(10 pts) 1. A small rock is thrown from the edge of the roof of a building with an initial velocity that has magnitude \( v_0 = 20.0 \text{ m/s} \) and a direction of \( \theta = 53.1^\circ \) above the horizontal. The rock hits the ground 4.00 s after it was thrown. Neglect air resistance.

a) What is the horizontal distance from the point where the rock was thrown to where it strikes the ground?

Ans. ___________

b) What is the height of the building?

Ans. ___________

c) What is the maximum height about the ground reached by the rock during its motion?

Ans. ___________

d) What is the speed of the rock just before it strikes the ground?

Ans. ___________
(10 pts) 2. A block of mass $m$ sits on a horizontal frictionless tabletop. It is connected by a light rope that passes over a light frictionless pulley to a block of mass 5.00 kg that is suspended from the end of the rope. The blocks are released from rest and the 5.00 kg block descends downward 6.00 m in 3.00 s.

a) While the blocks are moving, what is the tension in the rope?

Ans. ________

b) What is the mass $m$ of the block on the table?

Ans. ________
(10 pts) 3. A box of mass 5.00 kg is released from rest at the top of a ramp and slides down the ramp. The ramp is inclined at 53.1° above the horizontal. The coefficient of kinetic friction between the box and the ramp is $\mu_k = 0.400$.

a) What is the magnitude of the friction force that the ramp exerts on the box as the box slides down the ramp?

Ans. 

b) What is the magnitude of the acceleration of the box?

Ans. 

c) If the length of the ramp is 16.0 m, how much time does it take the box to reach the bottom of the ramp?

Ans. 
(8 pts) 4. A rock with mass 0.400 kg rests on a horizontal frictionless surface. A bullet with mass $5.0 \times 10^{-3}$ kg traveling horizontally in the $+x$-direction at 210 m/s strikes the rock and rebounds horizontally in the $+y$-direction with a speed of 90 m/s. What are the $x$ and $y$ components of the velocity of the rock after it has been struck by the bullet?

Ans. $x$-component

$y$-component

(7 pts) 5. A block with mass $m = 0.300$ kg is attached to one end of a horizontal spring and moves on a horizontal frictionless surface. The force constant $k$ of the spring is 195 N/m. The other end of the spring is attached to a wall. When the block is at $x = 0.0700$ m its velocity is $v_x = +6.00$ m/s. What is the amplitude of the motion?

Ans. ________________
(8 pts) 6. A small block with mass 5.00 kg is released from rest at point A at the top rim of a hemispherical bowl that has radius \( R = 0.600 \) m. The block slides down the inside surface of the bowl. When it reaches point B at the bottom of the bowl, its speed is 2.8 m/s.

![Diagram](image)

a) As the block slides from point A to point B, how much work is done on it by friction?

Ans. ______________ 

b) As the block slides through point B, what is the magnitude of the normal force that the bowl exerts on the block?

Ans. ______________ 

(10 pts) 7. A block of mass 5.00 kg is placed against a horizontal spring that is compressed with 230 J of potential energy stored in the spring. The spring is released and the block moves along a horizontal surface, leaving the spring behind. The coefficient of kinetic friction between the block and the surface is \( \mu_k = 0.400 \).

a) How much work does the friction force do on the block as the block moves 3.00 m from the point where it is released?

Ans. ______________ 

b) What is the speed of the block after it has traveled 3.00 m from its initial position?

Ans. ______________
8. A uniform bar that has mass 5.00 kg and length 6.00 m is attached to a vertical wall by a frictionless hinge at one end. A horizontal wire that runs from the upper end of the bar to the wall holds the bar at an angle of 53.1° above the horizontal. The moment of inertia of the bar for an axis at the hinge is \((1/3)ML^2\), where \(M\) is the mass of the bar and \(L\) is the length of the bar.

a) What is the tension \(T\) in the wire?

\[\text{Ans.} \] 

b) If the wire breaks, what is the initial angular acceleration of the bar right after the wire breaks?

\[\text{Ans.} \]
9. A rock that has density $3200 \text{ kg/m}^3$ is suspended from the end of a light string.

a) When the rock is in air, the tension in the string is 28.0 N. What is the volume of the rock?

Answer: __________

b) When the rock is totally immersed in water (density $1000 \text{ kg/m}^3$), what is the magnitude of the buoyant force that the water exerts on the rock?

Answer: __________

c) When the rock is totally immersed in water, what is the tension in the string?

Answer: __________
(9 pts) 10.

a) A sample of ideal gas has \( C_p = 5R/2 \). The temperature of 5.00 moles of the gas is raised from 80.0°C to 110.0°C while the gas pressure is kept constant. Calculate the work \( W \) done by the gas and the change in internal energy of the gas.

\[ \text{Ans. } W \]

\[ \Delta U \]

b) A sample of ideal gas has \( C_p = 5R/2 \). In an adiabatic process the temperature of 5.00 moles of the gas is raised from 80.0°C to 110.0°C.

In this process does the volume of the gas increase or decrease?

\[ \text{Ans. } \]

Calculate the work \( W \) done by the gas in this process.

\[ \text{Ans. } \]

c) A sample of ideal gas has \( C_p = 5R/2 \). In a constant temperature process at \( T = 127°C \) the volume of 5.00 moles of the gas is increased from \( V_1 = 3.00 \, \text{m}^3 \) to \( V_2 = 9.00 \, \text{m}^3 \).

What is the magnitude of the heat flow \( Q \) for this process?

\[ \text{Ans. } \]

Does heat flow into the gas or out of the gas?

\[ \text{Ans. } \]
(9 pts) 11. A hollow sphere \( I = (2/3)MR^2 \) with mass 2.00 kg and radius 0.120 m is released from rest at the top of a ramp that is inclined at 36.9° above the horizontal. The length of the ramp is 1.80 m.

a) If the hollow sphere rolls without slipping, what is the translational speed of its center of mass when it reaches the bottom of the ramp?

Ans. ________________

b) How long (time) does it take the sphere to reach the bottom of the ramp?

Ans. ________________

c) What is the magnitude of the static friction force required for the hollow sphere to roll without slipping?

Ans. ________________