

Recitation Worksheet (Optional Extra Practice)

Name:

key

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Textbook:

Chemistry & Chemical Reactivity

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Instructions:

- This recitation worksheet is optional extra practice for 17.3, 19.1
- You **do not** need to submit it to Gradescope.
- The answer key has been posted with this worksheet to eLC.
- A periodic table and formula sheet are attached to the end of this worksheet.

1. Calculate the molar solubility in mol/L of:



4.5×10^{-5} M

	$[\text{Mg}^{2+}]$	$[\text{AsO}_4^{3-}]$
Initial	0	0
Change	+3s	+2s
Equilibrium	3s	2s

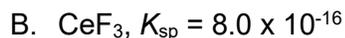
② $K_{sp} = [\text{Mg}^{2+}]^3 [\text{AsO}_4^{3-}]^2$
 $= [3s]^3 [2s]^2$
 $= 108s^5$

$\therefore 2.1 \times 10^{-20} = 108s^5$

$\therefore s = \sqrt[5]{\frac{2.1 \times 10^{-20}}{108}}$

$= 4.547357596 \times 10^{-5} \text{ M}$

$\approx 4.5 \times 10^{-5}$



7.4×10^{-5} M



	$[\text{Ce}^{3+}]$	$[\text{F}^-]$
Initial	0	0
Change	+s	+3s
Equilibrium	s	3s

② $K_{sp} = [\text{Ce}^{3+}][\text{F}^-]^3$
 $8.0 \times 10^{-16} = [s][3s]^3$
 $= 27s^4$

$\therefore s = \sqrt[4]{\frac{8.0 \times 10^{-16}}{27}}$

$= 7.377879463 \times 10^{-5} \text{ M}$

$\approx 7.4 \times 10^{-5} \text{ M}$

3. Which compound has the highest molar solubility?

E

- A. AgCN, $K_{sp} = 5.97 \times 10^{-17}$
- B. $PbSO_4$, $K_{sp} = 1.82 \times 10^{-8}$
- C. PbS, $K_{sp} = 9.04 \times 10^{-29}$
- D. NiS, $K_{sp} = 3.00 \times 10^{-20}$
- E. $MgCO_3$, $K_{sp} = 6.82 \times 10^{-6}$

All ionic compounds have the same dissociation stoichiometry \therefore they can be ranked by solubility using K_{sp}
 highest $K_{sp} \therefore$ highest solubility



4. Calculate K_{sp} given the molar solubilities of the following compounds:

A. Barium phosphate, molar solubility 8.89×10^{-9} M

6.00×10^{-39}



	$[Ba^{2+}]$	$[PO_4^{3-}]$
Initial	0	0
Change	+3s	+2s
Equilibrium	3s	2s

② $K_{sp} = [Ba^{2+}]^3 [PO_4^{3-}]^2$
 $= [3s]^3 [2s]^2$
 $= 108s^5$

$= 108 (8.89 \times 10^{-9})^5$
 $= 5.99697945 \times 10^{-39}$
 $\approx 6.00 \times 10^{-39}$

B. Ag_2S , molar solubility 1.26×10^{-16} M

8.00×10^{-48}



	$[Ag^+]$	$[S^{2-}]$
Initial	0	0
Change	+2s	+s
Equilibrium	2s	s

② $K_{sp} = [Ag^+]^2 [S^{2-}]$
 $= [2s]^2 [s]$
 $= 4s^3$

$\therefore K_{sp} = 4 (1.26 \times 10^{-16})^3$
 $= 8.001504 \times 10^{-48}$
 $\approx 8.00 \times 10^{-48}$

5. There are some data that suggest that zinc lozenges can significantly shorten the duration of a cold. If the solubility of zinc acetate, $Zn(CH_3COO)_2$, is 43.0 g/L, what is the solubility product, K_{sp} of this compound?

① convert 43.0 g/L to mol/L

$$5.15 \times 10^{-2}$$

or
0.0515

$$\frac{43.0 \text{ g } Zn(CH_3COO)_2}{1 \text{ L}} \times \frac{1 \text{ mol } Zn(CH_3COO)_2}{183.48 \text{ g } Zn(CH_3COO)_2} = 0.2343579682 \text{ M}$$



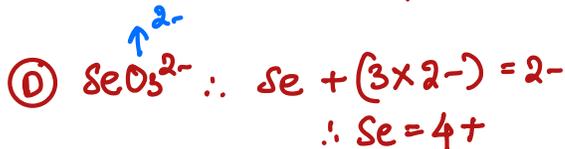
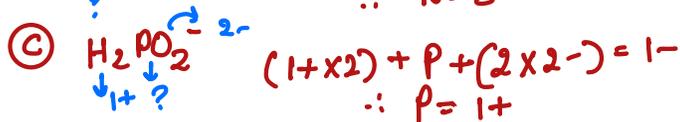
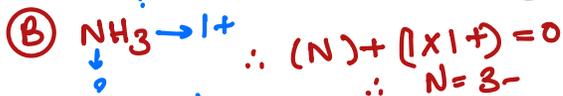
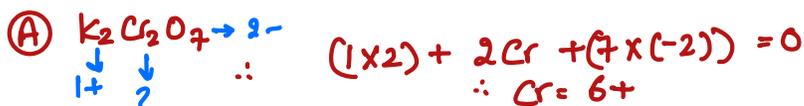
	$[Zn^{2+}]$	$[CH_3COO^{-}]$
Initial	0	0
Change	+s	+2s
Equilibrium	s	2s

③ $K_{sp} = [Zn^{2+}][CH_3COO^{-}]^2$
 $[s][2s]^2 = 4s^3 = 4(0.2343579682)^3 = 0.05148718689 \approx 0.0515$ or 5.15×10^{-2}

6. Which assignment of oxidation number is **INCORRECT** for the underlined element? Select all that apply. Insert letters without spaces in the answer box, example **ABCD**.

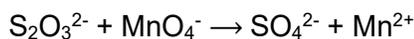
BE

- A. $K_2Cr_2O_7$; +6
 B. NH_3 ; +3
 C. $H_2PO_2^{-}$; +1
 D. SeO_3^{2-} ; +4
 E. $Cu(NO_3)_2$; +2

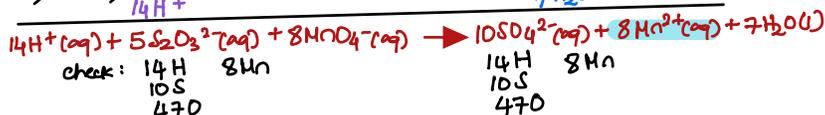
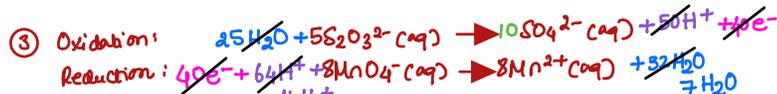
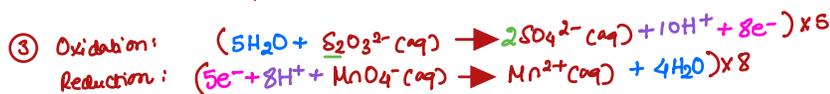
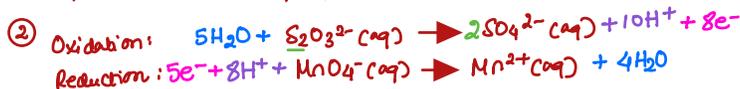
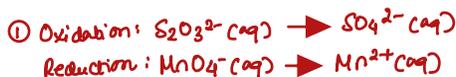


7. What is the coefficient of Mn^{2+} if the reaction below occurs in acidic solution?

C



- A. 5
- B. 7
- C. 8
- D. 10
- E. 14



8. What is the oxidation half-reaction in the chemical reaction $\text{Cr}_2\text{O}_7^{2-}(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{Cr}^{3+}(\text{aq}) + \text{Cl}_2(\text{aq})$ balanced in acidic medium?

A

- A. $2\text{Cl}^-(\text{aq}) \rightarrow \text{Cl}_2(\text{aq}) + 2\text{e}^-$
- B. $\text{Cl}_2(\text{aq}) + 2\text{e}^- \rightarrow 2\text{Cl}^-(\text{aq})$
- C. $\text{Cr}_2\text{O}_7^{2-}(\text{aq}) + 14\text{H}^+(\text{aq}) + 6\text{e}^- \rightarrow 2\text{Cr}^{3+}(\text{aq}) + 7\text{H}_2\text{O}(\text{l})$
- D. $\text{Cr}_2\text{O}_7^{2-}(\text{aq}) + 14\text{H}^+(\text{aq}) \rightarrow 2\text{Cr}^{3+}(\text{aq}) + 7\text{H}_2\text{O}(\text{l}) + 6\text{e}^-$

Oxidation half-reaction:

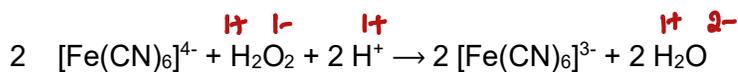


Reduction half-reaction:



9. What is the reducing agent in the following reaction between hexacyanoferrate (II) complex and hydrogen peroxide in acidic solution?

A

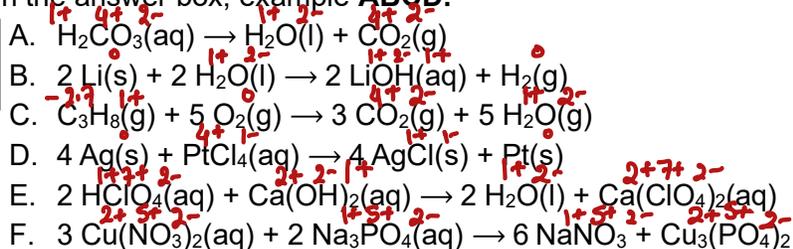


Reducing agent is oxidized (oxidation state of $[\text{Fe}(\text{CN})_6]$ decreases)

- A. $[\text{Fe}(\text{CN})_6]^{4-}$
- B. H_2O_2
- C. H^+
- D. $[\text{Fe}(\text{CN})_6]^{3-}$
- E. H_2O

10. Which of the following equations are an oxidation-reduction reaction? Select all that apply. Insert letters without spaces in the answer box, example ABCD.

BCD



Redox reactions:

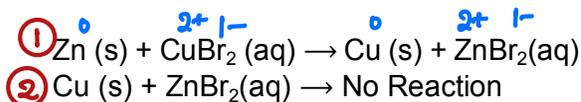
- 1) Single replacement (single displacement)
- 2) Combustion reaction

Reactions that are not redox:

- 1) Double replacement
- 2) Acid-base reactions
- 3) Decomposition reactions

11. Given the following laboratory observation, which of the following statements is FALSE?

C



- ~~A.~~ Zn is a stronger reducing agent than Cu. **True**
~~B.~~ Cu^{2+} is a stronger oxidizing agent than Zn^{2+} . **True**
 C. Cu is a stronger reducing agent than Zn.
~~D.~~ The fact that Cu doesn't react with ZnBr_2 proves that copper attracts electrons more than does Zn.
~~E.~~ None of the above.

From reaction 1: In the single replacement reaction Zn replaces Cu^{2+} in CuBr_2 & gets oxidized $\therefore \text{Zn}^0$ is a stronger reducing agent than Cu (also because reaction 2 does not occur)

12. The solubility of a salt MX_2 with a molar mass of 114 g/mol is 3.42 g/L. Calculate K_{sp} .

B

- A. 2.70×10^{-5}
 B. 1.08×10^{-4}
 C. 9.00×10^{-4}
 D. 2.25×10^{-4}
 E. 6.75×10^{-8}



	$[\text{M}^{2+}]$	$[\text{X}^{-}]$
Initial	0	0
Change	+S	+2S
Equilibrium	S	2S

② Convert $\frac{3.42 \text{ g MX}_2}{\text{L}} \times \frac{1 \text{ mol MX}_2}{114 \text{ g MX}_2} = \frac{0.030 \text{ mol}}{\text{L}} = S$
 $\therefore K_{sp} = 4(0.030)^3 = 1.08 \times 10^{-4}$

$K_{sp} = [\text{M}^{2+}][\text{X}^{-}]^2$
 $\therefore K_{sp} = [S][2S]^2 \rightarrow$ brackets indicate conc. in $\frac{\text{mol}}{\text{L}}$
 $= 4S^3$

13. Select a statement that best describes the oxidation process.

D

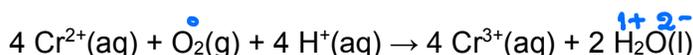
- some elements*
- A. In the oxidation process ~~all elements~~ change oxidation state. *some elements*
 B. In the oxidation process ~~all elements~~ experience an increase in oxidation state.
 C. In the oxidation process some elements change their oxidation state.
 D. In the oxidation process some elements experience oxidation state increase.
 E. In the oxidation process only oxygen increases its oxidation state.



Other elements can also experience oxidation or an increase oxidation state

14. Trace amounts of oxygen gas can be "scrubbed" from gases using the following reaction:

A



Which of the following statements is true regarding this reaction?

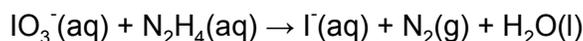
- A. Oxygen gas is reduced to water.
 B. $\text{Cr}^{2+}(\text{aq})$ is the ~~oxidizing agent~~. *reducing agent because it gets oxidized to Cr^{3+}*
 C. $\text{O}_2(\text{g})$ is the ~~reducing agent~~. *oxidizing agent because it gets reduced to O^{2-}*
 D. Electrons are transferred from O_2 to Cr^{2+} .



electrons are transferred from Cr^{2+} to O_2

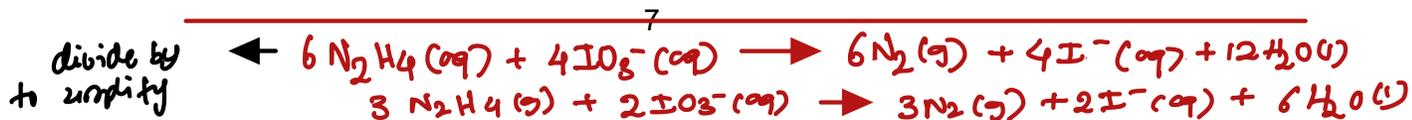
15. Balance the following equation for an oxidation-reduction reaction occurring in an acidic solution:

D



The sum of the coefficients is

- A. 8
 B. 25
 C. 18
 D. 16
 E. 32



Formula Sheet

Length

1 kilometer = 0.62137 mile
1 inch = 2.54 centimeters (exactly)
1 Ångstrom = 1×10^{-10} meter

Energy

1 joule = $1 \text{ kg}\cdot\text{m}^2/\text{s}^2$
1 calorie = 4.184 joules
1 Calorie = 1 kilocalorie = 1000 calories
1 L·atm = 101.325 joules

Pressure

1 pascal = $1 \text{ N}/\text{m}^2 = 1 \text{ kg}/\text{m}\cdot\text{s}^2$
1 atmosphere = 101.325 kilopascals = 760 mm Hg = 760 torr = 14.70 lb/in²
1 bar = 1×10^5 Pa (exactly)

Temperature

0 K = -273.15°C
K = $^\circ\text{C} + 273.15$
 $^\circ\text{C} = (5/9)(^\circ\text{F} - 32)$

Mass

1 kg = 2.205 lbs

Volume

1 mL = $1 \text{ cm}^3 = 1 \text{ cc}$

Constants

$c = 2.998 \times 10^8 \text{ m}/\text{sec}$
 $h = 6.626 \times 10^{-34} \text{ J}\cdot\text{sec}^{-1}$
 $R = 0.08206 \text{ L}\cdot\text{atm}/\text{mol}\cdot\text{K} = 8.314 \text{ J}/\text{mol}\cdot\text{K}$
Specific heat of water = 4.184 J/g·K
Mass of an electron: $9.109 \times 10^{-31} \text{ kg}$
Mass of a proton: $1.673 \times 10^{-27} \text{ kg}$
 $RH = 2.18 \times 10^{-18} \text{ J}$
Specific heat of water = 4.184 J/g·K
STP = 273.15 K and 1 atm
Avogadro's number: 6.022×10^{23}

Equations

d (density) = m/V

$P_1V_1 = P_2V_2$

$V_1/T_1 = V_2/T_2$

$P_1V_1/n_1T_1 = P_2V_2/n_2T_2$

$PV = nRT$

$(P + a(n^2/V^2))\cdot(V - nb) = nRT$

molar mass (M) = mRT/PV

density (d) = MP/RT

$x_A = n_A/n_{\text{tot}} = P_A/P_{\text{tot}} = V_A/V_{\text{tot}}$

$P_{\text{tot}} = P_A + P_B + \dots$

$n_{\text{tot}} = n_A + n_B + \dots$

$$\mu_{rms} = \sqrt{\frac{3RT}{M}}$$

$$\frac{\text{Rate of effusion A}}{\text{Rate of effusion B}} = \sqrt{\frac{MW_B}{MW_A}}$$

$$Q = C \times \Delta T = c_{\text{specific}} \times m \times \Delta T$$

$$Q = n \times \Delta H \text{ (kJ/mol)} = m \times \Delta H \text{ (kJ/g)}$$

$$w = -P\Delta V$$

$$\Delta E = q + w$$

$$\Delta H^\circ = \sum n\Delta H_f^\circ(\text{products}) - \sum n\Delta H_f^\circ(\text{reactants})$$

$$\Delta H^\circ = \sum n\Delta H^\circ(\text{bonds broken}) - \sum n\Delta H^\circ(\text{bonds formed})$$

$$E = h\nu$$

$$c = \lambda\nu$$

$$\lambda = h/mv$$

$$\Delta E = -2.18 \times 10^{-18} \text{ J} \left(\frac{1}{n_f^2} - \frac{1}{n_i^2} \right)$$

$$\ln\left(\frac{P_2}{P_1}\right) = \frac{\Delta H_{vap}}{R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)$$

$$C_g = kP_g$$

$$P_{\text{solution}} = P_{\text{solvent}} X_{\text{solvent}}$$

$$P_{\text{solution}} = \sum P_j = \sum P_j X_j$$

$$\Delta T_b = K_b m_i$$

$$\Delta T_f = K_f m_i$$

$$\pi = MRT_i$$

Thermodynamic and Electrochemistry

$$S = k_b \times \ln(W)$$

$$k_b = 1.381 \times 10^{-23} \text{ J/K}$$

$$\Delta S = q_{\text{rev}}/T$$

$$\Delta S_{\text{surr}} = q_{\text{surr}}/T = -q_{\text{rev}}/T$$

$$\Delta S_{\text{univ}} = \Delta S_{\text{sys}} + \Delta S_{\text{surr}}$$

$$\Delta S^\circ_{\text{rxn}} = \sum \nu S^\circ_{\text{products}} - \sum \nu S^\circ_{\text{reactants}}$$

$$\Delta H^\circ_{\text{rxn}} = \sum \nu H^\circ_{\text{products}} - \sum \nu H^\circ_{\text{reactants}}$$

$$\Delta G^\circ_{\text{rxn}} = \sum \nu G^\circ_{\text{products}} - \sum \nu G^\circ_{\text{reactants}}$$

$$\Delta G = \Delta H - T\Delta S$$

$$\Delta G = \Delta G^\circ + RT \cdot \ln Q$$

$$R = 8.314 \text{ J/mol}\cdot\text{K}$$

$$\Delta G^\circ = -RT \cdot \ln K$$

$$\Delta G = -nFE_{\text{cell}}$$

$$F = 96485 \text{ J/(V}\cdot\text{mol e}^-)$$

$$E^\circ_{\text{cell}} = RT/nF \ln K$$

$$E^\circ_{\text{cell}} = (0.0257/n) \ln K = (0.0592/n) \log K$$

$$E_{\text{cell}} = E^\circ_{\text{cell}} - (RT/nF) \ln Q$$

$$E_{\text{cell}} = E^\circ_{\text{cell}} - (0.0257/n) \ln Q$$

$$\text{Electrolysis: } Q \text{ (total charge)} = I \times t = n \times F$$

Integrated Rate Laws & half-life

$$\ln \frac{[A]}{[A]_0} = -kt$$

$$\frac{1}{[A]} = kt + \frac{1}{[A]_0}$$

$$[A] = -kt + [A]_0$$

$$t_{1/2} = \frac{[A]_0}{2k}$$

$$t_{1/2} = \frac{\ln 2}{k} = \frac{0.693}{k}$$

$$t_{1/2} = \frac{1}{k[A]_0}$$

$$\ln \frac{k_2}{k_1} = -\frac{E_a}{R} \left(\frac{1}{T_2} - \frac{1}{T_1} \right)$$

Equilibrium and Acid / Base

$$K_p = K_c \times (RT)^{\Delta n}$$

$$\text{pH} = -\log[\text{H}_3\text{O}^+]$$

$$K_w = 1.0 \times 10^{-14} \text{ at } 25^\circ\text{C}$$

$$K_w = [\text{H}_3\text{O}^+] \times [\text{OH}^-]$$

$$K_w = K_a \times K_b$$

$$\text{p}K_a = -\log[K_a]$$

$$\text{Buffer: pH} = \text{p}K_a + \log \frac{[\text{A}^-]}{[\text{HA}]}$$

$$\ln \frac{K_2}{K_1} = \frac{\Delta H_{rxn}^\circ}{R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)$$

Periodic Table of the Elements

1																		2												
1 H 1.01	2																2 He 4.00													
3 Li 6.94	4 Be 9.01															5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18									
11 Na 22.99	12 Mg 24.31															13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95									
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.63	33 As 74.92	34 Se 78.97	35 Br 79.90	36 Kr 83.80													
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.95	43 Tc [97]	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29													
57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm [145]	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.05	71 Lu 174.97																
87 Fr [223]	88 Ra [226]															104 Rf [267]	105 Db [268]	106 Sg [269]	107 Bh [270]	108 Hs [269]	109 Mt [277]	110 Ds [281]	111 Rg [282]	112 Cn [285]	113 Nh [286]	114 Fl [290]	115 Mc [290]	116 Lv [293]	117 Ts [294]	118 Og [294]
89 Ac [227]	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np [237]	94 Pu [244]	95 Am [243]	96 Cm [247]	97 Bk [247]	98 Cf [251]	99 Es [252]	100 Fm [257]	101 Md [258]	102 No [259]	103 Lr [262]																