## DPP – 1 (Gravitational Force)

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Q 1. By what percent will the gravitational force between the two bodies be increased if their masses are increased by 50%
(a) 50 % (b) 100 %
(c) 75 % (d) 125 %

Q 2. What will happen to the gravitational force between two bodies if they are brought closer by half of their initial separation ?
(a) It increases to 2 times (b) It decreases to 4 times
(c) It decreases to 2 times (d) It increases to 4 times

Q 3. The force of gravitation between two bodies does not depend upon
(a) The separation between them
(b) The gravitational constant
(c) The product of their masses
(d) the sum of their masses

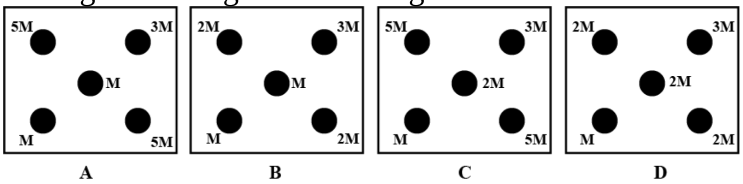
Q 4. The gravitational force between two stones of mass 1 kg each, separated by a distance of 1 m in vacuum is.
(a) zero (b) $6.675 \times 10^{-6}$N
(c) $8.326 \times 10^{-8}$N (d) $6.675 \times 10^{-11}$N

Q 5. If F is the force between two bodies of masses $m_1$ and $m_2$ at certain separation. Find the force between $\sqrt{2}m_1$ and $\sqrt{3}m_2$ at same separation
(a) F (b) 5F
(c) 6F (d) $\sqrt{6}$F

Q 6. Two planet of mass m and 100m. If gravitational force exerted by planet of mass 100m on the planet of mass m is $F_1$ and gravitational force exerted by planet of mass m on the planet of mass 100m is $F_2$. Then which of the following is true?
(a) $F_1 = 100F_2$ (b) $F_1 = 10F_2$
(c) $F_1 = F_2$ (d) $F_2 = 100F_1$

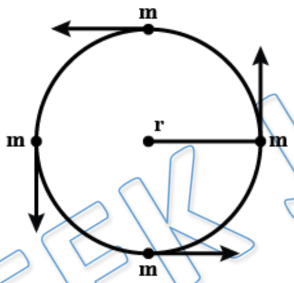
Q 7. Find the gravitational force between two protons kept at a separation of 1 femtometer (1 femtometer = $10^{-15}$m). The mass of a protons is $1.67 \times 10^{-27}$kg
(a) $1.8 \times 10^{-42}$N (b) $1.8 \times 10^{-29}$N
(c) $1.8 \times 10^{-34}$N (d) $1.86 \times 10^{-36}$N

Q 8. A mass is at the center of a square, with four masses at the corners as shown. Rank the choices according to the magnitude of the gravitational force on the center mass.



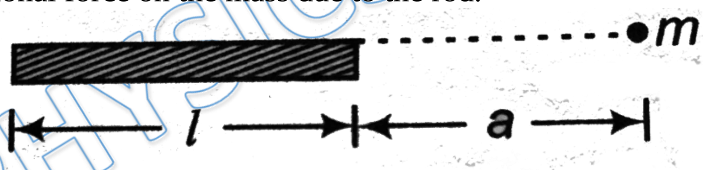

(a) $F_A = F_B < F_C = F_D$
(b) $F_A > F_B < F_C < F_D$
(c) $F_A = F_B > F_C = F_D$
(d) None

Q 9. Four similar particles of mass M are orbiting in a circle of radius r in the same angular direction because of their mutual gravitational attractive force. Velocity of a particle is given by




(a) $\left[\frac{GM}{r}\left(\frac{1+2\sqrt{2}}{4}\right)\right]^{1/2}$ (b) $\left[\frac{GM}{r}\right]^{3/2}$
(c) $\left[\frac{GM}{r}\left(1+2\sqrt{2}\right)\right]^{1/2}$ (d) $\left[\frac{GM}{2r}\left(\frac{1+\sqrt{2}}{2}\right)\right]^{1/2}$

Q 10. A mass m is at a distance a from one end of a uniform rod of length $l$ and mass M. Find the gravitational force on the mass due to the rod.




(a) $\frac{GmM}{al}$
(b) $\frac{GmM}{\left(a+\frac{l}{2}\right)}$
(c) $\frac{GmM}{(a+l)l}$
(d) $\frac{GmM}{a(a+l)}$

Q 11. Gravitational force between two masses at a distance 'd' apart is 6N. If these masses are taken to moon and kept at same separation, then the force between them will become :
(a) 1 N (b) $\frac{1}{6}$ N
(c) 36 N (d) 6 N

Q 12. Gravitational force _______ on the nature of the medium between the masses.

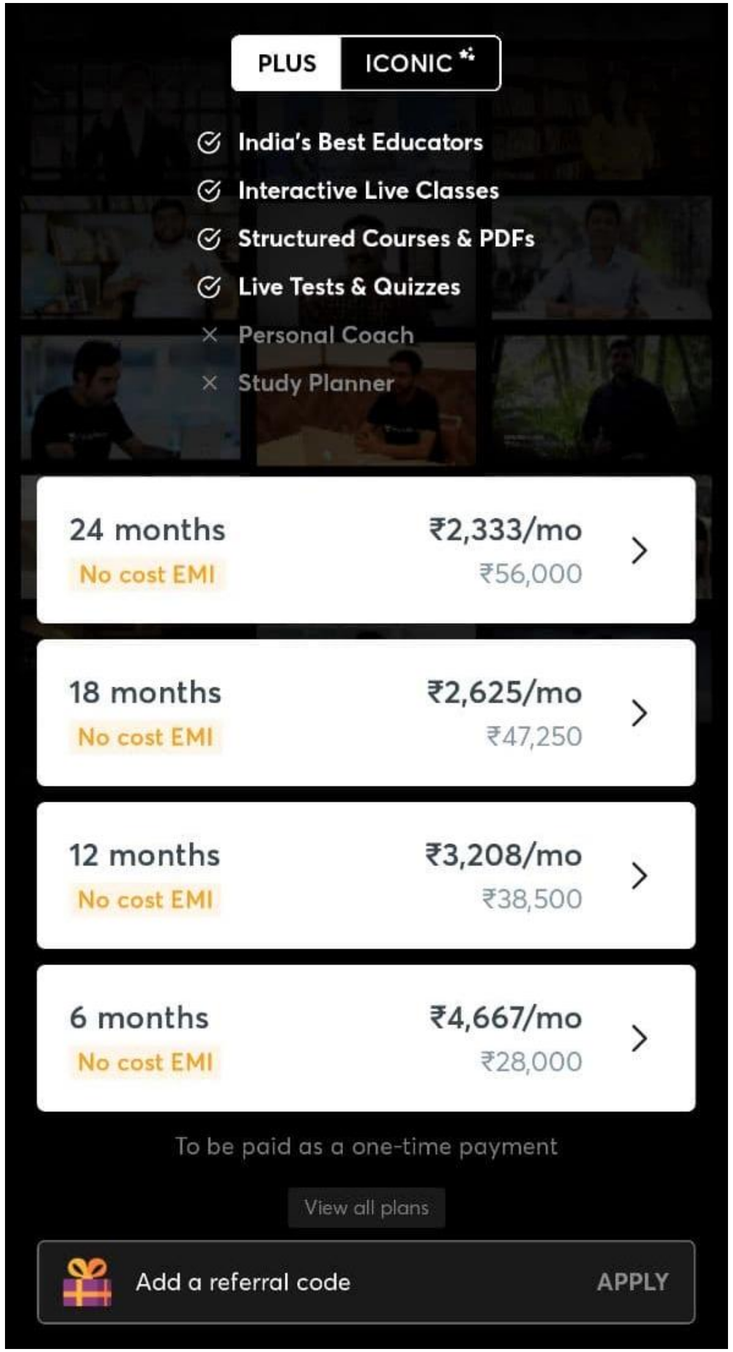
(a) depends (b) does not depend
(c) sometimes depends (d) none of these

Q 13. Two spheres of masses m and M are situated in air and the gravitational force between the is F. The space around the masses is now filled with a liquid of specific gravity 3. The gravitational force between spheres will now be
(a) 3F (b) F
(c) $\frac{F}{3}$ (d) $\frac{F}{9}$



# Answer Key

| | | | | |
|---|---|---|---|---|
| **Q.1 d** | **Q.2 d** | **Q.3 d** | **Q.4 d** | **Q.5 d** |
| **Q.6 c** | **Q.7 c** | **Q.8 a** | **Q.9 a** | **Q.10 d** |
| **Q.11 d** | **Q.12 b** | **Q.13 b** | | |

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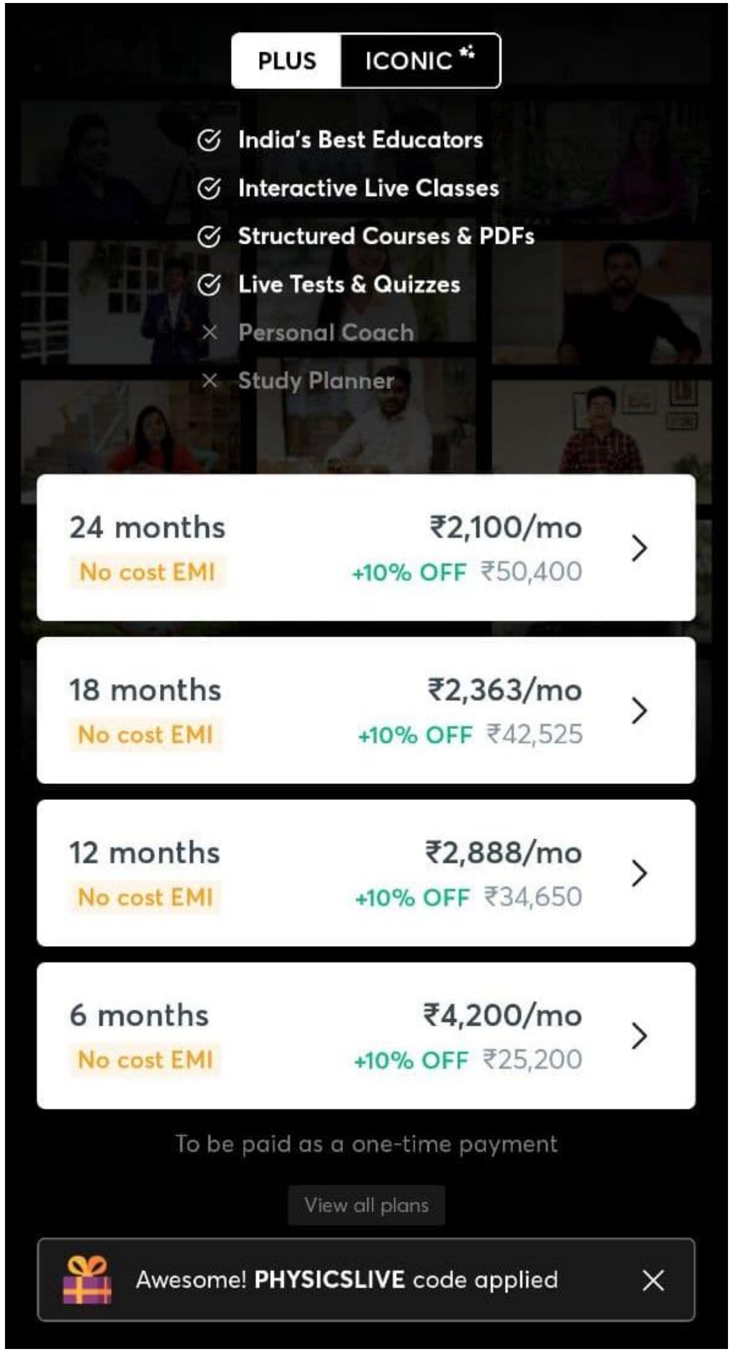


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# Written Solution

## DPP-1 Gravitation: Gravitational Force

## By Physicsaholics Team

# Solution: 1

Let; masses are: $m_1$ & $m_2$

& distance between them: $d$

so; $F = \frac{G m_1 m_2}{d^2}$

Now; masses become; $1.5m_1$ & $1.5m_2$

so; $F' = \frac{G(1.5m_1)(1.5m_2)}{d^2}$

$F' = (1.5)^2 \frac{G m_1 m_2}{d^2}$

$$\boxed{F' = (2.25)\frac{G m_1 m_2}{d^2}}$$

$\Delta F\% = \frac{F' - F}{F} \times 100$

$= \frac{(2.25)\left(\frac{G m_1 m_2}{d^2}\right) - \left(\frac{G m_1 m_2}{d^2}\right)}{\left(\frac{G m_1 m_2}{d^2}\right)} \times 100$

$= \left(\frac{2.25 - 1}{1}\right)\frac{\left(\frac{G m_1 m_2}{d^2}\right)}{\left(\frac{G m_1 m_2}{d^2}\right)} \times 100$

$\Delta F\% = \frac{1.25}{1} \times 100$

$$\boxed{\Delta F\% = 125\%}$$ Ans

Ans. d

Solution: 2

$$F_G = \frac{G m_1 m_2}{r^2}$$

$$F_G \propto \frac{1}{r^2}$$

$r_1 = r$ & $r_2 = \frac{r}{2}$

$$\frac{F_1}{F_2} = \frac{(r/2)^2}{r^2}$$

$$\frac{F_1}{F_2} = \frac{1}{4}$$

$$\boxed{F_2 = 4F_1}$$ Ans



Ans. d

Solution: 3

$\because F = \frac{G m_1 m_2}{r^2}$

$F \propto \frac{1}{r^2}$

F depends on 'G'

$F \propto m_1 m_2$

but F does not depend on $(m_1 + m_2)$.

Ans



Ans. d

Solution: 4

$$F = \frac{G m_1 m_2}{r^2}$$

$m_1 = m_2 = 1\ kg$

$r = 1\ m$

$G = 6.67 \times 10^{-11}\ Nm^2/kg^2$

$$F = \frac{6.67 \times 10^{-11} \times 1 \times 1}{(1)^2}$$

$$\boxed{F = 6.67 \times 10^{-11}\ N}$$ Ans.



Ans. d

Solution: 5

$$F = \frac{G m_1 m_2}{d^2} \quad \text{—(1)}$$

$$F' = \frac{G(\sqrt{2}\, m_1)(\sqrt{3}\, m_2)}{d^2}$$

$$F' = \frac{G(\sqrt{6}\, m_1 m_2)}{d^2}$$

$$F' = \sqrt{6}\, \frac{G m_1 m_2}{d^2} \quad \text{—(2)}$$

$$\frac{(1)}{(2)} \Rightarrow \frac{F}{F'} = \frac{\frac{G m_1 m_2}{d^2}}{\sqrt{6}\, \frac{G m_1 m_2}{d^2}} = \frac{1}{\sqrt{6}}$$

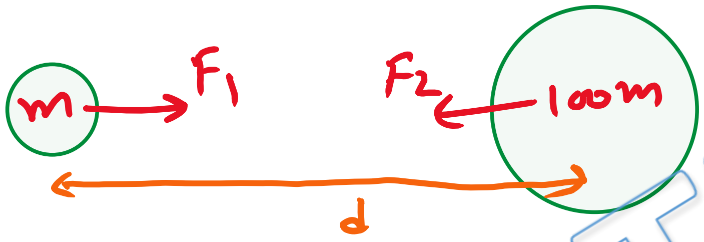
$$\frac{F}{F'} = \frac{1}{\sqrt{6}} \Rightarrow \boxed{F' = \sqrt{6}\, F} \text{ Ans}$$



Ans. d

Solution: 6

The two forces form action-reaction pair. Thus, they have same magnitude.




$$F_1 = F_2 = \frac{G(m)(100m)}{d^2}$$ Ans



Ans. c

## Solution: 7

$m_p = 1.67 \times 10^{-27}$ kg

$d = 10^{-15}$ m

$$F = \frac{G\, m_p \cdot m_p}{r^2} = \frac{G m_p^2}{r^2}$$

$$F = \frac{6.67 \times 10^{-11} \times (1.67 \times 10^{-27})^2}{(10^{-15})^2}$$

$$F = \frac{18.6 \times 10^{-11} \times 10^{-54}}{10^{-30}}$$

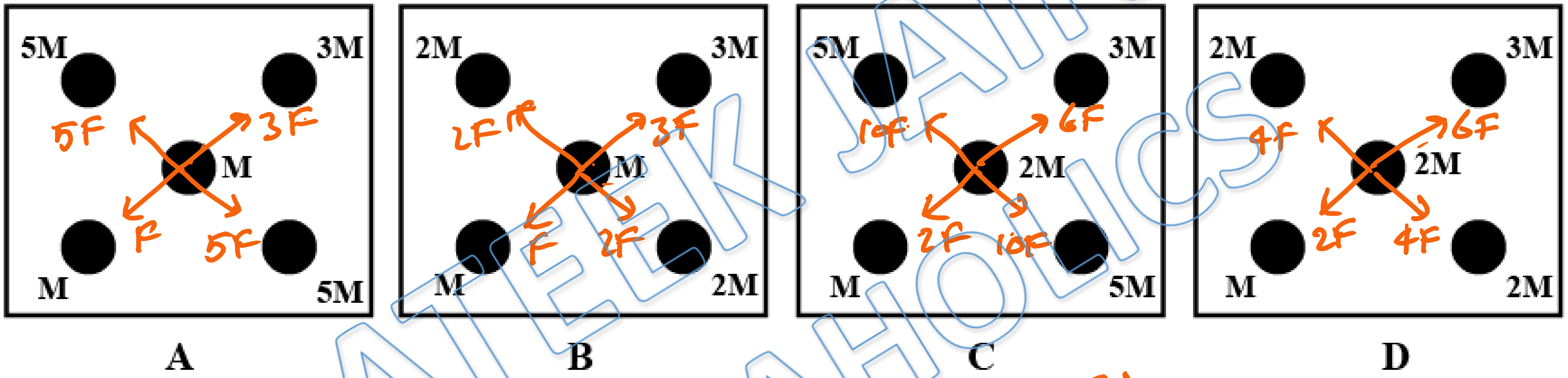
$$F = 18.6 \times \frac{10^{-65}}{10^{-30}}$$

$$\boxed{F = 18.6 \times 10^{-35}\ N} \quad \text{or} \quad \boxed{F = 1.86 \times 10^{-34}\ N}\ \text{Ans}$$

Ans. c

Solution: 8

if; $F = \frac{GMm}{r^2}$




$(F_{net})_A = 2F\ (\nearrow)$ $(F_{net})_B = 2F\ (\nearrow)$ $(F_{net})_C = 4F\ (\nearrow)$ $(F_{net})_D = 4F\ (\nearrow)$

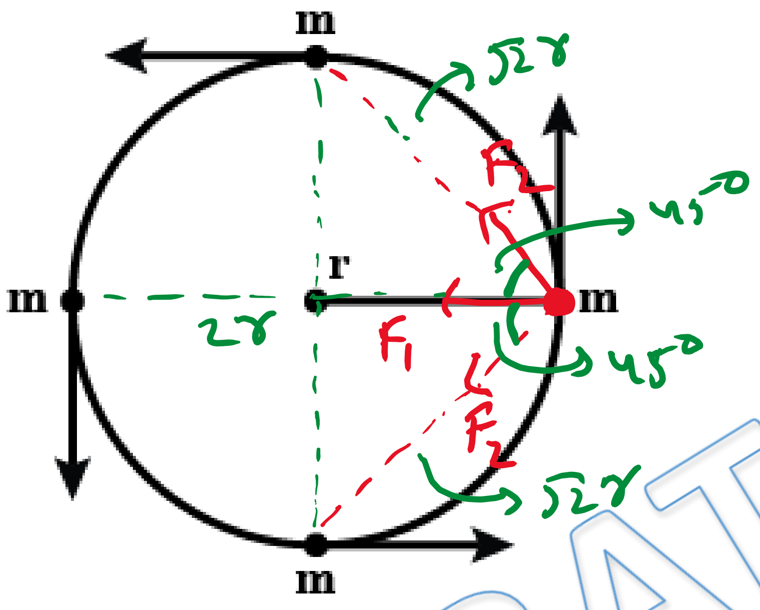
so; $F_A = F_B = 2F$ & $F_C = F_D = 4F$

so; $\boxed{F_A = F_B < F_C = F_D}$ Ans



Ans. a

## Solution: 9




$F_1 = \frac{Gm^2}{(2r)^2} = \frac{Gm^2}{4r^2}$

$F_2 = \frac{Gm^2}{(\sqrt{2}r)^2} = \frac{Gm^2}{2r^2}$

net force towards center

$F_c = F_1 + F_2\cos 45^\circ + F_2\cos 45^\circ$

$= F_1 + 2F_2\cos 45^\circ = F_1 + 2F_2\left(\frac{1}{\sqrt{2}}\right)$

$F_c = F_1 + \sqrt{2}F_2 = \frac{Gm^2}{4r^2} + \sqrt{2}\frac{Gm^2}{2r^2}$

$F_c = \frac{Gm^2}{r^2}\left(\frac{1}{4} + \frac{\sqrt{2}}{2}\right) = \frac{Gm^2}{2r^2}\left(\frac{1+2\sqrt{2}}{2}\right)$

$F_c = \frac{Gm^2}{r^2}\left(\frac{1+2\sqrt{2}}{4}\right) = \frac{mv^2}{r}$

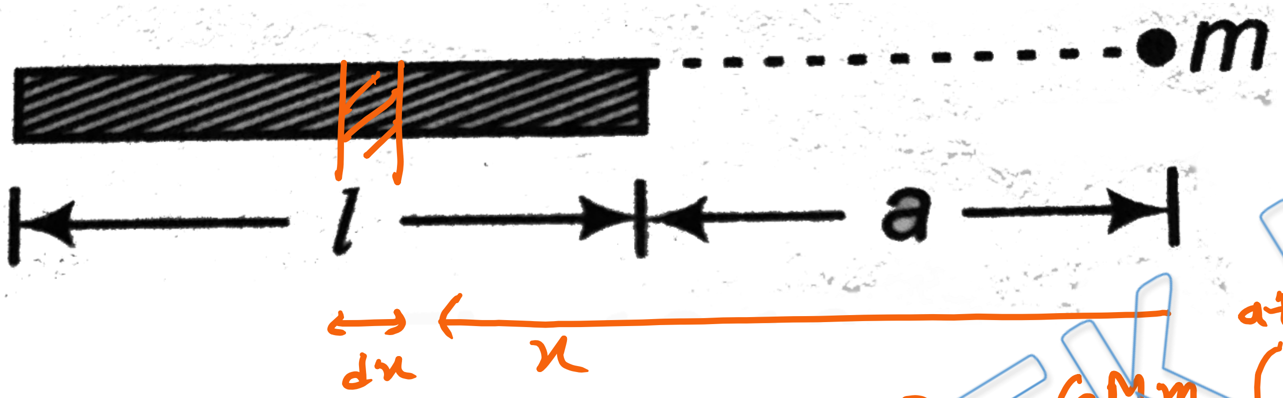
$v^2 = \frac{Gm}{r}\left(\frac{1+2\sqrt{2}}{4}\right)$

$$\boxed{v = \sqrt{\frac{Gm}{r}\left(\frac{1+2\sqrt{2}}{4}\right)}}$$ Ans



Ans. a

## Solution: 10




$$dm = \left(\frac{M}{l}\right)dx$$

$$dF = \frac{G\,m\,(dm)}{x^2}$$

$$dF = \frac{Gm}{x^2}\left(\frac{M}{L}\,dx\right)$$

$$\int_0^F dF = \int_a^{a+l} \frac{GMm}{L}\,\frac{dx}{x^2}$$

$$F = \frac{GMm}{L}\int_a^{a+L}\frac{dx}{x^2}$$

$$= \frac{GMm}{L}\left[\frac{-1}{x}\right]_a^{a+L} = \frac{GMm}{L}\left[\frac{-1}{a+L} - \left(\frac{-1}{a}\right)\right]$$

$$= \frac{GMm}{L}\left[\frac{1}{a} - \frac{1}{a+L}\right] = \frac{GMm}{L}\left[\frac{a+L-a}{a(a+L)}\right]$$

$$= \frac{GMm}{L}\left[\frac{L}{a(a+L)}\right]$$

$$\boxed{F = \frac{GMm}{a(a+L)}}$$ Ans

Ans. d

# Solution: 11

$$F = \frac{Gm_1m_2}{d^2} = 6N$$

$\because$ $m_1$ & $m_2$ = Same

$d$ = same

then; $\boxed{F' = F}$

so; $\boxed{F' = 6N}$ Ans



Ans. d

Solution: 12

Gravitational force does not depend on the medium between two bodies.



Ans. b

## Solution: 13

$\because F = \frac{GMm}{d^2}$

does not depend of medium

So; $\boxed{F' = F}$ Ans.



Ans. b

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