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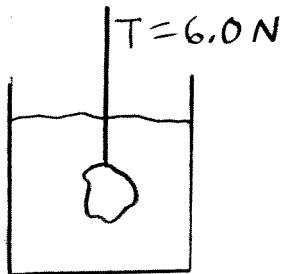
Name (signature as on ID) \_\_\_\_\_

Section \_\_\_\_\_

Final Exam Chpts. 1-16 in Young/Geller

Show all your work. Partial credit will be given if earned. Write your answers in the blanks provided.

(8 pts) 1. A rock has mass  $0.80 \text{ kg}$  and volume  $2.7 \times 10^{-4} \text{ m}^3$ . When the rock is suspended from a string and totally immersed in a liquid, the tension in the string is  $6.0 \text{ N}$ .



a) Calculate the force that the liquid exerts on the rock.

Ans. 1.84 N

b) Calculate the density of the liquid.

Ans. 69.5 kg/m<sup>3</sup>

(10 pts) 2. A small rock is projected from ground level with an initial velocity that has magnitude  $v_0 = 40$  m/s and that is at an angle of  $53^\circ$  above the horizontal. The rock strikes the vertical wall of a building 4.0 s after it leaves the ground. Neglect air resistance.



a) Calculate the horizontal distance from the initial position of the rock to the wall of the building.

Ans. 96 m

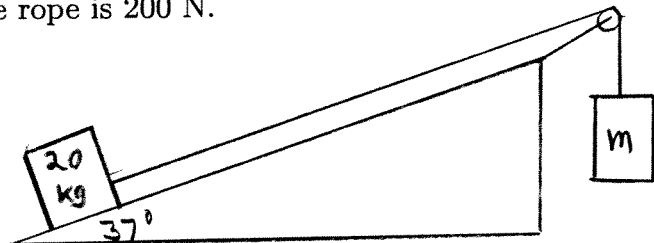
b) Calculate the vertical height above the ground of the point where the rock strikes the building.

Ans. 49.6 m

c) What is the speed of the rock just before it strikes the building?

Ans. 25.1 m/s

(10 pts) 3. A 20 kg block is placed on a ramp that is inclined at  $37^\circ$  above the horizontal. The coefficient of kinetic friction between the ramp surface and the block is 0.40. A light rope that passes over a light, frictionless pulley connects the 20 kg block to a block of mass  $m$ , that hangs suspended from the free end of the rope. When the system is released from rest, the 20 kg block moves up the incline. While the blocks are moving, the tension in the rope is 200 N.



a) Calculate the friction force on the 20 kg block.

Ans. 62.8 N

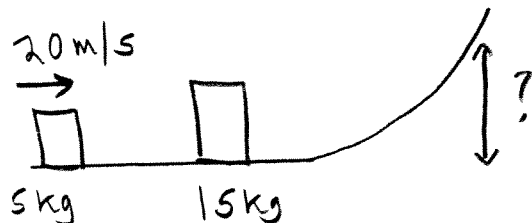
b) Calculate the acceleration of the 20 kg block.

Ans. 0.96 m/s<sup>2</sup>

c) Calculate the mass  $m$  of the hanging block.

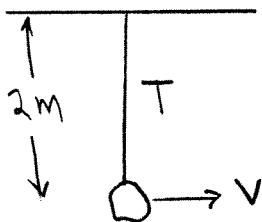
Ans. 22.6 kg

(8 pts) 4. A 5.0 kg chunk of ice is sliding at 20 m/s on a level frictionless surface. The 5.0 kg chunk collides with a 15.0 kg chunk of ice that is initially at rest and the two chunks of ice stick together. The combined object then slides up a frictionless hill. What maximum vertical height above the horizontal surface does the combined object reach?



Ans. 1.28 m

(10 pts) 5. A small rock of mass  $m$  is suspended from a 2.0 m long rope, with the other end of the rope fastened to the ceiling. The rock is pulled to one side and released. As the rock swings through its lowest point, where the rope is vertical, it has speed  $v = 4.0$  m/s and the tension in the rope at this point in the motion is  $T = 49$  N.



a) What are the magnitude and direction of the acceleration of the rock at this point?

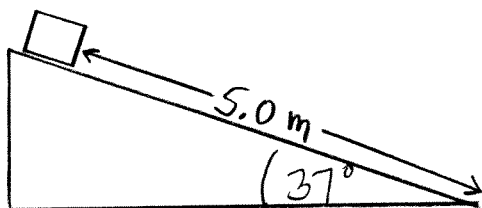
Ans.  $a =$  8 m/s<sup>2</sup>

direction? upward

b) Calculate the mass  $m$  of the rock.

Ans. 2.75 kg

(10 pts) 6. A box with mass 5.0 kg is placed on a ramp that is inclined at  $37^\circ$  above the horizontal. The box is released from rest and it slides 5.0 m down the ramp to the bottom. While the box is moving, the ramp exerts a constant friction force of 20.0 N on it.



a) During the motion from the initial position to the bottom of the ramp, how much work does the friction force do on the box?

Ans. -100 J

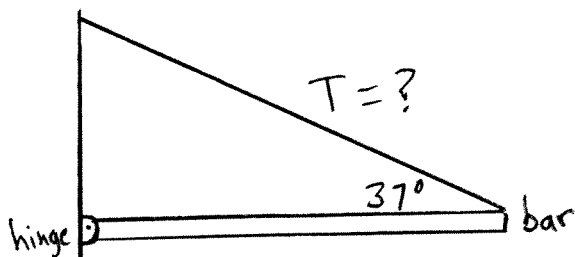
b) During the motion from the initial position to the bottom of the ramp, how much work does the gravity force do on the box?

Ans. 147 J

c) What is the speed of the box when it reaches the bottom of the ramp?

Ans. 4.34 m/s

(10 pts) 7. A uniform bar is 6.0 m long and has mass 20 kg. One end of the bar is attached to a vertical wall by a frictionless hinge. The bar is held in a horizontal position by a light rope that makes an angle of  $37^\circ$  with the bar. Calculate the tension in the rope.



Ans. 163 N

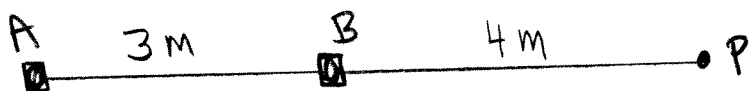
(8 pts) 8. A block with mass 0.40 kg is attached to a horizontal spring and moves in simple harmonic motion on a horizontal frictionless surface. The amplitude of the motion is 0.20 m. The maximum speed of the block during its motion is 5.0 m/s. What is the force constant  $k$  of the spring?

Ans. 250 N/m

(8 pts) 9. A solid uniform sphere that has mass 2.0 kg and radius 0.080 m is released from rest at the top of a ramp. The sphere rolls without slipping down the incline. The moment of inertia of a uniform sphere for rotation about an axis through its center is  $I = \frac{2}{5}MR^2$ . If the initial vertical height of the sphere above the bottom of the incline is  $h = 3.0$  m, calculate the angular velocity of the rotating sphere when it reaches the bottom of the incline.

Ans. 81.0 rad/s

(8 pts) 10. Two small speakers,  $A$  and  $B$ , operate from the same amplifier and emit coherent sound waves of frequency  $f$ . The speed of the sound waves is 340 m/s. Speaker  $B$  is 3.0 m to the right of speaker  $A$  and point  $P$  is 4.00 m to the right of speaker  $B$ . What is the smallest value of  $f$  for which there will be destructive interference at point  $P$ ?



Ans. 56.7 Hz

(10 pts) 11. A sample of monatomic ideal gas expands to twice its original volume, and 400 J of work is done in the process. For the gas,  $C_V = 3R/2$ . Find change in internal energy of the gas if the process is

a) isothermal (constant temperature)

Ans. 0

b) adiabatic ( $Q = 0$ )

Ans. -400 J

c) isobaric (constant pressure)

Ans. 600 J