WEEKLY TEST OYM TEST - 34 RAJPUR
SOLUTION Date 29-12-2019

[PHYSICS]

1. $\vec{F}_{satellite} + \vec{F}_{dust} = 0$

$\vec{F}_{satellite} - \vec{F}_{dust}$

$= -\vec{v}\dfrac{dM}{dt}$

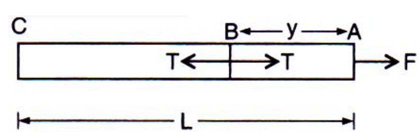
$\therefore \quad F_{satellite} = -v\dfrac{dM}{dt}$

$= - v/.\alpha v = - \alpha v^2$

$\therefore \quad (\text{acceleration})_s = -\dfrac{\alpha v^2}{M}$

2. Acceleration of the rope a = (F/M) .....(i)

Now, considering the motion of the part AB of the rope [which has mass $\left(\dfrac{M}{L}\right)y$ and acceleration given by eqn. (i) assuming that tension at B is T.



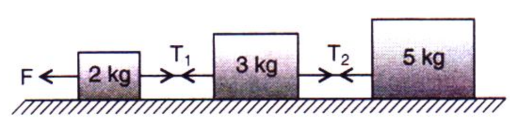
$F - T = \left(\dfrac{M}{L}y\right) \times a$

or $\quad F - T = \dfrac{M}{L}y \times \dfrac{F}{M} = \dfrac{Fy}{L}$

or $\quad T = F - F\dfrac{y}{L} = F\left(1 - \dfrac{y}{L}\right)$

3. One of the weights given a reading and the other prevents the acceleration of the styem. Therefore, the reading is not zero but 10 N.

4. Equations of motion are :



$F - T_1 = 2a$ .....(i)

$T_1 - T_2 = 3a$ ....(ii)

$T_2 = 5a$ ....(iii)

Adding all above equations, we get;

F = 10a = 10 × 1 = 10 N

5. Let the initial length of the string be L

$\therefore$ (x – L)K = 5, (y – K)K = 7

(z – L)K = 9

$$\frac{x-L}{y-L} = \frac{5}{7} \text{ and } \frac{y-L}{z-L} = \frac{7}{9}$$

Solving, we get; z = 2y – x.

6. $F_x = -\frac{dU}{dx} = -a$ and $F_y = -\frac{dU}{dy} = -b$

$$F = \sqrt{F_x^2 + F_y^2} = \sqrt{a^2 + b^2}$$

Acceleration, $\frac{F}{m} = \frac{\sqrt{a^2+b^2}}{m}$

7. Mg – T = Ma

$\therefore$ $T = M(g-a) = Mg\left(1-\frac{a}{g}\right)$

or $\frac{2}{5}Mg = Mg\left(1-\frac{a}{g}\right)$

or $\frac{a}{g} = 1 - \frac{2}{5} = \frac{3}{5}$

$\therefore$ a = 0.6 g

8. The tension in the string between P and Q accelerates double the mass as compared to that between A and R. Hence, tension between P and Q = 2 × tension between Q and R

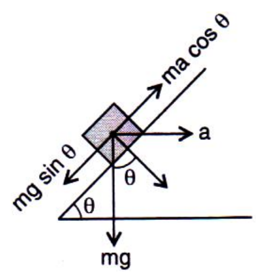
9. The weight of the body should be balanced by the vertical force exerted by the inclined plane on the block.

10. Momentum carried by each bullet = mv
= 0.010 × 500 kg-m/s = 5 kg-m/s
Now, force = change in momentum in 1 sec
= 5 × 10 = 50 N

$\therefore$ $\text{Acceleration} = \frac{50}{200} m/s^2 = 25 cm/s^2$

11. mg sinθ = ma cosθ

or a = g tanθ



$\because$ $\sin\theta = \frac{1}{l}$

Hence, $\tan\theta = \frac{1}{\sqrt{l^2-1}}$

$\therefore$ $a = \frac{g}{\sqrt{l^2-1}}$

12. Net force on the rod = $F_1 - F_2$
As mass of the rod is M, hence acceleration of the rod is :

$$a = \frac{(F_1 - F_2)}{M}$$

If we now consider the motion of part AB of the rod [whose mass is equal to (M/L)y], then

$$F_1 - T = \frac{M}{L} y \times a$$

where T is the tension in the rod at the point B.

Now, $F_1 - T = \frac{M}{L} y \times \left(\frac{F_1 - F_2}{M}\right)$

or $T = F_1\left(1-\frac{y}{L}\right) + F_2\left(\frac{y}{L}\right)$.

Alternative Method : Considering motion of the other part BC of the rod also, we can calculate tension at the point B. In this case,

$$T - F_2 = \frac{M}{L}(L-y) \times a$$

or $T = F_2 + \frac{M}{L}(L-y)\times\frac{(F_1 - F_2)}{M}$

$= F_1\left(1 - \frac{y}{L}\right) + F_2\left(\frac{y}{L}\right)$

13. $T\cos\theta = T_1 = 10 \times g$
$T\sin\theta = 98$

$\therefore$ $\tan\theta = \frac{98}{10 \times 9.8} = 1$ or $\theta = 45^o$

14. Change in momentum of each bullet $= 5[v-(v)]$
$\Delta p = 10v$
Because 10 bullets are fired per second, hence change in momentum per sec
i.e., $F = \Delta p \times 10 = 10v \times 10$
This force will be directed upwards and will balance the weight of the dish
i.e., $10v \times 10 = 10 \times 980$
$\therefore$ $= 98$ cm/sec

15. $x = 3t - 4t^2 + t^3$

$\frac{dx}{dt} = 3 - 8t + 3t^2$ and $a = \frac{d^2x}{dt^2} = -8 + 6t$

Now, $W = \int F dx \int madx = \int ma\frac{dx}{dt}dt$

$= \int_0^4 \frac{3}{1000} \times (-8 + 6t)(3 - 8t + 3t^2)dt$

On integrating, we get W = 530 mJ

16. The customer gets $\frac{W_1 + W_2}{2}$ instead of $\sqrt{W_1W_2}$

Now, $\frac{W_1 + W_2}{2} - \sqrt{W_1W_2} = \left[\frac{W_1 + W_2 - 2\sqrt{W_1W_2}}{2}\right]$

$= \frac{(\sqrt{W_1} - \sqrt{W_2})^2}{2}$

As $(\sqrt{W_1} - \sqrt{W_2})^2$ is +ve, hence the customer gets more than his due and the tradesman loses.

17. Firstly, when the cap is opened, gas and liquid rush out and as a reaction weight increases and then it decreases.

18. Momentum of one bullet
$= mv = 20 \times 10^{-3} \times 300$
$p = 6$kg-m/sec.
N = Number of bullets/sec = 4

$\therefore$ $\frac{dp}{dt} =$ change of momentum/sec or force

$= Np = 4 \times 6 = 24$ N

19. Now, $a = \frac{\sqrt{F_1^2 + F_2^2}}{m} = \frac{F_3}{m} = \frac{R_3}{m}$

20. If the applied force is increased beyond the force of limiting friction and the body starts moving, the friction opposing the motion is caleld kinetic or sliding or dynamic friction. Experimentally, it is also well established that dynamic friction is lesser than the limiting static friction and is given by
$f_k = \mu_k R$.
where μ_k is called coefficient of kinetic friction