Learning Check #7-12 pg. 367

7. The particles must collide with the proper orientation to one another and have sufficient kinetic energy to overcome the potential energy barrier (activation energy) between reactants and products.

8. Many collisions have the wrong collision geometry, and only a fraction of the collisions have sufficient energy to overcome the potential energy barrier (activation energy).

9. The angle at which the reactants collide must align with the angle at which the new bond or bonds in the products will form.

10. Diagrams for exothermic reactions show reactants with a higher potential energy than the potential energy for the products. Diagrams for endothermic reactions show reactants with a lower potential energy than that for the products.

11. a. The minimum kinetic energy required for a collision to result in a reaction between reactant particles.

b. Only the collisions with a kinetic energy equal to or greater than Ea will result in a reaction. For a reaction at room temperature with a high Ea, there will be few particles having sufficient energy to overcome the energy barrier when they collide.

12. The enthalpy change, the activation energy, and whether the reaction is endothermic or exothermic are three characteristics of a reaction that you can determine from a potential energy diagram. The enthalpy change is the difference between the initial (reactant) and final (product) potential energies. The activation energy is the difference between the initial potential energy and the maximum potential energy. The relative values of the potential energy of the reactants and products indicate whether it is an endothermic or exothermic reaction.

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13. The greater the activation energy, the slower the rate; the lower the activation energy, the faster the rate

14. a. The flame increases the energy of a few reactant particles so that when collisions occur, the reactant particles have energy equal to or greater than the activation energy. After a few successful collisions occur, the reaction itself releases enough energy to provide energy for the rest of the particles to react.

b. Combustion reactions such as the burning of natural gas are exothermic processes. The thermal energy given off provides the energy for further particles to react.

15. The thermochemical equation does not show the activation energy, which you would expect to be high, since graphite does not spontaneously change to diamond. Graphite and diamond have different arrangements of carbon atoms. Although the overall energy difference is small, to make the change, carbon-carbon bonds would need be broken and the atoms re-arranged.

16. a. An activated complex is an unstable, temporary chemical species formed of the reactant and product; it will break apart either to form the product(s) or reform the reactants.

b. The nitrogen atom in the NO collides with an oxygen atom in the NO_3. Sketches should show dotted lines indicating new bonds forming between the N of NO and the O of NO_3 and dotted lines indicating the breaking of bonds between the O and N of NO_3.

17. Exothermic; ΔH = Ea(fwd) - Ea(rev) = 45 kJ - 50 kJ = -5 kJ

18. Since the reverse of the reaction shown is endothermic, the product (carbon disulfide) has higher potential energy than the reactants (carbon and sulfur); the difference between the two values is 89 kJ.

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b. The products have a higher potential energy than the reactants.

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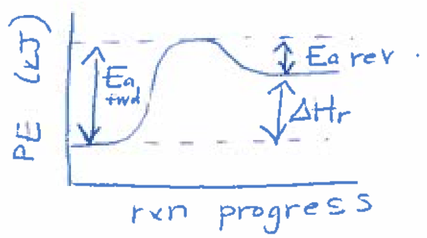
11. a. The reaction is endothermic.

b. The products have a higher potential energy than the reactants.

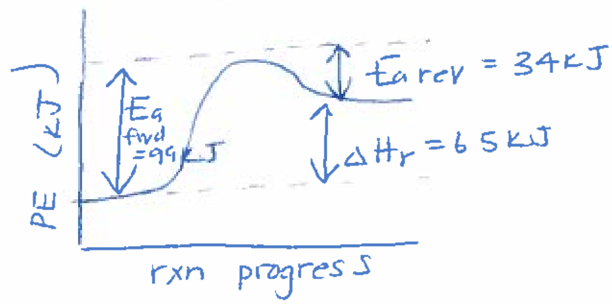


12. $\Delta H_r = E_{a\,fwd} - E_{a\,rev}$

$65\ kJ = E_{a\,fwd} - (+34\ kJ)$

$E_{a\,fwd} = 65\ kJ + 34\ kJ$

$= 99\ kJ$



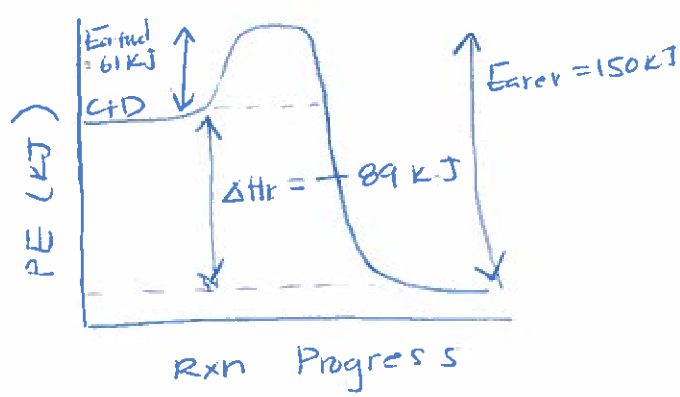
13. $C + D \rightarrow CD$ $\quad E_{a(fwd)} = +61\ kJ$

$E_{a(rev)} = +150\ kJ$

$\Delta H_r = E_a(fwd) - E_a(rev)$

$= 61\ kJ - 150\ kJ$

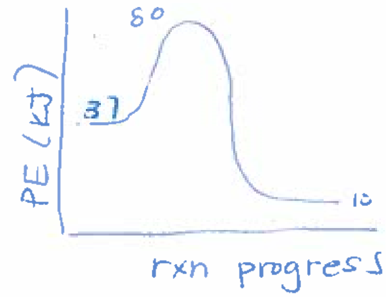
$= -89\ kJ$



14. $E_a(fwd) = 80 - 37 = 43\ kJ$

$E_a(rev) = 80 - 10 = 70\ kJ$

$\Delta H_r = -27\ kJ$

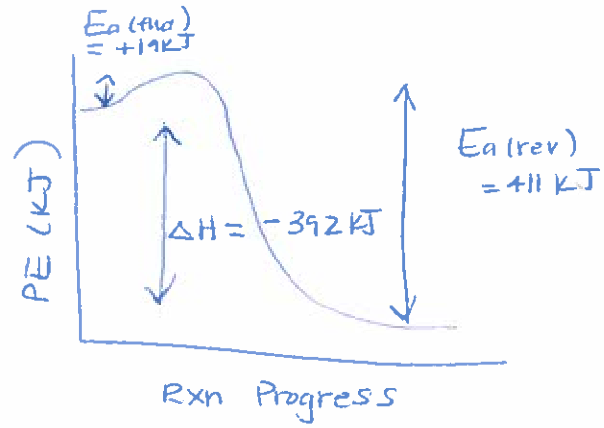


15. $\Delta H_r = E_a(fwd) - E_a(rev)$

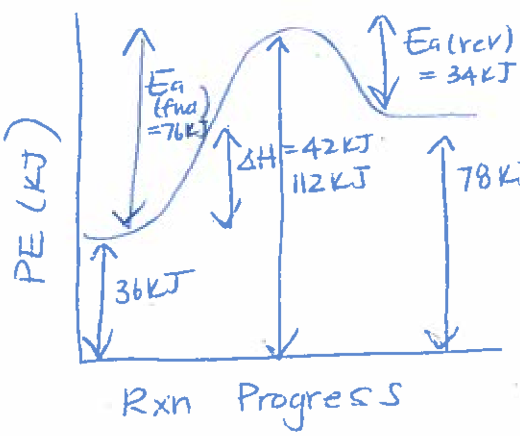
$-392\ kJ = 19.0\ kJ - E_a(rev)$

$E_a(rev) = 19.0\ kJ + 392\ kJ$

$= 411\ kJ.$



16.



a) $\Delta H = 78 - 36$

$= 42\ kJ$

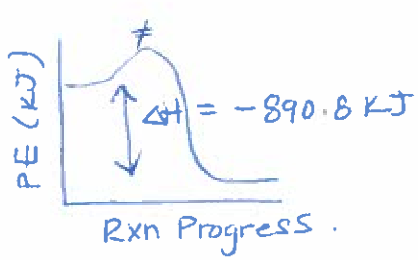
$E_a(fwd) = 112 - 36$

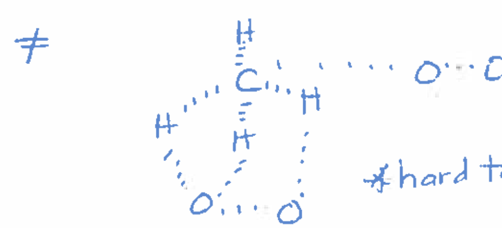
$= 76\ kJ$

$E_a(rev) = 112 - 78$

$= 34\ kJ.$

17. $CH_4(g) + 2O_2(g) \xrightarrow{\Delta} CO_2(g) + 2H_2O(l) + 890.8\ kJ.$





hard to predict

18. $3Fe(s) + 4H_2O(g) \rightleftharpoons Fe_3O_4(s) + 4H_2(g)$

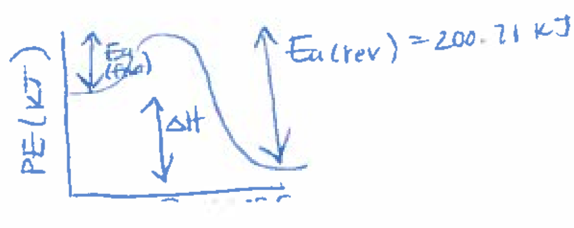
$\Delta H_r = -151.2\ kJ$

$E_a(rev) = 200.71\ kJ.$

$\Delta H_r = E_a(fwd) - E_a(rev)$

$E_a(fwd) = 200.71\ kJ - 151.2\ kJ$

$= 49.51\ kJ.$



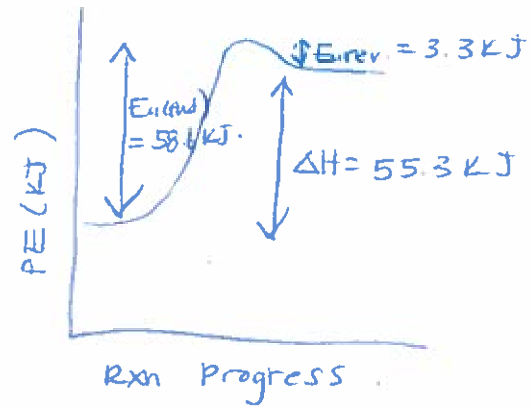
19. $N_2O_4(g) + 55.3\,kJ \longrightarrow 2NO_2(g)$

$E_a(fwd) = 58.6\,kJ$

$\Delta H_r = E_a(fwd) - E_a(rev)$

$E_a(rev) = 58.6\,kJ - 55.3\,kJ$

$= 3.3\,kJ$.



20. $\Delta H_r = E_a(fwd) - E_a(rev)$

$85\,kJ = E_a(fwd) - 235\,kJ$

$E_a(fwd) = 85\,kJ + 235\,kJ$

$= 320\,kJ$.