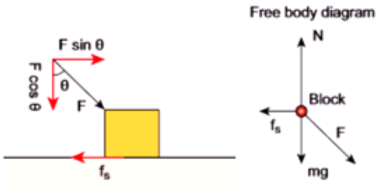
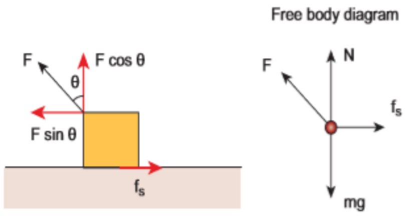
T.I. MATRICULATION HIGHER SECONDARY SCHOOL, AMBATTUR
HALF YEARLY EXAMINATION - DECEMBER 2018

PHYSICS SCORING KEY

MARKS: 70

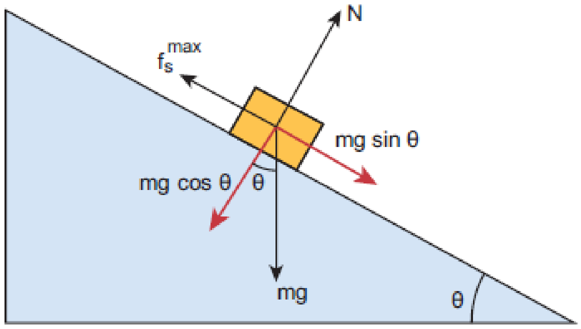
Class: XI

<table>
<tr><th>Q.No</th><th>Scoring Key</th><th>Marks</th></tr>
<tr><td>1</td><td>a) inertia of direction</td><td>1</td></tr>
<tr><td>2</td><td>b) need not to be zero</td><td>1</td></tr>
<tr><td>3</td><td>a) increases</td><td>1</td></tr>
<tr><td>4</td><td>b) only in rotating frames</td><td>1</td></tr>
<tr><td>5</td><td>c) 6 kg m s^{-1}</td><td>1</td></tr>
<tr><td>6</td><td>a) ½ mv^3</td><td>1</td></tr>
<tr><td>7</td><td>c) $\sqrt{5gr}$</td><td>1</td></tr>
<tr><td>8</td><td>b) zero</td><td>1</td></tr>
<tr><td>9</td><td>b) 3/2 k</td><td>1</td></tr>
<tr><td>10</td><td>a) 1</td><td>1</td></tr>
<tr><td>11</td><td>a) the centre point of the circle</td><td>1</td></tr>
<tr><td>12</td><td>a) 5 : 7</td><td>1</td></tr>
<tr><td>13</td><td>b) $\frac{13}{32}$ MR^2</td><td>1</td></tr>
<tr><td>14</td><td>a) a line perpendicular to the plane of rotation</td><td>1</td></tr>
<tr><td>15</td><td>b) solid cylinder</td><td>1</td></tr>
<tr><td>16</td><td>Force which acts on 1 kg of mass to give an acceleration 1 m s^{-2} in the direction of the force.</td><td>2</td></tr>
<tr><td>17</td><td>A pseudo force is an apparent force that acts on all masses whose motion is described using a non – inertial frame of reference such as a rotating reference frame.</td><td>2</td></tr>
<tr><td>18</td><td>It is to avoid slipping. A smaller step causes more normal force and thereby more friction.</td><td>2</td></tr>
<tr><td>19</td><td><table>
<tr><td>S.No</td><td>Elastic collision</td><td>Inelastic collision</td></tr>
<tr><td>1</td><td>Total momentum is conserved</td><td>Total momentum is conserved</td></tr>
<tr><td>2</td><td>Total kinetic energy is conserved</td><td>Not conserved</td></tr>
<tr><td>3</td><td>Forces involved are conservative forces</td><td>Non conservative forces</td></tr>
<tr><td>4</td><td>Mechanical energy is not dissipated</td><td>Dissipated into heat, light, sound, etc.</td></tr>
</table></td><td>2</td></tr>
<tr><td>20</td><td>Yes, when a bomb explodes momentum is conserved but kinetic energy changes.</td><td>2</td></tr>
</table>

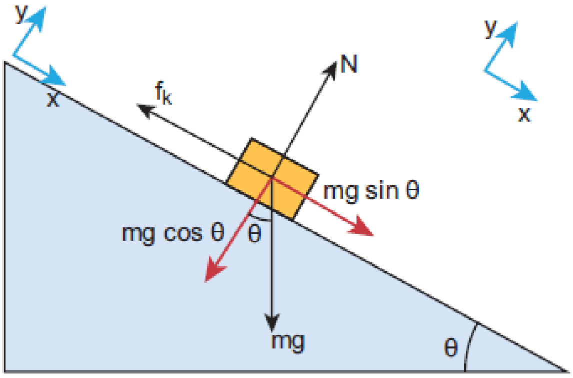
21	$W=\int_{x_i}^{x_f}F(x)dx=k\int_{0}^{4}x^2dx=\frac{64}{3}\text{ N m}$	2
22	$\vec{r}=7\hat{i}+4\hat{j}-2\hat{k}$ $\vec{F}=4\hat{i}-3\hat{j}+5\hat{k}$ Torque, $\vec{\tau}=\vec{r}\times\vec{F}$ $\vec{\tau}=\begin{vmatrix}\hat{i} & \hat{j} & \hat{k}\\ 7 & 4 & -2\\ 4 & -3 & 5\end{vmatrix}$ $\vec{\tau}=\hat{i}(20-6)-\hat{j}(35+8)+\hat{k}(-21-16)$ $\vec{\tau}=\left(14\hat{i}-43\hat{j}-37\hat{k}\right)\text{N m}$	2
23	The perpendicular distance from the axis of rotation to an equivalent point mass, which would have the same mass as well as the same moment of inertia of the object.	2
24	Rolling is the combination of ratational and translational motions. v_{roll} = 0 = translational velocity + tangential velocity due to rotation, i.e, $v - r\omega = 0$	2
25	  $N_{push} = mg + F\cos\theta$ $N_{pull} = mg - F\cos\theta$ $N_{pull} < N_{push}$ Hence it is easier to pull an object than to push	1 1 1
26	While trying to push a car from outside, he pushes the ground backward at an angle . the ground offers an equal reaction in the opposite direction, so car can be moved. But the person sits inside means car and the person becomes a single system, and the force given will be a internalforce. According to Newton's third law, total internal force acting on the system is zero and it cannot acccelerate the system.	3

<table>
<tr><td>27</td><td>Time of contact = $\frac{1}{60}$ s
Mass of ball = 0.8 kg
Velocty v = 12 ms^{-1}
Average force = $\frac{\Delta p}{\Delta t} = \frac{0.8\ x\ 12}{\frac{1}{60}}$ = 0.8 x 12 x 60 = 576 N</td><td>3</td></tr>
<tr><td>28</td><td>$W_{weight\ lifter} = F_w h \cos\theta = F_w h \cos(0^0)$
= 5000 x 5 x (1) = 25000 J = 25 kJ

$W_{gravity} = F_g h \cos\theta = mgh (\cos 180^0)$
= 250 x 10 x 5 x (-1)
= - 12500 J = - 12.5 kJ
$W_{net} = W_{weight\ lifter} + W_{gravity}$
= 25 kJ – 12.5 kJ = + 12.5 kJ</td><td>1
1
1</td></tr>
<tr><td>29</td><td>1. If the work done by the force on the body is positive then its kinetic energy increases.
2. If the work done by the force on the body is negative then its kinetic energy decreases.
3. If there is no work done by the force on the body then there is no change in its kinetic energy, which means that the body has moved at constant speed provided its mass remains constant.</td><td>3</td></tr>
<tr><td>30</td><td><table>
<tr><th>S.No</th><th>Conservative forces</th><th>Non – conservative forces</th></tr>
<tr><td>1</td><td>Work done is independent of the path</td><td>Work done depends upon the path</td></tr>
<tr><td>2</td><td>Work done in a round trip is zero</td><td>Work done in a round trip is not zero</td></tr>
<tr><td>3</td><td>Total energy remains constant</td><td>Energy is dissipated as heat energy</td></tr>
<tr><td>4</td><td>Work done is completely recoverable</td><td>Work done is not completely recoverable</td></tr>
<tr><td>5</td><td>Force is the negative gradient of potential energy</td><td>No such relation exists.</td></tr>
</table></td><td>3</td></tr>
<tr><td>31</td><td>The forces intersect or passing through the axis of rotation cannot produce torque as the perpendicular distance between the forces is 0
i.e. r = 0; $\vec{\tau} = \vec{r}$ x $\vec{F}$</td><td>3</td></tr>
<tr><td>32</td><td>When a porter carries a sack of rice, the line of action of his centre of gravity will go away from the body. It affects the balance, to avoid this he bends. By which centre of gravity will realign within the body ahain. So balance is maintained.</td><td>3</td></tr>
<tr><td>33</td><td>Speed of the cyclist v = 20 m s^{-1} ; Angle of bending $\theta = 30^0$
$\tan\theta = v^2 / rg$</td><td></td></tr>
</table>

	$r = \frac{(20)^2}{(\tan 30^\circ)\times 10} = \frac{20\times 20}{(\tan 30^\circ)\times 10}$ $= \frac{400}{\left(\frac{1}{\sqrt{3}}\right)\times 10}$ $r = (\sqrt{3})\times 40 = 1.732\times 40$ $r = 69.28\,\mathrm{m}$	3
34	Consider an inclined plane on which an object is placed, as shown in the figure. Let the angle which this plane makes with the horizontal be θ. For small angles of θ, the object may not slide down. As θ is increased, for a particular value of θ, the object begins to slide down. This value is called angle of repose. Hence, the angle of repose is the angle of inclined plane with the horizontal such that an object placed on it begins to slide.  Let us consider the various forces in action here. The gravitational force mg is resolved into components parallel (mg sinθ) and perpendicular (mg cosθ) to the inclined plane. The component of force parallel to the inclined plane (mg sinθ) tries to move the object down. The component of force perpendicular to the inclined plane (mg cosθ) is balanced by the normal force (N). $N = mg\cos\theta$ When object just begins to move, the static friction attains its maximum value $f_s = f_s^{max} = \mu_s N$ This friction also satisfies the relation $f_s^{max} = mg\sin\theta$ Equating the right hand side of equations $(f_s^{max})/N = \sin\theta/\cos\theta$ From the definition of angle of friction, we also know that $\tan\theta = \mu_s$ In which θ is the angle of friction. Thus the angle of repose is the same as angle of friction.	5

OR



$mg \sin\theta - f_k = ma$

but $a = g/2$

$$mg\sin 60° - f_k = mg/2$$

$$\frac{\sqrt{3}}{2}mg - f_k = mg/2$$

$$f_k = mg\left(\frac{\sqrt{3}}{2} - \frac{1}{2}\right)$$

$$f_K = \left(\frac{\sqrt{3}-1}{2}\right)mg$$

$$mg\cos\theta = N = mg/2$$

$$f_K = \mu_K N = \mu_K\, mg/2$$

$$\mu_K = \frac{\left(\frac{\sqrt{3}-1}{2}\right)mg}{\frac{mg}{2}}$$

$$\mu_K = \sqrt{3} - 1$$

35 (a) Consider an object of mass m moving with a velocity $\vec{v}$. Then its linear momentum is $\vec{p} = m\,\vec{v}$ and its kinetic energy, KE = $\frac{1}{2}$ m v^2

$$KE = \frac{1}{2}mv^2 = \frac{1}{2}m(\vec{v}.\vec{v})$$

Multiplying both the Nr and Dr of equation by mass, m

$$KE = \frac{1}{2}\frac{m^2(\vec{v}.\vec{v})}{m}$$

$$= \frac{1}{2}\frac{(m\vec{v}).(m\vec{v})}{m}$$

$$= \frac{1}{2}\frac{\vec{p}.\vec{p}}{m}$$

$$= \frac{p^2}{2m}$$

$$KE = \frac{p^2}{2m}$$

$$|\vec{p}| = p = \sqrt{2m\ (KE)}$$

(b) The kinetic energy of the mass is given by KE = $\frac{p2}{2m}$

For the object of mass 2 kg KE_1 = 100 J

For the object of mass 4 kg KE_2 = 50 J

$KE_1 = KE_2$

Thus the kinetic energy of both masses is not the same.

As the momentum, p = mv, the two objects will not have same speed.

OR

(a) Let us consider a body of mass m at rest on a frictionless horizontal surface.

The work (W) done by the constant force (F) for a displacement (s) in the same direction is,

$$W = F s$$

The constant force is given by the equation

$$F = ma$$

$$v^2 = u^2 + 2as$$

$$a = \frac{v^2 - u^2}{2s}$$

$$F = m\left(\frac{v^2 - u^2}{2s}\right)$$

$$W = m\left(\frac{v^2}{2s}s\right) - m\left(\frac{u^2}{2s}s\right)$$

$$W = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$$

$$KE = \frac{1}{2}mv^2$$

$$\Delta KE = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$$

Thus, $W = \Delta KE$

Work done by the force on the body change the kinetic energy of the body.

(b) It is possible when there is another force which acts exactly opposite to the external applied force. They both cancel each other and the resulting net force becomes zero, hence the object moves with zero acceleration.

36

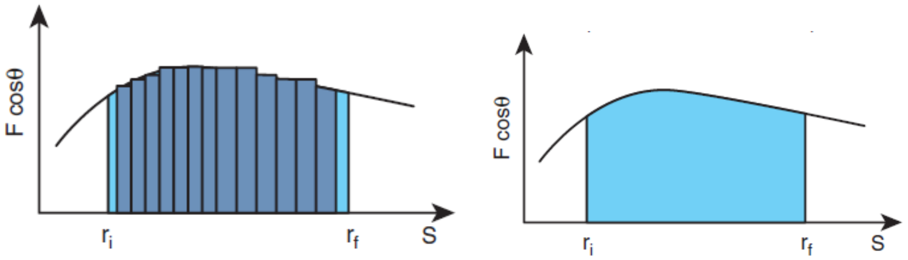
When the component of a variable force F acts on a body, the small work done (dW) by the force in producing a small displacement dr is given by the relation.

$$dW = (F \cos\theta)\, dr$$

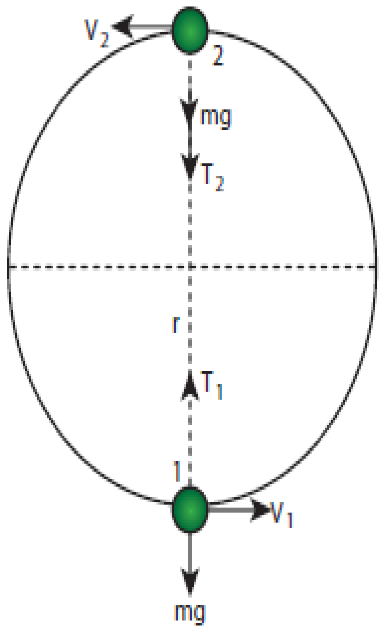
where, F and θ are variables. The total work done for a displacement from initial poaition r_i to final position r_f is given by the relation,

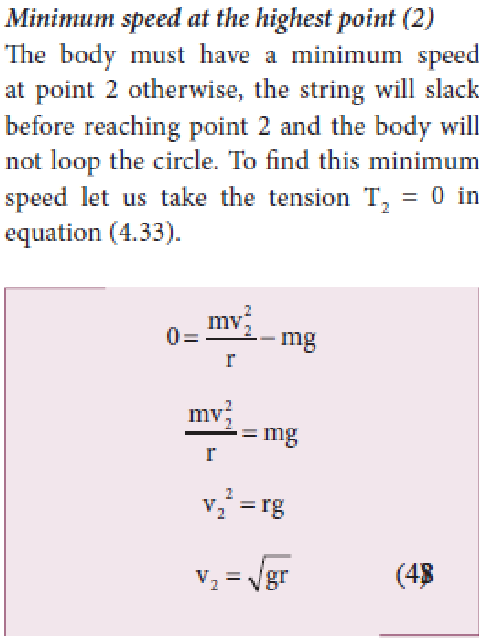
$$\int_{ri}^{rf} dW = \int_{ri}^{rf} F\cos\theta\ dr$$

A graphical representation of the work done by a variable force is shown in diagram. The area under the graph is the work done by the variable force.



OR





Minimum speed at the highest point (2)

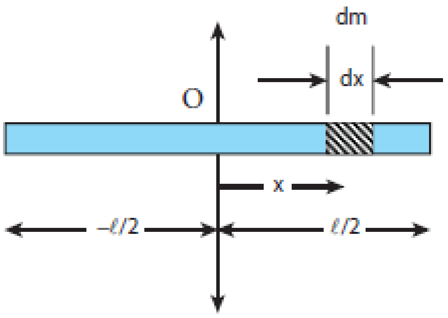
The body must have a minimum speed at point 2 otherwise, the string will slack before reaching point 2 and the body will not loop the circle. To find this minimum speed let us take the tension T_2 = 0 in equation (4.33).

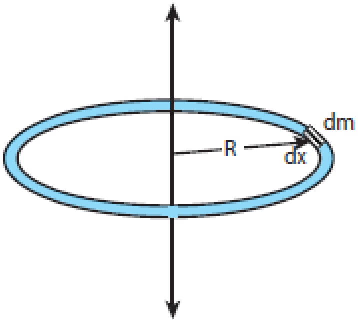
$$0 = \frac{mv_2^2}{r} - mg$$

$$\frac{mv_2^2}{r} = mg$$

$$v_2^2 = rg$$

$$v_2 = \sqrt{gr} \qquad (4)8$$

	The body must have a speed at point 2, $v_2 \geq \sqrt{gr}$ to stay in the circular path. *Minimum speed at the lowest point 1* To have this minimum speed $\left(v_2 = \sqrt{gr}\right)$ at point 2, the body must have minimum speed also at point 1. By making use of equation (4.36) we can find the minimum speed at point 1. $v_1^2 - v_2^2 = 4gr$ Substituting equation (4.38) in (4.36), $v_1^2 - gr = 4gr$ $v_1^2 = 5gr$ $v_1 = \sqrt{5gr}$ The body must have a speed at point 1, $v_1 \geq \sqrt{5gr}$ to stay in the circular path. From equations (4.38) and (4.39), it is clear that the minimum speed at the lowest point 1 should be $\sqrt{5}$ times more than the minimum speed at the highest point 2, so that the body loops without leaving the circle.	
37	 $dI = (dm)x^2$ $I = \int dI = \int (dm)x^2 = \int \left(\frac{M}{\ell}dx\right)x^2$ $I = \frac{M}{\ell}\int x^2 dx$ $I = \frac{M}{\ell}\int_{-\ell/2}^{\ell/2} x^2 dx = \frac{M}{\ell}\left[\frac{x^3}{3}\right]_{-\ell/2}^{\ell/2}$ $I = \frac{M}{\ell}\left[\frac{\ell^3}{24} - \left(-\frac{\ell^3}{24}\right)\right] = \frac{M}{\ell}\left[\frac{\ell^3}{24} + \frac{\ell^3}{24}\right]$ $I = \frac{M}{\ell}\left[2\left(\frac{\ell^3}{24}\right)\right]$ $I = \frac{1}{12}M\ell^2$ (5.4 **OR**	



$$dI = (dm)R^2$$

$$I = \int dI = \int (dm)R^2 = \int \left(\frac{M}{2\pi R}dx\right)R^2$$

$$I = \frac{MR}{2\pi}\int dx$$

$$I = \frac{MR}{2\pi}\int_0^{2\pi R} dx$$

$$I = \frac{MR}{2\pi}[x]_0^{2\pi R} = \frac{MR}{2\pi}[2\pi R - 0]$$

$$I = MR^2$$

38

$$(M - m)x = (m)\frac{R}{2}$$

$$x = \left(\frac{m}{(M - m)}\right)\frac{R}{2}$$

m = surface mass density × surface area

$$m = \sigma \times \pi\left(\frac{R}{2}\right)^2$$

$$m = \left(\frac{M}{\pi R^2}\right)\pi\left(\frac{R}{2}\right)^2 = \frac{M}{\pi R^2}\pi\frac{R^2}{4} = \frac{M}{4}$$

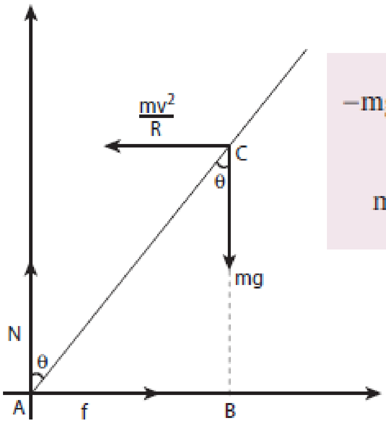
substituting m in the expression for x

$$x = \frac{\frac{M}{4}}{\left(M - \frac{M}{4}\right)} \times \frac{R}{2} = \frac{\frac{M}{4}}{\left(\frac{3M}{4}\right)} \times \frac{R}{2}$$

$$x = \frac{R}{6}$$

The center of mass of the remaining portion is at a distance $\frac{R}{6}$ to the left from the center of the disc.

OR



$$-mg\,AB + \frac{mv^2}{r}BC = 0$$

$$mg\,AB = \frac{mv^2}{r}BC$$

$$mg\,AC\,\sin\theta = \frac{mv^2}{r}AC\cos\theta$$

$$\tan\theta = \frac{v^2}{rg}$$

$$\theta = \tan^{-1}\left(\frac{v^2}{rg}\right)$$

While negotiating a circular level road of radius r at velocity v, a cyclist has to bend by the angle θ from verticle to stay in equilibrium.

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