Free-Radical Chlorination Mechanism Explained

https://gemini.google.com/app/bea064ef0ea6a0bd

Response: The correct answer is **(5)**.

Explanation

In the free-radical chlorination mechanism of methane:

- **Option (1)** is the **Initiation** step, where ultraviolet light ($h\nu$) causes homolytic cleavage of the $\mathrm{Cl–Cl}$ bond to form two chlorine radicals ($\mathrm{Cl^{\bullet}}$).
- **Options (2) & (3)** are the standard **Propagation** steps that yield chloromethane ($\mathrm{CH_3Cl}$) and regenerate a chlorine radical ($\mathrm{Cl^{\bullet}}$).
- **Option (4)** is a subsequent **Propagation** step where a chlorine radical abstracts a hydrogen atom from chloromethane ($\mathrm{CH_3Cl}$) to form a chloromethyl radical ($\mathrm{^{\bullet}CH_2Cl}$).

Why (5) is incorrect:

To produce dichloromethane ($\mathrm{CH_2Cl_2}$), the chloromethyl radical ($\mathrm{^{\bullet}CH_2Cl}$) must react with a chlorine molecule ($\mathrm{Cl_2}$), not hydrogen chloride (HCl):

$$\mathrm{^{\bullet}CH_2Cl + Cl_2 \longrightarrow CH_2Cl_2 + Cl^{\bullet}}$$

Free hydrogen radicals ($\mathrm{H^{\bullet}}$) are **not** generated during free-radical halogenation due to the high bond energy involved.
