MEGA LECTURE

**Answers to Topic 5 Exercises**

**Topic 5 Exercise 1**

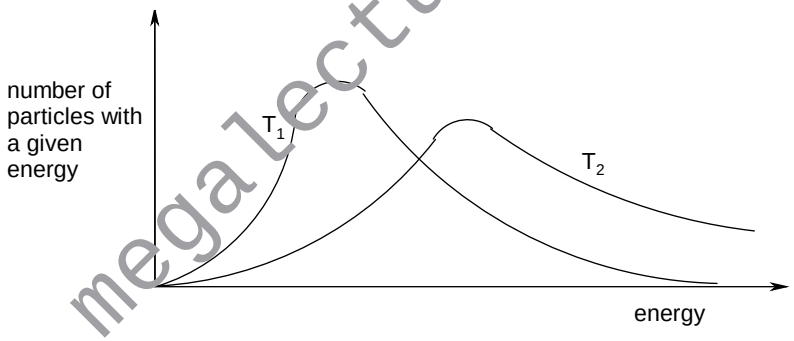
1. a) i) number of collisions between particles per second
   ii) combined energy of the colliding particles
   iii) minimum collision energy required for a collision to be successful

   b) Collisions only lead to a chemical reaction if the combined kinetic energy of the colliding particles is equal to or greater than the activation energy.

   c)

| | Increase in concentration | Increase in pressure | Increase in temperature | Addition of catalyst |
|---|---|---|---|---|
| Collision Frequency | Increases | Increases | Increases | No change |
| Collision Energy | No change | No change | Increases | No change |
| Activation Energy | No change | No change | No change | Decreases |

2. a)




on moving from T1 to T2

i) mean kinetic energy increases as particles are moving faster
ii) area under graph is the same as number of particles is the same
iii) number of particles having the most common amount of energy decreases as there is a greater spread of energies

b) the mean collision energy increases
so the chance of having a collision energy greater than the activation energy is much higher
so the fraction of successful collisions is much higher

3. a) a substance which changes the rate of a chemical reaction without itself being chemically unchanged at the end of the reaction.
   b) a catalyst lowers the activation energy of the reaction by providing an alternative route for the reaction
   c) if the activation energy is lower, the number of colliding particles with an energy greater than the activation energy will be higher
   so the fraction of successful collisions will be higher

**Topic 5 Exercise 2**

1. The system is closed; the forward and reverse reactions are taking place at the same rate; the concentrations of reactants and products are not changing

2. i) $\frac{[N_2O_4]}{[NO_2]^2}$ $mol^{-1}dm^3$ ii) $\frac{[CH_3CH_2CO_2CH_2CH_3][H_2O]}{[CH_3CH_2CO_2H][CH_3CH_2OH]}$ no units

   iii) $\frac{[HI]^2}{[H_2][I_2]}$ no units iv) $\frac{[SO_3]^2}{[SO_2]^2[O_2]}$ $mol^{-1}dm^3$

   v) $\frac{[NH_3]^2}{[N_2][H_2]^3}$ $mol^{-2}dm^6$

3. 0.042 $moldm^{-3}$
4. 1.33 x $10^{-3}$ $moldm^{-3}$
5. 56.3
6. 0.2 $moldm^{-3}$
7. 6.6 $mol^{-2}dm^6$
8. 1010 $mol^{-1}dm^3$
9. 3.2 x $10^{-4}$ $moldm^{-3}$
10. 46.3 $mol^{-2}dm^6$
11. 4.12
12. 12 $moldm^{-3}$

**Topic 5 Exercise 3**

1. a) equilibrium moves to right
   to replace lost water
   so $[Cl_2]$ increases and [HCl] decreases
   b) equilibrium moves to right
   to remove added oxygen
   so $[Cl_2]$ increases and [HCl] decreases
   c) pressure is increased
   so equilibrium moves to right
   in direction of fewer moles
   to reduce pressure
   so $[Cl_2]$ increases and [HCl] decreases
   d) equilibrium moves to left
   in endothermic direction
   to reduce temperature
   so $[Cl_2]$ decreases and [HCl] increases

e) equilibrium does not move
as forward and reverse reactions are getting faster
by the same amount
so $[Cl_2]$ and [HCl] remain the same

2. a) low temperature, as this will favour the exothermic direction
which is the forward direction
high pressure, as this will favour the direction decreasing the gas moles
which is the forward direction

b) high temperature, as this will favour the endothermic direction
which is the forward direction
low pressure, as this will favour the direction increasing the gas moles
which is the forward direction

c) low temperature, as this will favour the exothermic direction
which is the forward direction
any pressure, as there is no change un the number of gas moles

d) any temperature, as there is no exothermic or endothermic direction
any pressure, as there is no change in the number of moles

3. a) yield is poor at high temperatures

b) reaction is slow at low temperatures

c) expensive equipment is needed for high pressures

d) yield is poor at low pressures
reaction is slow at low pressures

e) catalyst increases the rate of the reaction
and reduces costs be allowing a lower temperature to be used