WEEKLY TEST MEDICAL PLUS -01 TEST - 11 RAJPUR SOLUTION Date 28-07-2019

[PHYSICS]

1. Given that $U = \frac{A}{r^2} - \frac{B}{r}$

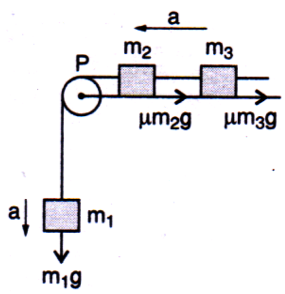
For stable equilibrium,

$$F = -\frac{dU}{dr} = 0$$

or $$-\frac{2A}{r^3} + \frac{B}{r} = 0$$

or $$\frac{2A}{r^3} = \frac{B}{r} \quad \text{or} \quad r = \frac{2A}{B}$$

2. Force of friction on mass $m_2 = \mu m_2 g$
Force of friction on mass $m_3 = \mu m_3 g$
Let a be common acceleration of the system



$$\therefore \quad a = \frac{m_1 g - m_2 g - \mu m_3 g}{m_1 + m_2 + m_3}$$

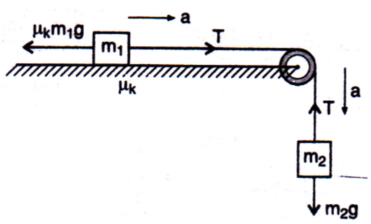
Here, $m_1 = m_2 = m_3 = m$

$$\therefore \quad a = \frac{mg - \mu mg - \mu mg}{m + m + m}$$

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

$$= \frac{g(1-2\mu)}{3}$$

3. For motion of mass m_1,



$T - \mu_k m_1 g = m_1 a$ ......(i)
$m_2 g - T = m_2 a$ ....(ii)
Adding eqns. (i) and (ii), we get

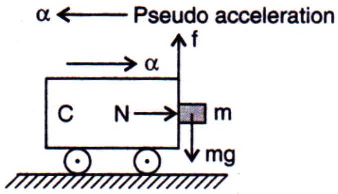
$$a = \frac{m_2 g - \mu_k m_1 g}{m_1 + m_2} \quad ....(iii)$$

Putting eqn. (iii), in eqn. (ii), we get

$$m_2 g - T = m_2 \left[\frac{m_2 g - \mu_k m_1 g}{m_1 + m_2}\right]$$

or $$T = \left[\frac{m_1 m_2 g(1+\mu_k)}{m_1 + m_2}\right]$$

4. Pseudo force or fictitious force, $F_{fic} = m\alpha$
Force of friction, $f = \mu N = \mu m\alpha$
The block of mass m will not fall as long as :
$f \geq mg$
$\mu m\alpha \geq mg$
$$\alpha \geq \frac{g}{\mu}$$



5. Force of friction, $f = \mu mg$
$$\therefore \quad a = \frac{f}{m} = \frac{\mu mg}{m} = \mu g = 0.5 \times 10 = 5ms^{-2}$$
Using, $v^2 - u^2 = 2aS$
$0^2 - 2^2 = 2(-5) \times S$
$S = 0.4$ m

6.

7. $R = mg\cos\alpha$
Force of friction $= \mu R = \mu mg\cos\alpha$
Force on the body along the direction of motion
$= mg\sin\alpha - \mu mg\cos\alpha$
$$\therefore \quad a = \frac{\text{force}}{\text{mass}} = g(\sin\alpha - \mu\cos\alpha)$$

8.

9. When a man walks on a rough surface, it is the frictional force which is responsible for motion, i.e., required angle between frictional force and ionstaneous velocity is zero

10. Vehicles are streamlined to reduce the frictional force offered by the surrounding air, i.e., reduce the fluid friction (also called WET friction). Friction between fluid and solid is called as wet friction.

11. Ball bearing are helpful in converting the sliding friction into rolling friction. Remember rolling friction is negligble as compared to sliding friction.

12. The forward tension on the tail bogey is least and hence the tail bogey is brought to rest first

13. When the cube is to be moved up, the minimum force needed is given by :
$F = mg\sin\theta + \mu R = mg\sin\theta + \mu mg\cos\theta$
$$= 10\sin\theta + 0.6 \times 10\cos\theta = 10 \times \frac{3}{5} + 0.6 \times 10 \times \frac{4}{5}$$
$= 10.8$ N

14. The retardation a is given by :
$$a = g\sin 45^o + \mu g\cos 45^o = \frac{g}{\sqrt{2}} + \frac{1}{2}g \times \frac{1}{\sqrt{2}}$$
$$= \frac{g}{\sqrt{2}}\left(1 + \frac{1}{2}\right)$$

15. Coefficient of static friction $\mu_s = (f_L R)$
When R is doubled, f_L or applied force F is also doubled so that μ_s remains same.

16. When the angle of inclination is equal ot angle of repose, the body just slides down the plane. But when the angle of inclination is greater than the angle of repose, the body begins to accelerate down the plane.

17. $\mu_s > \mu_k > \mu_r$. Rolling friction is always less than sliding friction, that is why it is easy to move heavy load from one place to another by rolling it over the surface instead of sliding it over the same surface. Moreover, it is quite obvious that static friction is always greater than kinetic friction

18. Proper inflation of the types reduces the area of contact between the tyre and road which in turn helps in decreasing the force of adhesion between two surfaces.

19. Given u = V, final velocity = 0

Using v = u + at

$\therefore$ 0 = V – at or $-a = \frac{0-V}{t} = -\frac{V}{t}$

f = μR = μmg (f is the force of friction)

$\therefore$ Retardation, a = μg

$\therefore$ $t = \frac{V}{a} = \frac{V}{\mu g}$

20. There occurs a loss in mass at the rate of $\Delta m.\Delta t$.

Hence, loss in mass in time $t = \frac{\Delta m}{\Delta t} \times t$

Mass of the rocket after time $t = M_0 - \frac{\Delta m}{\Delta t} \times t$

21.

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

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

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

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

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

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

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

On integrating, we get W = 530 mJ

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

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.

25. 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

26. When the body is rest, force of friction between the body and the floor = applied force = 2.8 N.

27.

28. Kinetic friction is constant, hence frictional force will remain same = (10 N)

29. The force on the block due to acceleration of the truck will be opposite to the acceleration of the truck and will be F = ma = 1 × 5 = 5 N
While the limiting friction
$f_L = \mu R = \mu mg = 0.6 \times 1 \times 9.8 = 5.88$ N
As applied force $F < f_L$, the block will reamin at rest in the truck and force of friction will be equal to applied force of 5 N (and not f_L) in the direction of acceleration of the truck.

30. Given that; $a = 70 km/h = 70 \times \frac{5}{18} = \frac{175}{9} m/s$

Final velocity = 0

Now, $\mu = \frac{F}{R} = \frac{(m-a)}{mg} = -\frac{a}{g}$ or $-a = \mu g$

∴ Retardation = 0.2 × 9.8 = 1.96 m/s^2
Using, $v^2 = u^2 + 2as$, we get

$$0 = \left(\frac{175}{9}\right)^2 + 2(-1.96)s$$

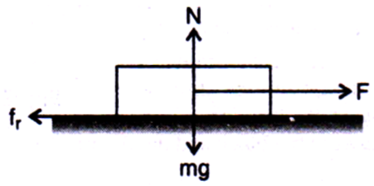
Solving, we get; s = 96.45 m

31.

32. $v = g(\sin\theta - \mu\cos\theta)t$

$$= 10\left[\frac{1}{2} - (0.2)\frac{\sqrt{3}}{2}\right]5 = 16.34\ ms^{-1}$$

33.

34. 

$F = f_r = \mu N = \mu mg = 0.1 \times 1 \times 9.8 = 0.98$ N
(Assuming that the value of μ = 0.1 is the coefficient of static friction)

35. $\frac{dM}{dt} = 0.1 kg/s$, v_{gas} = 50 m/s,

mass of the rocket = 2 kg, Mv = consant

$$-v\frac{dM}{dt} + M\frac{dv}{dt} = 0 \qquad \therefore \frac{dv}{dt} = \frac{1}{M}v\frac{dM}{dt}$$

or acceleration $= \frac{1}{2} \times 50 \times 0.1 = 2.5\ m/s^2$

36. According to work-energy theorem
T = fy
where f is the frictional force exerted on the body

or $f = \frac{T}{y}$

[Note : One can also verify that $\frac{T}{y}$ has the dimension of force,

i.e., $\frac{[T]}{[y]} = \frac{[ML^2T^{-2}]}{[L]}$

$= [MLT^{-2}]$

37. $v = \sqrt{gr} = \sqrt{10 \times 40} = 20 ms^{-1}$

38. Change in momentum,
$\Delta p = mv - (-mv) = 2mv$
$= 2 \times 0.25 \times 10 = 5$ kg ms^{-1}
Force × Time = Change in momentum

$\therefore$ $\text{Force} = \dfrac{\text{Change in momentum}}{\text{Time}}$

$= \dfrac{5 kgms^{-1}}{0.01 s} = 500$ N

39.

40.

41. Equal force will be exerted on both the cars. Hence, if a_1 and a_2 be the accelerations, then
$M_1 a_1 = M_2 a_2$

Also, $x_1 = \dfrac{v_1^2}{2a}$ and $x_2 = \dfrac{v_2^2}{2a_2}$

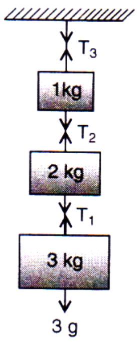
Therefore,

$$\frac{x_1}{x_2} = \frac{v_1^2}{v_2^2} \times \frac{a_2}{a_1} = \left(\frac{M_2}{M_1}\right)^2 \times \frac{M_1}{M_2} = \frac{M_2}{M_1} \qquad (\because M_1 v_1 = M_2 v_2)$$

Hence, $M_1 x_1 = M_2 x_2$

42. Suppose the force on the block be P and acceleration of the system be a. Then

$a = \dfrac{F}{(M+m)}$ and $P = Ma = \dfrac{MF}{(M+m)}$



43. From the figure, it follows that
$T_1 = 3g$
$2g + T_1 = T_2$
or $T_2 = 2g + 3g$
$= 5g$

44. Equation of motion are :
$m_1 g - T = m_1 a$
and $T - m_2 g = m_2 a$,
where T is the tension in the string
$(m_1 - m_2)g = (m_1 + m_2)a$

or $a = \dfrac{(m_1 - m_2)}{(m_1 + m_2)} g$

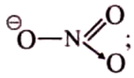
Putting the value of a in one of above equations,

$T = \dfrac{2m_1 m_2}{(m_1 + m_2)} g$

$\therefore$ Thrust on the pulley $= 2T = \dfrac{4m_1 m_2 g}{(m_1 + m_2)}$

45.

[CHEMISTRY]

46.  ; bond angle in H_2O is 104.5º

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

48. A covalent bond is formed by the partial overlap of electron clouds of half filled orbitals.

49. Highest product of charges of ions.

50.

51.

52. According to latest calculation of energy, the electron affinity of F is slightly more than that of Br and much less than Cl.

53. Ionisation energy of Be(Z = 4, electronic configuration $1s^2 2s^2$) is greater than that of B(Z = 5, EC $1s^2 2s^2 2p^1$).
IE of N(Z = 7, EC = $1s^2 2s^2 2p_x^1 2p_y^1 2p_z^1$) is greaer than that of O(Z = 8, EC $1s^2 2s^2 2p_x^2 2p_y^1 2p_z^1$)

54.

55. The species are isoelectronic. Higher the charge of nucleus, smaller the size.

56. $$E = \frac{hc}{\lambda} = \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{\lambda}$$

$$E(\text{given}) = \frac{242 \times 10^3}{6.02 \times 10^{23}} \text{ J}$$ per molecule of Cl–Cl bond

$$\frac{6.6 \times 10^{-34} \times 3 \times 10^8}{\lambda} = \frac{242 \times 10^3}{6.02 \times 10^{23}} \Rightarrow \lambda = 494 \text{ nm}$$

57. Highest product of charges of ions.

58. Phosphorus ($1s^2 2s^2 2p^6 3s^2 3p^6 \boxed{3d}$) can expand electronic configuration become of availability of 3d-subshell in valence shell.
Nitrogen ($1s^2 2s^2 2p^3$) has no d-subshell in valence shell for expansion of electronic configuration.

59.

60. O_2^- has one unpaired electron $(\pi^*_{2p_y})^1$.

61. L.E. is directly proportional to charge and inversely proportional to size.

62. (P) Similar lobes of d orbitals are joining linearly – (2)
(Q) Similar lobes of p and d orbitals are joining sidewise – (3)
(R) Opposite lobes of p and d orbitals are joining sidewise – (1)
(S) Opposite lobes of d_{z^2} and $d_{x^2-y^2}$ are joining linearly – (4)