Engineering Chemistry 2

→ 1.) Given:

$$\nu = 3.2 \times 10^{10} \text{ sec}^{-1}$$

We know that,

Energy, $E = h\nu$

$$\therefore E = 6.624 \times 10^{-34} \times 3.2 \times 10^{10}$$

$$= 21.197 \times 10^{-24} \text{ J}$$

$$\boxed{\therefore E = 2.1197 \times 10^{-23} \text{ J}}$$

We also know that,

$$\nu = \frac{c}{\lambda}$$

$$\therefore \lambda = \frac{c}{\nu} \qquad \text{where } \lambda = \text{wavelength}$$
$$c = \text{speed of light}$$

$$\therefore \lambda = \frac{3 \times 10^8}{3.2 \times 10^{-10}} = 0.9375 \times 10^{-2} \text{ m}$$

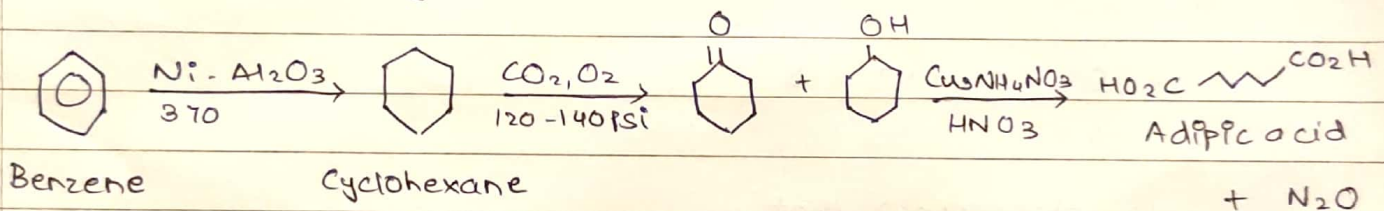$$\boxed{\therefore \lambda = 9375 \times \mu m = 9.375 \times 10^6 \text{ nm}}$$

∴ The smallest amount of energy emmitted or absorbed at given frequency is 2.1197×10^{-23} J

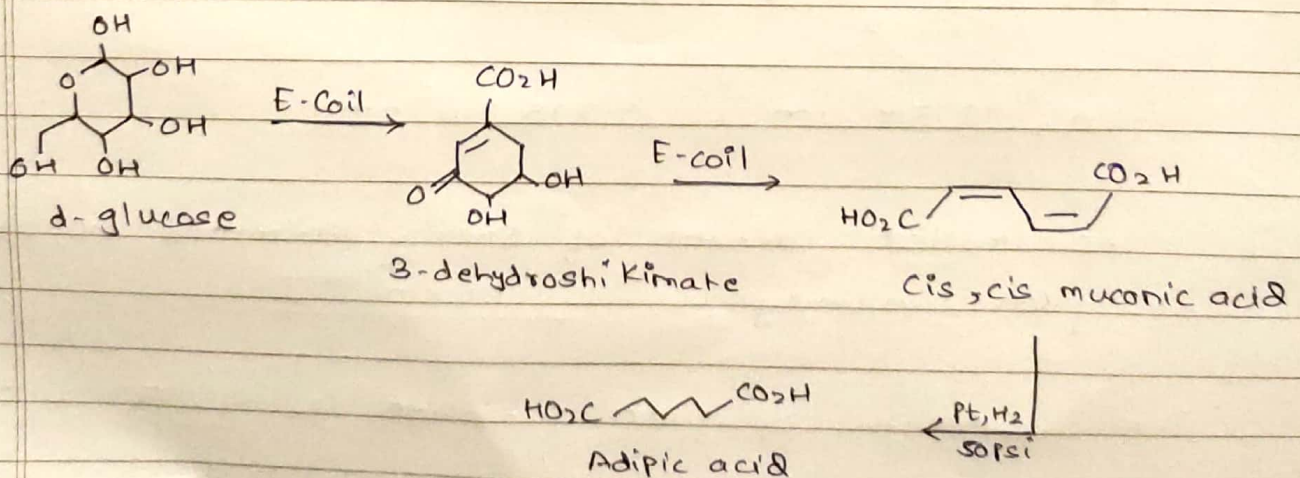The wavelength of given radiation is 9.375×10^6 nm

Q.2)

→ Synthesis of Adipic acid : For manufacture of adipic acid, cathechol and hydroquinone, initially the subustance used was benzene which is carcinogenic. The continuous use of benzene affects the human health.

The traditional synthetic pathway for manufacture of adipic acid is given below:

Benzene → (Ni-Al$_2$O$_3$, 370) → Cyclohexane → (CO$_2$,O$_2$, 120-140 psi) → cyclohexanone + cyclohexanol → (Cu$_3$NH$_4$NO$_3$, HNO$_3$) → HO$_2$C~~~CO$_2$H Adipic acid + N$_2$O

In a green synthetic pathway, traditionally used benzene is substituted by a new substrate glucose, a renewable feedstock. It is non-toxic and safer to use. The alternatie greener pathway is given below:

d-glucose → (E-Coil) → 3-dehydroshikimate → (E-coil) → cis, cis muconic acid

cis,cis muconic acid → (Pt, H$_2$, 50 psi) → HO$_2$C~~~CO$_2$H Adipic acid

→ The green principle involved in the above process is use of renewable feedstock. Raw materials and feedstock should be renewable rather than depleting whenever technically and economically practicable.

Q. 3)

→(i) $CH_3 - CH = CH_2 + Cl_2 \longrightarrow Cl - CH_2 - CH = CH_2 + HCl$

    MW = 42   MW = 71   MW = 76.5
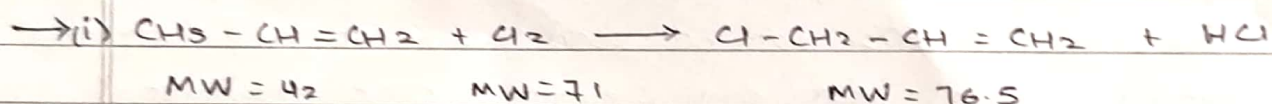
∴ % Atom Economy = $\dfrac{MW \text{ of product}}{Total \ MW \text{ of reactant}} \times 100$

$$= \frac{76.5}{42 + 71} \times 100$$

$$= \frac{76.5}{113} \times 100$$

$$= 67.69 \ \%$$

∴ | % Atom Economy = 67.69 % |

(ii) Applications of supercritical CO_2 are:

i) Supercritical CO_2 is useful for the decaffeination of coffee. The process is economic and environmentally sustainable.

ii) By using supercritical carbon dioxide, seperation of the reaction components from the starting material is much simpler than with traditional organic solvents.

iii) Supercritical CO_2 can be used as more environmentally friendly solvent for dry cleaning over traditional solvents such as hydrocarbons.