STUDENT NUMBER:

NAME:

SECTION NUMBER:

****

KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS

****

COURSE: PH101

****

EXAM: PH101 FINAL EXAM - 002

****

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 planet of mass m orbits around the Sun. The radius vector drawn from the Sun to the planet sweeps the area at the rate of 3.0 * 10**20 m2/s with an angular momentum 3.59* 10**45 kg*m2/s about the Sun.
Find the mass of the planet.

A. 3.4 * 10**27 kg
B. 1.9 * 10**24 kg
C. 7.6 * 10**35 kg
D. 6.0 * 10**24 kg
E. 8.0 * 10**24 kg

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

A simple pendulum has length L and period T.
If the length of the simple pendulum is reduced to L/4, then the period becomes

A. T
B. T/2
C. 4T
D. 2T
E. T/4

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

A 0.25 kg block oscillates on the end of a spring with spring constant of 200 N/m. If the system has a total energy of 6.0 J, then the amplitude of the oscillations is

A. 4.9 m
B. 1.2 m
C. 0.06 m
D. 0.17 m
E. 0.24 m

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

A uniform rod of mass 1.5 kg is 2.0 m long. The rod can pivot about a horizontal, frictionless pin through one end. The moment of inertia of the rod about the pivot is 2.0 kg.m2. It is released from rest at an angle of 30 degrees above the horizontal. What is the angular speed of the rod as it passes through the horizontal position (see Figure 1)?

A. 1.2 rad/s
B. 2.7 rad/s
C. 5.6 rad/s
D. 2.3 rad/s
E. 4.7 rad/s

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

A particle moves at constant speed in a horizontal circular path. The instantaneous velocity and instantaneous acceleration vectors are:

A. both perpendicular to the circular path
B. both tangent to the circular path
C. opposite to each other
D. in the same direction
E. perpendicular to each other

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

Neglecting air resistance, the escape speed from a certain planet of mass M for a rocket of mass m is Vesc. What is the escape speed for another rocket of mass 3m from the same planet?

A. 3*Vesc
B. sqrt(3)*Vesc
C. 2*Vesc
D. Vesc
E. Vesc/3

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

Figure 2 shows a pipe and gives the volume flow rate (in cm3/s) and the direction of flow for all but one section (B). What are the volume flow rate and direction of flow for section (B)?

A. 9 cm3/s, to the right
B. 4 cm3/s, to the left
C. 2 cm3/s, to the left
D. 3 cm3/s, to the right
E. 8 cm3/s, to the left

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

A wheel, starting from rest, turns through 8.0 revolutions in a time interval of 12 s. Assuming constant angular acceleration, what is the angular speed of the wheel at the end of this time interval ?

A. 3.0 rad/s
B. 8.4 rad/s
C. 1.7 rad/s
D. 0.9 rad/s
E. 5.9 rad/s

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

The rate of flow of water through a horizontal pipe is 2.0 m3/minute. Determine the speed of flow at a point where the radius of the pipe is 4.0 cm.

A. 0.84 m/s
B. 6.6 m/s
C. 9.8 m/s
D. 2.3 m/s
E. 400 m/s

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

A 2.0-kg block is projected down a rough plane that makes an angle of 30 degrees with the horizontal with an initial kinetic energy of 2.0 J. If the coefficient of kinetic friction between the block and the plane is 0.6, how far will the block slide down the plane before coming to rest ?

A. 1.8 m
B. 1.0 m
C. 1.3 m
D. 5.2 m
E. 3.0 m

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

A body is hanging from a spring balance supported from the roof of an elevator. The balance reads 98 N when the elevator is stationary. If the elevator moves with an upward acceleration of 2.0 m/sec2, What will be the reading of the balance?

A. 156 N
B. 118 N
C. 49 N
D. 78 N
E. 98 N

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

A bullet of mass m = 20 gram strikes a ballistic pendulum whose target block has a mass M = 5.0 kg. The block is observed to rise a distance of 5.0 cm. What is the speed of the bullet when it strikes the block?

A. 248 m/s
B. 460 m/s
C. 267 m/s
D. 192 m/s
E. 120 m/s

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

The area under a velocity-time graph represents:

A. impulse
B. acceleration
C. work
D. power
E. displacement

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

An astronaut weighs 140 N on the Moon's surface. When he is in a circular orbit about the moon at an altitude h = radius of the Moon, what gravitational force (magnitude) does the Moon exert on him?

A. 70 N
B. 100 N
C. 60 N
D. 25 N
E. 35 N

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

Two particles, of masses m and 2m, are fixed in place on the x-axis as shown in Figure 5. The net gravitational force, due to these two particles, on a third particle of mass 3m will most probably be zero at point:

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

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

A solid sphere has a radius of 0.20 m and a mass of 150 kg. How much work is required to get the sphere rolling with an angular speed of 50.0 rad/s on a horizontal surface? Assume the sphere starts from rest and rolls without slipping.

A. 0.30* 10**4 J
B. 1.75* 10**4 J
C. 1.05* 10**4 J
D. 0.75* 10**4 J
E. 1.30* 10**4 J

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

A boy throws an apple upwards with an initial vertical velocity V0. If the apple returns back to his hand (the original position) in 2.40 seconds, what was the initial velocity V0 ?

A. 23.5 m/s
B. 9.41 m/s
C. 11.8 m/s
D. 5.88 m/s
E. 2.40 m/s

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

If A = 3i - 4j and B = 8i - 6j, find the angle between A and B.
(i, j are unit vectors in x and y directions)

A. 90 degrees
B. 30 degrees
C. 16 degrees
D. 0 degree
E. 37 degrees

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

A 3-kg block, attached to a spring, executes simple harmonic motion according to: x = 2 cos (50 t) where x is in meters and t is in seconds. Find the value of the spring constant.

A. 9200 N/m
B. 1400 N/m
C. 7500 N/m
D. 1 N/m
E. 100 N/m

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

One end of a 0.80 m string is fixed, the other end is attached to a 2.00 kg stone. The stone swings in a vertical circle, passing the top point at 4.00 m/s. The string tension at this point is:

A. 20.4 N
B. 32.7 N
C. 0 N
D. 12.4 N
E. 10.1 N

****
QUESTION NO: 21
****

A body moving along the x axis is acted upon by a force (Fx) that varies with x as shown in Fig 7. Find the work done by this force on the object as it moves from x=0.0 m to x=8.0 m.

A. +18 J
B. -10 J
C. -16 J
D. -34 J
E. -18 J

****
QUESTION NO: 22
****

The fresh water behind a reservoir dam is 15 m deep (see Figure 3). A horizontal pipe 2.0 cm in radius passes through the dam 8.0 m below the water surface. A plug secures (closes) the pipe opening. Find the force on the plug due to the water pressure only.
(Density of water = 1000 kg/m3)

A. 7.8 N
B. 42 N
C. 120 N
D. 34 N
E. 99 N

****
QUESTION NO: 23
****

An airplane is flying horizontally at a height of 490 m above the surface of the earth and at a speed of 200 m/s. How far from a target (horizontal distance) should it release a bomb to hit the target on the ground?

A. 1000 m
B. 2000 m
C. 200 m
D. 980 m
E. 490 m

****
QUESTION NO: 24
****

A uniform horizontal beam of weight W is supported by a hinge and cable as shown in Figure 6. The force exerted on the beam by the hinge has a vertical component that must be equal to:

A. W/2 and up
B. W and down
C. W/2 and down
D. zero
E. W and up

****
QUESTION NO: 25
****

A 0.5 kg box connected to a light spring of force constant 20 N/m oscillates on a horizontal frictionless surface. The amplitude of the motion is 3.0 cm. Find the speed of the box when its displacement x = 2.55 cm.

A. 2.0 m/s
B. 0.10 m/s
C. 0.30 m/s
D. 1.2 m/s
E. 1.5 m/s

****
QUESTION NO: 26
****

A particle (mass M) at rest decays into two particles. One particle of mass m has a speed v. The other particle of mass (M-m) has a speed of:

A. mv/M
B. mv/(m+M)
C. (m+M)v/m
D. mv/(M-m)
E. v

****
QUESTION NO: 27
****

An object is released from rest when it is at an altitude h = 4.0 * 10**6 m above the surface of a planet of mass M = 4.0 * 10**24 kg and radius R = 5.0 * 10**6 m. What is the speed of the object just before striking the surface of the planet?

A. 4.1 km/s
B. 6.9 km/s
C. 5.4 km/s
D. 3.5 km/s
E. 7.8 km/s

****
QUESTION NO: 28
****

In simple harmonic motion, the displacement is maximum when the

A. velocity is zero
B. kinetic energy is maximum
C. velocity is maximum
D. momentum is maximum
E. acceleration is zero

****
QUESTION NO: 29
****

An object (density = 7.87 g/cm3) hangs from a spring balance. The balance reads 80 N when the object is in air, and 70.9 N when completely immersed in a liquid of unknown density. What is the density of the liquid?

A. 1.0 g/cm3.
B. 0.68 g/cm3.
C. 0.90 g/cm3.
D. 0.01 g/cm3.
E. 8.8 g/cm3.

****
QUESTION NO: 30
****

A large gasoline tank is sealed (closed) and is under 3.0 atm absolute pressure (see Figure 4). A small hole is made 40 m below the surface of the gasoline. At what speed (v) does the gasoline begin to shoot out of the hole? (Density of gasoline = 660 kg/m3).

A. 37 m/s
B. 32 m/s
C. 98 m/s
D. 40 m/s
E. 21 m/s

Dec 26, 01

Q1

$$\frac{dA}{dt} = \frac{L}{2m}$$

$$3\times10^{20} = \frac{3.59\times10^{45}}{2\,m}$$

$$m = \frac{3.59\times10^{45}}{2\,(3\times10^{20})} = 6.0\times10^{24}\ \text{Kg}.$$

Q2

$$T = \sqrt{\frac{g}{L}}$$

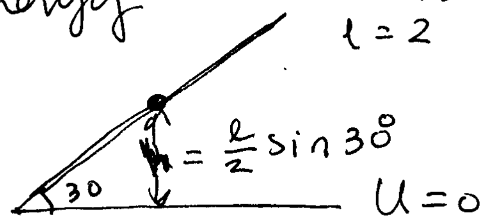
$$T_{new} = \sqrt{\frac{g}{L_{new}}} = \sqrt{\frac{g}{\frac{L}{4}}} = 2\sqrt{\frac{g}{L}} = 2T$$

Q3

$$E = \frac{1}{2}kx_m^2 = \frac{1}{2}200\,x_m^2 = 6$$

$$x_m = \sqrt{\frac{6}{100}} = 0.24\ m$$

Q4 conservation of mechanical energy



$$K_i + U_i = K_f + U_f$$

$$\frac{1}{2}I\omega_i^2 + mgh = \frac{1}{2}I\omega_f^2 + 0$$

($\omega_i = 0$)

$$mg\frac{l}{2}\sin 30 = \frac{1}{2}I\omega_f^2 \Rightarrow \omega_f = \sqrt{\frac{(1.5)(9.8)(\frac{2.0}{2})(\sin 30)2}{2.0}}$$

$$= 2.7\ \text{rad/s}$$

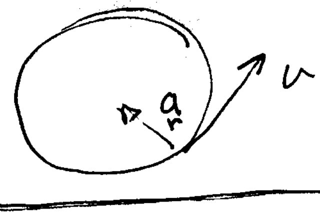
Q5 Perpendicular to each other

Q6

$$V_{esc} = \sqrt{\frac{2GM}{R}}$$ ← mass of the planet

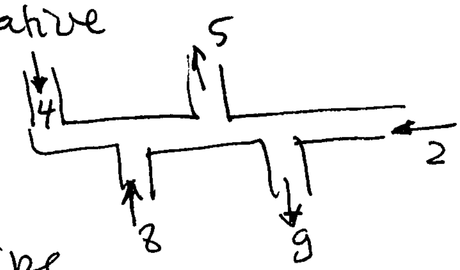
it does not depend on the mass of the rocket.

answer: V_{esc}.



Q7 Volume flow rate is conserved.

Let flow out of the pipe be positive
let flow into the pipe be negative



$(V_R)_B - 4 + 5 - 8 + 9 = 0$

$(V_R)_B = -2 \text{ cm}^2/\text{s}$

↑ negative ⇒ flow into the pipe
2 cm²/s to the left

Q8

$$\theta - \theta_0 = \frac{\omega + \omega_0}{2} t$$

$$8 \left(\frac{2\pi \text{ rad}}{\text{rev}}\right) = \frac{\omega + 0}{2} 12 \Rightarrow \omega = \frac{8(2\pi)}{6} = 8.4 \text{ rad/s}$$

Q9

$R_v = Av$

$$2 \frac{m^3}{min}\left(\frac{1 min}{60 s}\right) = (\pi r^2) v = \left(\pi \left[4.0 \text{ cm} \left(\frac{1 m}{100 cm}\right)\right]^2\right) v$$

$$v = \frac{2}{\pi (0.04)^2 \, 60} = 6.6 \text{ m/s}$$

Q10

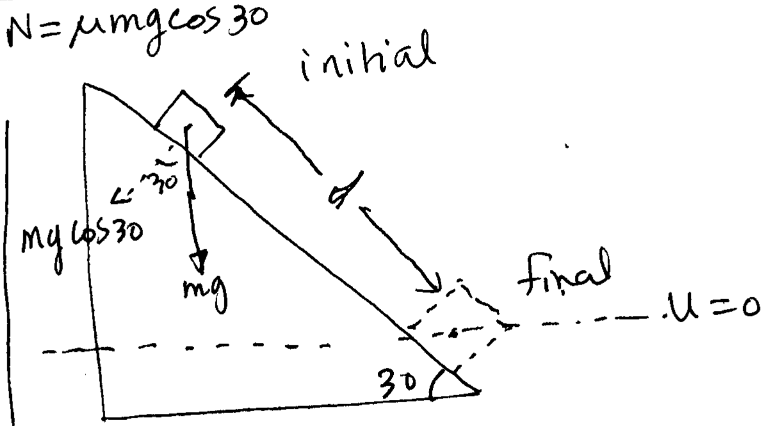
$W = \Delta K + \Delta U + \Delta E_{th}$

$\mu N = \mu mg\cos 30$

→ $0 = K_f - K_i + U_f - U_i + f_k d$

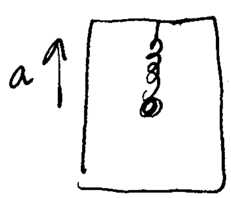
no work done by external force

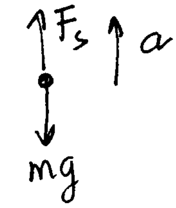
$0 = 0 - 2 + 0 - mg(d\sin 30) + \mu mg\cos 30\, d$
(height)



$$d = \frac{2}{mg(\mu\cos 30 - \sin 30)} = 5.2 \text{ m}$$

Q11 Newton's second law





$F_s - mg = ma$ $\quad m = \frac{mg}{g}$

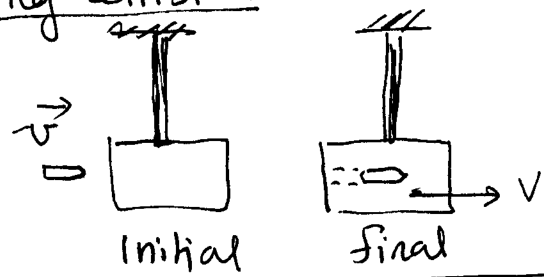
$F_s = mg + ma$

$= 98 + \frac{98}{9.8}(2) = 118 \text{ N}$

Dec 26, 01

Q12

During collision



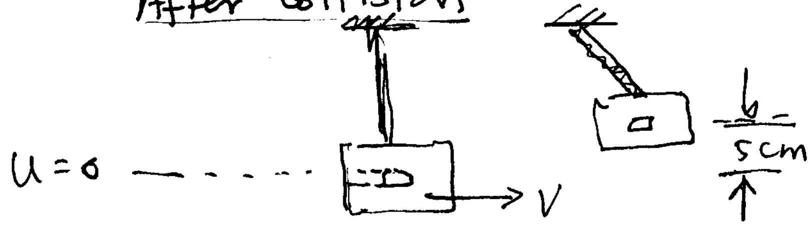
conservation of linear momentum

$$P_i = P_f$$

$$mv + 0 = (m + M)V$$

$$V = \frac{mv}{m+M}$$

After collision



conservation of mechanical energy

$$K_i + U_i = K_f + U_f$$

$$\frac{1}{2}(m+M)V^2 + 0 = 0 + (m+M)gh$$

$$\frac{1}{2}\cancel{(m+M)}\left(\frac{mv}{m+M}\right)^2 = \cancel{(m+M)}gh$$

$$v = \sqrt{2\left(\frac{m+M}{m}\right)^2 gh} = \sqrt{2\left(\frac{0.02+5}{0.02}\right)^2(9.8)(0.05)}$$

$$= 248 \text{ m/s}$$

Q13

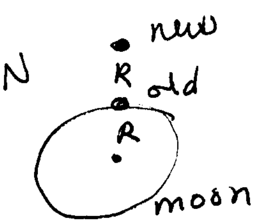
Displacement

$$v = \frac{dx}{dt}$$

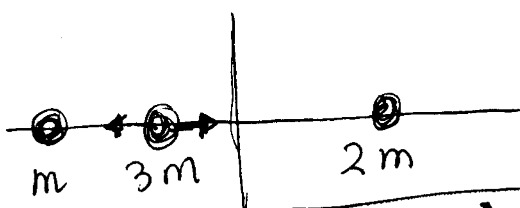
$$x - x_0 = \int_{t_0}^{t} v\,dt$$

Q14

$$F_{new} = G\frac{Mm}{(2R)^2} = \frac{1}{4}\,\frac{GMm}{R^2} = \frac{1}{4}\,140 = 35 \text{ N}$$



Q15 E



Q16

$$W = \Delta K = K_f - \cancel{K_i}^{\,0} = \frac{1}{2}I\omega^2 + \frac{1}{2}mv^2$$

$$= \frac{1}{2}\left(\frac{2}{5}MR^2\right)\omega^2 + \frac{1}{2}M(R\omega)^2 = \left(\frac{1}{5} + \frac{1}{2}\right)MR^2\omega^2$$

$$= \frac{7}{10}(150)(0.2)^2(50)^2 = 1.05 \times 10^4 \text{ J}$$

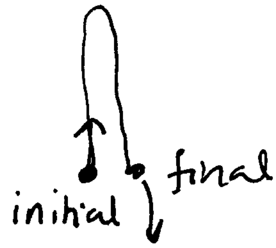
Q17

$v = v_0 + at$

$-v_0 = v_0 - gt$

$-2v_0 = -gt$

$v_0 = \frac{gt}{2} = \frac{9.8(2.4)}{2} = 11.8 \text{ m/s}$



Q18

$A \cdot B = AB\cos\theta$

$(3i-4j)\cdot(8i-6j) = \sqrt{(3)^2+(-4)^2}\sqrt{8^2+(-6)^2}\cos\theta$

$3(8)+(-4)(-6) = \sqrt{9+16}\sqrt{64+36}\cos\theta$

$24 + 24 = (5)(10)\cos\theta$

$\theta = \cos^{-1}\frac{48}{50} = 16^\circ$

Q19

$\omega = \sqrt{\frac{k}{m}} \Rightarrow k = m\omega^2 = 3(50)^2 = 7500 \text{ N/m}$

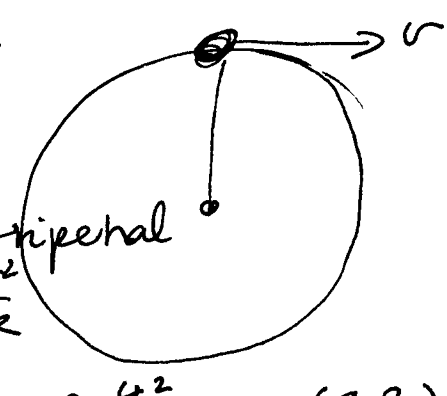
$x = 2\cos(50t)$ ← ω

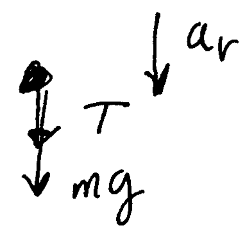
Q20 Newton's Second law

$-T - mg = -ma$ ← centripetal

$T + mg = m\frac{v^2}{R}$ $= \frac{v^2}{R}$

$T = m\frac{v^2}{R} - mg = 2\frac{4^2}{0.8} - 2(9.8) = 20.4 \text{ N}$

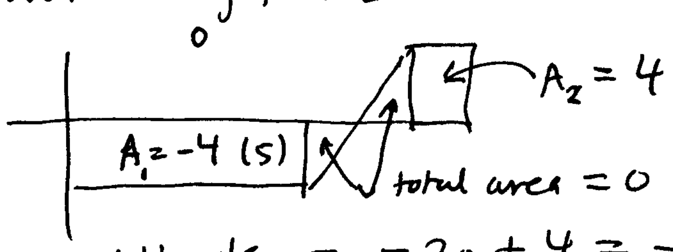




Q21

$\text{Work} = \int_0^8 F\,dx$ = area under the curve

Note when the curve is under the x-axis the area is negative



$\text{Work} = -20 + 4 = -16 \text{ J}$

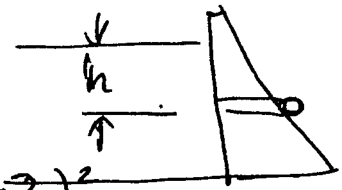
Q22

pressure due to the weight of water only is $\rho g h$.

$$F = PA = \rho g h A \quad (A = \pi r^2)$$

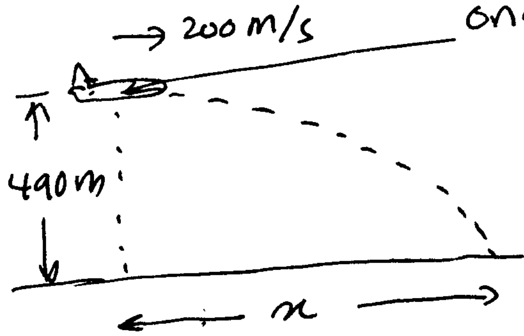
$$= (1000)(9.8)(8)(\pi(0.02)^2)$$

$$= 99\ N$$



Q23

to release a bomb means the bomb has zero velocity (initial) with respect to the plane or 200 m/s along horizontal direction with respect to ground.



<u>consider the vertical motion</u>

time to reach ground can be found from

$$y - y_0 = v_{oy} t - \frac{1}{2} g t^2 \quad (v_{oy} = 0)$$

$$-490 - 0 = -\frac{1}{2}(9.8) t^2$$

$$t = \sqrt{\frac{2(490)}{9.8}} = 10\ s$$

<u>consider the horizontal motion</u>

during 10 s the bomb will travel

$$x - x_0 = v_{ox} t = 200(10) = 2000\ m.$$

Q24

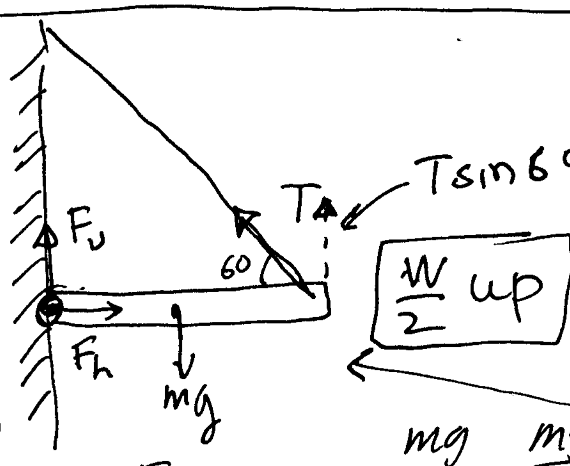
Total torque about the hinge should be zero

$$-\frac{\ell}{2} mg + T \ell \sin 60 = 0$$

$$T \sin 60 = \frac{mg}{2}$$

Apply Newton's second law along the vertical direction

$$F_v - mg + T \sin 60 = 0 \Rightarrow F_v = mg - \frac{mg}{2} = \frac{mg}{2}$$



Dec 26, 01

Q25 conservation of mechanical energy

$$K_i + U_i = K_f + U_f$$

$K_f + U_f$ ← when it has maximum displacement

$$\frac{1}{2}mv^2 + \frac{1}{2}kx^2 = 0 + \frac{1}{2}kx_m^2$$

(0 ←) At maximum displacement velocity $= 0$

$$\frac{1}{2}(0.5)v^2 + \frac{1}{2}(20)\left(\frac{2.55}{100}\right)^2 = \frac{1}{2}(20)\left(\frac{3.0}{100}\right)^2$$

$$v = \sqrt{\frac{\frac{1}{2}(20)(0.03)^2 - \frac{1}{2}(20)(0.0255)^2}{\frac{1}{2}(0.5)}} = 0.10 \text{ m/s}$$

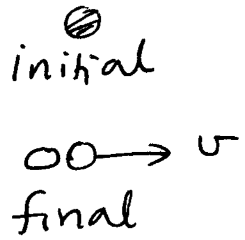
Q 26 conservation of linear momentum

$$\vec{P_i} = \vec{P_f}$$

$$0 = mv + (M-m)v_2$$

$$v_2 = \frac{-m}{M-m}v$$

$$\text{speed} = \frac{m}{M-m}v$$



Q27 conservation of mechanical energy

$$K_i + U_i = K_f + U_f$$

$$0 - \frac{GMm}{R+h} = \frac{1}{2}mv^2 - \frac{GMm}{R}$$

$$v = \sqrt{2GM\left(\frac{1}{R} - \frac{1}{R+h}\right)} =$$

$$= \sqrt{2(6.67\times10^{-11})(4\times10^{24})\left(\frac{1}{5\times10^6} - \frac{1}{5\times10^6+4\times10^6}\right)}$$

$$= 6.9 \text{ km/s}$$