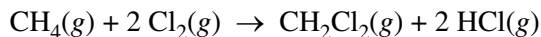


**2009 AP<sup>®</sup> CHEMISTRY FREE-RESPONSE QUESTIONS**

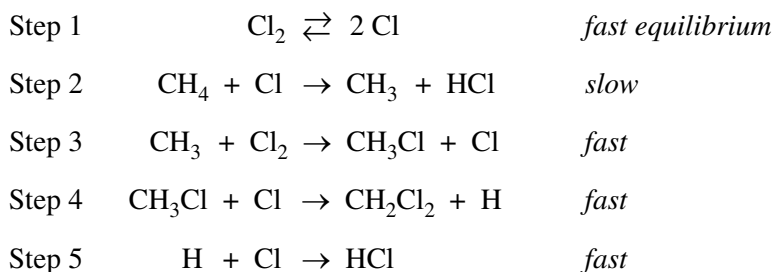
3. Methane gas reacts with chlorine gas to form dichloromethane and hydrogen chloride, as represented by the equation above.

- (a) A 25.0 g sample of methane gas is placed in a reaction vessel containing 2.58 mol of  $\text{Cl}_2(g)$ .
- (i) Identify the limiting reactant when the methane and chlorine gases are combined. Justify your answer with a calculation.
- (ii) Calculate the total number of moles of  $\text{CH}_2\text{Cl}_2(g)$  in the container after the limiting reactant has been totally consumed.

Initiating most reactions involving chlorine gas involves breaking the Cl–Cl bond, which has a bond energy of  $242 \text{ kJ mol}^{-1}$ .

- (b) Calculate the amount of energy, in joules, needed to break a single Cl–Cl bond.
- (c) Calculate the longest wavelength of light, in meters, that can supply the energy per photon necessary to break the Cl–Cl bond.

The following mechanism has been proposed for the reaction of methane gas with chlorine gas. All species are in the gas phase.



- (d) In the mechanism, is  $\text{CH}_3\text{Cl}$  a catalyst, or is it an intermediate? Justify your answer.
- (e) Identify the order of the reaction with respect to each of the following according to the mechanism. In each case, justify your answer.
- (i)  $\text{CH}_4(g)$
- (ii)  $\text{Cl}_2(g)$

**STOP**

**If you finish before time is called, you may check your work on this part only.  
Do not turn to the other part of the test until you are told to do so.**