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● **1.** An elementary reaction is a reaction that cannot be broken down into a simpler reaction. An overall reaction is an addition of elementary reactions. The overall reaction rate will be the same as the reaction rate for which the energy level of the activated complex is the highest. Its reaction rate will also be the slowest.

● **3.** *a)* 4 *b)* 3 *c)* 8 *d)* 7 *e)* 5

◆ **9.** *a)* The second only.

b) The first and the third.

c) The third.

d) Endothermic.

e)

f) *Several possible answers.*
Examples:
- Increase the number of effective collisions, by increasing the concentration of the reactive substances in the third reaction.
- Add a catalyst.
- Etc.

● **4.** *a)* 1) 3 steps.
2) 1st step: 400 kJ/mol; 2nd step: 100 kJ/mol; 3rd step: 550 kJ/mol.
3) The third step will be the rate-determining step, since the activated complex of this step is 500 kJ/mol, while the other two have a lower energy level. Therefore, the reaction rate of the third step will be the slowest.

c) 1) 2 steps.
2) 1st step: 40 kJ/mol; 2nd step: 80 kJ/mol.
3) The second step will be the rate-determining step, since the activated complex of this step is 100 kJ/mol, while the other one has a lower energy level. Therefore, the reaction rate of the second step will be the slowest.

● **5.** *a)* The rate increases. By doubling the number of particles, the number of effective collisions doubles and the reaction rate will double.

b) The rate increases. By doubling the pressure, the effect is the same as if the volume were reduced, therefore there will be two times less space for the molecules, and two times more effective collisions. The reaction rate will double.

c) The rate decreases. If the temperature is decreased, the speed of the particles will decrease and therefore, there will be fewer effective collisions. The reaction rate will decrease.

■ **6.** *a)* The rate-determining step will be the slow reaction, since an overall reaction cannot go faster than its slowest reaction. The energy level of its activated complex will be higher.

■ **8.** No. An increase in the temperature does not affect the activation energy. It increases the number of effective collisions and therefore, the reaction rate. The activation energy will be attained more quickly, but it will be at the same level.

◆ **10.** The mixture of methane (CH_4) and oxygen (O_2) does not react immediately, since the particles do not have sufficient energy to form the activated complex and allow the reaction.