl^-(g) \rightarrow Cl^-(aq)$ $\quad \Delta G^\circ = \Delta G^\circ_{solvation}(Cl^-, aq)$

and presented in the following overall reaction:

$\frac{1}{2} H_2(g) + \frac{1}{2} Cl_2(g) \rightarrow H^+(aq) + Cl^-(aq)$ $\quad \Delta G^\circ_R = -131.2 \text{ kJ mol}^{-1}$

Based on the convention that $\Delta G^\circ_{solvation}(H^+, aq) = 0$, then $\Delta G^\circ_{solvation}(Cl^-, aq)$ is:

A) $-1141 \text{ kJ mol}^{-1}$
B) $+131.2 \text{ kJ mol}^{-1}$
C) $+1403 \text{ kJ mol}^{-1}$
D) $-1403 \text{ kJ mol}^{-1}$
E) $+1141 \text{ kJ mol}^{-1}$

2. Which of the following statements is correct?
   A) When the chemicals in a battery reach equilibrium it is at its maximum voltage.
   B) The emf of an electrochemical cell always increases as temperature increases.
   C) The voltage of a battery is not zero when the reacting chemicals are at equilibrium.
   D) There is no limit on the number of times that a battery can be recharged.
   E) The emf of a cell is measured when it works reversibly.

3. A buffer solution is 0.105 M in CH_3COOH and 0.100 M CH_3COONa. Given that the ionization constant, K_a, of acetic acid is 1.75×10^{-5}. Use the DHLL to obtain the pH of this buffer.
   A) 7.00
   B) 1.12
   C) 4.41
   D) 8.01
   E) 2.76

4. The process of ion formation of an electrolytic solution is dependent on the value of the dielectric constant of the solvent, ε_r. Which of the following statements is correct?
   A) When $\varepsilon_r < 1$, ions are solvated.
   B) When $\varepsilon_r < 1$, the solvation process is spontaneous.
   C) When $\varepsilon_r > 1$, ions are not solvated.
   D) When $\varepsilon_r > 1$, the solvation process is non-spontaneous.
   E) When $\varepsilon_r > 1$, ions are solvated.

5. The solubility of MgF_2 in aqueous solution is 1.34×10^{-3} mol kg^{-1} at room temperature. Using the Debye-Hückel limiting law, the $\gamma_\pm$ of the solution is:
   A) 0.902
   B) 0.862
   C) 0.597
   D) 0.760
   E) 0.891

6. The standard half-cell potential for the reaction,

$$O_2 + 2\,H_2O + 4e^- \rightarrow 4\,OH^-$$

is 0.401 V at 25 °C. What should a_{OH^-} be to make the half-cell potential to 0.607 V at 25 °C if $f_{O_2} = 1$?
   A) 0.883
   B) 9.59×10^{-9}
   C) 3.29×10^{-4}
   D) 0.135
   E) 9.90×10^{-3}

7. Which of the following statements is correct?
   A) The dielectric constant for water is the same in both the bulk solvents and the solvation shell around the ion
   B) $\gamma_\pm$ approaches 1 from values greater than 1.
   C) When salting in occurs, solubility of electrolyte is lowered.
   D) $\gamma_\pm$ is greater than 1 for a very dilute electrolyte.
   E) Where DHLL is nearly obeyed, an increase in ionic strength increases solubility.

8. It can be shown that at 25 °C the potential for the cell,

$$\tfrac{1}{2}\ H_2(g, 1\ bar)\ \big|\ H^+(aq, a=1)\ \big\|\ Ag^+(aq, m)\ \big|\ Ag\ (s)$$

varies with the molality, m, of Ag^+, according to the relation,

$$E = E^\circ_{Ag^+|Ag} + \frac{RT}{2.303\ F}\log(m/m^\circ) - \frac{RT}{2.303\ F} \times 0.5090\ \sqrt{m/m^\circ} \quad (m^0 = 1\ mol\ kg^{-1})$$

in the region where $\gamma_\pm \to 1$ for $AgNO_3$ which is the source of Ag^+. If a plot of $[\ E - \frac{RT}{2.303\ F}\log(m/m^\circ)\ ]$ versus $\sqrt{m/m^\circ}$ has an intercept of 0.8000 V, calculate the cell potential when $m = 0.112\ mol\ kg^{-1}$.

A) 0.454 V
B) 0.787 V
C) 0.514 V
D) 0.853 V
E) 0.846 V

9. The cell,

$$Pt\ \big|\ H_2\ (1\ bar)\ \big|\ HCl\ (m)\ \big|\ AgCl\ \big|\ Ag$$

has a potential of 0.517 V at 25 °C. Given,

$$AgCl\ +\ e^-\ \rightarrow\ Ag\ +\ Cl^- \qquad\qquad E^\circ = 0.22233\ V$$

determine the pH of the HCl solution, assuming its $\gamma_\pm = 1$.

A) 3.66
B) 2.49
C) 4.98
D) 5.74
E) 9.96

10. The Debye-Hückel limiting law (DHLL) screening length $1/\kappa$ (in nm) at 298 K in a 0.0062 M aqueous solution of K_3PO_4 is:

A) 1.1
B) 0.78
C) 1.6
D) 0.96
E) 1.9

11. In an acidic solution E° for reducing the oxidizing agent $Cr_2O_7^{2-}$ to Cr^{3+} is 1.33 V.
Given,

$Ag^+(aq) + e^- \rightarrow Ag(s)$ $\quad E^\circ = 0.799\ V$

$Zn^{2+}(aq) + 2e^- \rightarrow Zn(s)$ $\quad E^\circ = -0.762\ V$

$Au^+(aq) + e^- \rightarrow Au(s)$ $\quad E^\circ = 1.692\ V$

Among the above metals, which of the following choices is correct?

A) Ag and Au will be dissolved by the dichromate aqueous solution.
B) All metals will be easily oxidized by the dichromate aqueous solution.
C) None of the metals will be oxidized by the dichromate aqueous solution.
D) Zn and Ag are dissolved by the dichromate aqueous solution.
E) Only gold will be oxidized by the dichromate aqueous solution.

12. Given,

$Hg_2^{2+}(aq) + 2e^- \rightarrow 2Hg(s)$ $\quad E^\circ = 0.7973\ Volts$

$Hg_2Cl_2(s) + 2e^- \rightarrow 2Hg(s) + 2Cl^-(aq)$ $\quad E^\circ = 0.2681\ Volts$

calculate the equilibrium constant for the reaction at 25 °C,

$$Hg_2^{2+}(aq) + 2Cl^- \rightarrow Hg_2Cl_2(s)$$

A) 8.92×10^8
B) 7.79×10^{17}
C) 1.04×10^{18}
D) 1.09×10^{36}
E) 3.77×10^{-7}

13. The mean activity coefficient $\gamma_\pm$ for a completely dissociated 0.0210 m Na_3PO_4 in aqueous solution using the Davies equation is

A) 0.374
B) 0.307
C) 0.126
D) 0.454
E) 0.251

14. At a constant 1.00 m concentration of H_2SO_4 in a lead-acid cell the potential E in volts varied with temperature t in °C according to the equation,

$$E(V) = 1.91737 + (56.1\times10^{-6})\,t + (108\times10^{-8})\,t^2$$

ΔS°_R for the cell reaction

$$PbO_2(s) + Pb(s) + 2\,H_2SO_4(aq) \rightleftharpoons 2\,Pb\,SO_4(s) + 2\,H_2O(liq)$$

at 30 °C is:

A) 46.6 J K^{-1} mol^{-1}
B) 11.7 J K^{-1} mol^{-1}
C) 69.1 J K^{-1} mol^{-1}
D) 23.3 J K^{-1} mol^{-1}
E) 138 J K^{-1} mol^{-1}

15. Assuming complete dissociation, write the correct expressions of $\mu_\pm$ in terms of μ_+ and μ_- for $Al_2(SO_4)_3$:

A) $\frac{2\mu_+ + 4\mu_-}{6}$
B) $\frac{2\mu_+ + 4\mu_-}{4}$
C) $\frac{2\mu_+ + \mu_-}{3}$
D) $\frac{2\mu_+ + 3\mu_-}{5}$
E) $\frac{2\mu_+ + 3\mu_-}{2}$

16. Determine the potential E_{cell}, for the cell,

$$Sc(s)\left|Sc^{3+}(aq, a=0.014)\right\|Ti^{2+}(aq, a=1.30)\left|Ti\ (s)\right.$$

given that $E^\circ_{Sc^{3+}|Sc} = -2.08\ V$ and $E^\circ_{Ti^{2+}|Ti} = -1.63\ V$.

A) 0.750 V
B) 0.433 V
C) 0.490 V
D) 0.410 V
E) 0.467 V

[redacted]

VIE _____

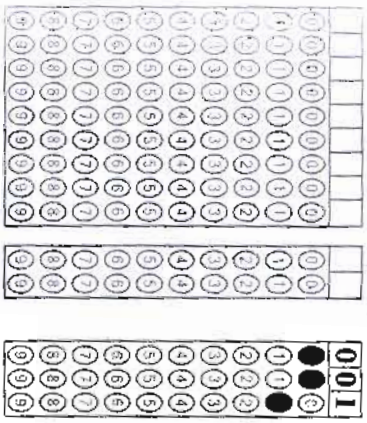
JDENT No. _____

CTION No. _____

TEST ANSWER FORM

ARKING INSTRUCTIONS

TESTING SERVICES SYSTEM



1

DIRECTIONS:

Read each question and its numbered answers. When you have decided which answer is correct, blacken the corresponding oval on this form with a no. 2 pencil. Make no extra marks. They may be counted as incorrect answers. Erase incorrect answers fully before filling in correct answer.

DO NOT USE INK OR BALL POINT PEN

SAMPLE

1. RIYADH is:

A - a country
B - a mountain
C - an island
D - a city
E - a river

1 Ⓐ Ⓑ Ⓒ ● Ⓔ

1 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	26 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	51 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	76 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	101 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
2 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	27 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	52 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	77 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	102 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
3 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	28 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	53 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	78 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	103 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
4 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	29 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	54 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	79 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	104 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
5 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	30 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	55 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	80 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	105 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
6 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	31 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	56 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	81 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	106 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
7 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	32 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	57 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	82 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	107 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
8 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	33 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	58 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	83 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	108 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
9 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	34 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	59 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	84 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	109 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
10 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	35 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	60 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	85 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	110 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
11 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	36 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	61 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	86 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	111 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
12 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	37 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	62 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	87 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	112 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
13 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	38 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	63 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	88 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	113 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
14 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	39 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	64 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	89 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	114 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
15 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	40 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	65 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	90 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	115 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
16 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	41 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	66 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	91 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	116 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
17 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	42 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	67 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	92 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	117 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
18 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	43 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	68 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	93 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	118 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
19 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	44 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	69 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	94 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	119 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
20 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	45 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	70 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	95 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	120 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
21 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	46 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	71 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	96 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	121 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
22 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	47 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	72 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	97 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	122 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
23 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	48 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	73 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	98 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	123 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
24 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	49 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	74 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	99 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	124 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
25 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	50 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	75 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	100 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	125 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ

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Answer Key

1. D
2. E
3. C
4. E
5. B
6. C
7. E
8. B
9. B
10. C
11. D
12. B
13. D
14. D
15. D
16. C

Answer Key

1. C
2. B
3. D
4. B
5. B
6. B
7. D
8. D
9. C
10. A
11. B
12. A
13. D
14. C
15. D
16. A

Answer Key

1. C
2. E
3. D
4. A
5. D
6. E
7. D
8. B
9. D
10. C
11. E
12. B
13. E
14. A
15. B
16. A

Answer Key

1. D
2. C
3. B
4. D
5. D
6. B
7. A
8. A
9. B
10. C
11. E
12. A
13. D
14. E
15. E
16. B

King Fahd University of Petroleum and Minerals
Information Technology Center
Computing Services Section

Dept. of: CHEM
Course: chem311 First Major Exam
Semseter: 151
Section: 01 **Thursday, October 15, 2015**

ID	Raw Score	% Score
200926350	50	62.5
200939750	70	87.5
201034240	50	62.5
201037840	50	62.5
201064800	45	56.25
201070280	65	81.25
201128030	60	75
201132090	70	87.5
201132910	70	87.5
201135470	70	87.5
201136490	70	87.5
201137970	60	75
201139470	75	93.75
201143590	35	43.75
201149350	45	56.25
201152710	50	62.5
201153870	55	68.75
201158950	55	68.75
201159890	50	62.5
201168750	75	93.75
201171910	60	75
201174270	70	87.5
201179310	35	43.75
201179510	70	87.5
201218560	60	75
201224620	55	68.75
201232080	65	81.25
201232900	40	50
201239760	65	81.25
201254140	60	75

out of 80 out of 100

Total no. of Students	30	**Section Mean:**	58.33	72.92
Section Std. Dev. :	11.47	**Max. Score:**	75	93.75
		Min. Score:	35	43.75

King Fahd University of Petroleum and Minerals
Information Technology Center
Computing Services Section

Dept. of: CHEM
Course: chem311 First Major Exam
Semseter: 151
Section: 02 **Thursday, October 15, 2015**

ID	Raw Score	% Score
200940570	20	25
201016200	55	68.75
201029380	40	50
201131070	75	93.75
201132070	35	43.75
201141530	35	43.75
201142010	45	56.25
201154950	45	56.25
201162390	40	50
201165010	65	81.25
201168450	60	75
201219080	50	62.5
201220800	55	68.75
201236360	50	62.5

out of 80 out of 100

Total no. of Students	14	**Section Mean:**	47.86	59.82
Section Std. Dev. :	13.97	**Max. Score:**	75	93.75
		Min. Score:	20	25

King Fahd University of Petroleum and Minerals
Information Technology Center
Computing Services Section

Dept. of: CHEM
Course: chem311 First Major Exam
Semseter: 151
Section: 03 **Thursday, October 15, 2015**

ID	Raw Score	% Score
201021520	35	43.75
201026240	40	50
201060600	50	62.5
201135130	60	75
201136590	30	37.5
201138610	55	68.75
201147590	60	75
201152470	20	25
201168910	60	75
201183250	30	37.5
201219620	55	68.75
201226420	75	93.75
201242300	70	87.5
201253060	75	93.75
201254300	80	100
201260580	60	75
201264900	55	68.75

out of 80 out of 100

Section 1 72.92% best
" 2 59.82% 4. best
" 3 66.91% 2. best
" 4 66.88% 3. best

Course: 67.79%

Total no. of Students	17	**Section Mean:**	53.53	66.91
Section Std. Dev. :	17.39	**Max. Score:**	80	100
		Min. Score:	20	25

King Fahd University of Petroleum and Minerals
Information Technology Center
Computing Services Section

Dept. of: CHEM
Course: chem311 First Major Exam
Semseter: 151
Section: 04 **Thursday, October 15, 2015**

ID	Raw Score	% Score
200918470	45	56.25
201057900	40	50
201060360	45	56.25
201065320	45	56.25
201079360	35	43.75
201131950	45	56.25
201132170	50	62.5
201134150	70	87.5
201135630	20	25
201137650	40	50
201137950	60	75
201139170	55	68.75
201149250	60	75
201149790	60	75
201152530	45	56.25
201153210	45	56.25
201156930	45	56.25
201158650	55	68.75
201163590	60	75
201164010	55	68.75
201175130	65	81.25
201175210	60	75
201175410	65	81.25
201178470	70	87.5
201192610	65	81.25
201194070	70	87.5
201231380	40	50
201238140	45	56.25
201241240	80	100
201264540	70	87.5

out of 80 out of 100

Total no. of Students	30	**Section Mean:**	53.5	66.88
Section Std. Dev. :	13.14	**Max. Score:**	80	100
		Min. Score:	20	25