

SENIOR 4 CHEMISTRY**FINAL — PRACTICE REVIEW TEST**

Name _____

Student Number _____

Attending Non-Attending

Phone Number _____

Address _____

**ANSWER
KEY****VALUE: TOTAL 100 MARKS****PART A Multiple Choice**

1. (c) Using the solubility chart
 i) Solution I: Cannot be Ag^+ , Pb^{2+} , Hg^+ , Cu^+
 ii) Solution SO_4^{2-} : could be Ag^+ , Pb^+ , Ca^{2+} , Ba^{2+} , Sr^+
 iii) Cation could be Ca^+ , Ba^{2+} , Sr^{2+}
 iv) Solution OH^- : could not be group 1A, NH_4^+ , Sr^{2+} , Ba^{2+}
 From (iii) and (iv) only Ca^{2+} remains – choice (c)

2. (c)
- $$\underbrace{\text{Pb}(\text{OH})_2}_{0.155 \text{ g/L}} \rightarrow \text{Pb}^{2+} + 2\text{OH}^-$$
- $$\frac{0.155 \text{ g/L}}{241 \text{ g/mol}} \rightarrow 6.43 \times 10^{-4} \quad \frac{2(6.43 \times 10^{-4})}{1.29 \times 10^{-3}}$$
- $$6.43 \times 10^{-4} \text{ M} \rightarrow 6.43 \times 10^{-4} \text{ M} \quad 1.29 \times 10^{-3} \text{ M}$$

3. (b) $\text{Ca}_3(\text{PO}_4)_{2(s)} \rightarrow 3\text{Ca}_{(\text{aq})}^{2+} + 2\text{PO}_{4(\text{aq})}^{3-}$
- $$K_{\text{sp}} = [\text{Ca}_{(\text{aq})}^{2+}]^3 [\text{PO}_{4(\text{aq})}^{3-}]^2$$

4. (c) Solubilities of compounds given are as follows

$$\text{CuI}; \quad \chi = \sqrt{1.6 \times 10^{-16}} = 1.3 \times 10^{-8}$$

$$\text{AgI}; \quad \chi = \sqrt{8.3 \times 10^{-17}} = 9.1 \times 10^{-9}$$

$$\text{CaCO}_3; \quad \chi = \sqrt{5.0 \times 10^{-9}} = 7.1 \times 10^{-5}$$

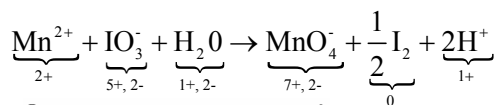
$$\text{BaSO}_4; \quad \chi = \sqrt{1.5 \times 10^{-9}} = 3.9 \times 10^{-5}$$

5. (a) $2\text{NH}_4\text{Cl} + \text{CuSO}_4 \rightarrow \text{CuCl}_2 + (\text{NH}_4)_2\text{SO}_4$
 Both CuCl_2 and $(\text{NH}_4)_2\text{SO}_4$ are soluble compounds. See solubility chart, page 1 of the exam.

6. (d) $\text{ZnS}_{(s)} \rightleftharpoons \text{Zn}_{(\text{aq})}^{2+} + \text{S}_{(\text{aq})}^{2-}$
 Since the solution is saturated, equilibrium exists between the solid ZnS and its ions and there would be no change in their concentrations. Therefore, the correct answer is choice (d).

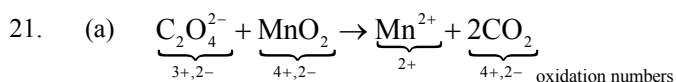
7. (b) The sudden rise in Ag^+ concentration ($\text{AgNO}_3 \rightarrow \text{Ag}^+ + \text{NO}_3^-$) must be from the addition of the AgNO_3 . This is confirmed by the CO_3^{2-} concentration decreasing, which it should because of the shift in equilibrium to the left to precipitate so Ag_2CO_3 to maintain equilibrium of the silver carbonate equilibrium, that is
- $$\text{Ag}_2\text{CO}_{3(s)} \rightleftharpoons 2\text{Ag}_{(aq)}^+ + \text{CO}_{3(aq)}^{2-}$$
8. (c) $\text{SrF}_{2(s)} \rightleftharpoons \text{Sr}_{(aq)}^{2+} + 2\text{F}_{(aq)}^-$
 $S \quad S \quad 2S$ (where S = solubility)
 $K_{sp} = [\text{Sr}^{2+}][\text{F}^-]^2$
 $K_{sp} = (S)(2S)^2 = 4S^3$
 $\therefore S = \sqrt[3]{\frac{K_{sp}}{4}}$
9. (c) Select the largest K_{sp} which is AgCl ; $K_{sp} = 1.8 \times 10^{-10}$
10. (b) From the acide chart on page 41, Module 3, Lesson 5, we see that H_2SP_3 is the strongest acid (highest up on the left-hand side).
11. (b) Normal rain has a pH of about 6, due to dissolved CO_2 from hydrocarbon combustion. Acid rain is rain with a pH lower than 6, due to SO_2 dissolved in water.
12. (c) Choice (a) is a mass unit, choice (b) is a quantity unit, and choice (d) is a rate of reaction unit.
13. (a) $\text{NiCl}_{2(s)} \rightarrow \text{Ni}_{(aq)}^{2+} + \underbrace{2\text{Cl}_{(aq)}^-}_{0.60\text{M}}$
 $\therefore [\text{Ni}^{2+}] = \frac{0.60\text{ M}}{2} = 0.30\text{ M}$
14. (c) See solubility chart on page 1 of the exam.
 S^{2-} would cause both Zn^{2+} and Sr^{2+} to precipitate
 Cl^- both Zn^{2+} and Sr^{2+} are soluble
 CO_3^{2-} both Zn^{2+} and Sr^{2+} are soluble
 SO_4^{2-} ZnSO_4 is soluble but SrSO_4 is not
15. (a) $\text{PbS}_{(s)} \rightleftharpoons \text{Pb}_{(aq)}^{2+} + \text{S}_{(aq)}^{2-}$
 $\underbrace{2.9 \times 10^{-14}} \quad \underbrace{2.9 \times 10^{-14}} \quad \underbrace{2.9 \times 10^{-14}}$
 $K_{sp} = [\text{Pb}^{2+}][\text{S}^{2-}] = [2.9 \times 10^{-14}]^2 = 8.4 \times 10^{-28}$
16. (c) According to equilibrium equation the Ag^+ and Cl^- concentrations would have to be equal and only graph (b) shows this to be the case.
17. (c) An oxidizing agent undergoes reduction and therefore must gain (accept) electrons.

18. (d) A reducing agent itself is, undergoes, oxidation (that is, loses electrons). This means that its oxidation number must **increase**.



oxidization number increases

19. (a) Use the reduction potential chart in your notes. Select the substance located on the left-hand side of your chart, which is highest up. Only I_2 gains; Li, Au, and Hg occur on the RHS.
20. (b) HCl is a strong acid and strong acids in equation format should always be represented as H^+ or more correctly H_3O^+ . Only answer (b) does this.



C has increased by 1

22. (a) Using the standard reduction potential chart, select the substance from the RHS of the equilibrium arrows that is higher up than $\text{Pb}_{(s)}$.
23. (b) Any equation which shows changes in oxidation numbers.
- $$\underbrace{\text{CuS}}_{2+, 2-} + \underbrace{\text{H}_2}_0 \rightarrow \underbrace{\text{H}_2\text{S}}_{1+, 2-} + \underbrace{\text{Cu}}_0$$
24. (c) The zinc electrode is the anode and the copper electrode is the cathode. Therefore, copper ions migrate to the copper plate. Cations migrate to the copper plate. Copper ions migrate to the copper plate and gain electrons to become copper metal, and stick to the plate and thus the mass increases. Anions migrate to the anode which is the zinc electrode.
25. (c) $E_{\text{all}} = E_{\text{Zn}}^0 - E_{\text{Cu}}^0 = 0.76 \text{ V} - (-0.34) \text{ V} = 1.10 \text{ V}$
26. (d) Both cations and anions would have to migrate to maintain electrical neutrality within the electrolytic cell.
27. (a) To electroplate anything (such as an iron spoon), it would have to be the cathode (i.e., reduction would have to occur). The only answer which shows the reduction of silver is choice (a).
28. (b) Using Le Chatelier's Principle, any change which causes a shift in equilibrium to the **left** would work. Choice (a) shifts it right as do (c) and (d).
29. (b) MgO and $\text{Mg}(\text{OH})_2$ are solids and should not appear in the mass actions expression, i.e., the RHS of the expression. Therefore, choice (b).
30. (a) The larger the K_{eq} the more complete the reaction is (that is, favours products.) Therefore we selected the smallest K_{eq} .
31. (b) Reducing the volume would increase all concentrations but would not affect equilibrium because we have an equal number of moles on both sides of the equation.

32. (a)

	N_2O_4	\rightleftharpoons	2NO_2
Initial	0.200 M		0.000 M
React	$\frac{0.160}{2} = 0.080 \text{ M}$		0.160 M
Equilibrium	0.120 M		0.160 M

33. (c) Use solubility chart on page 1 of the exam.

- a) NO_3^- both soluble
 b) SO_4^{2-} both precipitate
 c) CO_3^{2-} both precipitate

34. (b) Both $\text{Sr}(\text{OH})_2$ and H_2SO_4 are strong and should be written in ionic format. Also SrSO_4 is a precipitate and H_2O is a molecular substance and should be written as such. This all occurs in choice (d).

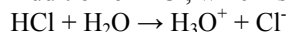
35. (b) The vertical rise in the forward reaction graph indicates addition of HI and immediate increase in its rate followed by a decrease in rate. Correspondingly, the reverse reaction rate would increase as more product molecules are formed.

36. (a) Acid strength depends on degree of ionization. Strong means essentially 100% ionization. That means your concentration and pH values must agree.

For example,

- a) $0.01 \text{ M} = 10^{-2} = \text{pH of } 2$
 b) 0.01 M does not equal pH of 1.0

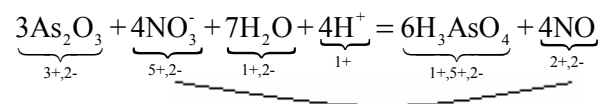
37. (c) Addition of HCl, which is a strong acid and therefore ionizes 100%.

Therefore, the H_3O^+ concentration would increase greatly and the pH value would decrease.

38. (a)

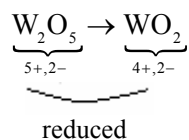
$$\begin{aligned} & \text{C}_2\text{O}_4^{2-} \\ 2(x) + 4(2-) &= 2- \\ 2x - 8 &= -2 \\ 2x &= 6 \\ x &= 3 \end{aligned}$$

39. (c)



Oxidizing agents are reduced (i.e., their oxidation numbers should decrease or gain electrons).

40. (b)

41. (b) Reaction #1: Te is a stronger oxidizing agent than V^{2+}
 Reaction #2: U^{4+} is a stronger oxidizing agent than Te
 Therefore (decending order): U^{4+} , Te, V^{2+} 42. (a) Since the nickel electrode supplies the electrons, it must be the **anode** (ie, $\text{Ni}_{(s)} \rightarrow \text{Ni}^{2+} + 2\text{e}^-$)43. (b) Cell negative ions (NO_3^-) would migrate to the Ni electrode and all positive ions (K^+ , Pd^{2+} , Ni^{2+}) would

migrate to the palladium electrode.

44. (c)
$$\begin{array}{l} \text{Ni} \rightarrow \text{Ni}^{2+} + 2\text{e}^- \quad E^0 = +0.25\text{V} \\ \text{Pd}^{2+} + 2\text{e}^- \rightarrow \text{Pd} \quad E^0 = x \\ \hline \text{Ni} + \text{Pd}^{2+} \rightarrow \text{Ni}^{2+} + \text{Pd} \quad E_{\text{cell}}^0 = 1.21\text{V} \\ \therefore 0.25 + x = 1.21; x = 0.96\text{V} \end{array}$$
45. (d) The substance N_2O_4 is formed in the first step but used up in the second step and is therefore a reaction intermediate.
46. (c) The formation of iron rust must have both H_2O and O_2 present, but not N_2 .
47. (d) Reaction occurring at the cathode is always reduction. Only choice (a) or (d) are reduction reactions but choice (d) has the more positive value of the two and would occur before choice (a).
Choice (a), $E^0 = -2.71$; choice (d) $E^0 = -0.83$.

PART B Written Response

- (1) 1. (a) $\text{Ag}^+_{(\text{aq})} + \text{IO}_3^-_{(\text{aq})} \rightarrow \text{AgIO}_3_{(\text{aq})}$
- (3) (b)
$$\left[\text{Ag}^+ \right] = \frac{15.0}{50.0} \times 0.50 = 0.15$$
- $$\left[\text{IO}_3^- \right] = \frac{35.0}{50.0} \times 0.50 = 0.35 \text{ (excess } \text{IO}_3^- \text{ [0.20])}$$
- $$K_{\text{sp}}^{(\text{Trial})} = \left[\text{Ag}^+ \right] \left[\text{IO}_3^- \right] = [0.15][0.35] = 0.0525$$
- Since $K_{\text{sp}}^{(\text{Trial})} > K_{\text{sp}}$; a precipitate of AgIO_3 will form
($K_{\text{sp}}(\text{AgIO}_3) = 3.1 \times 10^{-8}$)
- (3) 2.
$$\underbrace{\left(K_{\text{sp}}(\text{Ag}_2\text{CO}_3) = 8.2 \times 10^{-12} \right)}_{\text{AgCO}_3(\text{s}) \rightleftharpoons 2\text{Ag}^+_{(\text{aq})} + \text{CO}_3^{2-}_{(\text{aq})}}$$
- $$\underbrace{\text{AgNO}_3(\text{s})}_{1.3 \times 10^{-4}} \rightarrow \underbrace{\text{Ag}^+_{(\text{aq})}}_{1.3 \times 10^{-4}} + \underbrace{\text{NO}_3^-_{(\text{aq})}}_{1.3 \times 10^{-4}}$$
- $$K_{\text{sp}} = \left[\text{Ag}^+ \right]^2 \left[\text{CO}_3^{2-} \right]; 8.2 \times 10^{-12} = \left[1.3 \times 10^{-4} \right]^2 \left[\text{CO}_3^{2-} \right]$$
- $$\left[\text{CO}_3^{2-} \right] = \frac{8.2 \times 10^{-12}}{1.69 \times 10^{-8}} = 4.9 \times 10^{-4}$$
- (3) 3.
$$\left[8\text{H}^+ + 8\text{e}^- + \text{ClO}_4^- \rightarrow \text{Cl}^- + 4\text{H}_2\text{O} \right] \times 3$$
- $$\left[\text{Al} \rightarrow \text{Al}^{3+} + 3\text{e}^- \right] \times 8$$
- $$24\text{H}^+ + 3\text{ClO}_4^- + 8\text{Al} \rightarrow 3\text{Cl}^- + 8\text{Al}^{3+} + 12\text{H}_2\text{O}$$
- (1) 4. (a) $\text{Cu}_{(\text{s})} + 2\text{Ag}^+_{(\text{aq})} \rightarrow \text{Cu}^{2+}_{(\text{aq})} + 2\text{Ag}_{(\text{s})}$
- (3) 4. (b) $\text{AgCH}_3\text{COO}_{(\text{s})} \rightarrow \text{Ag}^+_{(\text{aq})} + \text{CH}_3\text{COO}^-_{(\text{aq})}$

$$K_{sp} = [\text{Ag}^+_{(aq)}][\text{CH}_3\text{COO}^-_{(aq)}]$$

$$\text{Cu} = \frac{2.00\text{g}}{63.5\text{g/mol}} = 3.15 \times 10^{-2}$$

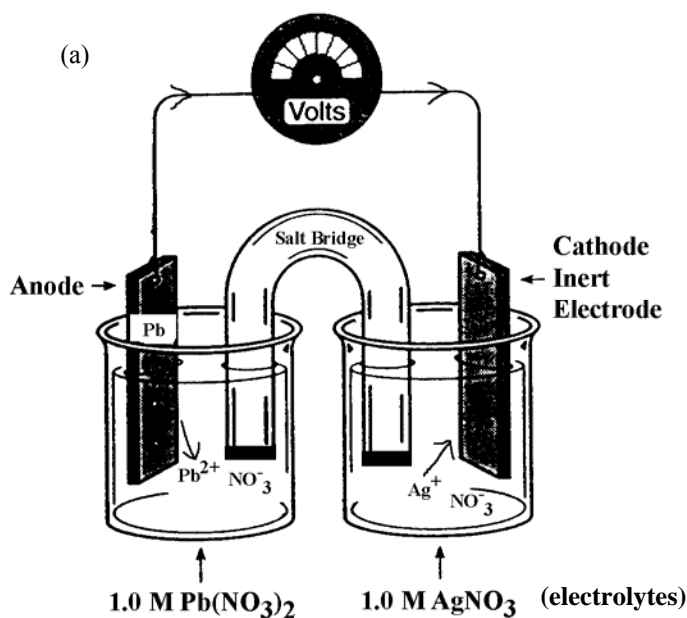
$$\text{Ag}^+ = 2\text{Cu} = 2(3.15 \times 10^{-2}) = 6.30 \times 10^{-2}$$

$$[\text{Ag}^+] = \frac{6.30 \times 10^{-2} \text{ mol}}{1.00\text{L}} = 6.30 \times 10^{-2} \frac{\text{mol}}{\text{L}}$$

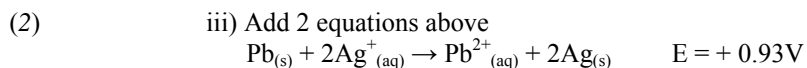
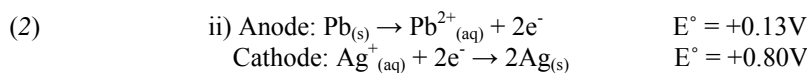
$$[\text{Ag}^+] = [\text{CH}_3\text{COO}^-] = \frac{6.30 \times 10^{-2}}{1.00\text{L}} = 6.30 \times 10^{-2}$$

$$K_{sp} = [6.30 \times 10^{-2}]^2 = 3.97 \times 10^{-3}$$

(3) 5. (a)



(1) (b) i) on diagram



(1) iv) on diagram

(1) v) $\underbrace{\text{Pb}^{2+}, \text{Ag}^+}_{\text{cations}}$ left to right : $\underbrace{\text{NO}_3^-}_{\text{anion}}$ right to left

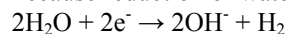
(1) 6. (a) Anything below Fe on the Reduction Potential Chart ie Cr, Zn, Al...

(1) (b) Cr metal will undergo oxidation: $\text{Cr}_{(s)} \rightarrow \text{Cr}^{3+} + 3e^-$ and therefore iron cannot undergo oxidization (i.e., rust),
 $\text{Fe}_{(s)} \rightarrow \text{Fe}^{2+} + 2e^-$

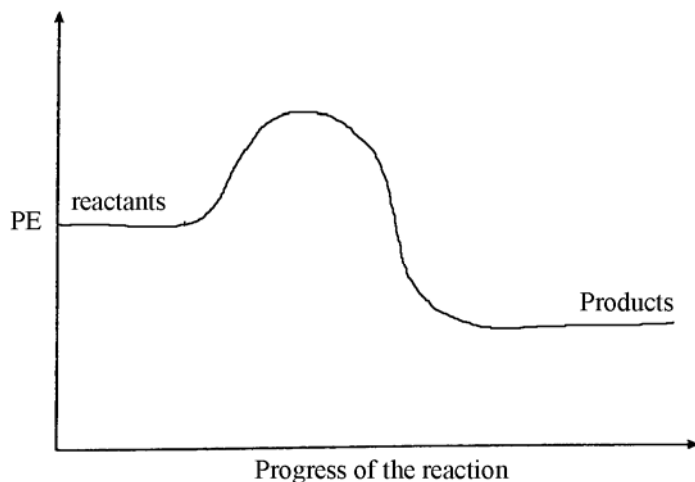
(1) 7. (a) $2\text{I}^- \rightarrow \text{I}_2 + 2e^-$

(2) (b) i) H_2 (hydrogen)

ii) Because reduction of water occurs at electrode B (cathode) producing OH^- (base) ions:



(2) 8. (a)

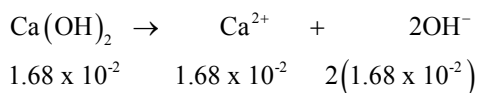


(1) (b) Equilibrium will shift to the right (product) side & therefore the concentration of Cl_2 decreases.

(1) (c) Equilibrium shifts right & therefore K_{eq} increases.

(4) 9. moles $\text{Ca}(\text{OH})_2 = \frac{0.125 \text{ g}}{74.08 \text{ g/mol}} = 1.68 \times 10^{-3} \text{ mol}$

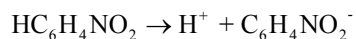
$$[\text{Ca}(\text{OH})_2] = \frac{1.68 \times 10^{-3}}{0.10000 \text{ L}} = 1.68 \times 10^{-2}$$



$$\begin{aligned} K_{sp} &= [\text{Ca}^{2+}][\text{OH}^-]^2 \\ &= [1.68 \times 10^{-2}][3.36 \times 10^{-2}]^2 = 18.97 \times 10^{-6} \\ K_{sp} &= 1.90 \times 10^{-5} \end{aligned}$$

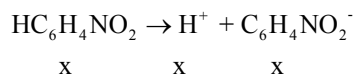
(2) 10. $\text{Ba}_{(\text{aq})}^{2+} + \text{SO}_4^{2-}_{(\text{aq})} \rightarrow \text{BaSO}_{4(\text{s})}$

(6) 11. Nicotinic acid, $\text{HC}_6\text{H}_4\text{NO}_2$, is a weak acid found in vitamin B. Calculate the pH of 0.100 M $\text{HC}_6\text{H}_4\text{NO}_2$ ($K_a = 1.4 \times 10^{-5}$).



Solution

$$K_A = \frac{[\text{H}^+][\text{C}_6\text{H}_4\text{NO}_2^-]}{\text{HC}_6\text{H}_4\text{NO}_2}$$



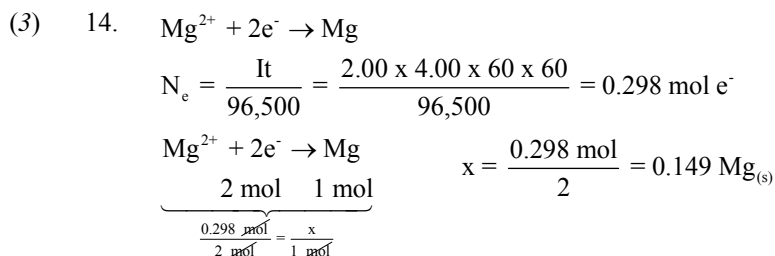
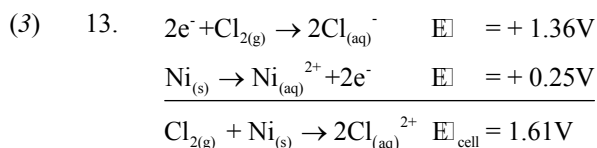
$$1.4 \times 10^{-5} = \frac{(x)(x)}{0.100-x} \quad \text{"x" can be dropped from the denominator as it is very small compared to the value 0.100}$$

$$\begin{aligned} \therefore x^2 &= (1.4 \times 10^{-5})(0.100) \\ &= 1.4 \times 10^{-6} \end{aligned}$$

$$\begin{aligned} x &= \sqrt{1.4 \times 10^{-6}} = 1.2 \times 10^{-3} \\ [\text{H}^+] &= x = 1.2 \times 10^{-3} \end{aligned}$$

$$\text{pH} = \log(1.2 \times 10^{-3}) = 2.92$$

- (2) 12. (a) None of the atoms change oxidation number and therefore (a) is **not** a Redox Reaction.
 (b) H changes oxidation number from 0 \rightarrow 1⁺ and N changes oxidation number from 0 \rightarrow 3⁺ therefore (b) is a Redox Reaction



$$\begin{aligned} \text{Mass Mg} &= 0.149 \text{ mol} \times 24.31 \text{ g/mol} \\ m &= 3.63 \text{ g} \end{aligned}$$

