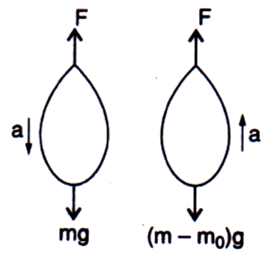
WEEKLY TEST MEDICAL PLUS -01 TEST - 10 Balliwala SOLUTION Date 21-07-2019

[PHYSICS]



1. Let F be the upthrust of the air. As the balloon in descending down with an acceleration a,

$\therefore$ $mg - F = ma$ ......(i)

Let mass m_0 be removed from the balloon so that it starts moving up with an acceleration a. Then,

$F - (m - m_0)g = (m - m_0)a$

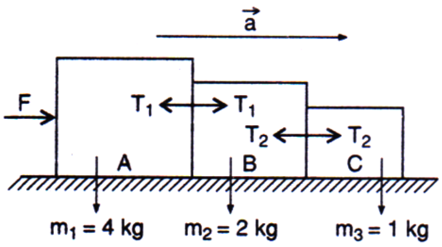
$F - mg + m_0g = ma - m_0a$ .....(ii)

Adding eqns. (i) and (ii), we get

$m_0g = 2\,ma - m_0a$

$m_0(g + a) = 2ma$

$$m_0 = \frac{2ma}{a+g}$$



2. According to free body diagram of block A,

$F - T_1 = m_1a$ ......(i)

$T_1 - T_2 = m_2a$ .....(ii)

$T_2 = m_3a$ .....(iii)

Addding all the three eqns., we get

$F = (m_1 + m_2 + m_3)a$ or $a = \dfrac{F}{m_1 + m_2 + m_2}$

$$= \frac{14}{4+2+1}$$

Putting in eqn. (i), contact force between A and B is

$T_1 = F - m_1a = 14 - 4 \times 2 = 6$ N

Hence, correct option is (a)

4. Time periof of a simple pendulum is given :

$$T = 2\pi\sqrt{\frac{l}{g}} \quad \text{or } T \propto \sqrt{\frac{l}{g}}$$

When the elevator is accelerating downwards, then net gravitational acceleration is (g – a). So, the time period when elevator is accelerating downwards, is greatest.

5. As per Newton's third law of motion, when a horse pulls a wagon, the force that causes the horse to move forward is the force the ground exerts on it.

6. $$F = \frac{d}{dt}(Mv) = v\frac{dM}{dt} + M\frac{dv}{dt}$$

As v is a constant, $F = v\dfrac{dM}{dt}$

But $\dfrac{dM}{dt} = M\ \text{kg/s}$

$\therefore$ To keep the conveyer belt moving at v m/s,

Force needed = vM newton

7. Given that;

$u = 10\ \text{m/s},\ \frac{dm}{dt} = 2\ \text{kg/s}$

Total mass of the truck, M = (100 + 100)kg = 200 kg

We know that,

$$F = \frac{udm}{dt}$$

or F = 10 × 2 = 20 N

8. Direction of resultant will be given by $\tan\theta$, where θ is the angle which resultant makes with x-axis.

$\therefore\ \tan\theta = \frac{y}{x} = \frac{1}{2}$

or 2y = x

or 2y – x = 0

9.

10. F – Mg = Ma

8000 = 2000 a

$\therefore$ Acceleration is 4 ms^{-2} upwards

11. For minimum stopping distance the tyres should be jammed. Here, the car will stop due to sliding friction. Hence, F = µMg.

The retarding force produced will be

Ma = µMg

$\therefore$ a = µg (independent of mass)

So, both the cars will have the same stopping distance

12. Considering free-body diagrams of the masses, we have

T – 3g = 3a and 5g – T = 5a

Solving for T, we have

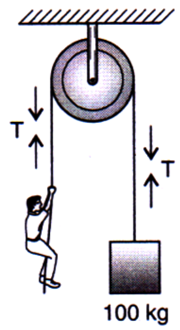
T = (15/4)g

$\therefore$ F = Force on the pulley

$$= 2T = 2 \times \frac{15}{4} = 7.5\ \text{kg f}$$

13. Let T be the tension in the rope and a the acceleration of the rope.

The absolute acceleraion of man is therefore $\left(\frac{5g}{4} - a\right)$. Equations of motion for mass and man gives.



T – 100g = 100a .....(i)

$$T - 60g = 60\left(\frac{5g}{4} - a\right) \quad ....(ii)$$

14. Change in momentum in one sec, i.e.,

F = change in momentum per bullet × no. of bullets fired per second

= mv × n = mnv

15. Reading of spring balance = tension

Tension, $T = \frac{2m_1m_2g}{m_1 + m_2} = \frac{2 \times 2 \times 2 \times 9.8}{2+2}$

$$19.6\ \text{N} = \frac{19.6}{9.8}\text{kgf} = 2\text{kgf}$$

16. Let the accelerationbe a.

Then 20 = 0 + 0.1 × a

$\therefore$ a = 200 ms^{-2}

and Force = 0.150 × 200 N = 30 N

17. Tension = m(g + a)

= 5000(9.8 + 2) = 5900 N

18. $T_2 = \frac{6}{6+6+6}F = \frac{F}{3}$

19. Accelerations of the skaters will be in the ratio $\frac{F}{4} : \frac{F}{5}$, i.e., 5 : 4

Now according to the equation, $s = 0 + \frac{1}{2}at^2$ we get;

$\frac{s_1}{s_2} = \frac{a_1}{a_2} = \frac{5}{4}$

20. Suppose F = upthrust due to buoyancy
Then while descending, we find:
$Mg - F = M\alpha$ ......(i)
when ascending, we have:
$F - (M - m)g = (M - m)\alpha$ .....(ii)
Solving eqns. (i) and (ii), we get;

$m = \left[\frac{2\alpha}{\alpha + g}\right]M$

21. For a body to the equilibrium, it should exist both in translational equilibrium.
For translational equilibruim, $\Sigma F = 0$
and for rotational equilibrium, $\Sigma \tau = 0$

22. For on M_1 will be $F_1 = M_1a_1$
Let the force on M_2 be F_2. Then $F_2 = M_2a_2$
Also, $F = F_1 + F_2 = M_1a_1 + M_2a_2$

$\therefore \quad a_2 = \frac{(F - M_1a_1)}{M_2}$

23. Acceleration of the mass m_3 = common acceleration of the system $= \frac{F}{\text{total mass}} = \frac{F}{m_1 + m_2 + m_2}$

24. Because the raindrop is falling with uniform velocity, there will be no change in its actual weight,

i.e., $\text{Weight} = mg = \frac{0.2}{1000} \times 10 = 0.002\ N$

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

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

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

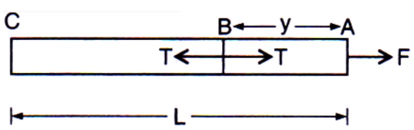
$\therefore \quad F_{satellite} = -v\frac{dM}{dt}$

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

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

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

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



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

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

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

27. 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.

28. 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

29. Let the initial length of the string be L

∴ $(x - L)K = 5$, $(y - K)K = 7$

$(z - L)K = 9$

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

Solving, we get; z = 2y – x.

30. Mg – T = Ma

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

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

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

∴ a = 0.6 g

31. 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

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

33. Momentum carried by each bullet = mv

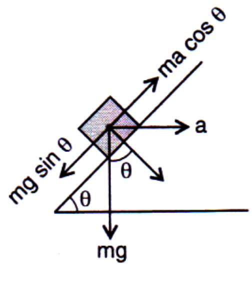
= 0.010 × 500 kg-m/s = 5 kg-m/s

Now, force = change in momentum in 1 sec

= 5 × 10 = 50 N

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

34. $mg \sin\theta = ma \cos\theta$



or $a = g \tan\theta$

∵ $\sin\theta = \frac{1}{l}$

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

∴ $a = \frac{g}{\sqrt{l^2 - 1}}$

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

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

36. $T\cos\theta = T_1 = 10 \times g$

$T\sin\theta = 98$

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

37. 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

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

39. Momentum of one bullet

$= mv = 20 \times 10^{-3} \times 300$

p = 6kg-m/sec.

N = Number of bullets/sec = 4

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

= Np = 4 × 6 = 24 N

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

41.

42. $\frac{dm}{dt} = 0.1 kg/sec;$ Mass of the rocket = 100 kg

v = 1 km/sec = 1000 m/sec

$$F = \frac{d(mv)}{dt}$$

$= m\frac{dv}{dt} - v\frac{dm}{dt}$ (as the mass is decreasing)

0 = 100a – 1000 × 0.1

a = 1 m/s^2

43. $\vec{F} = 6\hat{i} - 8\hat{j} + 10\hat{k}$

$|\vec{F}| = \sqrt{36 + 64 + 100} = \sqrt{200}\,N = 10\sqrt{2}\ N$

Acceleration, a = 1 ms^{-2}

$\therefore$ Mass, $M = \frac{10\sqrt{2}}{1} = 10\sqrt{2}kg$

44.

45. The net upward acceleration is 9.8 – 2.8 = 7 m/sec^2

Total mass = 80 + 5 = 85 kg

So, net upward force is F = 85 × 7 = 595 N