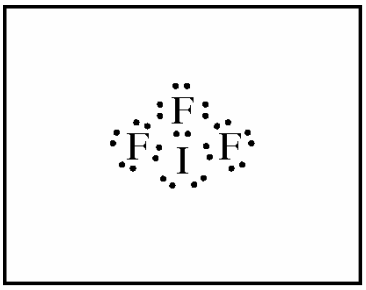
AP® CHEMISTRY
2007 SCORING GUIDELINES

Question 6

Answer the following questions, which pertain to binary compounds.

(a) In the box provided below, draw a complete Lewis electron-dot diagram for the IF_3 molecule.

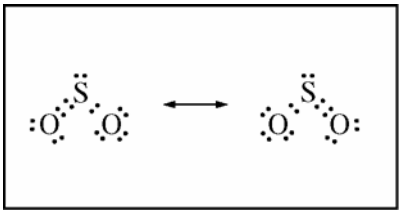


One point is earned for a correct Lewis diagram (can be done with dots or lines).

(b) On the basis of the Lewis electron-dot diagram that you drew in part (a), predict the molecular geometry of the IF_3 molecule.

T-shaped	One point is earned for the molecular geometry consistent with the Lewis diagram in part (a).

(c) In the SO_2 molecule, both of the bonds between sulfur and oxygen have the same length. Explain this observation, supporting your explanation by drawing in the box below a Lewis electron-dot diagram (or diagrams) for the SO_2 molecule.



One point is earned for a correct diagram (can be done with dots or lines). One point is earned for some indication or discussion of resonance (but the point is <u>not</u> earned for a description of resonance as a dynamic process). **OR**	
$\overline{\underline{O}}=\overline{S}=\overline{\underline{O}}$ The bonds are the same length because they are both double bonds.	One point is earned for a correct diagram (can be done with dots or lines). One point is earned for stating that both bonds are double bonds.

Question 6 (continued)

(d) On the basis of your Lewis electron-dot diagram(s) in part (c), identify the hybridization of the sulfur atom in the SO_2 molecule.

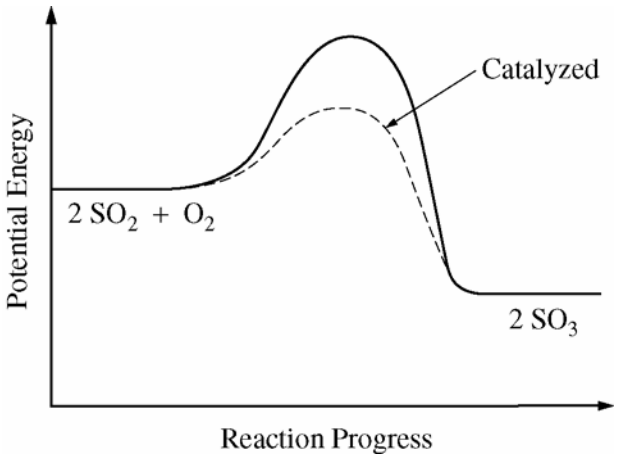
sp^2	One point is earned for hybridization consistent with part (c).

The reaction between $SO_2(g)$ and $O_2(g)$ to form $SO_3(g)$ is represented below.

$$2\ SO_2(g) + O_2(g) \rightleftarrows 2\ SO_3(g)$$

The reaction is exothermic. The reaction is slow at 25°C; however, a catalyst will cause the reaction to proceed faster.

(e) Using the axes provided below, draw the complete potential-energy diagram for both the catalyzed and uncatalyzed reactions. Clearly label the curve that represents the catalyzed reaction.



One point is earned for an uncatalyzed reaction curve that must show that $E_a > 0$ and $\Delta H < 0$.

One point is earned for a catalyzed reaction curve that must show $E_a <$ uncatalyzed E_a, must be clearly labeled, and must begin and end at the same energies as the uncatalyzed curve.

Question 6 (continued)

(f) Predict how the ratio of the equilibrium pressures, $\frac{p_{SO_2}}{p_{SO_3}}$, would change when the temperature of the uncatalyzed reaction mixture is increased. Justify your prediction.

The ratio $\frac{p_{SO_2}}{p_{SO_3}}$ would increase as the temperature increases. Because the reaction is exothermic ($\Delta H < 0$), as the temperature is raised the reaction shifts to the left.	One point is earned for the correct answer and explanation.

(g) How would the presence of a catalyst affect the change in the ratio described in part (f)? Explain.

The catalyst would not affect the value of the two equilibrium ratios but would increase the rate of the shifting of the system to the new equilibrium position. The catalyst does this by providing an alternate path with a lower activation energy.	One point is earned for the correct answer and explanation.