STUDENT NUMBER:

NAME:

SECTION NUMBER:

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KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS

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COURSE: PH101

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EXAM: 2ND MAJOR EXAM - 002

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TEST CODE NUMBER: XXX

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INSTRUCTIONS:

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1. PRINT YOUR STUDENT NUMBER, NAME, AND SECTION NUMBER ON THE EXAM.

2. PRINT YOUR STUDENT NUMBER, SECTION NUMBER, AND YOUR NAME ON THE EXAM ANSWER FORM. PRINT THE TEST CODE NUMBER, OR CHECK IT IF IT HAS ALREADY BEEN PRINTED ON YOUR ANSWER FORM.

3. CODE YOUR STUDENT NUMBER AND SECTION NUMBER ON THE EXAM ANSWER FORM. CODE THE TEST CODE NUMBER, OR CHECK IT IF IT IS ALREADY CODED.

4. CODE YOUR ANSWERS ON THE EXAM ANSWER FORM. YOU MUST NOT GIVE MORE THAN ONE ANSWER PER QUESTION.

5. RETURN THE EXAM AND ANSWER FORM TO THE INSTRUCTOR WHEN YOU HAVE FINISHED.

****
QUESTION NO: 1
****

A mass of 102 kg is supported by a wire of length 2.0 m and cross sectional area 0.10 cm**2. The wire is stretched by 0.22 cm. Find the Young's modulus of this wire.

A. 5.5*10**10 N/m**2
B. 2.2*10**9 N/m**2
C. 1.5*10**7 N/m**2
D. 9.1*10**10 N/m**2
E. 8.5*10**9 N/m**2

****
QUESTION NO: 2
****

A solid sphere, of mass m and radius R, rolls without slipping as shown in Figure 7. As the sphere passes the point A (height of point A is H=5.3 R) on the track the speed of its center of mass is found to be SQRT(gR). If the sphere is to come momentarily to a stop at point B, then the height, h, of point B must be

A. 6R
B. 9R
C. 10R
D. 8R
E. R

****
QUESTION NO: 3
****

Two objects, A and B, have the same momentum. B has more kinetic energy than A. Which of the following statements is CORRECT?

A. B is moving faster than A.
B. B weighs the same as A.
C. B is moving slower than A.
D. B has a larger momentum than A.
E. B weighs more than A.

****
QUESTION NO: 4
****

Three small bodies, which can be considered as particles, are connected by massless rigid rods, as shown in Figure 5. The system is rotating with an angular velocity of 4.0 rad/s about an axis coinciding with the rod BC. Find the rotational kinetic energy of the system about the given axis.

A. 0.91 J
B. 0.38 J
C. 0.43 J
D. 0.51 J
E. 0.13 J

****
QUESTION NO: 5
****

A 0.15 kg ball moving along a straight line has a velocity of (20 i) m/s. It collides with a wall and rebounds with a velocity of (-10 i) m/s. If the ball is in contact with the wall for 0.005 s, what is the average force exerted by the wall on the ball?

A. (+300 i) N
B. (-300 i) N
C. (-900 i) N
D. 0.0 N
E. (+900 i) N

****
QUESTION NO: 6
****

A point on the rim of a 0.375 m radius grinding wheel changes speed uniformly from 12 m/s to 25 m/s in 6.2 s. What is the average angular acceleration of the wheel during this interval.

A. 5.6 rad/s**2.
B. 3.4 rad/s**2.
C. 2.1 rad/s**2.
D. 6.7 rad/s**2.
E. 1.2 rad/s**2.

****
QUESTION NO: 7
****

As shown in Figure 4, a block of mass m = 4.0 kg and initial speed vo = 8.5 m/s at point C moves towards a spring (k = 2400 N/m). The track CD is frictionless except for the portion AB, of length 7.0 m. The coefficient of kinetic friction between the surface AB and the block is 0.35. Find the maximum compression of the spring when the block hits the spring.

A. 0.35 m
B. 0.45 m
C. 0.20 m
D. 0.57 m
E. 0.15 m

****
QUESTION NO: 8
****

A 5.0 kg object starts from rest at point A, and slides 4.0 m down an inclined plane to point B (see Fig 2). The coefficient of friction is 0.2. Calculate the speed of the object at point B.

A. 66 m/s
B. 2.7 m/s
C. 31 m/s
D. 0 m/s
E. 5.9 m/s

****
QUESTION NO: 9
****

A uniform beam having a weight of 600 N and a length of 4.0 m is supported by a pin and a horizontal cable as shown in Figure 10. What is the tension in the cable?

A. 220 N
B. 740 N
C. 300 N
D. 520 N
E. 600 N

****
QUESTION NO: 10
****

Figure 1 shows a force F, directed along the x-axis, acting on a particle. The particle begins at rest at x = 0. What is the particle's coordinate when it has the greatest speed?

A. 4 m
B. 8 m
C. 2 m
D. 10 m
E. 6 m

****
QUESTION NO: 11
****

A disk has a moment of inertia 6.0 kg*m**2 about a fixed axis of rotation through its center. It has a constant angular acceleration of 2.0 rad/s**2. If it starts from rest, the work done during the first 5.0 s by the net torque on it is:

A. 0 J
B. 30 J
C. 600 J
D. 300 J
E. 60 J

****
QUESTION NO: 12
****

A block of mass m is dropped from a height of 50 cm onto a vertical spring of spring constant k = 1400 N/m (Fig. 6). If the maximum compression of the spring is 10 cm, find the mass m of the block.

A. 0.75 kg
B. 1.2 kg
C. 2.0 kg
D. -2.3 kg
E. 0.5 kg

****
QUESTION NO: 13
****

Two blocks, m1 = 1.0 kg and m2 = 2.0 kg, are connected by a light string as shown in Figure 3. If the radius of the pulley is 1.0 m and its moment of inertia is 5 kg.m**2, the magnitude of the acceleration of the system is
(Take g = acceleration due to gravity)

A. (3/8) g
B. (1/2) g
C. (1/6) g
D. (1/8) g
E. (5/8) g

****
QUESTION NO: 14
****

An 800 kg elevator is moving upward at a constant speed of 3.0 m/s. A total frictional force of 3000 N retards (opposes) its motion. What must be the minimum horsepower delivered by the motor to lift the elevator?
(1 horsepower, hp = 746 W)

A. 39 hp
B. 12 hp
C. 44 hp
D. 76 hp
E. 32 hp

****
QUESTION NO: 15
****

Blocks A and B are moving toward each other. A has a mass of 2.0 kg and a speed of 50 m/s, while B has a mass of 4.0 kg and speed of 25 m/s. They collide and stick together. Find the final speed of the blocks.

A. 25 m/s
B. 100 m/s
C. 33 m/s
D. 50 m/s
E. 0 m/s

****
QUESTION NO: 16
****

A horizontal platform in the shape of a circular disk of radius = 2.0 m rotates about a frictionless vertical axle through its center. The platform has a moment of inertia of 200 kg*m**2 about the axis of rotation. The platform has an initial angular speed of 2.0 rad/s when a 60 kg man stands on the platform at a distance of 0.50 m from its center. If the man walks slowly radially outward to the rim, find the final angular speed of the system.
(Treat the man as a point mass)

A. 3.5 rad/s
B. 2.0 rad/s
C. 4.1 rad/s
D. 0.52 rad/s
E. 0.98 rad/s

****
QUESTION NO: 17
****

A particle Q with a mass of 2.0 kg has a position vector r (r = 5.0 m) and a velocity v (v=4.0 m/s) as shown in Figure 9. Calculate the angular momentum of the particle about the origin O.
(i, j, k are rectangular unit vectors)

A. 37.6 k kg m**2/s
B. 7.68 j kg m**2/s
C. -17.6 k kg m**2/s
D. 17.6 k kg m**2/s
E. -37.6 k kg m**2/s

****

QUESTION NO: 18

****

A pedulum of length 1.2 m and mass M is released from rest from point A where it makes an angle of 30 degrees with the vertical (see Fig 8). If the kinetic energy of the mass is 36 J at the bottom of its path (point B), calculate the work done by the tension (T) in the string from point A to point B.

A. 48 J
B. 0 J
C. 36 J
D. 18 J
E. 0.5 J

****

QUESTION NO: 19

****

The moment of inertia of an object does NOT depend upon:

A. its size and shape.
B. its angular velocity.
C. the location of the axis of rotation.
D. its mass.
E. the distribution of its mass.

****

QUESTION NO: 20

****

A thick uniform metallic wire in the shape of a square with one side missing is shown in Figure 11. Which point indicates the probable location of the center of mass of this wire?

A. D
B. B
C. E
D. C
E. A

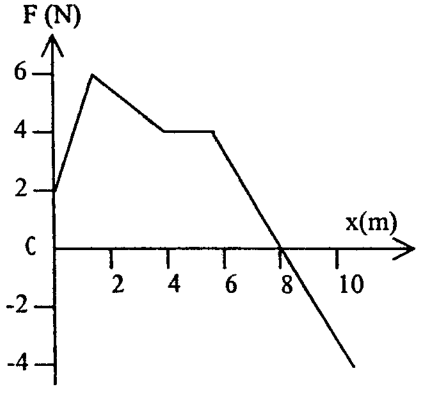

Figure 1

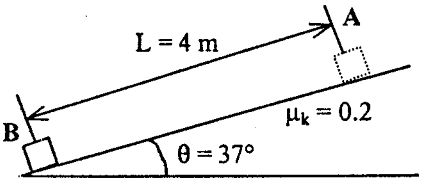

Figure 2

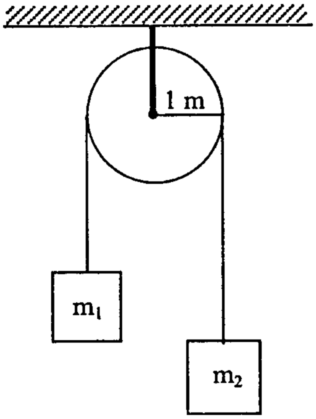

Figure 3

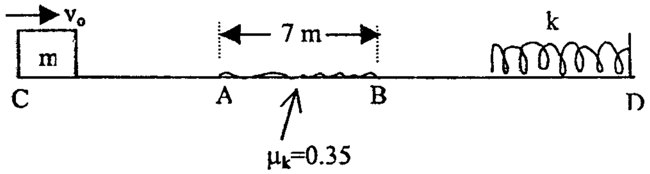

Figure 4

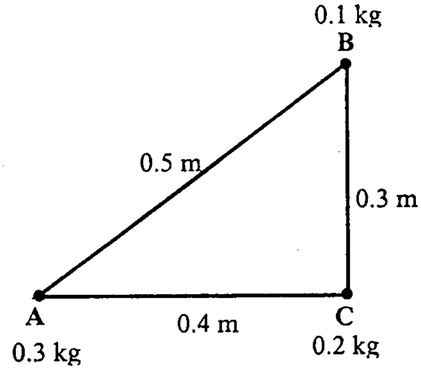

Figure 5

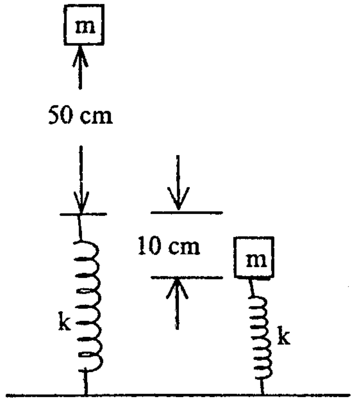

Figure 6

g = acceleration due to gravity

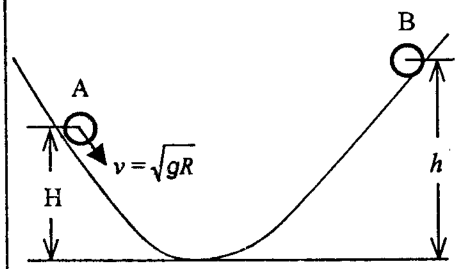

Figure 7

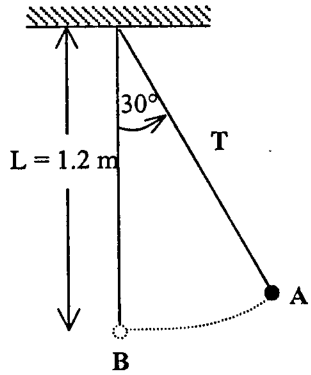

Figure 8

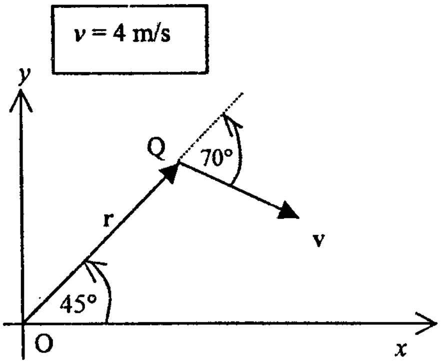

Figure 9

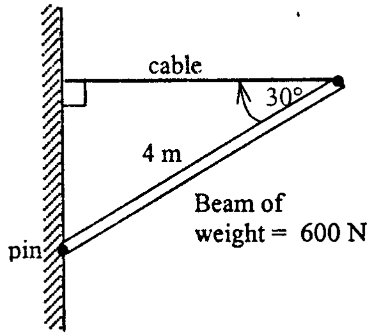

Figure 10

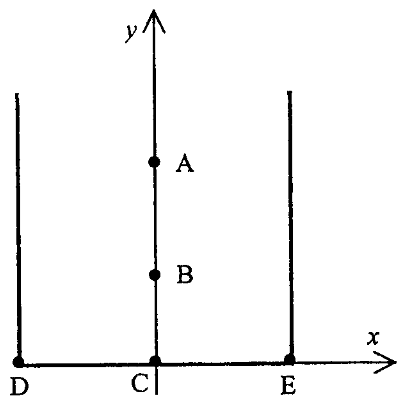

Figure 11

002

PHYS-101 Formula Sheet for Major Exam II

$g = 9.80\ m/s^2$

$r = r_0 + v_o t + \frac{1}{2} a t^2$

$v = v_o + at$

$v^2 = v_0^2 + 2a(x-x_0)$

$x - x_0 = \frac{(v_0 + v)t}{2}$

$a_r = \frac{v^2}{r}$, $a_t = \frac{dv}{dt}$

$\vec{a} = \vec{a}_t + \vec{a}_r$

$\sum \vec{F} = m\vec{a} = \frac{d\vec{p}}{dt}$

$f_k = \mu_k N$

$f_s \leq \mu_s N$

$W = \vec{F} . \vec{s}$ if $\vec{F} = \text{Constant}$

$W = \int \vec{F} \bullet d\vec{s}$

$\vec{A} \cdot \vec{B} = A B \cos\theta$

$W_{net} = \Delta K = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$

$P = \frac{dW}{dt} = \vec{F} . \vec{v}$

$U_s = \frac{1}{2} kx^2$, $F_s = -kx$

$U_g = mgy$

$E = K + U$

$W_c = -\Delta U$

$\Delta E = \Delta K + \Delta U = -f_k d$

$\vec{p} = m\vec{v}$

$\vec{I} = \Delta\vec{p} = \overline{F}\Delta t = \int \vec{F}\ dt$

$\vec{p}_{1i} + \vec{p}_{2i} = \vec{p}_{1f} + \vec{p}_{2f}$

$\sum \vec{F}_{ext} = M\vec{a}_{cm}$

$I_{cm}(\text{disk}) = (1/2)MR^2$

$I_{cm}(\text{sphere}) = (2/5)MR^2$

$\vec{R}_{cm} = \frac{\Sigma m_i \vec{r}_i}{\Sigma m_i} = \frac{1}{M} \int \vec{r}\ dm$

$\vec{v}_{cm} = \frac{\Sigma m_i \vec{v}_i}{\Sigma m_i}$; $\vec{p}_{cm} = \Sigma m_i \vec{v}_i$

$\omega = \frac{d\theta}{dt}$; $\alpha = \frac{d\omega}{dt}$

$s = r\theta$, $v = r\omega$

$a_t = r\alpha$; $a_r = r\omega^2$

If α = constant,

$\omega = \omega_o + \alpha t$

$\theta = \theta_o + \omega_o t + \frac{1}{2} \alpha t^2$

$\omega^2 = \omega_0^2 + 2\alpha(\theta - \theta_0)$

$I = \Sigma m_i r_i^2 = \int r^2\ dm$

$I_p = I_{cm} + M h^2$

$\vec{\tau} = \vec{r} \times \vec{F}$

$|\vec{A} \times \vec{B}| = AB \sin\theta$

$P = \frac{dW}{dt} = \tau\omega$

For a solid rotating about a fixed axis,

$K_{rot} = \frac{1}{2} I \omega^2$, $L_z = I\omega$

$W = \int \tau\ d\theta$

$\vec{L} = \vec{r} \times \vec{p} = m\vec{r} \times \vec{v}$

$\vec{\tau} = \frac{d\vec{L}}{dt}$

$\sum \tau_{ext} = \frac{dL}{dt} = I\alpha$

For static equilibrium,

$\Sigma\vec{F} = 0$; $\Sigma\vec{\tau} = 0$

$E = \frac{F/A}{\Delta L / L_o}$; $G = \frac{F/A}{\Delta x / h}$; $B = -\frac{F/A}{\Delta V / V} = -\frac{\Delta P}{\Delta V / V}$

$I_{cm}(\text{thin rod}) = (1/12)ML^2$

$I_{cm}(\text{hoop}) = MR^2$

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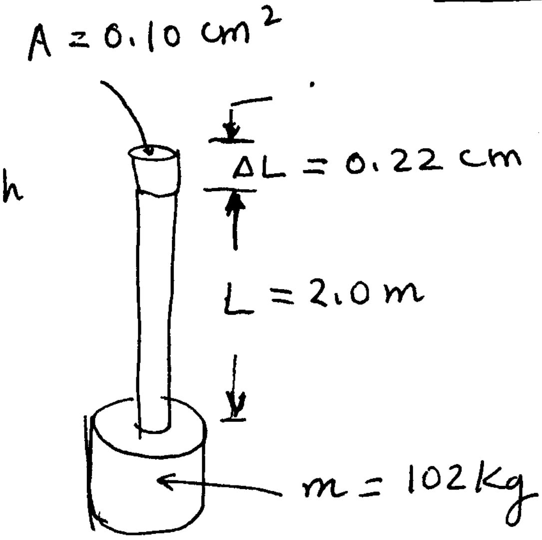
P-1

Q1

Force on the wire; change in length

$$\boxed{\frac{F}{A} = E\,\frac{\Delta L}{L}}$$

Young's Modulus; cross sectional area; original length

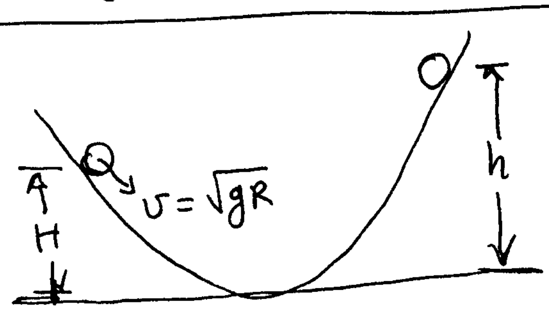


$$\frac{(102\text{ kg})(9.8\text{ m/s}^2)}{(0.10\text{ cm}^2)\left(\frac{1\text{m}}{100\text{cm}}\right)^2} = E\,\frac{0.22\text{ cm}\left(\frac{1\text{ m}}{100\text{cm}}\right)}{2.0\text{ m}}$$

conversion Factor

$$E = \frac{(102)(9.8)(2.0)}{\frac{0.1}{(100)^2}\ \frac{0.22}{100}} = 9.1\times10^{10}\ \text{N/m}^2$$

Q2



I will choose this point to have $U=0$

The mechanical energy of ball-earth system is conserved.

$$K_i + U_i = K_f + U_f$$

$$\frac{1}{2}I_{com}\,\omega^2 + \frac{1}{2}m v_{com}^2 + mgH = 0 + mgh$$

$$I_{com} = \frac{2}{5}MR^2$$

why?

1. The only external force on our ball-earth system is normal force. But normal force does not do work because it is always perpendicular to the motion path
2. we have no friction.

$$\frac{1}{2}\left(\frac{2}{5}\cancel{m}\cancel{R^2}\right)\left(\frac{v_{com}}{\cancel{R}}\right)^2 + \frac{1}{2}\cancel{m}v_{com}^2 + \cancel{m}gH = \cancel{m}gh$$

$$\frac{1}{5}(\cancel{g}R) + \frac{1}{2}(\cancel{g}R) + \cancel{g}(5.3R) = \cancel{g}h$$

$$6R = h$$

Q3

$P_A = P_B \implies m_A v_A = m_B v_B$

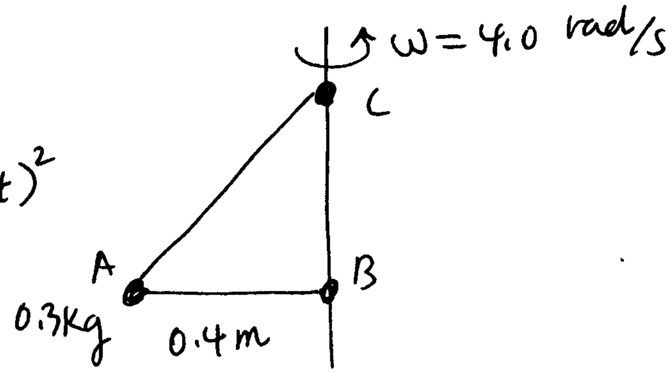
$K_B > K_A \implies \cancel{\tfrac{1}{2}} m_B v_B^2 > \cancel{\tfrac{1}{2}} m_A v_A^2$

OR $\underbrace{(m_B v_B)\, v_B > (m_A v_A)}_{\text{equal}}\, v_A$

OR $v_B > v_A$

Q4

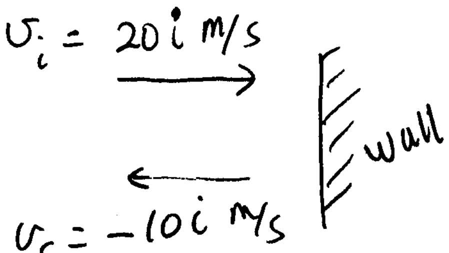
$$K = \frac{1}{2} I \omega^2$$
$$= \frac{1}{2}(0.3)(0.4)^2(4)^2$$
$$= 0.38\ \text{J}$$



$$I = I_A + I_B + I_C$$
$$= m_A x_A^2 + m_B x_B^2 + m_C x_C^2$$
$$= (0.3)(0.4)^2 + 0 + 0$$

Here x is the distance from the rotating axis.

Q5



$$F_{avg} = \frac{J}{\Delta t} = \frac{P_f - P_i}{\Delta t} = \frac{+0.15(-10\hat{i}) - 0.15(20\hat{i})}{0.005} = -900\,\hat{i}\ \text{N}$$

The wall exert $-900\,\hat{i}$ N on the ball.

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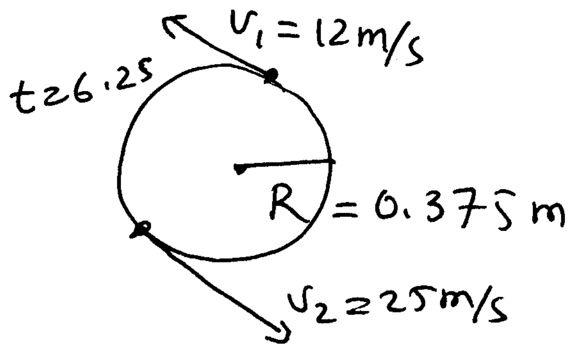
p-3

Q6

$$\alpha_{avg} = \frac{\omega_2 - \omega_1}{t_2 - t_1}$$

$$= \frac{\frac{v_2}{R} - \frac{v_1}{R}}{t_2 - t_1}$$

$$= \frac{\frac{25}{0.375} - \frac{12}{0.375}}{6.2} = 5.6 \text{ rad/s}^2$$



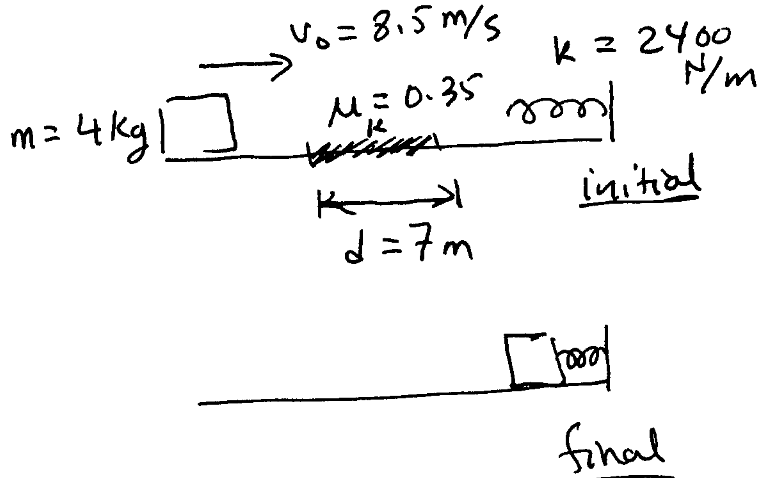
Q7

$$W = \Delta K + \Delta U + \Delta E_{th}$$

$$0 = K_f - K_i + U_f - U_i + f_k d$$

$$0 = 0 - \frac{1}{2} m v_0^2 + \frac{1}{2} k x^2 - 0 + \mu m g d$$

normal force does not do work because it is perpendicular to the path.



$$0 = -\frac{1}{2}(4)(8.5)^2 + \frac{1}{2}(2400)x^2 + (0.35)(4)(9.8)(7)$$

$$x = \sqrt{\frac{\frac{1}{2}(4)(8.5)^2 - (0.35)(4)(9.8)(7)}{\frac{1}{2}(2400)}}$$

$$= 0.20 \text{ m}$$

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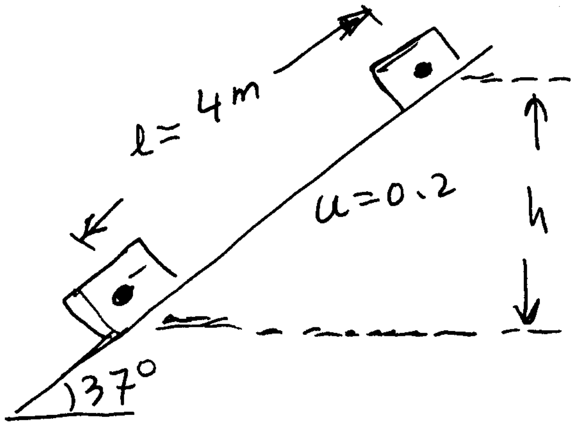
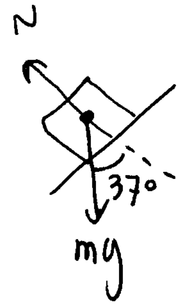
P-4

Q 8





$f_k l$ $\qquad$ $N = mg\cos 37$

$$W = \Delta K + \Delta U + \Delta E_{th}$$

$$0 = K_f - K_i + U_f - U_i + \mu_k N l$$

$$0 = \frac{1}{2}\cancel{m}v^2 - 0 + 0 - \cancel{m}gh + \mu_k \cancel{m}g\cos(37)\,l$$

$l\sin 37$

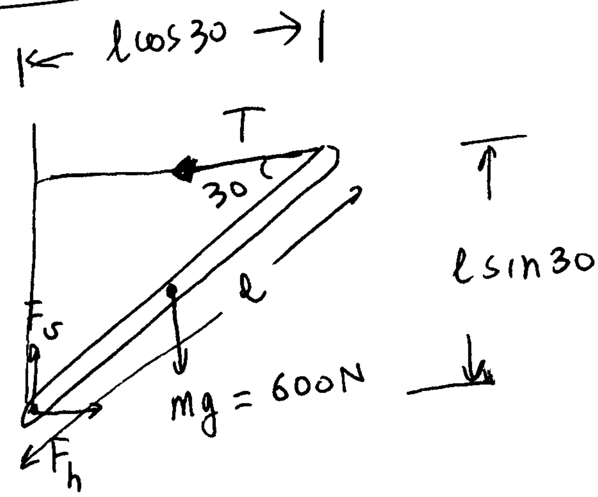
normal Force does not do work because it is perpendicular to the path

$$v = \sqrt{2(gl\sin 37 - \mu_k g l\cos 37)}$$

$$= \sqrt{2((9.8)(4)\sin 37 - 0.2(9.8)(4)\cos 37)}$$

$$= 5.9 \text{ m/s}$$

Q.9 Torque about pin = 0



$$\tau = -\frac{l\cos 30}{2}mg + l\sin 30\,T$$

$$T = \frac{mg\cos 30}{2\sin 30}$$

$$= \frac{600\cos 30}{2\sin 30}$$

$$= 520 \text{ N}$$

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Q10

The area under the curve is the work done by the force on the particle. but we know that work done by an external force is equal to chang in Kinetic energy.

$$W = K_f - K_i$$

$$\underbrace{\int F\,dx}_{\text{maximum area when particle at } x = 8\text{ m}} = K_f - K_i$$

$$= \frac{1}{2} m v_f^2 - 0 \quad (\text{maximum velocity})$$

maximum area when particle at $x = 8$ m.

Q11

$$W = \frac{1}{2} I \omega_f^2 - \frac{1}{2} I \omega_i^2 \qquad \omega_i = 0.$$

$$W = \frac{1}{2} I (\omega_i + \alpha t)^2$$

$$= \frac{1}{2} I (\alpha t)^2 = \frac{1}{2}(6)((2)(5))^2 = 300\text{J}$$

Q12

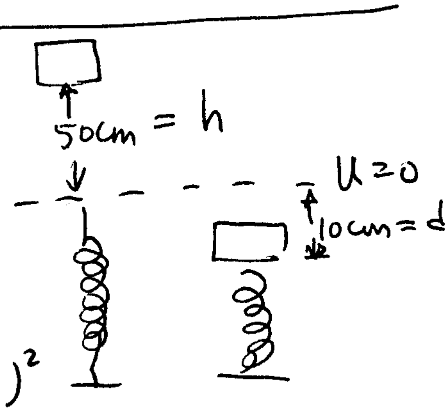
$$K_i + U_i = K_f + U_f$$

$$0 + mgh = 0 + mg(-d) + \frac{k}{2} d^2$$

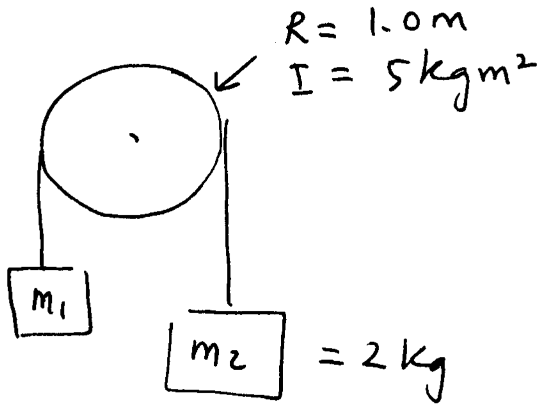
$$mg(h+d) = \frac{k}{2} d^2$$

$$m = \frac{k d^2}{2g(h+d)} = \frac{(1400)(0.1)^2}{2(9.8)(0.6)}$$

$$= 1.2 \text{ kg}$$



Q13 Newton's 2nd law



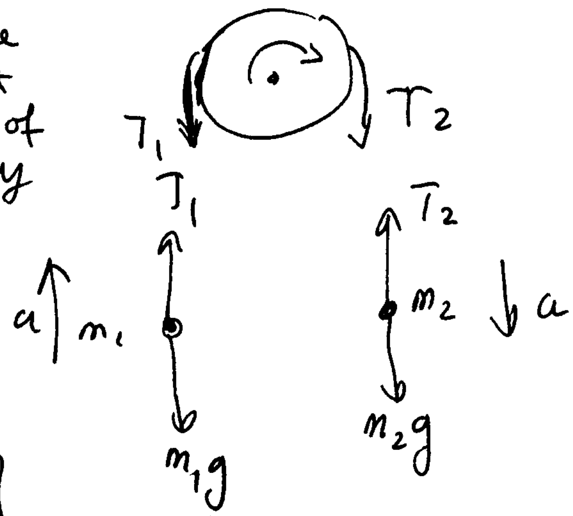
$$T_2 - m_2 g = -m_2 a$$

$$T_1 - m_1 g = m_1 a$$

$$-RT_2 + RT_1 = -I\alpha$$

Torque about center of pulley

$$\alpha = \frac{a}{R}$$



$$T_2 - T_1 = I\frac{a}{R^2}$$

$$\left.\begin{aligned} T_2 &= m_2 g - m_2 a \\ T_1 &= m_1 g + m_1 a \end{aligned}\right\}$$

$$T_2 - T_1 = (m_2 - m_1)g - (m_2 + m_1)a$$

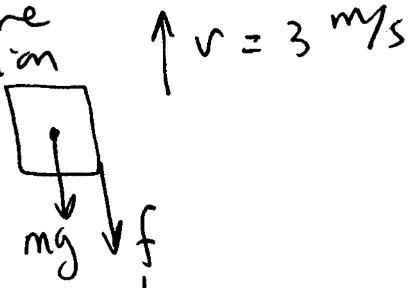
$$(m_2 - m_1)g - (m_2 + m_1)a = I\frac{a}{R^2}$$

$$(2-1)g - (2+1)a = 5\frac{a}{1^2}$$

$$g = 8a$$

$$a = g/8$$

Q14 The external forces on the elevator are the gravitational force and the friction



$$P = Fv = (mg + f)v$$

$$= ((800)(9.8) + 3000)3$$

$$= 32520\,W\left(\frac{1\,hp}{746\,W}\right) = 44\,hp$$

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Q15

$$\vec{P}_i = \vec{P}_f$$

$$m_A v_A + m_B v_B = M V$$

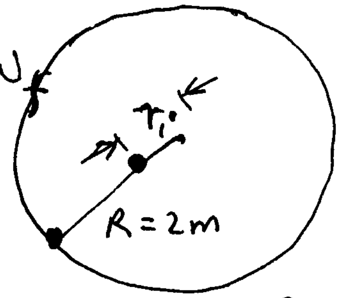
$$2(50) + 4(-25) = (2+4) V$$

$$V = \frac{100 - 100}{6} = 0 \text{ m/s}$$

Q16

$$\vec{L}_i = \vec{L}_f$$

$$(I + M r_i^2)\,\omega_i = (I + M r_f^2)\,\omega_f$$



$$\omega_f = \frac{(I + M r_i^2)\,\omega_i}{I + M r_f^2}$$

I = 200 kg m²

$$= \frac{[200 + 60(0.5)^2](2)}{200 + 60(2)^2} = 0.98 \text{ rad/s}$$

Q17

$$\vec{\ell} = \vec{r} \times \vec{p}$$

$$\ell = r \underset{\uparrow \atop mv}{p} \sin\theta = 5(2)4)\sin 70 = 37.6 \text{ kg m}^2\text{/s}$$

The direction of ℓ will be perpendicular to the plane containing $\vec{r}$ and $\vec{p}$. That is it will be along z axis. To find ~~[illegible]~~ wheather it is along positive or negative z axis use right-hand rule. Acording to this ℓ points toward negative z axis

$$\vec{\ell} = -37.6\,\hat{k}$$