pg 411

1. a) time units
   b) 4 km/h
   c) 0.05 mol/min or 3 mol/hr

2. $r = \frac{\Delta C_{H_2}}{\Delta t}$

3. Ammonia (NH_3) has intramolecular hydrogen bonds while PH_3 does not. Therefore when ammonia reacts with oxygen hydrogen bonds must be overcome that do not need to be overcome when PH_3 reacts with oxygen.

4. a) slow: many bonds must be broken
   b) slow: " " " " "
   c) fast: no bonds must be broken
   d) fast: no bonds must be broken, only the transfer of two electrons
   e) fast: no bonds must be broken
   f) slow: several bonds must be broken

6. Use finely divided Fe(s). The increase in surface area will enhance the reaction rate. Increase the concentration of Ca^{2+} by evaporating some of the water solvent. Increase in concentration will speed up the reaction rate.

7. The higher concentration of oxygen increases the rate of the oxidation reaction of the hydrocarbons. The increase in reaction in turn increases the rate at which heat is produced by this strongly exothermic reaction. The resulting rise in temperature reaches the ignition point of the wooden splint.

pg 393 15-1

a) will be very fast: no bonds must be broken for a reaction to occur (only the transfer of electrons), therefore very fast

c) will be very slow: several bonds must be broken for a reaction to occur

pg 395 15-2

$C_{25}H_{52} + 38O_2 \rightarrow 26H_2O + 25CO_2$

Due to the number of bonds that must be broken in the above equation for the reaction to occur it is unlikely that above equation represents the actual reaction mechanism. It is more likely that the wax molecules react to form molecules of intermediate size that then react further to form water and carbon dioxide. There are likely several steps in this reaction

pg 397 15-3

a) slight

b) unnoticeable

c) great improvement

Consider the total amount to time required for each step in the sending of the telegraph. The Land delivery is by far the slowest step and is therefore the rate determining step. The electronic transmission of the message is very short compared to this rate

pg 412

8. a) It is extremely unlikely that four molecules will collide simultaneously.

b) The equation as written requires a simultaneous collision of five different molecules

c) see pg 396. Since the concentration of HBr and the concentration of O_2 have an equal affect on the reaction rate it is reasonable to assume that the slowest step involves a collision between these two molecules

$HBr + O_2 \rightarrow HOOBr.$

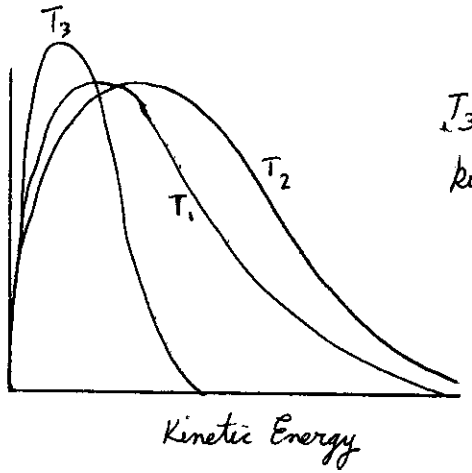
9. a) The higher temperature on a cupboard shelf allows the metabolic processes of bacteria to proceed and spoil the milk. At the lower temperature in the fridge many metabolic processes of the bacteria will not proceed because there is insufficient energy available for the activation energy

b) Propane and oxygen have a very high activation energy. The heat from the match can supply this energy an start a reaction. Since the reaction between propane and oxygen is also very exothermic, once the reaction has started, the reaction itself supplies the necessary energy to unreacted propane and oxygen.

10. The kinetic energy in the <u>hot</u> chocolate is sufficient to overcome the attractive forces holding the sugar crystals together. The lack of kinetic energy in the ice tea would not be able to easily overcome these same attractive forces. Therefore it is preferable to use more finely divided sugar

11. The eleventh slice contains the slowest moving atoms

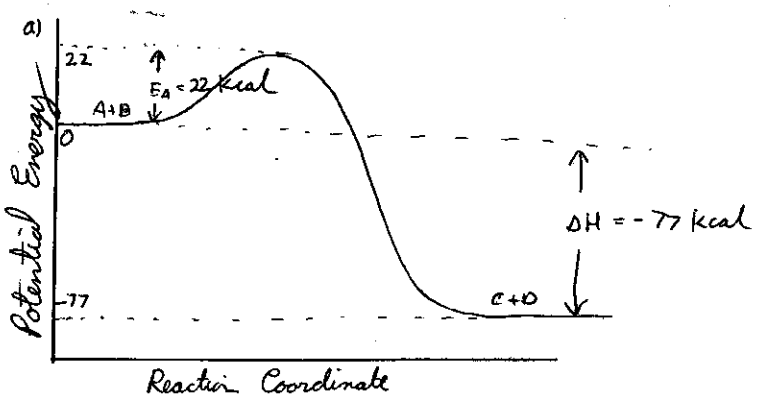
12.



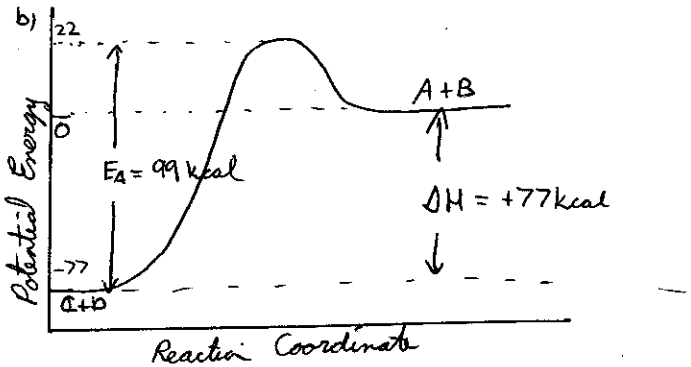
T_3 will a "colder" kinetic energy distribution

13. R = reactants
P = products
A = activated complex

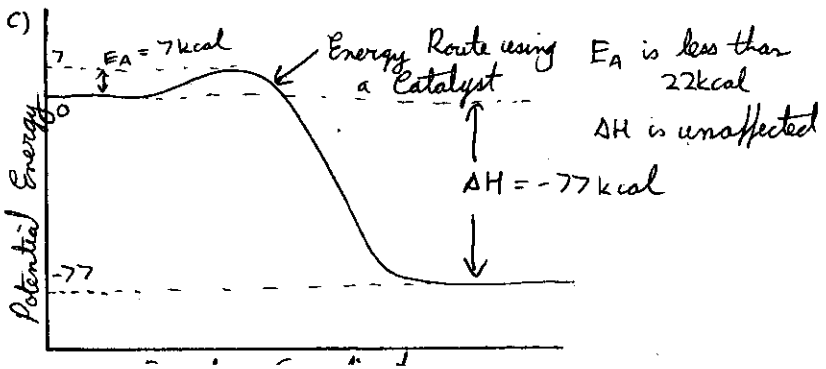
14. a)



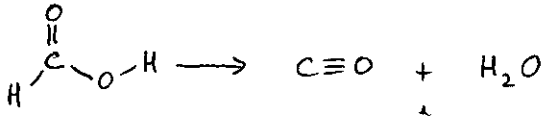
b)



c)



15.



The catalyst is a H^+ ion from an acid like HCl or H_2SO_4

16. The activated complex forms at the peak of potential energy. The activated complex can: a) reform the reactants
b) form products

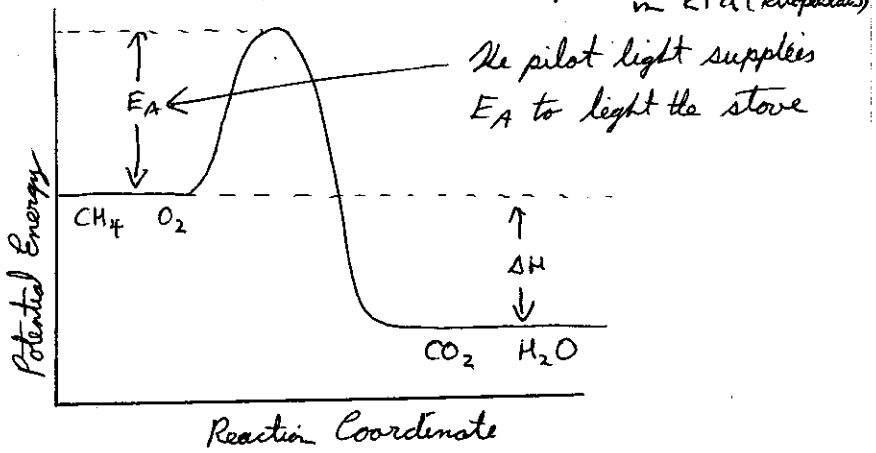
17. a) $\frac{200 \text{ miles}}{70 \text{ min}} = 2.86 \text{ miles/min}$

or $\frac{200 \text{ miles}}{1.16 \text{ hr}} = 171 \text{ miles/hr}$

b) The aircraft will travel fastest once cruising altitude has been reached. It will travel slower during take off and decent.

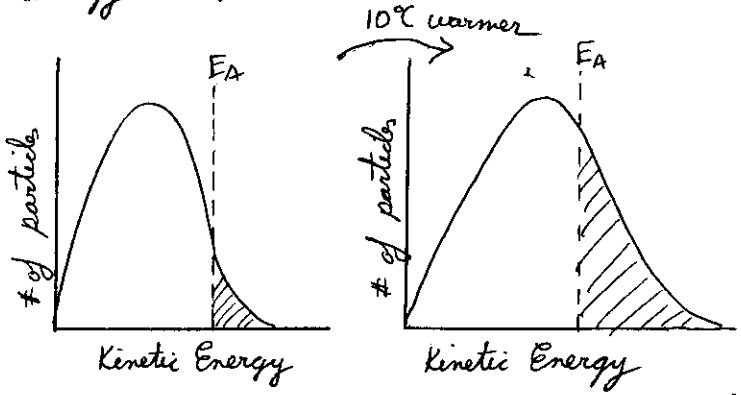
c) The rate determining step is often take-off and landing clearance

18. Microseconds (one millionth of a second) would be useful units. μs / Pressure change in kPa (kilopascals)

20. 

21. The manufacture would wish to slow the reaction down. He/She could do this by
a) reducing the concentration of reactants
b) reducing the surface area of contact between magnesium and oxygen
c) somehow increase the activation energy of the reaction (poison catalyst)

22. A 10°C increase in temperature does not double the kinetic energy of the reactants. However it could double the number of energy to form an activated complex



Shaded area represents reactant molecules that can react successfully

23. It is next to impossible for four molecules to simultaneously collide

25. a) exothermic - potential energy decreases
b) yes - activation energy is low, particularly when compared to the heat produced in this reaction
c) 30 kcal/mol
d) 10 kcal/mol
e) at the top of the energy curve
f) 1) - exothermic low activation energy ✓
2) - endothermic X
3) - high activation energy X

26 a) neither or just slightly endothermic

b) no : very high activation energy, the energy barrier is too high for range of kinetic energies available at room temperature

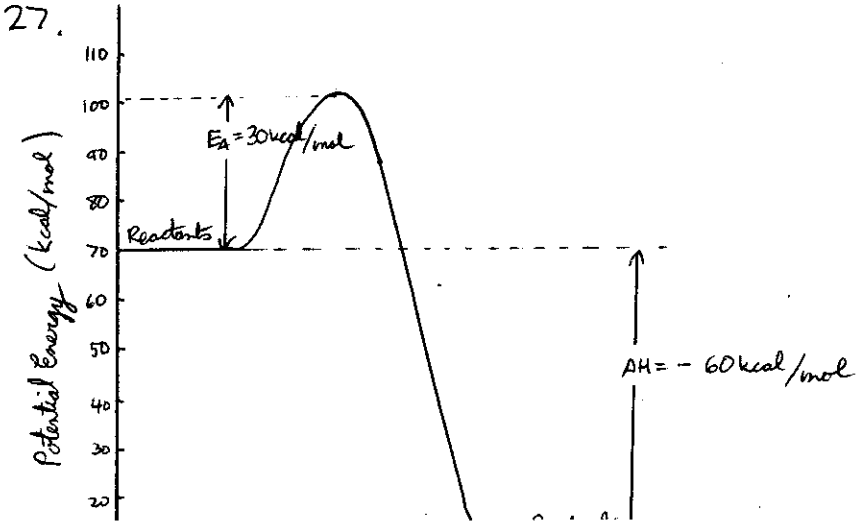
c) 4) - slightly endothermic, high activation energy ✓

1) - very exothermic X

2) - very endothermic X

3) - very exothermic X

27.



28. a) $r = \frac{\Delta V_{H_2}}{\Delta t} = \frac{\text{change in volume of } H_2 \text{ gas}}{\text{change in time}}$

b) mL or L for volume

s or min for time

c) increased reaction rate (qualitative)

d) Without experimental observations it is impossible to make a quantitative statement about the increase in reaction rate. Note a reaction does not necessarily vary linearly with the concentration of the reactants

29. The power mill grinds the mixture into a very fine powder. This increases the surface area of contact between the reactants. This improves the rate of reaction significantly. This a match is <u>better</u> able to initial a chain reaction. The faster reaction rate can supply more heat energy and thus [illegible] to [illegible] to limit the

30. If the NO concentration is 5 the reaction rate should be 25

$R \propto [NO]^2$

This rate expression is not consistent with the mechanism shown as written. If $N_2O_2 + O_2 \rightarrow 2NO_2$ is the slower or rate determining step then the concentration of NO would have little effect on the overall reaction rate. If $NO + NO \rightarrow N_2O_2$ were the slower or rate determining step, then the concentration of NO would be of concern. Since this step is a two body collision between NO and NO the exponent 2 in $R \propto [NO]^2$ is appropriate

31. b) $NO + O_3 \rightarrow NO_2 + O_2$ ✓

a) rate expression should be $r \propto [NO]$

c) rate expression should be $r \propto [O_3]$

32. $\frac{2400}{60} = 40$ revolutions per second

$\frac{1}{12} \times \frac{1}{40} = \frac{1}{480}$ second per slice

∴ slice 1: $\frac{1.0\,cm}{1/480\,s} = 480\,cm/sec$

∴ slice 2: $\frac{1.0\,cm}{2/480\,s} = 240\,cm/sec$

33.