Written out problems – Show all work for partial credit.

26. **Write the structural formula** for the **major** organic product in each of the following chemical reactions. For the organic product, **name** the compound.
(9)

a) $C_6H_6 \xrightarrow[FeI_3]{I_2}$

b) $CH_2{=}CH{-}CH{=}C(CH_3)CH_3 \xrightarrow{HBr\ (excess)}$

c) $CH_3CH_2{-}C{\equiv}CH \xrightarrow{Cl_2\ (excess)}$

27. When H_2O is reacted with 1-propene in the presence of H^+, two products are obtained. Propose a detailed mechanism for the major product formed from this reaction. Explain why the major product is preferred over the minor product.

(10)

28. a) Two of the structural isomers of $C_5H_{11}Cl$ have a chiral carbon, i.e, is optically active. Name the structural isomers that are optically active.

(11)

b) Two of the structural isomers with the formula C_5H_{10} exhibit geometric (cis/trans) isomerism. Name the two structural isomers.

c) Name the structural isomers of trichlorobenzene.

29. (12) Consider a galvanic cell at 25°C based on the following half-reactions:

$Pb^{2+} + 2e^- \rightarrow Pb \qquad E° = -0.13\ V$

$Zn^{2+} + 2e^- \rightarrow Zn \qquad E° = -0.76\ V$

a) Draw the cell under **standard** conditions labeling the anode, the cathode, the direction of electron flow, the concentration of ions, the electrodes, and the direction of flow of cations and anions through the salt bridge.

b) To the standard cell above, OH^- is added to the zinc compartment causing $Zn(OH)_2$ to precipitate. After equilibrium is reached, the measured cell potential is 1.05 V. Given the following K_{sp} value for $Zn(OH)_2$:

$$Zn(OH)_2(s) \longrightarrow Zn^{2+}(aq) + 2\ OH^-(aq) \qquad K_{sp} = 6.5 \times 10^{-17}$$

calculate the equilibrium $[OH^-]$ in the zinc compartment.

30. Hydrogen-oxygen fuel cells are utilized in some cities to produce electricity. The fuel cell reaction and equilibrium constant at 25°C are:

(9)

$$2\ H_2(g) + O_2(g) \rightarrow 2\ H_2O(l) \qquad K = 1.28 \times 10^{83}$$

a) Fuel cells produce power by producing a voltage. Calculate E°, the standard cell potential, for this fuel cell reaction at 25°C.

b) This fuel cell utilizes the following half-reactions:

	E°
$4\ H_2O(l) + 4e^- \rightarrow 2\ H_2(g) + 4\ OH^-(aq)$	–0.83 V
$O_2(g) + 2\ H_2O(l) + 4e^- \rightarrow 4\ OH^-(aq)$	?

Using your result from part a, and given the information above, determine the standard reduction potential for:

$$O_2(g) + 2\ H_2O(l) + 4e^- \rightarrow 4\ OH^-(aq) \qquad E° = ?$$

c) The reverse reaction of this fuel cell:

$$2\ H_2O(l) \rightarrow 2\ H_2(g) + O_2(g)$$

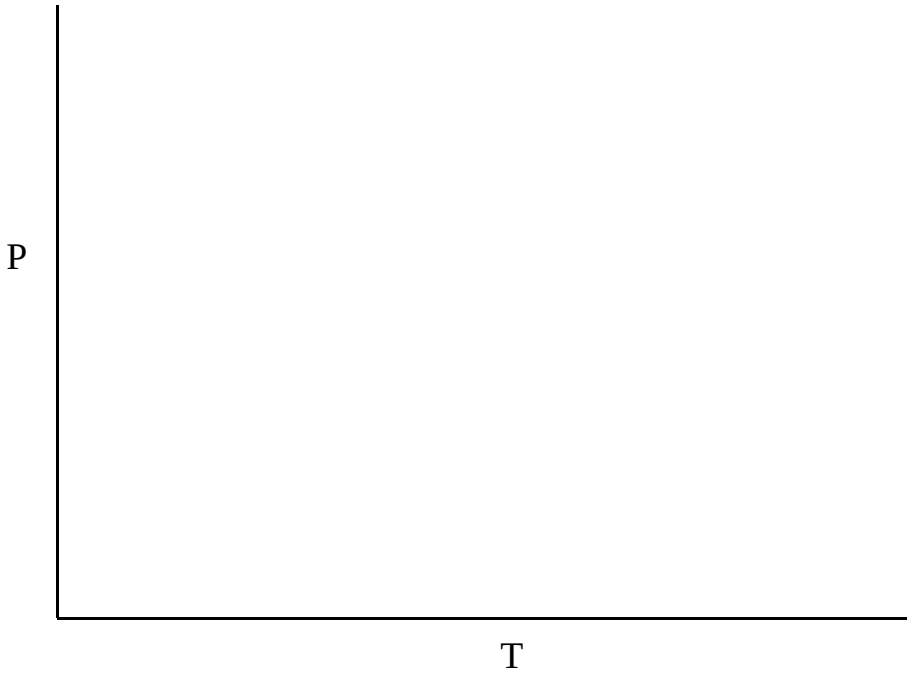
can be used to produce hydrogen and oxygen gases in an electrolytic cell. How many moles of $O_2(g)$ can be produced if water is electrolyzed by a current of 10.0 amps for 220 minutes?

31. Like most substances, xenon exists in one of three typical phases: solid, liquid and gas. Some important data points in the phase diagram for xenon are:

(12)

1. normal melting point = –112°C
2. normal boiling point = –107°C
3. triple point = –121°C and 0.37 atm
4. critical point = 17 °C and 58 atm

a) Sketch the phase diagram (P vs. T) for Xe, showing the four data points given above (label them 1-4) as well as indicating the area in which each phase is stable (label the various areas solid, liquid or gas). Your phase diagram does **not** have to be to scale. However, on your axes indicate the pressures and temperatures for the four data points given above.



b) For the following four questions, circle the correct response.

i) Which is the denser phase, **Xe(s)** or **Xe(l)**?

ii) As pressure increases, does the melting point of xenon **increase** or **decrease**?

iii) As pressure increases, does the boiling point of xenon **increase** or **decrease**?

iv) If solid xenon is heated at a constant pressure of 0.15 atm, will Xe(s) **sublime** or **melt**?

32. a) Draw the molecular orbital diagrams for O_2 and N_2. Only draw the diagrams for the molecular orbitals formed from the 2p atomic orbitals.

(11)

b) Is O_2 **paramagnetic** or **diamagnetic**? Circle your answer.

Is N_2 **paramagnetic** or **diamagnetic**? Circle your answer.

c) Explain why the removal of one electron from O_2 strengthens the bond, while the removal of one electron from N_2 weakens the bond.

d) Does the O_2 molecule have a **larger** or **smaller** ionization energy than O atoms? Circle your answer.

Does the N_2 molecule have a **larger** or **smaller** ionization energy than N atoms? Circle your answer.