Answer Key: SCH4U: Practice Exam

Answers: Multiple Choice

1	2	3	4	5	6	7	8	9	10
A	C	D	A	C	A	D	A	C	A
11	12	13	14	15	16	17	18	19	20
B	C	C	E	D	A	A	D	B	D
21	22	23	24	25	26	27	28	29	30
D	A	C	B	D	E	A	B	D	C
31	32	33	34	35	36	37	38	39	40
A	B	E	B	A	A	B	B	D	C
41	42	43	44	45	46	47	48	49	50
A	A	D	A	D	A	D	B	C	C
51	52	53	54	55	56	57	58	59	60
E	E	C	A	A	B	C	D	C	D

Answers: Problems

1. For the reaction: $2\ N_2O_5\,(g) \rightarrow 4\ NO_2\,(g) + O_2\,(g)$ $\Delta H^0 = +126.4$ kJ

a. Use Table of Standard enthalpies of formation to determine the enthalpy of formation of N_2O_5. $[\Delta H^0{}_f(NO_2) = +33.2$ kJ/mol$]$

b. State the sign of ΔS and ΔG that you would expect for this reaction.

ANSWER

a. $\Delta H^0{}_{f,}$ enthalpy of formation of N_2O_5 $= +3.2$ kJ mol^{-1}

b. ΔS = +, increasing

ΔG = spontaneous only at high temperatures, since $\Delta H_{rxn} = +126.4$ kJ and ΔS is +.

2. Given the following reaction with experimental data:

$$C_4H_{11}CF_{(aq)} + OH^{-1}_{(aq)} \longrightarrow C_4H_{11}COH_{(aq)} + F^{-1}_{(aq)}$$

Trial	**Initial $[C_4H_{11}CF]$ (mol/L)**	**Initial $[OH^-]$ (mol/L)**	**Initial Rate of Formation of F^- (mol/L/s)**
1	0.10	0.20	5.5×10^{-4}
2	0.20	0.20	1.1×10^{-3}
3	0.10	0.40	5.5×10^{-4}

a) Determine the order of the reaction with respect to $C_4H_{11}CF$

b) Determine the order of the reaction with respect to OH^-

c) What is the overall order of the reaction ?

d) Write the rate law expression for the reaction.

e) Determine the value of the rate law constant for the reaction.

f) State the molecularity of the reaction.

g) State the effect of doubling the concentration of $C_4H_{11}CF$ and the concentration of the OH^{-1} on the rate of the reaction.

ANSWER

a. Order with respect to $C_4H_{11}CF_{(aq)}$ = 1

b. Order with respect to $OH^{-1}_{(aq)}$ = 0

c. overall order of the reaction = 1

d. rate law expression for the reaction is: Rate = $k\,[C_4H_{11}CF_{(aq)}]^1$

e. value of the rate law constant, k, for the reaction = $5.0 \times 10^{-3}\ s^{-1}$

f. molecularity of the reaction = unimolecular

g. Rate will double when the concentration of $C_4H_{11}CF$ and the concentration of the OH^{-1}, since Rate = $k\,[C_4H_{11}CF_{(aq)}]^1$, only the concentration of $C_4H_{11}CF$ will have any effect and since it is first order with respect to $C_4H_{11}CF$, thus the rate will double.

3. Given the equation:

$$2\,A_{(g)} + B_{(g)} \rightleftharpoons 3\,C_{(g)} + D_{(g)} \qquad \Delta H^0 = -315.9\ kJ$$

a) Write the equilibrium law expression (K_c) for the above reaction.

b) When equal volumes of A and B are combined in a 3.5 L flask, their initial concentrations were each 1.75 mol/L. Once equilibrium is reached, the equilibrium concentration of C , is [C] = 0.65 mol/L. Determine the K_c for this reaction.

ANSWER

a. $Kc = \dfrac{[C]^3\,[D]}{[A]^2\,[B]}$

b. $Kc = 0.022$

4. The solubility product constant (K_{sp}) of $Ag_2CrO_{4\,(s)}$, in water is 5.02×10^{-13} at 25 ºC. What is the solubility of silver chromate (in g/L) at 298 K?

ANSWER

$$Ag_2\,CrO_{4(s)} \rightleftharpoons 2Ag^{+1}_{(aq)} + CrO_4{}^{-2}_{(aq)} \qquad K_{sp} = 5.02 \times 10^{-13}$$

solubility of silver chromate, $Ag_2\,CrO_{4(s)} = 1.66 \times 10^{-3}$ g/L

5. Hypobromous acid, $HOBr_{(aq)}$, has a $K_a = 3.75 \times 10^{-8}$ at a given temperature. Calculate the pH of a 0.225 M solution of hypobromous acid. State clearly any assumptions you have made at arriving your answer.

ANSWER

The pH of a 0.225 M solution of hypobromous acid, $HOBr_{(aq)}$ = 4.04

6. A new drug obtained from the seeds of a strange Colombian plant was found to be a weak organic base. A solution of this weak base has a concentration of 0.0100 mol /L, and a pH of 10.8. Determine the K_b for the drug.

ANSWER

K_b for the Colombian drug, a weak base = 3.98×10^{-5}

7. Oxalic acid is a diprotic acid. 0.200 g of oxalic acid, $H_2C_2O_4$ was neutralized with 35.5 mL of $NaOH_{(aq)}$. Determine the concentration of the $NaOH_{(aq)}$.

ANSWER

$$H_2C_2O_{4(aq)} + NaOH_{(aq)} \longrightarrow Na_2C_2O_{4(aq)} + 2\,H_2O_{(l)}$$

Concentration of the $NaOH_{(aq)}$. = 0.0313 mol L^{-1}

8. An electrochemical cell consists of a compartment with a zinc electrode in contact with 1.0 mol/L $Zn(NO_3)_{2\,(aq)}$, and a compartment with a silver electrode in contact with 1.0 mol/L $Ag(NO_3)_{(aq)}$. Ammonium nitrate, $NH_4NO_{3\,(aq),}$ is placed in the salt-bridge.
The standard reduction potentials are:

$$Ag_{(aq)}^{+1} + e^{-1} \rightleftharpoons Ag_{(s)} \qquad E^0 = +0.80 \text{ V}$$

$$Zn_{(aq)}^{+2} + 2e^{-1} \rightleftharpoons Zn_{(s)} \qquad E^0 = -0.76 \text{ V}$$

a. For the above cell, write the two half-reactions that will occur at each electrode.
b. State which of the two metals silver or zinc is acting as the anode and which the cathode and state the polarity of each electrode.
c. Write the overall reaction for the cell and calculate the standard cell potential.
d. State the direction of the electron flow.
e. State the direction of the ion flow in the salt-bridge.
f. State the oxidizing agent and state what is oxidized.
g. Write the standard cell notation for the spontaneous reaction occurring in the cell.

ANSWER

a. Anode: Oxidation: $Zn_{(s)} \longrightarrow Zn^{+2} + 2\,e^{-1}$ $+0.76$ V

Cathode: reduction: $Ag^{+1}_{(aq)} + e^{-1} \longrightarrow Ag_{\,(s)}$ $+0.80$ V

b. Anode (negative) : Zinc Cathode (positive): Silver

c. Overall reaction for the cell and the standard cell potential:

$$Zn_{(s)} + 2\,Ag^{+1}_{(aq)} \longrightarrow Zn^{+2}_{(aq)} + 2\,Ag_{(s)} \qquad E^0 = +1.56 \text{ V}$$

d. Electron will flow from zinc to silver: $Zn \longrightarrow Ag$

e. Direction of the ion flow in the salt-bridge:

NH_4^{+1} to the cathode, NO_3^{-1} to the anode

f. Oxidizing agent: Ag^{+1} oxidized: Zn

g. Standard cell notation for the spontaneous reaction occurring in the cell:

$Zn_{(s)}\,|\,Zn^{+2}_{(aq)}$ (1 M) $|\,|$ Ag^{+1} (1M) $|\,Ag_{(s)}$ $E^0 = +1.56$ V

9. Molten magnesium chloride is electrolysed. Use the following standard reduction potentials to answer the following questions:

$$Mg_{(aq)}^{+2} + 2e^{-1} \rightleftharpoons Mg_{(s)} \qquad E^0 = -2.36\ V$$

$$\tfrac{1}{2}\ Cl_{(aq)}^{-1} + e^{-1} \rightleftharpoons Cl^{-1}_{(aq)} \qquad E^0 = +1.36\ V$$

a. Write the two half-reactions that will occur at each electrode.
b. State the products at each electrode
c. State the polarity of each electrode.
d. Write the overall reaction for the cell and calculate the standard cell potential.
e. Is the reaction spontaneous or non-spontaneous.
f. State the sign of ΔG^0.
g. If **dilute** aqueous magnesium chloride is electrolysed, a different product is obtained at each electrode. Identify the product formed at each electrode, the overall E^0 value and write an overall equation, showing the formation of the product at each electrode.

ANSWER

a. Cathode: $Mg^{+2}{}_{(l)} + 2\ e^{-1} \longrightarrow Mg_{(s)}$

Anode: $2\ Cl^{-1} \longrightarrow Cl_{2(g)} + 2\ e^{-1}$

b. Cathode: $Mg_{(s)}$ Anode: $Cl_{2(g)}$

c. Cathode: negative (–) Anode: positive (+)

d. $Mg^{+2}{}_{(l)} + 2\ Cl^{-1} \longrightarrow Mg_{(s)} + Cl_{2(g)} \qquad E^0 = -1.00\ V$

e. Reaction is Non-spontaneous, since E^0 is negative

f. ΔG^0 will be positive (+), since non-spontaneous reaction.

g. If **dilute** aqueous magnesium chloride is electrolysed:

Cathode: reduction of water will preferentially take place to produce $H_{2\ (g)}$

Anode: oxidation of water will take place to produce oxygen gas, $O_{2(g)}$.

Overall equation: $2\ H_2O_{(l)} \longrightarrow 2\ H_{2(g)} + O_{2(g)} \qquad E^0 = -2.06\ V$