Gravitation II

Applied Force is known

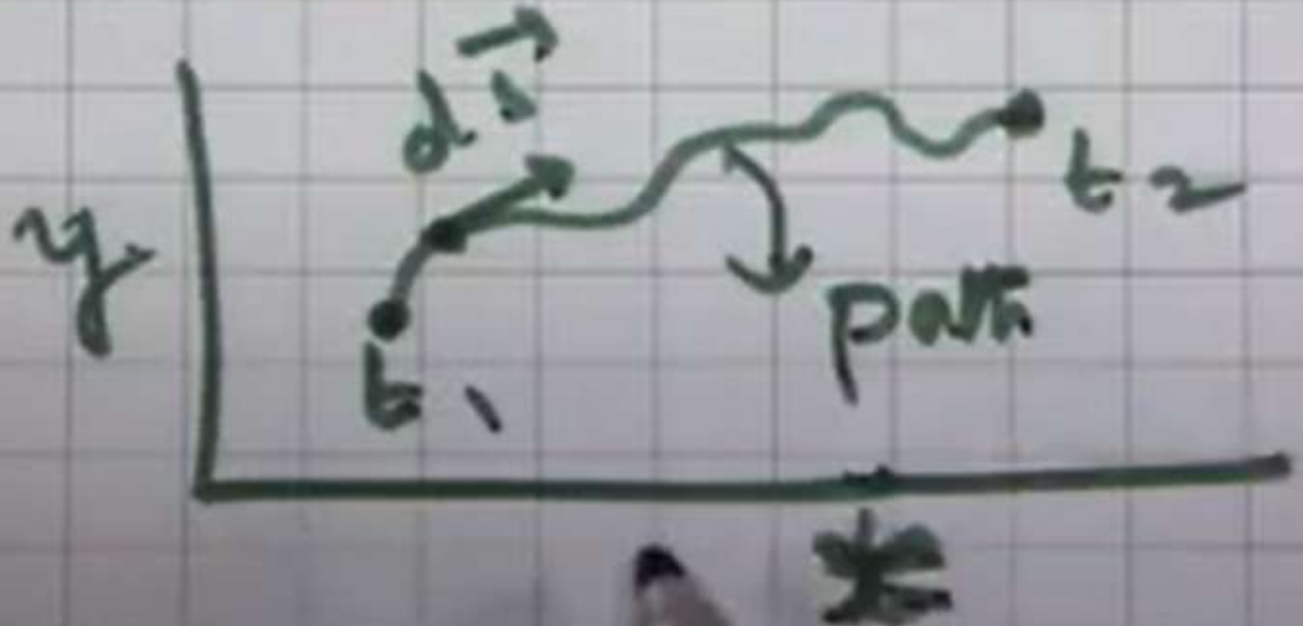
$$F = -kx$$

$$F = \frac{e^2}{r^2}\hat{r}$$

$$\rightarrow \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{r^2}\hat{r}$$

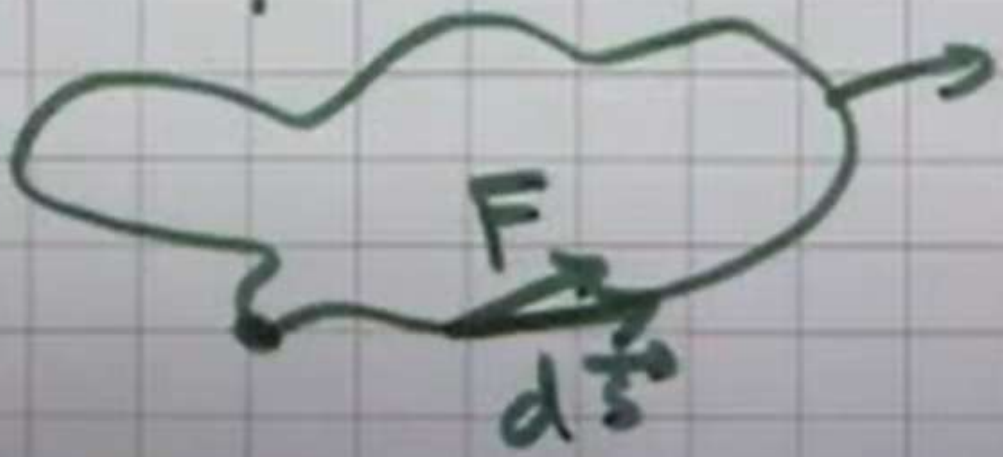
Work done

$\vec{F}$ acts on a particle and the body moves



$$\int_{t_1}^{t_2} \vec{F} \cdot d\vec{s}$$

We say that a Force is Conservative if the work done is independent of the path.



Total Work done is Zero

$$F = -\frac{dV(r)}{dr}$$

$$\Rightarrow \frac{1}{2} m \vec{v}^2 + V(r) = \text{Constant}$$

→ Kinetic energy

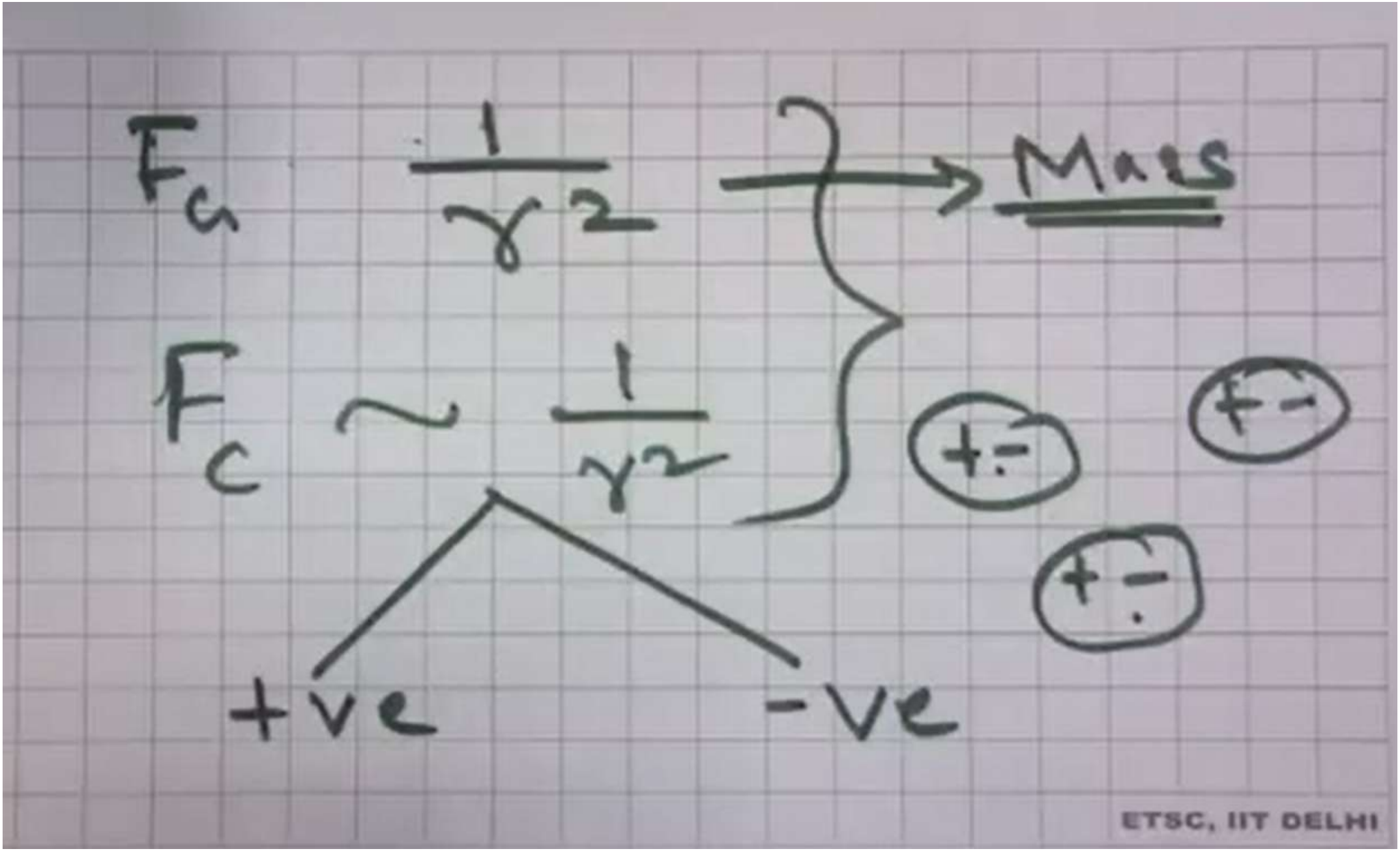
→ potential energy.

Fundamental Forces

- Gravitation
- Electromagnetic
- Nuclear
- Weak

Properties
Two Nucleons

Interaction	*Range*	*Strength*
Gravitation	∞	$\approx 10^{-37}$
Electromagnetic	$\infty(screened)$	$\approx 10^{-2}$
NuclearForces	$10^{-15}m$	≈ 1
WeakForces	$< 10^{-17}m$	$\approx 10^{-7}$


$F_G \quad \frac{1}{r^2}$
Mass
$F_C \sim \frac{1}{r^2}$
+ve
-ve
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Distances and Masses

- Size of the Earth
- Size of the Moon
- The Earth Moon distance
- The Earth Sun distance
- Masses of (i) The Earth, (ii) The Moon, and (iii) The stars

Gravitational Force

$$F_G = + \frac{G_n M m}{r^2}$$

$\equiv$ attractive

$\Leftarrow$ 4 unknowns

$$m a = \frac{G m M}{r^2}$$

A : m ; B = M .

Radius of the Earth

Observation and inference

4th Century BC

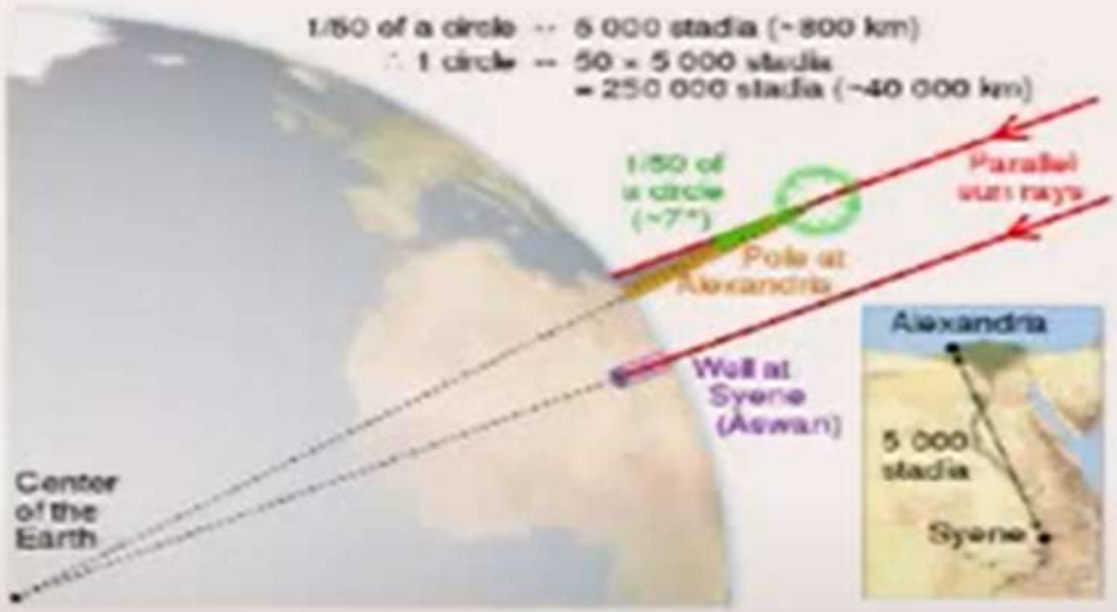
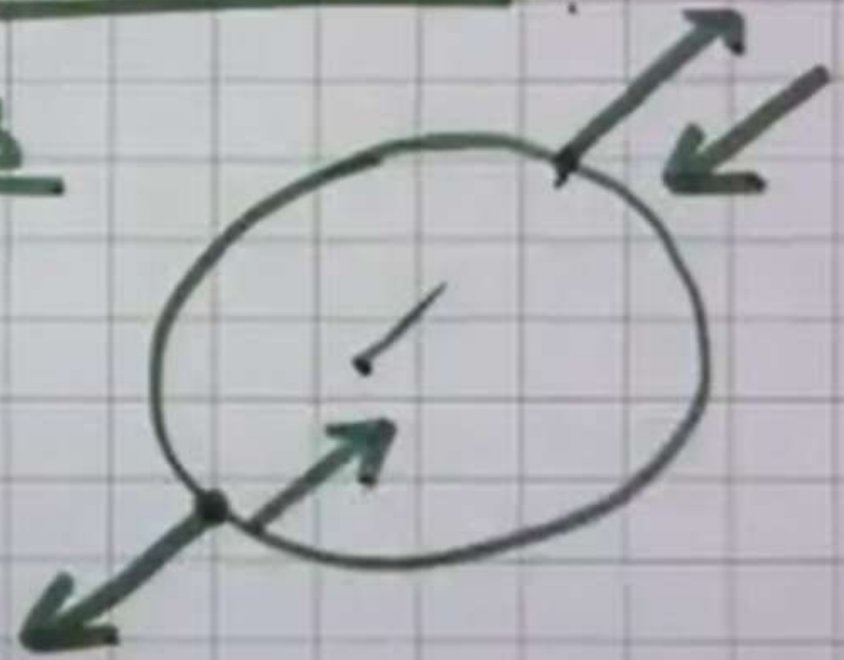


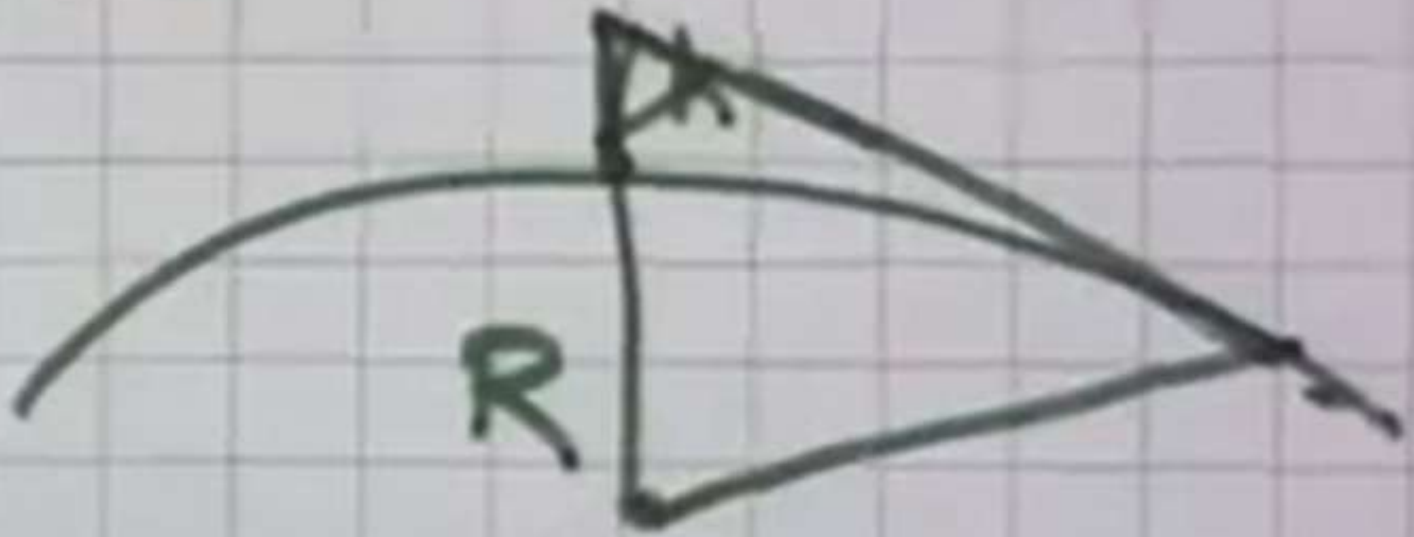
Figure: Eratosthenes: Wiki

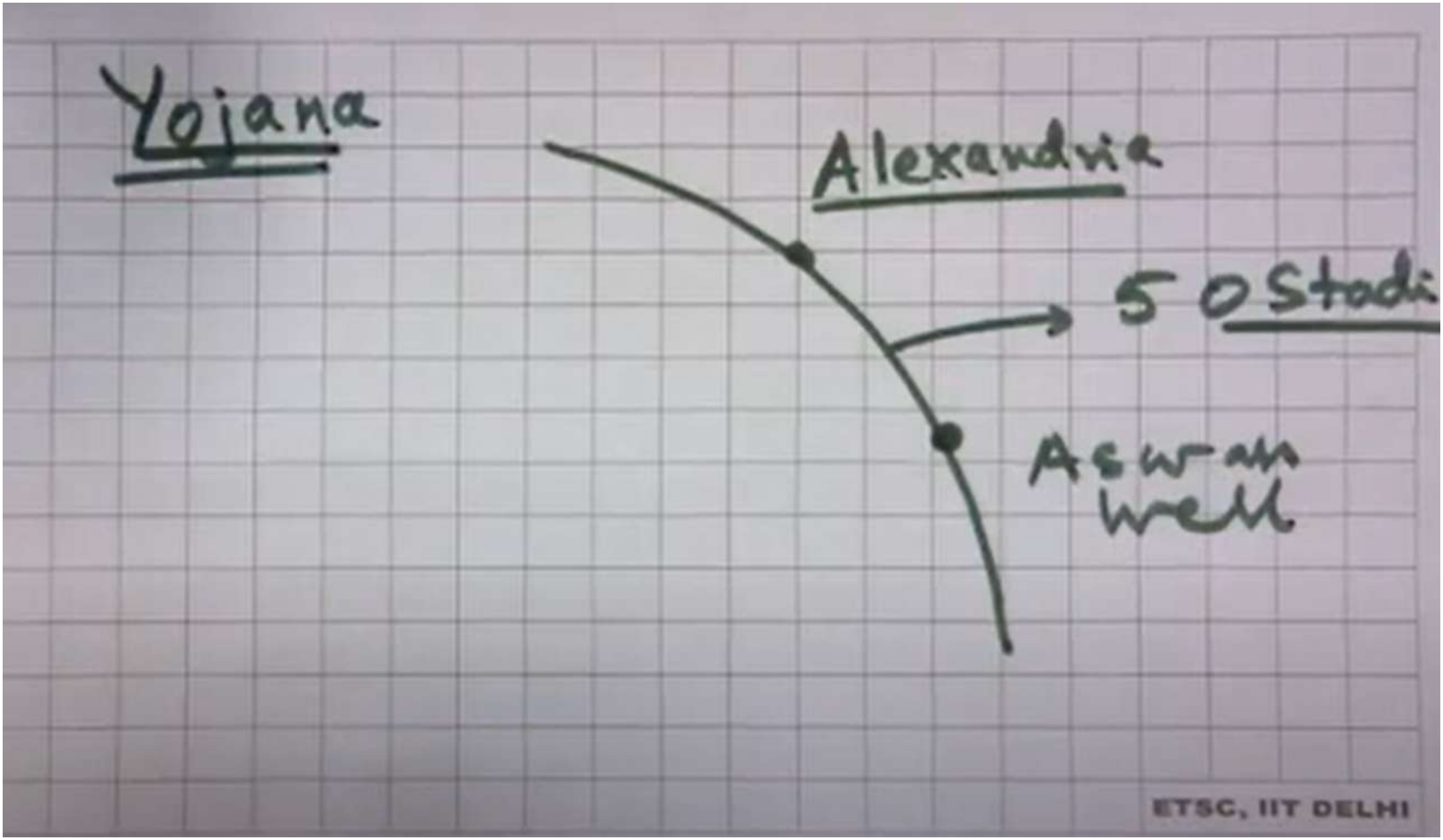
Radius of the Earth

Eclipses



Simple example




Yojana
Alexandria
5 0 Stadi
Aswan
well
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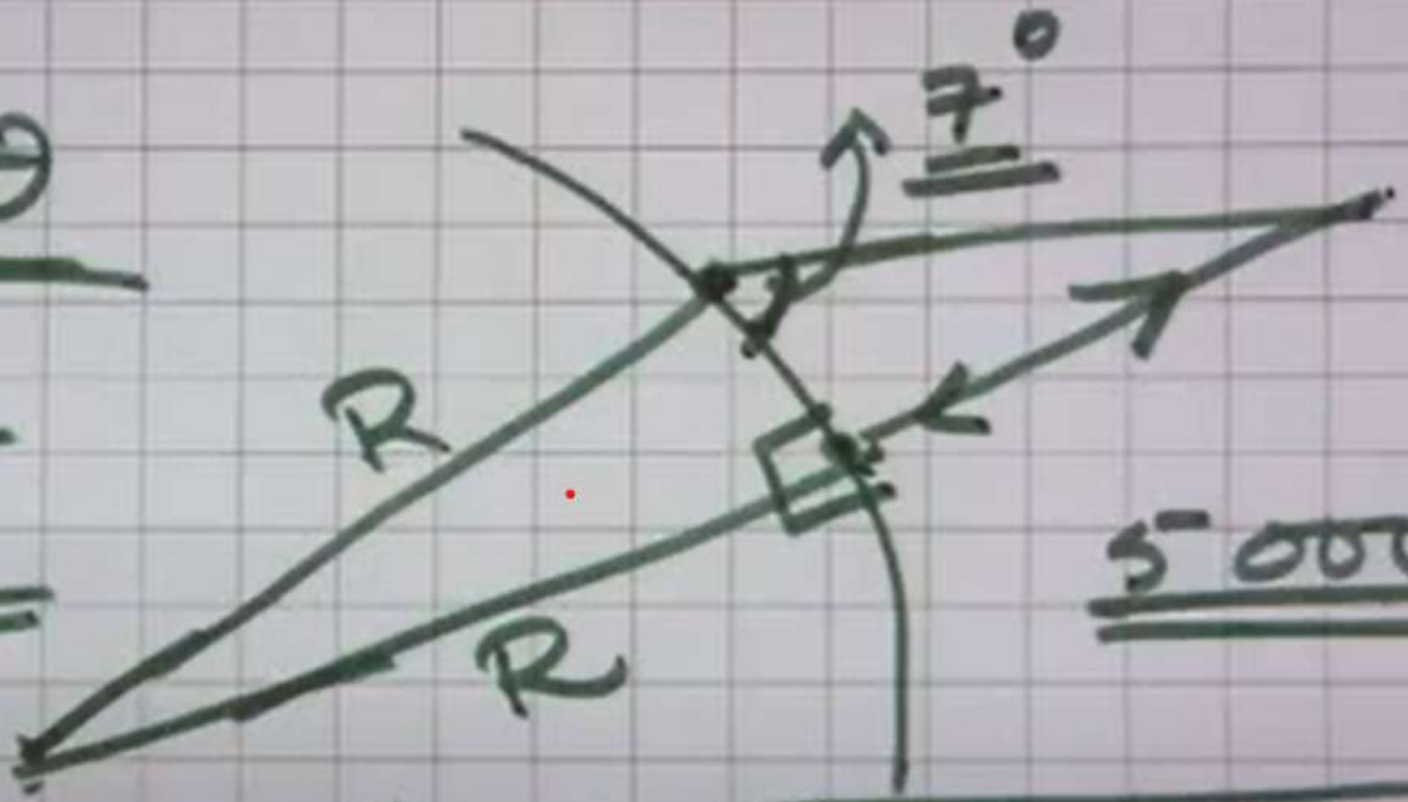
$s = r\theta$

$r = \frac{s}{\theta}$



800 km

$C = 2\pi R =$ 40,000 km

The Earth Moon distance

Large baseline trigonometry

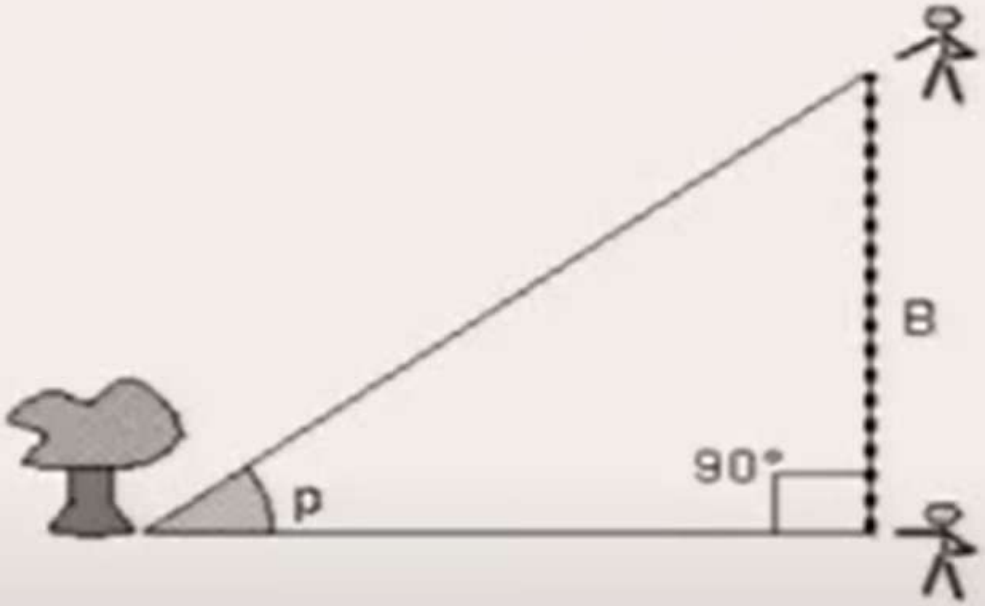
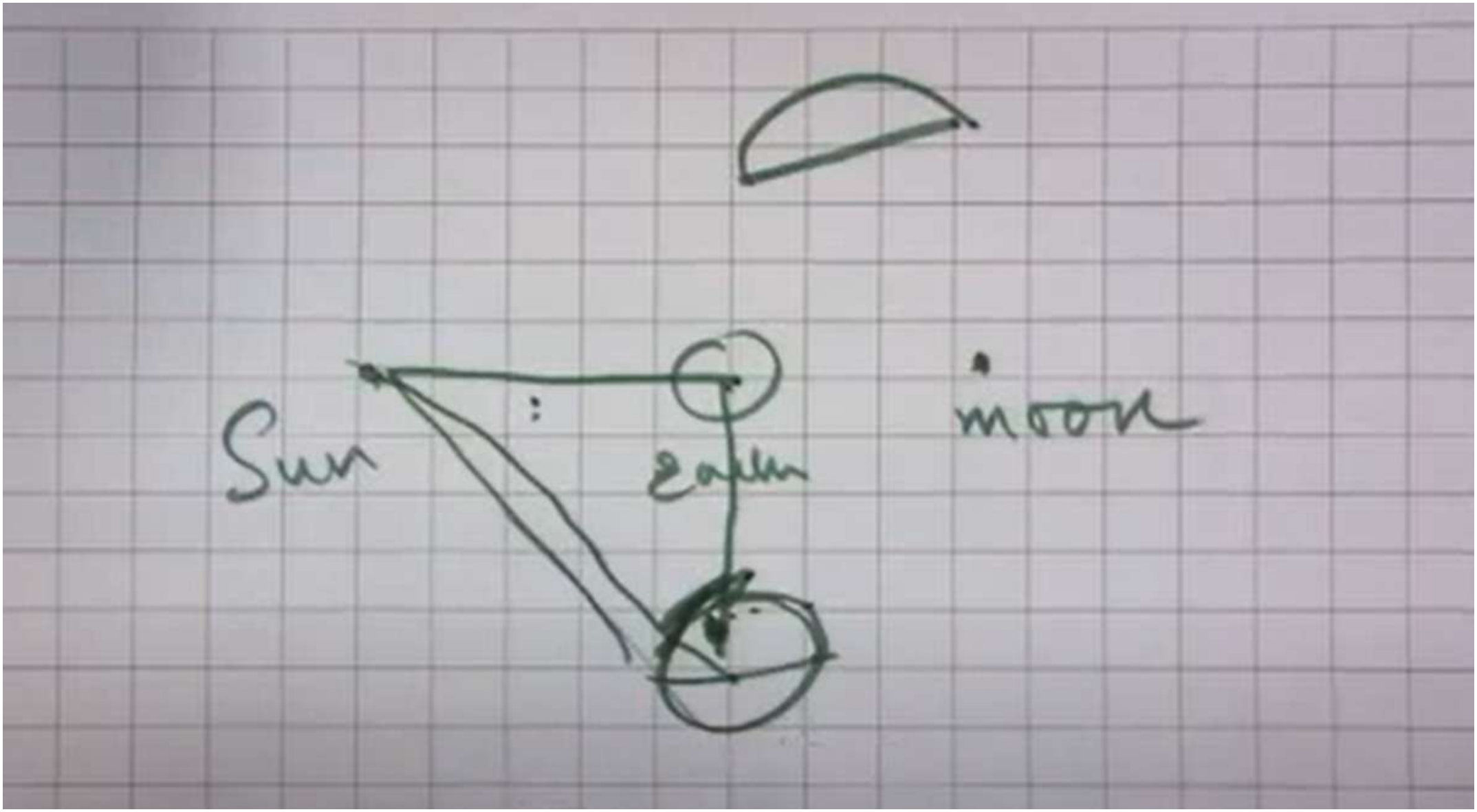


Figure: Trigonometry: Astronomy notes


Sun
moon