6. State second law of thermodynamics. How is heat engine different from a refrigerator.

AP 15,16,19 TS 15,18

A: A) Second law of thermodynamics: It consists of two statements.

I) Kelvin - Plank Statement: It is impossible to construct a heat engine which absorbs heat from a hot reservoir that converts completely the heat into work . **1 Mark**

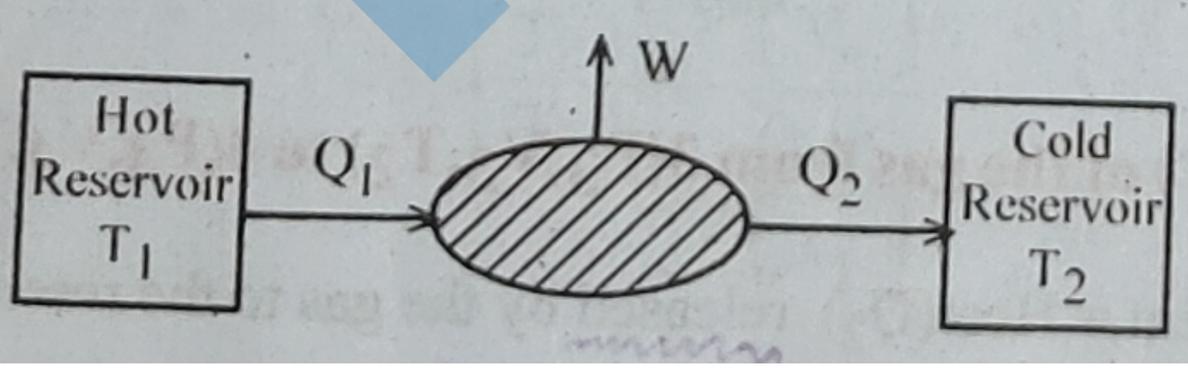
(or) It is impossible to construct an ideal heat engine with 100% thermal efficiency.

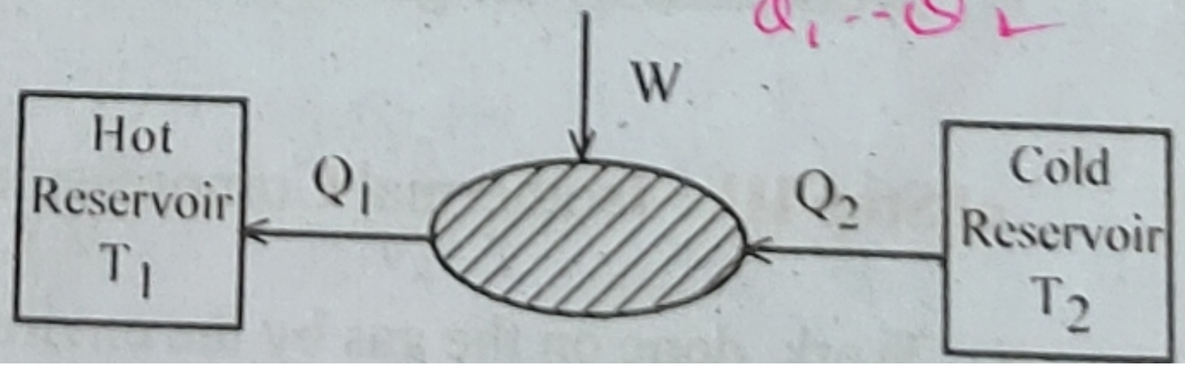
II) Clausius Statement: It is impossible to transfer heat from a colder object to a hotter object.

(or) It is impossible to construct an ideal refrigerator. **1 Mark**

B) Differences between Heat engine and Refrigerator: HOT & COOL 'Q'

HEAT ENGINE	REFRIGERATOR
1) Heat engine converts heat into work.	1) Refrigerator is a reversed heat engine.
2) The working substance absorbs heat (Q_1) from the hot reservoir at high temperature (T_1)	2) The working substance absorbs heat (Q_2) from the cold reservoir at low temperature (T_2)
3) The working substance rejects heat (Q_2) to cold reservoir at lower temperature (T_2)	3) The working substance rejects heat (Q_1) to the hot reservoir at high temperature (T_1)
4) Here, work (W) is done by the system.	4) Here, work is done on the system
5) The efficiency (η) of a heat engine is $\eta = \frac{W}{Q_1} = \frac{Q_1 - Q_2}{Q_1} = 1 - \frac{Q_2}{Q_1}$	5) The coefficient of performance of a refrigerator is $\alpha = \frac{Q_2}{W} = \frac{Q_2}{Q_1 - Q_2}$
6) η is less than 1.	6) α is greater than 1.



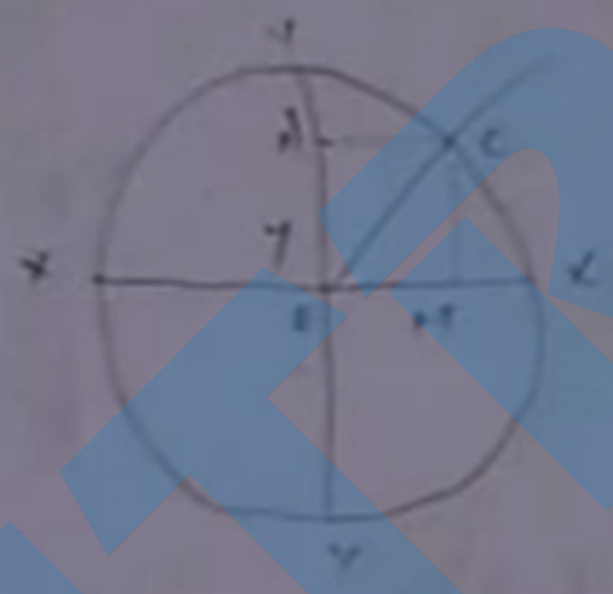


Simple harmonic motion....

*: A body is said to be in simple harmonic motion its acceleration is directly proportional to its displacement but in opposite direction.

$$\boxed{a \propto -y}$$

- Consider a particle [P] moving on a circle of radius
- 'O' be Centre of the Circle.



→ XX, YY are the diameter of the Circle

$\Rightarrow y = A \sin\omega t$

$v = A \cos\omega t \cdot \omega$

$a = -A \sin\omega t \cdot \omega \cdot \omega$

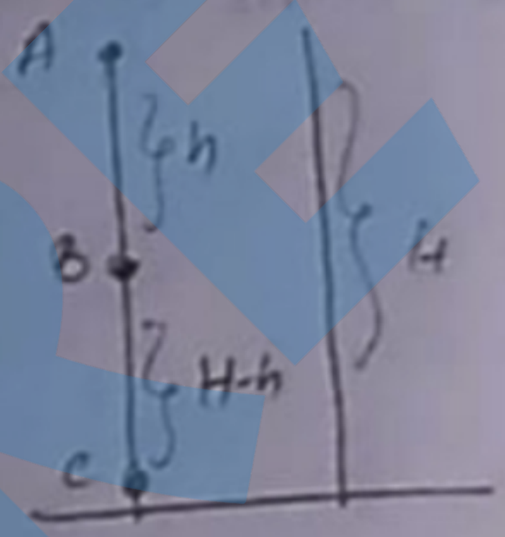
$a = -A \sin\omega t \, \omega^2$

$$\boxed{a \propto -y}$$

Law of Conservation of Energy

Statement :- 1. Energy can neither be Created nor be destroyed.

2. Consider a body with mass [m] and dropped height (h)



At point A :- $PE = mgH$

$PE = mgh$

$K = 0$

$\boxed{TE = MgH}$

At point B :- $PE = mg(H-h)$

$KE = \frac{1}{2} m(2gh)$

$= mgh$

$\boxed{TE = MgH}$

At point C :- $PE = 0$

$KE = \frac{1}{2} m(2gH)$

$KE = MgH$

$\boxed{TE = MgH}$

∴ Here energy is Conserved.

Q. Simple pendulum?

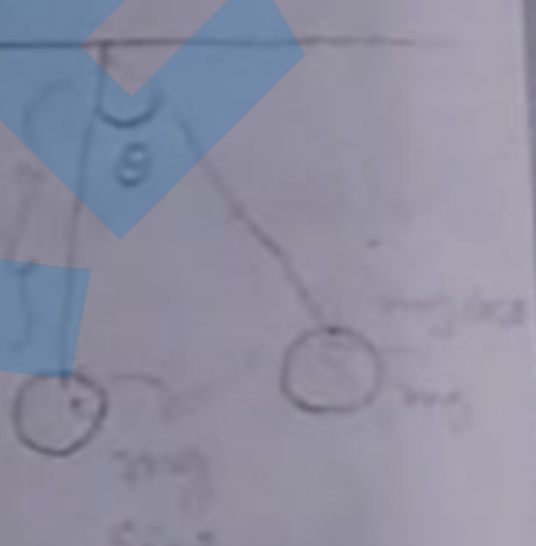
A) Statement:

→ Consider a simple pendulum of length 'l' has 'm' suspended from a rigid support

→ Weight (mg) can be resolved into components

→ mg Cos θ which balances the tension

→ mg Sin θ provides restoring force.



Restoring force :- $F \propto mg \sin\theta$

$$F = -mg\theta$$

$$Ma = -mg\theta$$

$$a = -g\theta$$

$$-\omega^2 x = g\left[\frac{x}{l}\right]$$

$$\omega^2 = \left[\frac{g}{l}\right]$$

$$\omega = \sqrt{\frac{g}{l}}$$

Time period :- $T = \frac{2\pi}{\omega}$

$$T = \frac{2\pi}{\sqrt{\frac{g}{l}}}$$

Second pendulum :- A pendulum with time period of 2 seconds is called Second pendulum.