STUDENT NUMBER:

NAME:

SECTION NUMBER:

****

KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS

****

COURSE: PH101

****
EXAM: 2ND MAJOR EXAM - 992
****

TEST CODE NUMBER: XXX

****

INSTRUCTIONS:
****

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 1200 N uniform beam is supported by a cable as in Fig 7. The beam is pivoted at the bottom point O. Find the tension in the cable.

A. 725 N
B. 1200 N
C. 1465 N
D. 338 N
E. 125 N

****

QUESTION NO: 2

****

A disk has a moment of inertia 6.0 kg*m**2 about a fixed axis of rotation. 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. 600 J
B. 300 J
C. 30 J
D. 60 J
E. 0 J

****

QUESTION NO: 3

****

A 2.0 kg object moves in a straight line with an initial speed of 4.0 m/s. It accelerates uniformly to a final speed of 7.0 m/s in 15 seconds. Calculate the average power delivered to the object.

A. 11 W
B. 33 W
C. 2.2 W
D. 5.5 W
E. 1.0 W

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

Which of the following quantities CANNOT be used
as a unit of potential energy?

A. N*m
B. kg*m**2/s**2
C. Joule
D. kg*m/s**2
E. watt*second

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

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 4). If the kinetic energy of the mass
is 36 J at the bottom of its path (B), calculate the work done
by the tension (T) in the string from point A to point B.

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

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

A cylindrical copper wire 1.0 m long has a cross-sectional
diameter of 2.0 mm. Under what tension does it stretch
by 1.0 cm?
(Young's modulus of copper is Y=1.1*10**11 N/m**2)

A. 6911 N
B. 0 N
C. 2163 N
D. 3456 N
E. 5420 N

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

Two masses m1=2.0 kg and m2=4.0 kg are connected to each other by a light cord that passes over a pulley of radius 3.0 cm and having a moment of inertia 0.045 kg.m**2 about its axis of rotation. The cord does not slip on the pulley. At any instant after the masses start moving (see Fig 5), which of the following statements is CORRECT:

A. The pulley has the greatest kinetic energy.
B. The kinetic energy of the two masses is the same as that of the pulley.
C. The total kinetic energy of the two masses is larger than that of the pulley.
D. Mass m1 has the greatest kinetic energy.
E. Mass m2 has the greatest kinetic energy.

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

A wheel has a moment of inertia 12 kg*m**2 about its axis of rotation. As it turns through 5.0 rev, its angular velocity increases from 5.0 rad/s to 6.0 rad/s. If the net torque about the axis of rotation is constant, its value is:

A. 0.016 N*m
B. 2.1 N*m
C. 0.57 N*m
D. 3.6 N*m
E. 0.18 N*m

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

Two objects of uniform density, a solid disk and a solid hoop, have the same mass and radius. They are placed at the bottom of an incline. They are given the same initial speed up the incline and roll without slipping. Which object travels a larger distance along the incline?
[Icm(disk) = (M*R**2)/2 & Icm(hoop) = M*R**2]

A. The disk.
B. Depends on the angle of the incline with the horizontal.
C. The hoop.
D. Both.
E. Depends on the initial speed.

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

A body moving along the x axis is acted upon by a force (Fx) that varies with x as shown in Fig 2. Find the work done by this force on the object as it moves from x=0.0 m to x=8.0 m.

A. -34 J
B. -2.0 J
C. +18 J
D. -18 J
E. -10 J

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

A point mass M, at the end of a string, moves in a circle on a horizontal frictionless table as shown in Fig 6. As the string is slowly pulled through a small hole (O) in the table:

A. the kinetic energy of M remains constant
B. none of the other answers
C. the angular momentum of M about O decreases
D. the kinetic energy of M decreases
E. the angular momentum of M about O remains constant

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

A 2.5 kg hangs at rest from the free end of a vertical spring attached by one end to the ceiling. What is the change in elastic potential energy of the spring when the mass is lifted straight up until the spring reaches its unstretched position? (k=240 N/m)

A. -1.25 J
B. 2.50 J
C. -4.60 J
D. 1.80 J
E. -3.90 J

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

Under the action of a conservative force, 96 J of work are required to move an object from point A to point C, 136 J of work to move the object from point B to point D, and 54 J of work to move the object from point B to point C (see Fig 3). How much work is required to move the object from point A to point D?

A. 167 J
B. 96 J
C. 178 J
D. 133 J
E. 286 J

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

A 0.20 kg ball is released from rest and falls 1.5 m to the floor. It rebounds to a maximum height of 1.0 m. Neglecting air resistance, find the impulse exerted by the floor on the ball.

A. 1.97 N*s, vertically upward
B. 0.85 N*s, vertically downward
C. 0.85 N*s, vertically upward
D. 2.49 N*s, vertically downward
E. 2.49 N*s, vertically upward

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

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

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

A 3.0 kg object (A), moving at 8.0 m/s in the positive x direction, makes a head-on elastic collision with an object B, of mass=M, initially at rest. After the collision, object B has a velocity of 6.0 m/s in the positive x direction. What is the value of M?

A. 5.0 kg
B. 4.2 kg
C. 6.0 kg
D. 7.5 kg
E. 8.0 kg

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

The position vector of a particle of mass 4.0 kg is given as a function of time (t) by
r(t) = (2.0 i + 7*t j + 3 k) m.
Find the angular momentum of the particle about the origin.

A. (-84 i + 56 k) kg*m**2/s
B. (28 j) kg*m**2/s
C. (8 i + 28*t j + 12 k) kg*m**2/s
D. (8 i + 12 k) kg*m**2/s
E. (27*t j) kg*m**2/s

****
QUESTION NO: 18
****

Which of the following statements is WRONG?

A. The net work done by external forces in rotating a symmetric object about a fixed axis equals to the change in its rotational kinetic energy.
B. For rotation about a fixed axis, every particle of the rigid body has the same angular velocity.
C. The torque acting on a particle is proportional to its angular speed.
D. For rotation about a fixed axis, every particle of the rigid body has the same angular acceleration.
E. Torque is defined only when a reference axis is specified.

****
QUESTION NO: 19
****

An object at rest explodes into three pieces A, B and C. After the explosion, A has a mass of 2.0 kg and velocity (3.0*i) m/s, B has a mass of 3.0 kg and velocity (-1.0*j) m/s, and C has a mass of 1.0 kg and velocity v. Find the velocity v.

A. (-6*i + 3*j) m/s
B. (3*i + 6*j) m/s
C. (6*i + 3*j) m/s
D. (6*i - 3*j) m/s
E. (3*i - 6*j) m/s

****
QUESTION NO: 20
****

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 1). The coefficient of friction is 0.2. Calculate the speed of the object at point B.

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

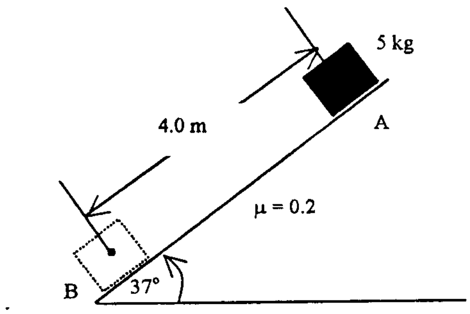


Figure 1

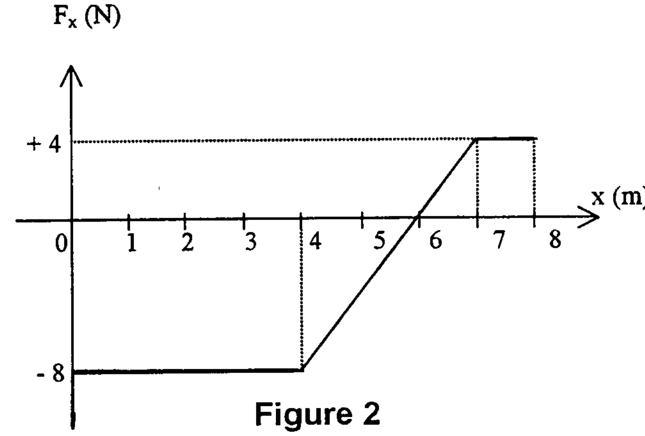


Figure 2

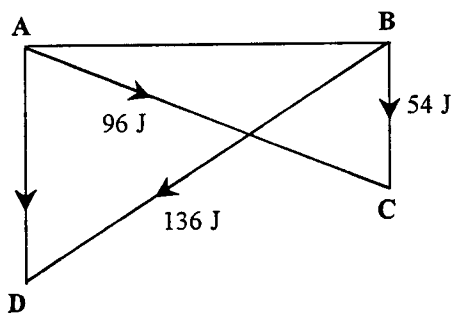


Figure 3

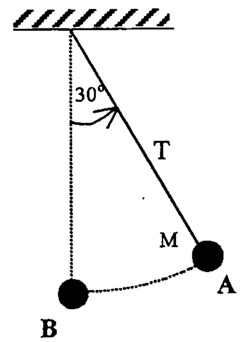


Figure 4

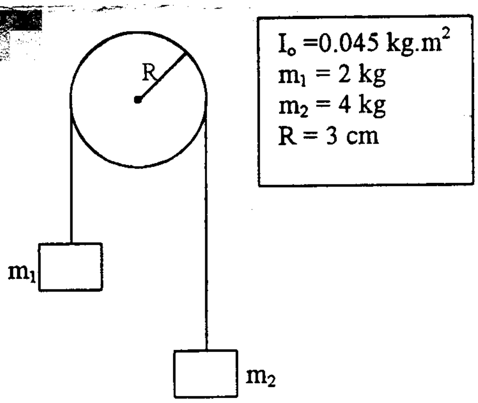


Figure 5

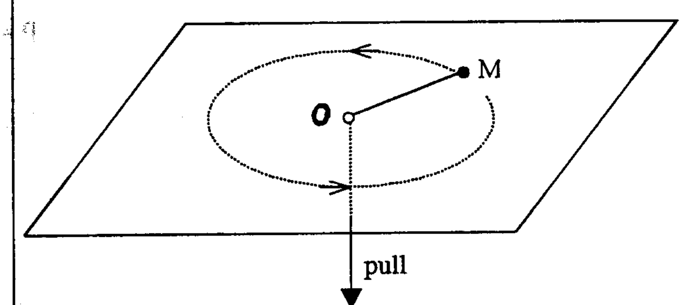


Figure 6

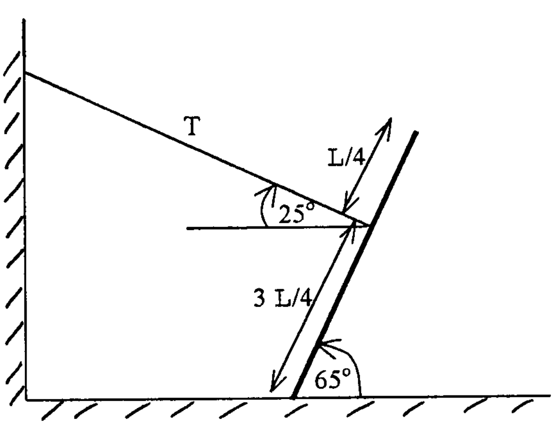


Figure 7

$g = 9.8\ m/s^2$

992

PHYS-101 Formula Sheet for Major Exam II

$g = 9.80\ m/s^2$

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

$v = v_o + at$

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

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

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

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

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

$f_k = \mu_k N$

$f_s \le \mu_s N$

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

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

$\mathbf{A} \bullet \mathbf{B} = A B \cos\theta$

$W_{net} = \Delta K = \frac{1}{2} mv_f^2 - \frac{1}{2} mv_i^2$

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

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

$U_g = mgy$

$E = K + U$

$W_c = -\Delta U$

$Wnc = \Delta K + \Delta U = \Delta E$

(or $\Delta K + \Delta U = \Delta K_{int\text{-}nc} + \Delta K_{ext}$)

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

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

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

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

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

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

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

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

If α = constant,

$\omega = \omega_o + \alpha t$

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

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

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

$I_P = I_{cm} + M d^2$

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

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

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

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,

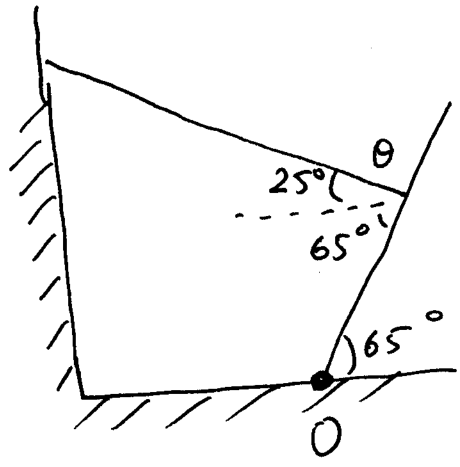
$\Sigma\vec{F} = 0$; $\Sigma\vec{\tau} = 0$

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

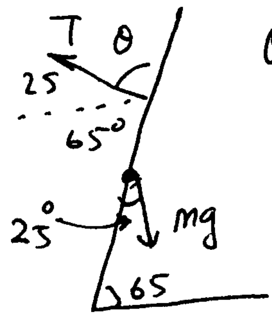
Nov 15, 01

Major 2 - 992

Q1 Torque about O is zero



$$\tau_0 = 0 = -\frac{L}{2} mg \sin 25 + \frac{3L}{4} T \sin 90$$



$$\theta = 180 - (25 + 65) = 90^\circ$$

$$T = \frac{\frac{L}{2} mg \sin 25^\circ}{\frac{3L}{4} \sin 90^\circ} = \frac{\frac{1200}{2} \sin 25}{\frac{3}{4}} = 338 \text{ N}$$

Q2

$$W = K_f - K_i = \frac{1}{2} I \omega_f^2 - \frac{1}{2} I \omega_i^2$$

$\omega_i = 0$ start from rest.

$\omega_f = \omega_i + \alpha t = 0 + (2)(5) = 10$ rad/s

$$W = \frac{1}{2} 6 (10)^2 = 300 \text{ J}$$

Q3

$$P_{avg} = \frac{W}{\Delta t} = \frac{K_f - K_i}{\Delta t} = \frac{\frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2}{\Delta t}$$

$$= \frac{\frac{1}{2}(2)(7)^2 - \frac{1}{2}(2)(4)^2}{15} = 2.2 \text{ W}$$

Q4

$U = mgh$ → unit of U is $kg \frac{m^2}{s^2}$

(m: kg, g: $\frac{m}{s^2}$, h: m)

so $kg \frac{m}{s^2}$ is wrong unit.

Nov 15, 01

Major 2 - 992

p-2

Q5 since Tension is always perpendicular to the motion, $W = 0$. ←

$$W = \vec{F} \cdot \vec{d} = F d \cos 90 = 0$$

Q6

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

F ← This is our tension

E ← In previous edition, the symbol of Young's modulus is Y

$1\,m = \ell$

diameter = 2.0 mm

$$T = E \frac{\Delta \ell}{\ell} A = (1.1 \times 10^{11}) \frac{(1.0 \times 10^{-2})}{1.0} \cdot \pi \left(\frac{2 \times 10^{-3}}{2}\right)^2$$

(1.0×10^{-2}) ← to convert from cm to m

$\pi \left(\frac{2 \times 10^{-3}}{2}\right)^2$ ← cross sectional area πr^2

$= 3456$ N

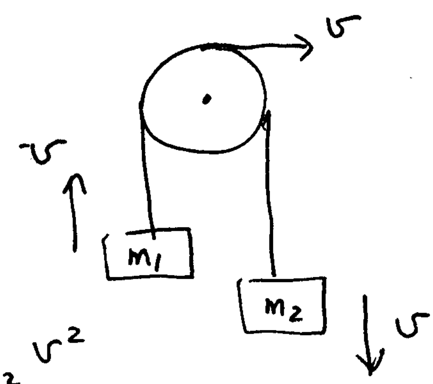
Q7 Kinetic energy of $m_1 = \frac{1}{2} m_1 v^2$

Kinetic energy of $m_2 = \frac{1}{2} m_2 v^2$

Kinetic energy of the pulley

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

$$= \frac{1}{2} I \left(\frac{v}{R}\right)^2 = \frac{1}{2} \frac{I}{R^2} v^2$$



$m_1 = 2.0$ kg

$m_2 = 4.0$ kg

$$\frac{I}{R^2} = \frac{0.045}{(0.03)^2} = 50 \text{ kg}$$

note
m_1, m_2 and a point on the rim of the pulley have the same speed.

⇒ The pulley has the greatest kinetic energy

Q8 $\tau = I\alpha$

↑ to find α use

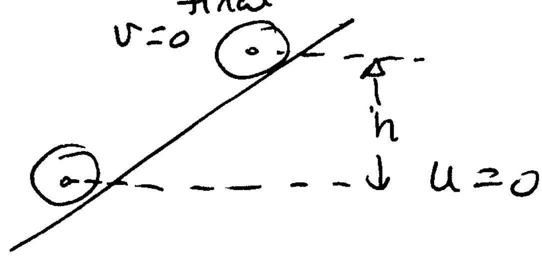
$$\omega^2 = \omega_0^2 + 2\alpha(\theta - \theta_0)$$

$$6^2 = 5^2 + 2\alpha(5(2\pi))$$ ← to convert to rad

$$\alpha = \frac{6^2 - 5^2}{2(5)(2\pi)} = \frac{11}{20\pi}\ \text{rad}/s^2$$

$$\tau = 12\left(\frac{11}{20\pi}\right) = 2.1\ \text{N.m}$$

Q9 $K_i + U_i = K_f + U_f$



$$\frac{1}{2}I\omega_i^2 + \frac{1}{2}mv_i^2 + 0$$

$$= 0 + mgh$$

for hoop: $I = MR^2$

$$\frac{1}{2}MR^2\left(\frac{v_i}{R}\right)^2 + \frac{1}{2}mv_i^2 = mgh$$

$$h = \frac{v_i^2}{g}$$

for disk: $I = \frac{1}{2}MR^2$

$$\frac{1}{2}\left(\frac{1}{2}mR^2\right)\left(\frac{v_i}{R}\right)^2 + \frac{1}{2}mv_i^2 = mgh$$

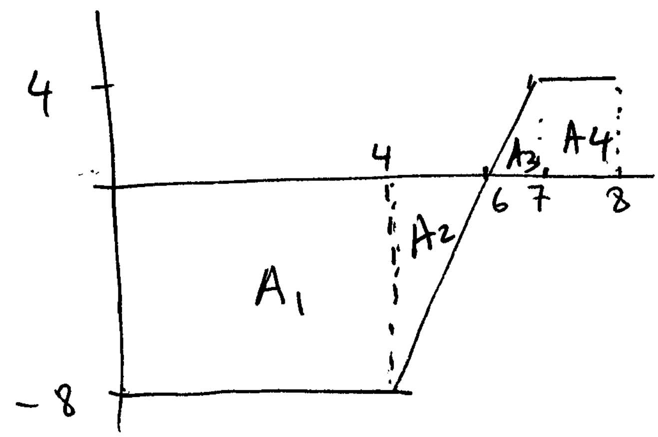
$$\frac{3}{4}v_i^2 = gh$$

$$h = \frac{3}{4}\frac{v_i^2}{g}$$

Thus, hoop travels more.

Q10

$W = \int F_x\, dx$ ← area under the curve. Note for curve below x-axis the area is negative



$A_1 = (-8)(4) = -32\ J$

$A_2 = \frac{1}{2}(-8)(2) = -8\ J$

$A_3 = \frac{1}{2}(4)(1) = 2\ J$

$A_4 = (4)(1) = 4\ J$

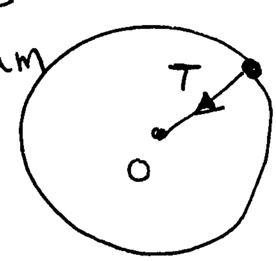
$$\text{Area} = A_1 + A_2 + A_3 + A_4 = -32 - 8 + 2 + 4 = 34\ J = W$$

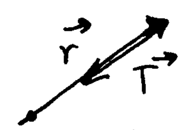
Q11

Since the torque due to T about O is zero, the angular momentum is conserved.

so angular momentum remains constant.

$\vec{L_i} = \vec{L_f}$





$\tau = \vec{r} \times \vec{T}$
$= rT \sin 180$
$= 0$

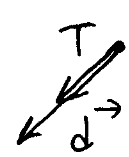
Kenetic energy changes because T does work on the particle when the particle moves radially.

$W = K_f - K_i \neq 0$

Kenitic energy increases because work done by T on the particle is positive

$K_f = W + K_i$

↑ positive $= Td\cos 0° = Td$.

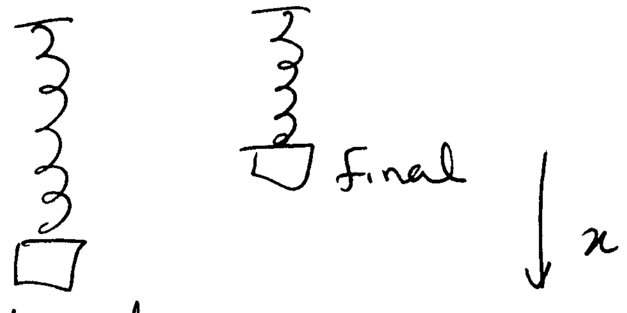


Nov 15, 01

Major 2 — 992

P-5

Q12



$$\Delta U = U_f - U_i = 0 - \frac{k}{2} x^2$$

to find use

$$F = -kx$$

$$-mg = -kx$$

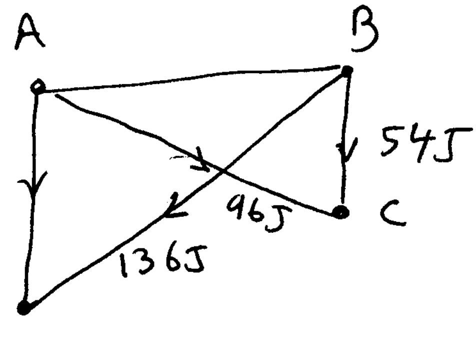
$$x = \frac{mg}{k}$$

$$\Delta U = -\frac{240}{2}\left(\frac{2.5(9.8)}{240}\right)^2$$

$$= -1.25 \text{ J}$$

Q13

Since our force is a conservative force, work done along any closed bath is zero



$$W_{AC} + W_{CB} + W_{BA} = 0$$

$$96 - 54 + W_{BA} = 0 \Rightarrow W_{BA} = -96 + 54 = -42 \text{ J}$$

$$W_{AB} + W_{DB} + W_{BA} = 0$$

$$W_{AB} + (-136) + (-42) = 0$$

$$\Rightarrow W_{AB} = 136 + 42 = 178 \text{ J}$$

W_{AC} is work done to move the object from A to C

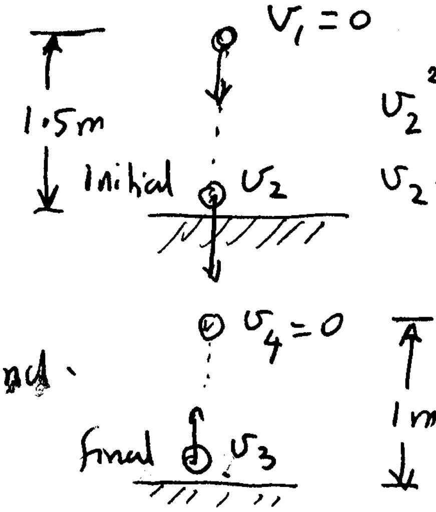
$W_{AC} = -W_{CA}$

Q14

$\vec{J} = m\vec{v}_f - m\vec{v}_i$

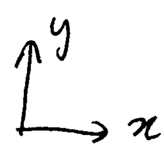
$\vec{v}_f$: velocity just after it bounces.

$\vec{v}_i$: velocity just before it hits the ground.



$v_2^2 = v_1^2 - 2g(-1.5)$

$v_2 = \sqrt{2(9.8)(1.5)} = v_i$



$v_4^2 = v_3^2 - 2g(1.0)$

$v_3 = \sqrt{2(9.8)(1)} = v_f$

$\vec{J} = 0.2\sqrt{2(9.8)}\,\hat{j} - 0.2(-\sqrt{2(9.8)(1.5)}\,\hat{j})$

$= (0.885 + 1.084)\hat{j}$ kg m/s

$= 1.97\,\hat{j}$ kg m/s

1.97 upward.

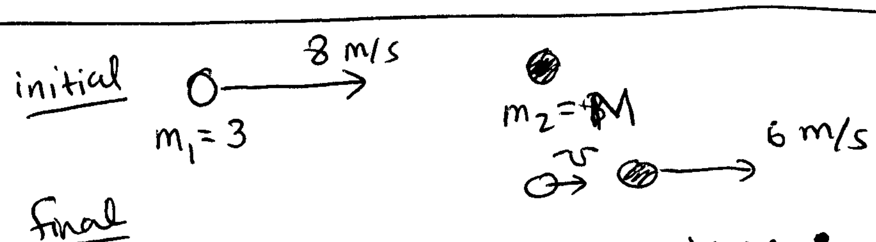
Q15 $P_A = P_B \Rightarrow m_A v_A = m_B v_A$

$K_A < K_B \Rightarrow \frac{1}{2} m_A v_A^2 < \frac{1}{2} m_B v_B^2$

$\frac{1}{2}(m_A v_A) v_A < \frac{1}{2}(m_B v_B) v_B$

$v_A < v_B$

Q16



conservation of linear momentum: $\vec{P}_i = \vec{P}_f$

① —— $3(8) + M(0) = 3v + M6$

conservation of kinetic energy: $K_i = K_f$

② —— $\frac{1}{2}(3)(8)^2 + \frac{1}{2}M(0)^2 = \frac{1}{2}3v^2 + \frac{1}{2}M(6)^2$

From equation ①, $v = 8 - 2M$

substitute in equation ②

$$\frac{1}{2}(3)(8)^2 = \frac{1}{2}3(8-2M)^2 + \frac{1}{2}M(6)^2$$

$$(8)^2 = (8-2M)^2 + M(12)$$

$$(8)^2 = 8^2 - 2(2M)(8) + 4M^2 + M(12)$$

$$0 = -5 + M \Rightarrow M = 5.0\ kg$$

Q17

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

$$\vec{v} = \frac{d\vec{r}}{dt} = 7\hat{j}$$

$$\vec{L} = 4(2.0\hat{i} + 7t\hat{j} + 3\hat{k}) \times (7\hat{j})$$
$$= 4(2.0(7)(\hat{i}\times\hat{j}) + 7t(7)(\hat{j}\times\hat{j}) + 3(7)(\hat{k}\times\hat{j}))$$
$$= -84\hat{i} + 56\hat{k}$$

$\hat{i} \times \hat{j} = \hat{k}$

$\hat{j} \times \hat{j} = 0$

$\hat{k} \times \hat{j} = -\hat{i}$

Q18 "Torque is defined only when a refrence axis is specified" is wrong. You need only to specify a point to define torque.