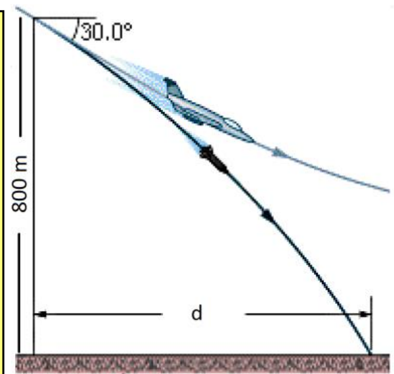
Final Exam Name:____________________Box#_____ Physics 160-01

1) A certain airplane has a speed of 400.0 km/h and is diving at an angle of 30.0° below the horizontal when a radar decoy is released. The plane is 800 m high when the decoy is released. What is the horizontal distance between the release point and the point where the decoy strikes the ground? Neglect air resistance.



A) 1200 m
B) 1100 m
C) 1000 m
D) 900 m
E) 800 m
F) 700 m
G) 600 m
H) 500 m
I) 400 m
J) 300 m

$y_0 = 800m$
$y_f = 0m$
$v_{y0} = -111.11m/s*\sin 30$
$v_{yf} = ?$
$a = -9.8m/s^2$
$t = ?s$
$y_f = y_0 + v_0t + 1/2at^2$
$0m = 800m - 55.55m/s*t - ½(9.8m/s^2)t^2$

$$t = \frac{55.55\,m/s - \sqrt{(55.55\,m/s)^2 + 4(4.9\,m/s^2)(800m)}}{-2(4.9\,m/s^2)}$$

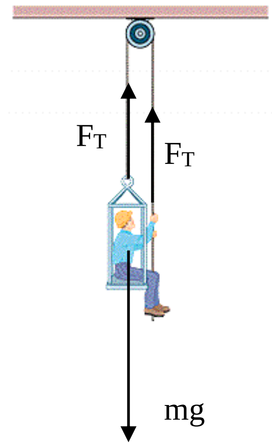
$$t = 8.31s$$

$x_0 = 0m$
$x_f = ?m$
$v_{x0} = 111.11m/s*\cos 30$
$v_{xf} = $ same
$a = 0$
$t = 8.31s$
$x_f = x_0 + v_0t + 1/2at^2$
$x_f = 800.0m$

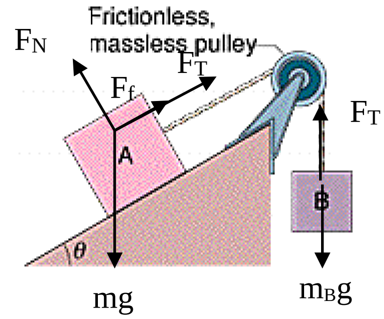
2) Figure 5-61 shows a man sitting in a bosun's chair that dangles from a massless rope, which runs over a massless, frictionless pulley and back down to the man's hand. The combined mass of the man and chair is 200.0 kg. With what force must the man pull on the rope for him to rise with an upward acceleration of 2.2 m/s^2?

A) 2600 N
B) 2400 N
C) 2200 N
D) 2000 N
E) 1800 N
F) 1600 N
G) 1400 N
H) 1200 N
I) 1000 N
J) 800 N

$$\sum F_y = ma$$
$$2F_T - mg = ma$$
$$2F_T = m(g+a) = 200kg(9.8m/s^2+2.2m/s^2)$$
$$F_T = 1200N$$



3) Two blocks are connected over a pulley. The mass of block *A* is 10 kg and the coefficient of kinetic friction between *A* and the incline is 0.20. Angle θ is 30°. Block *A* is **sliding down the incline at constant speed**. What is the mass of block *B*?



A) 5.98 kg
B) 6.86 kg
C) 7.69 kg
D) 2.97 kg
E) 3.27 kg
F) 4.24 kg
G) 6.31 kg
H) 14.1 kg
I) 14.7 kg
J) 16.1 kg

$$\sum F_y^A = 0 = F_N - m_A g\cos(30) \Rightarrow$$
$$F_N = m_A g\cos(30)$$
$$\sum F_x^A = m_A g\sin(30) - F_f - F_T = 0 \Rightarrow$$
$$F_T = m_A g\sin(30) - F_f$$
$$\sum F_x^B = F_T - m_B g = 0 \Rightarrow F_T = m_B g \Rightarrow$$
$$m_B g = -F_f + m_A g\sin(30)$$
$$m_B g = -\mu_k F_N + m_A g\sin(30)$$
$$m_B g = -\mu_k m_A g\cos(30) + m_A g\sin(30)$$
$$m_B = -(0.20) m_A\cos(30) + m_A\sin(30)$$
$$m_B = 3.27\ kg$$

4) A load of bricks with mass m_1 = 20.0 kg hangs from one end of a rope that passes over a pulley of radius 0.10 m and moment of inertia 0.60 kgm^2. A counterweight of mass m_2 = 35.0 kg is suspended from the other end of the rope, as shown in the figure. The system is released from rest. What is the magnitude of the upward acceleration of the load of bricks?

A) 0.92 m/s^2
B) 1.00 m/s^2
C) 1.28 m/s^2
D) 1.72 m/s^2
E) 2.13 m/s^2
F) 2.84 m/s^2
G) 3.62 m/s^2
H) 4.11 m/s^2
I) 4.79 m/s^2
J) 5.01 m/s^2

For mass 1:

$$\sum F_y = T_1 - m_1 g = m_1 a$$

For mass 2:

$$\sum F_y = T_2 - m_2 g = -m_2 a$$

here, T_1 is not equal to T_2,

for the pulley:

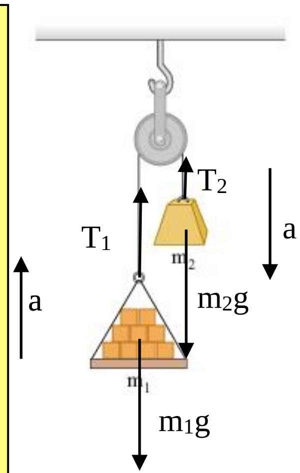
$$\sum \tau_z = rT_2 - rT_1 = I\alpha \Rightarrow$$

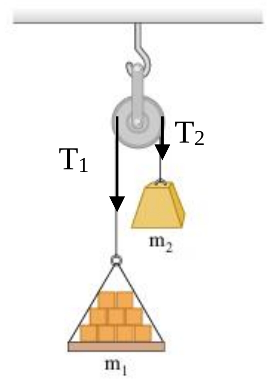
$$r(T_2 - T_1) = Ia/r \implies$$

$$(m_2 g - m_2 a - m_1 g - m_1 a) = Ia/r^2$$

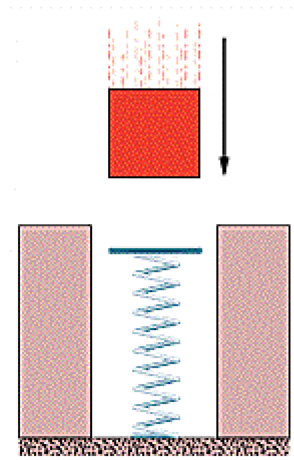
$$a = \frac{g(m_2 - m_1)}{I/r^2 + (m_2 + m_1)} = \frac{9.8\,m/s^2\,(35kg - 20kg)}{0.6kgm^2/(0.1m)^2 + (35kg + 20kg)}$$

$$a = 1.28\ m/s^2$$





5) A 0.40 kg block is dropped onto a relaxed vertical spring that has a spring constant of k = 400 N/m. The block becomes attached to the spring and compresses the spring .10 m before momentarily stopping. What is the speed of the block just before it hits the spring? (Assume that friction is negligible.)



A) 3.37 m/s
B) 11.5 m/s
C) 7.92 m/s
D) 5.79 m/s
E) 1.21 m/s
F) 4.23 m/s
G) 2.84 m/s
H) 8.19 m/s
I) 3.65 m/s
J) 9.00 m/s

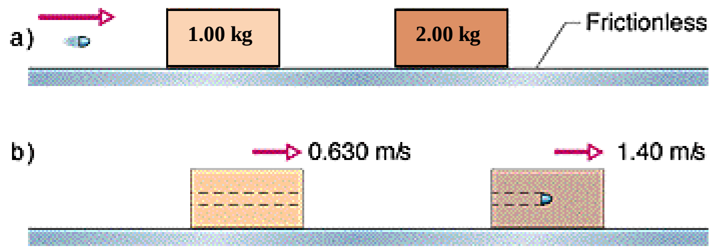
$KE_i = 1/2mv^2$	$KE_f = 0$
$U_{g,i} = mg(.1m)$	$U_{g,f} = 0$
$U_{el,i} = 0$	$U_{el,f} = ½(400N/m)(.1m)^2$

$$E_{Mech,i} = E_{Mech,f}$$

$$½(0.40kg)v^2 + (0.40kg)(9.8\,m/s^2)(0.1m) = ½(400N/m)(0.1m)^2$$

$$v = 2.84\,m/s$$

6) A 10.0 g bullet is fired horizontally at two blocks at rest on a frictionless tabletop. The bullet passes through the first block, with mass 1.00 kg, and embeds itself in the second, with mass 2.00 kg. Speeds of 0.630 m/s and 1.40 m/s, respectively, are thereby given to the blocks. Neglect the mass removed from the first block by the bullet. Find the bullet's original speed.



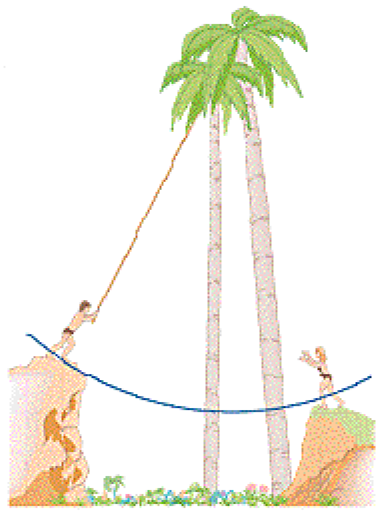
A) 937 m/s
B) 721 m/s
C) 854 m/s
D) 1170 m/s
E) 518 m/s
F) 344 m/s
G) 619 m/s
H) 801 m/s
I) 994 m/s
J) 781 m/s

$p_i = m_b v_b$ $\qquad$ $p_f = m_1 v_1 + (m_2 + m_b) v_2$

$(.01\text{ kg})v_b = (1.0\text{ kg})(0.63\text{ m/s}) + (2.01\text{ kg})(1.4\text{ m/s})$
$v_b = 344\text{ m/s}$

7) Tarzan, who weighs 920 N, swings from a cliff at the end of a convenient vine that is 10 m long. From the top of the cliff to the bottom of the swing, he descends by 2.0 m. The vine will break if the force on it exceeds 2000 N. What is the greatest force on the vine during the swing?

A) 1466 N
B) 1186 N
C) 999 N
D) 1694 N
E) 1875 N
F) 1333 N
G) 1580 N
H) 1711 N
I) 847 N
J) 1287N



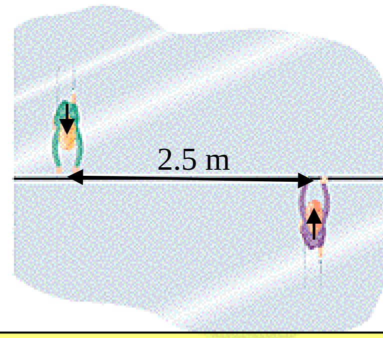
At bottom of swing, $1/2mv^2 = mgh \Rightarrow v = 6.26$ m/s

$\sum F_y = F_V - mg = ma = mv^2/r$

$F_V = mv^2/r + mg = 920N/(9.8m/s^2)(6.26m/s)^2/10m + 920N$

$F_V = 1287$ N

8) Two skaters, each of mass 50 kg, approach each other along parallel paths separated by 2.5 m. They have equal and opposite velocities of 1.0 m/s. The first skater carries one end of a long pole with negligible mass, and the second skater grabs the other end of it as she passes. By pulling on the pole, the skaters reduce their separation to 1.0 m. What is their angular speed then? Assume frictionless ice.

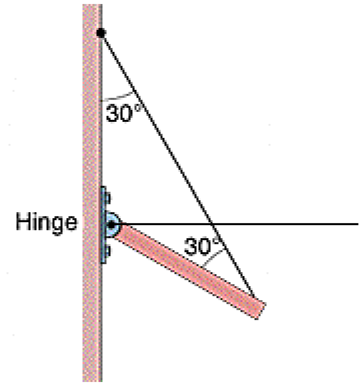


A) 4.32 rad/s
B) 5.00 rad/s
C) 9.32 rad/s
D) 8.64 rad/s
E) 0.80 rad/s
F) 2.77 rad/s
G) 3.92 rad/s
H) 2.03 rad/s
I) 6.32 rad/s
J) 0.40 rad/s

Use point in between skaters as reference point, then angular momentum brought into system is:
$L = r \times p = 1.25m(50kg)(1.0m/s) + 1.25m(50kg)(1.0m/s)$
$= 125.0\ kgm^2/s$
As they pull together, angular momentum stays constant:
$L = I\ \omega = 125.0\ kgm^2/s$ but $I = mr^2$ so:
$125.0\ kgm^2/s = (2)(50)(0.5m)^2\omega$
$\omega = 5.00s^{-1}$

9) One end of a uniform beam that weighs 197 N is attached to a wall with a hinge. The other end is supported by a wire. Find the horizontal component of the force from the hinge on the beam.

A) 118 N
B) 188 N
C) 98.5 N
D) 142 N
E) 85.3 N
F) 171 N
G) 102 N
H) 122 N
I) 131 N
J) 0 N



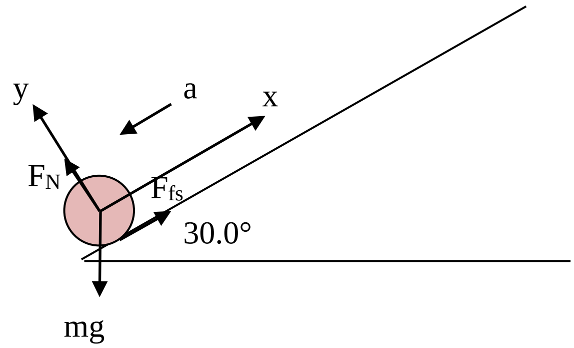
About the hinge: $\sum \tau = 0 = -mg\cos(30)(L/2) + F_W\sin(30)(L)$

$F_W = (mg\cos(30))/(2\sin(30)) = 171N$

The horizontal component of this foce is 171 N * cos60 = 85.3 N

10) A uniform hollow spherical ball ($I=2/3MR^2$) of mass 3.50 kg rolls without slipping **up** a ramp that rises at 30.0° above the horizontal. The speed of the ball at the base of the ramp is 3.50 m/s. What is the magnitude and direction of the frictional force acting on the ball?

A) 6.11 N down the ramp
B) 3.97 N down the ramp
C) 4.63 N down the ramp
D) 5.21 N down the ramp
E) 3.43 N down the ramp
F) 6.86 N up the ramp
G) 3.97 N up the ramp
H) 4.63 N up the ramp
I) 5.21 N up the ramp
J) 3.43 N up the ramp



In the x-direction:
$\sum F_x = F_{fs} - mg*\sin 30 = -ma$

and the torques:
$\sum \tau_z = r F_{fs} = I\alpha = 2/3mr^2*a/r$ =>

$F_{fs} = 2/3ma$ => $a = 3/2 F_{fs} / m$

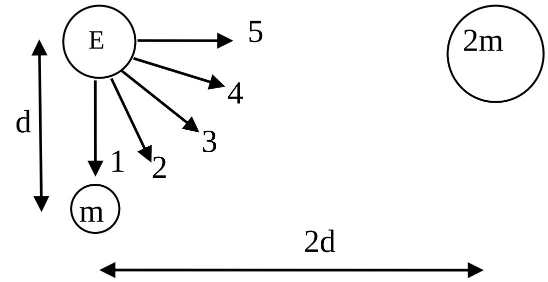
then,

$F_{fs} - mg*\sin 30 = -3/2 F_{fs}$ =>

$F_{fs} = 2/5 mg*\sin 30 = 6.86N$ Up the ramp.

11) A planet of mass m is a distance d from Earth. Another planet of mass 2m is a distance 2d from Earth. Which force vector best represents the direction of the total gravitation force on Earth?

A) 1
B) 2
C) 3
D) 4
E) 5
F) Depends on the mass of the earth.
G) It depends on the distance, d.
H) Not enough information to solve.



12) A meteoroid, heading straight for Earth, has a speed of 10.2 km/s relative to the center of Earth when it is a distance of 8.00×10^8 m from the earth's center. What is the meteoroid's speed as it hits the earth? You can neglect the effects of the moon, earth's atmosphere, and any motion of the earth. ($G = 6.67 \times 10^{-11}$ N · m^2/kg^2, $M_{earth} = 5.97 \times 10^{24}$ kg, $R_{earth} = 6.37 \times 10^6$ m)

A) 87.3 km/s
B) 32.4 km/s
C) 18.5 km/s
D) 21.5 km/s
E) 45.6 km/s
F) 96.0 km/s
G) 15.1 km/s
H) 28.7 km/s
I) 11.5 km/s
J) 10.5 km/s

13) In order to have simple harmonic motion, the acceleration must be proportional to the:

A) amplitude
B) frequency
C) velocity
D) displacement
E) displacement squared

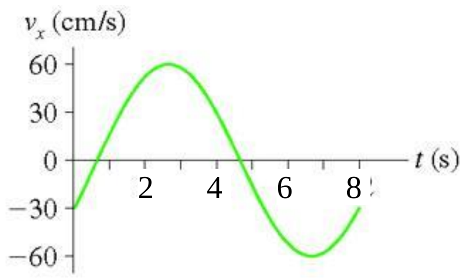
14) An object attached to one end of a spring makes 25 complete oscillations in 5s. Its period is:

A) 4 Hz
B) 0.2 s
C) 0.5 Hz
D) 2 s
E) 0.50 s
F) 3 s
G) 0.3 s
H) 5 s
I) 25 Hz
J) 5 Hz

15) A 2.5 kg ideal harmonic oscillator has a total mechanical energy of 35 J. If the oscillation amplitude is 20.0 cm, what is the oscillation frequency?

A) 4.2 Hz
B) 2.1 Hz
C) 7 Hz
D) 3.5 Hz
E) 26.4 Hz
F) 13.2 Hz
G) 8.9 Hz
H) 119.4 Hz
I) 63.1 Hz
J) 42.0 Hz

16) The figure below is the velocity-versus-time graph of a particle in simple harmonic motion. What is the amplitude of oscillations?



A) 76 cm
B) 30 cm
C) 12 s
D) 24 cm
E) 60 cm
F) 53 cm
G) 5.0 cm
H) 12 cm
I) 120 cm
J) No way to determine.

17) A particle is in simple harmonic motion along the horizontal x axis. The amplitude of the motion is x_m. When it is at $x = 1/2x_m$, its kinetic energy is K = 4J and its potential energy (measured with U = 0 at x = 0) is U = 2J. When it is at $x = -x_m$, the kinetic and potential energies are:

A) K = 2J and U = 4J
B) K = 0J and U = 4J
C) K = 6J and U = 0
D) K = 0 and U = 6J
E) K = 0 and U = -6J
F) K = 2J and U = -4J
G) K = 0J and U = 2J
H) K = 4J and U = 2J
I) K = 4J and U = 6J
J) Not enough information to determine.