① $F \propto M_m$

$F \propto \frac{1}{r}$

$\therefore F = G\frac{Mm}{r^2}$

R/Q r is halfed which means $r = \frac{r}{2}$

$F = \frac{GMm}{(\frac{r}{2})^2} \Rightarrow G\frac{Mm}{\frac{r^2}{4}} \Rightarrow 4G\frac{Mm}{r^2}$

∴ The gravitational force becomes 4 times more when we reduce the distance to half.

② The gravitational force acts on all objects in proportion to their masses.

$F = ma$

Let $F = 0$ then $m = \frac{1}{a}$ & $a = \frac{1}{m}$

or $m \propto \frac{1}{a}$ & $a \propto \frac{1}{m}$

∴ heavy mass has less acceleration as compared to light mass. ∴ A heavy object does not fall faster than a light object.

(3) Earth & the moon attract each other at equal gravitational force because the force of attraction is in different direction therefore they remain at their position.

(4) (5) $F = \frac{G M m}{r^2}$

If mass is doubled

$\Rightarrow \frac{G 2M m}{r} \Rightarrow 2F \left(\text{as } F = G\frac{Mm}{r^2}\right)$

$\therefore$ force becomes twice of original.

(ii) If d is doubled

$F = \frac{G M m}{r^2} \Rightarrow \frac{G M m}{(2r)^2} \Rightarrow \frac{G M m}{4r^2} \Rightarrow \frac{1}{4} \times \frac{G M m}{r^2}$

$\therefore$ The force becomes $\frac{1}{4}$th of original force.

If d is tripled,

$\Rightarrow \frac{G M m}{(3r)^2} \Rightarrow \frac{G M m}{9r^2} \Rightarrow \frac{1}{9} \times \frac{G M m}{r^2} \Rightarrow \frac{1}{9} \times F$

The force becomes $\frac{1}{9}$th of original force

(iii) $F = \frac{GMm}{R^2}$

If both M & m is doubled

$\Rightarrow \frac{G \times 2M \times 2m}{R^2} \Rightarrow 4\frac{GMm}{R^2} \Rightarrow 4F$

∴ The force becomes 4 times of original.

(Q) (4) Statement 1 is False & Statement 2 is true

(5) Whenever an object falls towards earth an acceleration is involved. This is called the acceleration due to gravity.

(6) The earth attracts the apple & the apple also attracts the earth in order to make action & reaction pair equal. The attraction of earth due to apple is negligible.

(7) This describes the gravitational force acting b/w any two body. Ex - Like the earth & Moon. It also describes that due to gravity of Sun & the planets, it binds the planet on its orbit.

(8) Acceleration due to gravity on surface of earth

Let - Radius of earth be - R_E

Mass of earth = M_E

$$g = \frac{G M_E}{R_E^2} \quad \text{—— (I)}$$

.

Acceleration due to gravity at a height h from surface of earth

$$g' = \frac{G M_E}{(R_E + h)^2} \quad \text{—— (II)}$$

A/Q $g' = \frac{1}{2} g$

$$\frac{1}{2} \frac{G M_E}{R_E^2} = \frac{G M_E}{(R_E + h)^2}$$

$$(R_E + h)^2 = 2 R_E^2 \Rightarrow R_E + h = \sqrt{2} R_E$$

$$h = (\sqrt{2} - 1) R_E \Rightarrow \sqrt{2} - 1 \times 6400 \Rightarrow 2650.27 \text{ km}$$

(9) (b) Does not change from place to place

(10) (c) 80 N

(11) (3) Statement 1 is true & Statement 2 is false.