QUES 01:-

Supposing Newton's law of gravitation for gravitation forces $\vec{F}_1$ and $\vec{F}_2$ between two masses m_1 and m_2 at positions $\vec{r}_1$ and $\vec{r}_2$ read $\vec{F}_1 = -\vec{F}_2 = -\frac{\mathbf{r}_{12}}{r_{12}^3} G M_0^2 \left(\frac{m_1 m_2}{M_0^2}\right)^n$ where M_0 is a constant of dimension of mass, $\vec{r}_{12}$ and $\vec{r}_1$ - $\vec{r}_2$ and n is a number. In such a case,

i. the acceleration due to gravity on earth will be different for different objects.
ii. none of the three laws of Kepler will be valid.
iii. only the third law will become invalid.
iv. for n negative, an object lighter than water will sink in water.

Sol. Given:

$\vec{F}_1 = -\vec{F}_2 = -\frac{\mathbf{r}_{12}}{r_{12}^3} G M_0^2 \left(\frac{m_1 m_2}{M_0^2}\right)^n$

where

M_0 = constant

For calculating acceleration due to gravity let

M_1 = Mass of earth = M

M_2 = mass of object

M_{12} = radius of earth = R

Then magnitude of force between the object and earth is given by

$F = \frac{GM_0^{2-2n}}{R^2} \times (MM_2)^n$

Which can be said as

$F = K \times M_2^n$

Where K is a constant

Therefore, acceleration due to gravity can be calculated as

$g = \frac{F}{M_2} = KM_2^{n-1}$

Which depends on mass and hence different for different objects

Therefore (i) is the correct option

since this force follows inverse square law, hence Kepler's first two laws are valid but since g is no longer constant, therefore Kepler's third law (Law of periods) does not remain valid

therefore (iii) is the correct option

when n is negative than force is given by

$F = km^n = \frac{k}{m^a}$

Where a = -n

Therefore, force is inversely proportional to the mass of the body, hence an object lighter than water will experience more force than water and therefore will sink in water

Therefore (i), (iii) and (iv) are the correct options