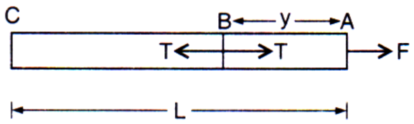
WEEKLY TEST MEDICAL PLUS -02 TEST - 08 RAJPUR SOLUTION Date 25-08-2019

[PHYSICS]

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



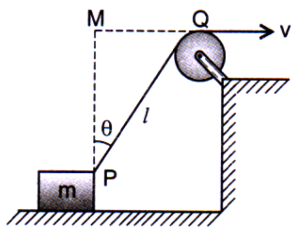
Now, considering the motion of the part AB of the rope [which has mass $\left(\frac{M}{L}\right)y$ and acceleration given by, eqn (i)] assuming that tension at B is T.

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

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

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

2. Here θ and the length PQ vary with time. Let PQ = 1 at any instant.
PM = l cosθ,
MQ = l sinθ



$V = \frac{dl}{dt}$(given)

As the block does not move vertically

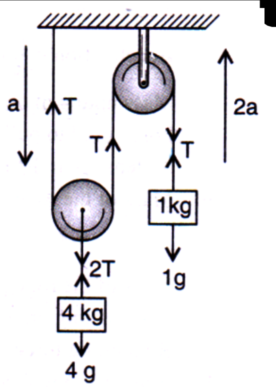
Further, $\frac{d}{dt}(MQ) =$ required velocity

or $\frac{d}{dt}(l\sin\theta) = v$(say)

Solving these equations, we get;

$$V = \frac{v}{\sin\theta}$$

3. Suppose a be the downward acceleration of the 4 kg mass, therefore, 2a is the upward acceleration of the 1 kg mass. Hence, equations of motion are :



$1 \times 2a = T - 1g$ ......(i)
$4a = 4g - 2T$ ......(ii)
Adding after multiplying the equation (i) by 2,

$$8a = 2g \text{ or } a = \frac{2g}{8} = \frac{g}{4} \text{ or } 2a = \frac{g}{2}$$

Thus, the acceleration of the mass 1kg is $\frac{g}{2}$ upwards.

4. **Given** : m_1 = 1kg, m_2 = 6kg and m_3 = 3 kg
If a is the acceleration of the system
$m_1a = T_1 - m_1g$
$m_2a = T_2 - T_1$
$m_3a = m_3g - T_2$
Adding, $a(m_1 + m_2 + m_3) = (m_3 - m_1)g$

$$\therefore \quad a = \frac{(m_3 - m_1)g}{(m_1 + m_2 + m_3)} = \frac{(3-1)\times 10}{1+6+3} = 2ms^{-2}$$

5. **Case I** : $a = \frac{(m_2 - m_1)}{(m_2 + m_1)}g \frac{2m - m}{2m + m} g = \frac{m}{3m} g = \frac{g}{3}$

Case II : F – T = 0 or T = 2mg
Also, T – mg = ma' or 2mg – mg = ma'
∴ a' = g, i.e., a < a'

6. Mg – T = Ma

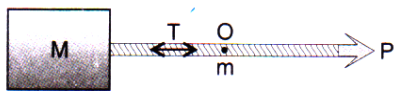
$$\therefore \quad T = M(g-a) = Mg\left(1 - \frac{a}{g}\right)$$

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

7. Let a be the common acceleration of the system.



Here, T = Ma (for the block)
P – T = ma (for the rope)
∴ P – Ma = ma

or $$p = a(m+M) \text{ or } a = \frac{P}{(M+m)}$$

Now, $$T = Ma = \frac{MP}{(M+m)}$$

8.

9. Net force on the rod = $F_1 - F_2$ $(\because F_1 > F_2)$
As mass of the rod is M, hence acceleration of the rod is

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

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

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

10. $m_2 g - T = m_2 a$ ......(i)
$T - m_1 g \sin 30^o = m_1 a$ ....(ii)
Adding two equations,

$$a = \frac{m_2 - m_1 \sin 30^o}{m_1 + m_2} \times g = \frac{4 - 8 \times \frac{1}{2}}{4 + 8} \times g = 0$$

11.

12. $T_1 = (12 + 3)a$ and $T_2 = 3a$

$\therefore$ $\frac{T_1}{T_2} = \frac{15a}{3a} = \frac{5}{1}$

13. Net pulling force = 2g – 1g = 10 N
Mass being pulled = 2 + 1 = 3 kg
$\therefore$ Acceleration of the system is,

$$a = \frac{10}{3} m/s^2$$

Velocity of both of the blocks at t = 1 s will be,

$$v_0 = at = \frac{10}{3} \times 1 = \frac{10}{3} m/s$$

Now at this moment, velocity of 2 kg block becomes zero, while that of 1 kg block is $\frac{10}{3} m/s$ upwards.

Hence, string tight again when
displacement of 1 kg block = displacement of 2kg block

or $v_0 t - \frac{1}{2} g t^2 = \frac{1}{2} g t^2$

$$t = \frac{v_0}{g} = \frac{(10/3)}{10} = \frac{1}{3} \text{sec}$$

14. Let T be the tension in the string C. Hence,
T cos 45º = Mg
T sin45º = tension in B
Hence, tension in B = Mg = 100 gN

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

16.

17. 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.

18. From constraint relations we can see that the acceleration of block B in upward direction is

$a_B = \left(\frac{a_C + a_A}{2}\right)$ with proper aigns

So $a_B = \left(\frac{3-12t}{2}\right) = 1.5 - 6t$

or $\frac{dv_B}{dt} = 1.5 - 6t$ or $\int_0^{v_B} dv_B = \int_0^1 (1.5-6t)dt$

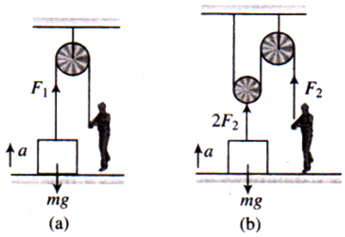
or $v_B = 1.5t - 3t^2$ or $v_B = 0$ at $t = 1/2s$

19. Since, $h = \frac{1}{2}at^2$, a should be same in both cases, because h and t are same in both cases as given.

In figure, $F_1 - mg = ma \Rightarrow F_1 = mg + ma$

In figure, $2F - mg = ma \Rightarrow F_2 = \frac{mg+ma}{2}$

$\therefore F_1 > F_2$



20. Let at any time, their velocities are v_1 and v_2, respectively. Then $v_1 = v_2\cos\theta$

Differentiating : $a_1 = a_2\cos\theta - v_2\sin\theta\frac{d\theta}{dt}$

Hence, none of them is correct.

21. Acceleration of cylinder down the plane is

$a = (g\sin 30^o)(\sin 30^o) = 10\left(\frac{1}{2}\right)\left(\frac{1}{2}\right) = 2.5ms^{-2}$

Time taken $t = \sqrt{\frac{2s}{a}} = \sqrt{\frac{2\times 5}{2.5}} = 2s$

22. The acceleration of block-rope system is $a = \frac{F}{(M+m)}$, where M is the mass of block and m is the mass of rope. So the tension in the middle of the rope will be

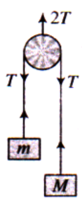
$T = \{M + (m/2)\}a = \frac{M+(m/2)F}{M+m}$

Given that m = M/2

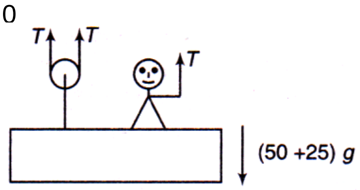
$\therefore T = \left[\frac{M + M/4}{M+(M/2)}\right]F = \frac{5F}{6}$

23. $T = \frac{2mMg}{m+M} = \frac{2mg}{1+\frac{m}{M}} = 2mg$

Hence, total downward force is 2T = 4 mg



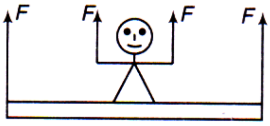
24 Steady rate means, net force = 0



$\therefore$ $3T = 75g = 750$

or $T = 250$ N

25. Total upward force $= 4\left(\frac{mg}{2}\right) = 2mg$

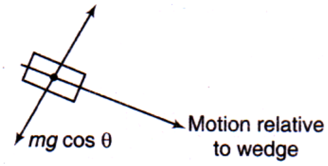


Total downward force = (m + m)g = 2 mg

$\therefore$ Net force = 0

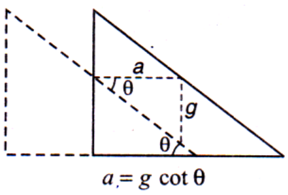
$F = \frac{mg}{2}$

26. During motion of block, a component of its acceleration comes in the direction of mg $\cos\theta$. Therefore,



$mg\cos\theta > N$

27. $\frac{a}{g} = \cot\theta$



$\therefore$ $a = g\cot\theta$

28. $a_1 = \frac{m_2 g}{m_1 + m_2} = \frac{30}{7} m/s^2$

$a_2 = \frac{(m_1 - m_2)g}{m_1 + m_2}$

$= \frac{10}{7} m/s^2$

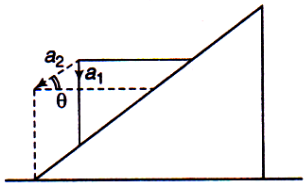
$a_3 = \frac{m_2 g - m_1 g \sin 30^o}{m_1 + m_2}$

$= \frac{10}{7} m/s^2$

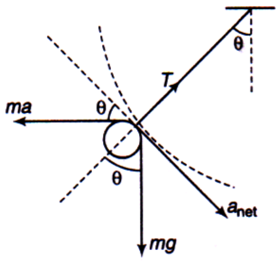
$\therefore$ $a_1 > a_2 = a_3$

29. $\frac{a_1}{a_2} = \sin\theta$

$\therefore$ $a_1 = a_2 \sin\theta$

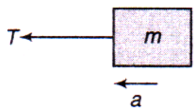


30. With respect to trolley means, assume trolley at rest and apply a pseudo force (=ma, towards left) on the bob.

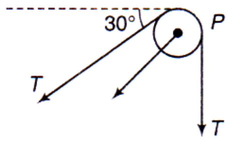


$$a_{net} = \frac{mg\sin\theta - ma\cos\theta}{m}$$

31. $a = \frac{\text{Net pulling force}}{\text{Total mass}}$



$= \frac{2mg\sin 30^o}{2m + m} = \frac{g}{3}$



FBD of m

T = ma = mg/3

Resultant of tensions

$$R = -(T\cos 30^o)\hat{i} - (T\sin 30^o + T)\hat{J}$$

Putting T = mg/3

$$R = -\frac{\sqrt{3}}{6}mg\hat{i} - \frac{mg}{2}\hat{j}$$

Since pulley P is in equilibriu. Therefore,

F + R = 0

where, F = force applied by clamp on pulley

$$\therefore \quad F = -R\frac{mg}{6}(\sqrt{3}\,\hat{i} + 3\,\hat{j})$$

32. Acceleration, $a = \frac{2F - F}{m + m} = \frac{F}{2m}$ (towards left)

Horizontal forces on B gives the equation,

2F – N sin30º = m.a

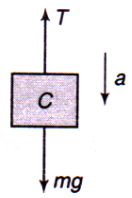
or $2F - \frac{N}{2} = m\left(\frac{F}{2m}\right)$

$\therefore$ N = 3F

33. $a = \frac{\text{Net pulling force}}{\text{Total mass}}$

$= \frac{(2+2-2)g}{2+2+2} = \frac{g}{3}$

FBD of C



$mg - T = ma = \frac{mg}{3}$

$\therefore \quad T = \frac{2}{3}mg$

$= \frac{2}{3}(20) = 13.3 \text{ N}$

34. $T_A = 10g = 100 \text{ N}$

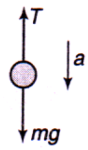
$T_B \cos 30^o = T_A$

$\therefore \quad T_B = \frac{200}{\sqrt{3}} \text{N}$

$T_B \sin 30^o = T_C$

$\therefore \quad T_C = \frac{100}{\sqrt{3}} \text{N}$

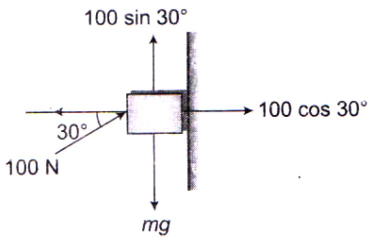
35. $a = \frac{mg - T}{m} = g - \frac{T}{m}$



$a_{min} = g - \frac{T_{max}}{m}$

$= g - \frac{\frac{2}{3}mg}{m} = \frac{g}{3}$

36.



$N' = 100\cos 30° = 100.\frac{\sqrt{3}}{2} = 50\sqrt{3}\ N$

Net driving force = $\left(100 \times \frac{1}{2} - 30\right)$

= 20 N (upward)

$f_{limiting} \frac{1}{\sqrt{3}}(50\sqrt{3}) = 50\,N$

$\therefore$ Friction = 20 N (downward)

37.

$P = f_{ms} = \mu_s mg$

When the body starts moving with acceleration a, then $P - f_{ms} = ma$

$\mu_s mg - \mu_k mg = ma$

or $a = (\mu_s - \mu_k)g$ or $a = (0.5 - 0.4)10$

$= 0.1 \times 10\ ms^{-2} = 1\ ms^{-2}$

38.

Forces acting on block in y direction are

$$30\ N\downarrow, N\uparrow, \frac{3F}{5}\uparrow \Rightarrow N = 30 - \frac{3F}{5}$$

$$\Rightarrow \quad f = \mu N = \frac{1}{3}\left(30 - \frac{3F}{5}\right) = 10 - \frac{F}{5}$$

Forces acting on block in x direction are

$$f \leftarrow, \frac{4F}{5} \rightarrow \quad \text{Now } \frac{4F}{5} \geq f \Rightarrow F \geq 10$$

39.

Driving force w.r.t. platform = ma

$= 2 \times 4 = 8$ N

and resisting force $= f_{lim} = \mu N$

$= 0.2 \times 2 \times 10 = 4$ N

Here resisting force is sufficient to keep the block at rest w.r.t. plank hence, the block will slide on plank and friction force will be 4 N.

40.

If α represents angle of repose, then, $\tan \alpha = 0.8$

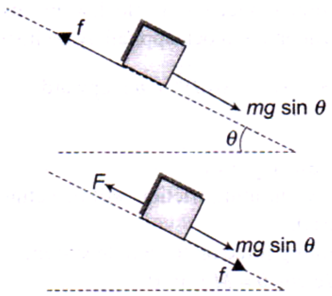
$\alpha = \tan^{-1}(0.8) = 39°$

The given angle of inclination is less is less than the angle of repose. So, the 1 kg block has no tendency to move. [Note that $mg \sin\theta$ is exactly balanced by the force of friction. So, $T = 0$.]

41. As object just being to slide

$f = mg \sin\theta$ ...(i)

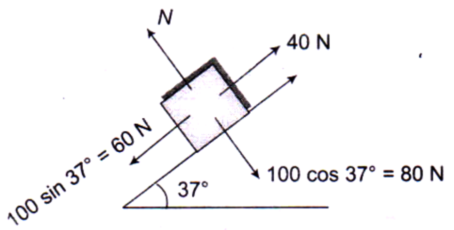
If we start sliding the block up, the friction force will be downward direction, hence minimum force applied in upward direction.



Component of weight along inclined plane + force of friction

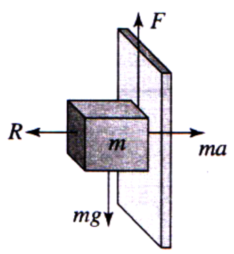
$= 2mg \sin\theta$

42.



$f_{lim} = \mu N = 0.7 \times 80 = 56$ N
Net driving force = 60 – 40 = 20 N (down the plane)
As resisting force is greater than net driving force, the friction will be static of nature and friction force is 20 N (up the plane).

43.



For the limiting condition upward friction force between board and block will balance the weight of the block.

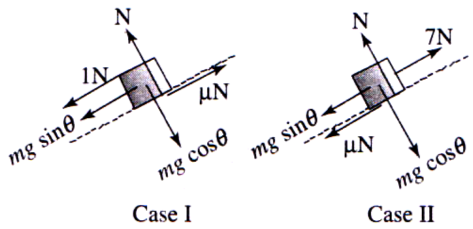
i.e. $F > mg$

$\Rightarrow \mu(R) > mg$

$\Rightarrow \mu(ma) > mg$

$\Rightarrow \mu > \frac{g}{a}$

44.



Case I: When block is about to slide down

$1 + mg \sin\theta = \mu\, mg \cos\theta$ (1)

Case II: When block is about to slide up

$mg \sin\theta + \mu\, mg \cos\theta = 7$ (2)

45.

$f_k = 0.4 \times 2 \times 10$ N = 8 N
$f_{ms} = 0.5 \times 2 \times 10$ N = 10 N
Since the applied force is less than force of friction, therefore the force of friction is equal to the applied force i.e. 2.5 N.

[CHEMISTRY]

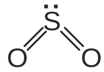
46 $CH_2{=}CH{-}CH_2{-}C{\equiv}CH$ has 10σ-bonds are 3π-bonds

47. 34 electrons

48.

49.

50. BF_3 and NO_2^- have sp^2-hybridised central atom while NH_2^- and H_2O have sp^3 hybridised central atom.

51.  sp^2-hybridisation

52. SF_4 and I_3^- and PCl_5 are sp^3d-hybridised. In general $PCl_5(g)$ in considered sp^3d. In solid state, PCl_5 exists as $(PCl_4)^{\oplus}(PCl_6)^{\ominus}$ with sp^3 and sp^3d^2-hybridisations respectively.

$SbCl_5^{2-}$ has 5σ bonds and one lone pair. It is sp^3d^2-hybridised.

53. Four atoms directly related with $C{\equiv}C$ are linearly arrnaged

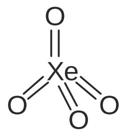
54. XeF has 8 electrons in valence shell. In XeF_2, XeF_4 and XeF_6, two sigma bonds, four sigma bonds and six sigma bonds are respectively formed. Hence, in XeF_2 3 pairs of electrons are left, in XeF_4 2 pairs of electron are left and in XeF_6 only 1 pair of electron is left.

55. In BH_3, B-atom forms 3σ-bonds has sp^2-hybridization. In B_2H_6, each B-atom is joined with 4H atoms and is sp^3-hybridization

56. $\underset{\text{Al is } sp^2}{AlH_3} \xrightarrow{H^-} \underset{\text{Al is } sp^3}{AlH_4^-}$

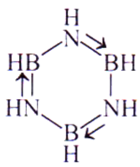
57. Each f C^1 and C^2 are forming two sigma bonds. Hence, both are sp-hybridised.

58.

59.  XeO_4 has 4σ- and 4π-bonds.

60. In SF_4, sulphur atom is sp^3d hybridized with two axial and two equitorial F-atoms and one lone pair on equitorial position.
The axial S–F bonds are larger than equitorial S–F bonds.

61. In methane C-atom is sp^3-hybridized with 25 s-character. In ethene, it is sp^2 with 33 s-character has to be less than 25 (actual value is 21.43)

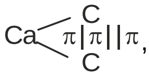
62. 

12 σ and 3π bonds. Ratio $\sigma : \pi$ bonds = 4 : 1

63. Highest product of charges of ions.

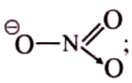
64. Phosphorus ($1s^22s^22p^63s^23p^6$ 3d) can expand electronic configuration become of availability of 3d-subshell in valence shell.
Nitrogen ($1s^22s^22p^3$) has no d-subshell in valence shell for expansion of electronic configuration.

65. Cu^{2+} and SO_4^{2-} have coulombic forces of attraction giving rise to ionic bond. Four H_2O molecules form coordinate bonds with Cu^{2+}. One H_2O molecule joins two H_2O related to Cu^{2+} and also SO_4^{2-} by H-bonds. H_2O itself has covalent bonds.

66. 

, one sigma and two pi bonds

67. x is related to sp^3-hybridized C-atom, y is related to sp^2-hybridized C-atom and z is related to sp-hybridised C-atom.

68. 

; bond angle in H_2O is 104.5º

69. In B_2H_6, each BH_3 unit has 6 electrons on B-atom

70. A covalent bond is formed by the partial overlap of electron clouds of half filled orbitals.
71. A
72. C
73. O_2^- has one unpaired electron $(\pi_{2p_y}^*)^1$.
74. L.E. is directly proportional to charge and inversely proportional to size.