Rotational K.E:

The K.E of the rotating body is called rotational K.E.

OR

The energy possesed by a body due to the Spinning about an axis of rotation is called rotational K.E.

we know that

$$(K.E)_T = \frac{1}{2} m v^2$$

In angular motion

$$V = r\omega$$

$$(K.E)_r = \frac{1}{2} m (r\omega)^2$$

$$(K.E)_r = \frac{1}{2} m r^2 \omega^2$$

$$mr^2 = I$$

$$(K.E)_r = \frac{1}{2} I \omega^2$$

Explanatio

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$m_1, m_2,$

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

motion

$V = r\omega$

$\frac{1}{2}m(r\omega)^2$

$= \frac{1}{2}mr^2\omega^2$

$mr^2 = I$

$= \frac{1}{2}I\omega^2$

Explanation:-

If a body is Spining about an axis with constant angular velocity say 'ω'. Each point of the body is rotating has some K.E.

. In order to determine the total K.E of the body having 'n' number of tiny particles say

$m_1, m_2, m_3, \dots, m_n,$

having distances

$r_1, r_2, r_3, \dots, r_n$ from centre 'O'.

So $(K.E)_r$ of 'n' number of

masses will be

$(K.E)_{r_1} = \frac{1}{2}m_1$

Similarly

$(K.E)_{r_2} = \frac{1}{2}m_2$

$\vdots$

$(K.E)_{r_n} = \frac{1}{2}m_n$

Hence Total $(K.E)_r$ is

$(K.E)_{r_T} = (K.E)_{r_1}$

$= \frac{1}{2}m_1 r_1^2 \omega_1^2$

Since the body
Constant ang
say 'ω' So

$(K.E)_{r_T} = \frac{1}{2}m_1 r_1^2 \omega^2$

$= \frac{1}{2}\omega\left[m_1 r_1^2 +\right.$

Spining
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masses will be

$$(K.E)_{r_1} = \frac{1}{2} m_1 r_1^2 \omega_1^2$$

Similarly

$$(K.E)_{r_2} = \frac{1}{2} m_2 r_2^2 \omega_2^2$$

$$\vdots \qquad \vdots$$

$$(K.E)_{r_n} = \frac{1}{2} m_n r_n^2 \omega_n^2$$

Hence Total $(K.E)_r$ is

$$(K.E)_{r_T} = (K.E)_{r_1} + (K.E)_{r_2} + \dots + (K.E)_{r_n}$$

$$= \frac{1}{2} m_1 r_1^2 \omega_1^2 + \frac{1}{2} m_2 r_2^2 \omega_2^2 + \dots + \frac{1}{2} m_n r_n^2 \omega_n^2$$

Since the body is moving with constant angular velocity say 'ω' So

$$(K.E)_{r_T} = \frac{1}{2} m_1 r_1^2 \omega^2 + \frac{1}{2} m_2 r_2^2 \omega^2 + \dots + \frac{1}{2} m_n r_n^2 \omega^2$$

$$= \frac{1}{2} \omega \left[m_1 r_1^2 + m_2 r_2^2 + \dots + m_n r_n^2 \right]$$

$(K.E)_{r_T} = \frac{1}{2} \omega^2 \Big[\sum$

$(K.E)_{r_T} = \frac{1}{2} \omega^2$

$(K.E)_{r_T} = \frac{1}{2} I \omega$

Rotational K

we know

$(K.E)_{rot} =$

where $I =$

for disc

$I_{dis} = \frac{1}{2} m$

put eq (2)

$(K.E)_{rot} = \frac{1}{2}$

$= \frac{1}{}$

$+\cdots+(K.E)_{rn}$

$\omega_2^2+\cdots+\frac{1}{2}m r_n^2\omega_n^2$

oving with

velocity

$\omega^2+\cdots+\frac{1}{2}m_n r_n^2\omega^2$

$\cdots+m_n r_n^2]$

$$(K.E)_{rT}=\frac{1}{2}\omega^2\left[\sum_{i=1}^{n} m_i r_i^2\right]$$

$$\sum_{i=1}^{n} m_i r_i^2 = I$$

$$(K.E)_{rT}=\frac{1}{2}\omega^2 I$$

$$(K.E)_{rT}=\frac{1}{2}I\omega^2$$

Rotational K.E for a disc:-

we Know That

$$(K.E)_{rot}=\frac{1}{2}I\omega^2 \rightarrow (1)$$

where I = moment of inertia of The body

for dis

$$I_{dis}=\frac{1}{2}mr^2 \rightarrow (2)$$

put eq (2) in (1) we get

$$(K.E)_{rot}=\frac{1}{2}\left(\frac{1}{2}mr^2\right)\omega^2$$

$$=\frac{1}{4}mr^2\omega^2$$

$(K.E)_{rot}=\frac{1}{4}m$

This is The ex

disc can be w

$(K.E)_{rot}=\frac{1}{4}I$

$(K.E)_{rot}=\frac{1}{4}m$

Rotational K

Again we c

$(K.E)_{rot}=\frac{1}{2}I\omega$

Moment of Ine

So again put

$(K.E)_{rot}=\frac{1}{2}m$

This is the expres

can be written as

$(K.E)_{rot}=\frac{1}{2}m$

$]$

$m_i r_i^2 = I$

r a disc:-

$^2 \rightarrow$ 1

ment of inertia

e body

$\rightarrow$ 2

) we get

$mr^2)\omega^2$

$r^2\omega^2$

$$(K.E)_{rot} = \frac{1}{4} m r^2 \omega^2$$

This is the expression for $(K.E)_{rot}$ for disc can be written as

$$(K.E)_{rot} = \frac{1}{4} I\omega^2$$

$mr^2 = I$

OR

$r^2\omega^2 = v$

$$(K.E)_{rot} = \frac{1}{4} m v^2 \longrightarrow (a)$$

Rotational K.E for hoop:-

Again we consider

$$(K.E)_{rot} = \frac{1}{2} I\omega^2 \rightarrow 3$$

Moment of Inertia for hoop $= I = mr^2 \rightarrow 4$

So again put 4 in 3

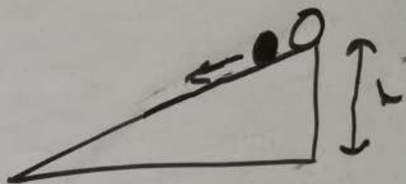
$$(K.E)_{rot} = \frac{1}{2} m r^2 \omega^2$$

This is the expression of $(K.E)_{rot}$ for hoop can be written as

$$(K.E)_{rot} = \frac{1}{2} m v^2 \longrightarrow (b)$$

Calculation for velocities:

Suppose, disc & hope both moving down from a certain heigh on an incline path as shown



we observe that while moving downward, both disc & hoop have rotional & translational motion. Ignoring the air friction we can write

$$P.E = (K.E)_{Trans} + (K.E)_{rot}$$

velocity E

we know

$P.E = (K$

$(K.E)_{Tran} =$

while f

$(K.E)_{rot}$

put in a

$P.E = \frac{1}{2}$

$mgh = m$

$\cancel{m}gh =$

$gh =$

$\frac{4g}{3}$

5

...cities::

...hope both
...n a certain
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...t while
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$...)_{Trans} + (K.E)_{rot}$

7

Velocity of Disc:-

we know that

$P.E = (K.E)_{rot} + (K.E)_{Trans}$

$(K.E)_{Tran} = \frac{1}{2} m v^2$

while for disc

$(K.E)_{rot} = \frac{1}{4} m v^2$ from (a);

put in above eq we get

$P.E = \frac{1}{2} m v^2 + \frac{1}{4} m v^2$

$mgh = m v^2 \left[\frac{1}{2} + \frac{1}{4}\right]$

$\cancel{m} gh = \cancel{m} v^2 \left[\frac{2+1}{4}\right]$

$gh = v^2 \left[\frac{3}{4}\right]$

$\frac{4gh}{3} = v^2$

$\sqrt{\frac{4}{3} gh} = V_{disc} \rightarrow 5$

8

velocity for hoop

we know that

$P.E = (K.E)_{rot} ...$

$(K.E)_{Trans} = \frac{1}{2} ...$

$(K.E)_{rot}$ for hoop ...

Now

$mgh = \frac{1}{2} m v^2 ...$

$\cancel{m} gh = \cancel{m} v^2 [...$

$gh = v^2 [...$

$gh = v^2 [...$

$gh = v^2 (1)$

$\sqrt{gh} = V_{hoop}$

velocity for hoop:-

we know that

$$P.E = (K.E)_{rot} + (K.E)_{Trans}$$

$$(K.E)_{Trans} = \frac{1}{2} m v^2$$

$$(K.E)_{rot} \text{ for hoop} = \frac{1}{2} m v^2 \text{ from (b)}$$

Now

$$mgh = \frac{1}{2} m v^2 + \frac{1}{2} m v^2$$

$$\cancel{m} g h = \cancel{m} v^2 \left[\frac{1}{2} + \frac{1}{2}\right]$$

$$gh = v^2 \left[\frac{1+1}{2}\right]$$

$$gh = v^2 \left[\frac{2}{2}\right]$$

$$gh = v^2 (1)$$

$$\sqrt{gh} = v_{hoop} \rightarrow 6$$

$(K \cdot E)_{Trans}$

v^2

v^2 from (a);

we get

$\frac{1}{4} m v^2$

$+ \frac{1}{4}]$

$\frac{2+1}{4}]$

$1]$

$V_{disc} \rightarrow 5$

9

S/R 5.10

we know

$V_{disc} = \sqrt{\frac{4}{3}}$

$V_{hoop} = \sqrt{}$

$V_{disc} = \sqrt{\frac{4}{}}$

$V_{disc} = 1.1$

$V_{disc} >$

$\frac{V_{dis}}{V_{hoo}}$

S) R 5.10.

we know

$V_{disc} = \sqrt{\frac{4}{3}gh}$

$V_{hoop} = \sqrt{gh}$

$V_{disc} = \sqrt{\frac{4}{3}}\sqrt{gh}$

$V_{disc} = 1.15\, V_{hoop}$

$V_{disc} > V_{hoop}$

$$\boxed{\frac{V_{dis}}{V_{hoop}} = 1.15}$$ M.C.Q

Artificial satellite:

From book
page #115 + 116
S/Q + M.C.Qs

L/Q

Real & Apparent weight :-

Real weight:

. The gravitational pull of earth on the object is called its real weight

. we often hear that object appear to be weightless in a space ship or moon.

. Because at moon, the weight is the gravitational pull of moon on the object.

Apparent wei

The
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is equal to
gravity on th
i.e weight

Explanation:

Consider a
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Spring and
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Spring balance

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object.

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Apparent weight:-

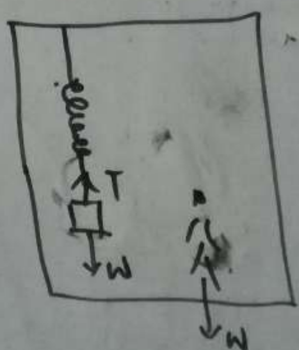
The weight which is measured by the spring balance

• The force exerted by the object on the scale is equal to the pull due to gravity on the object i.e weight of the object

Explanation:-

Consider a body of mass 'm' suspended with a spring and spring balance is in a lift as shown

- The reading of spring balance



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• Its val
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case1:-

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$F_{net} = T$

$ma = T$
$m(0) = $
$0 = T$

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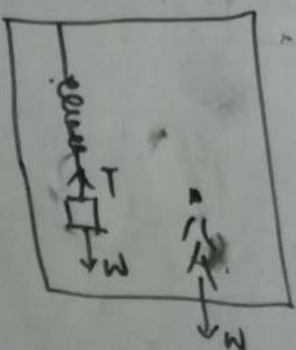

indicates a tension in the string which indicate apparent weight of the object.

- Its value depends on the accelation of the lift

Case1:-

When lift is at rest or moving with uniform velocity:-

If the lift is at rest of moving uniform velocity so accelration $a = 0$

The net force will be

$$F_{net} = T - W$$

$$W = mg$$

$$F_{net} = ma$$

$$ma = T - W$$

$$m(0) = T - W$$

$$0 = T - W$$

$W = T$

This shows
apparent we
to the real
the object
observer in

Case 2:-

When lif
upward w

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The net for
object wil

$F_{net} = T -$