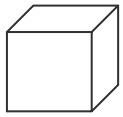
The following problems constitute an Honor Code assignment. Please produce clear, cogent solutions to each problem on separate sheets of paper. You may use your text and notes but may not use any other resources. If you have any questions, please talk to me.

1. A helicopter holding a 70-kg package suspended from a 5.0 meter long rope accelerates upward at a rate of 5.2 m/s^2. Neglect air resistance on the package.

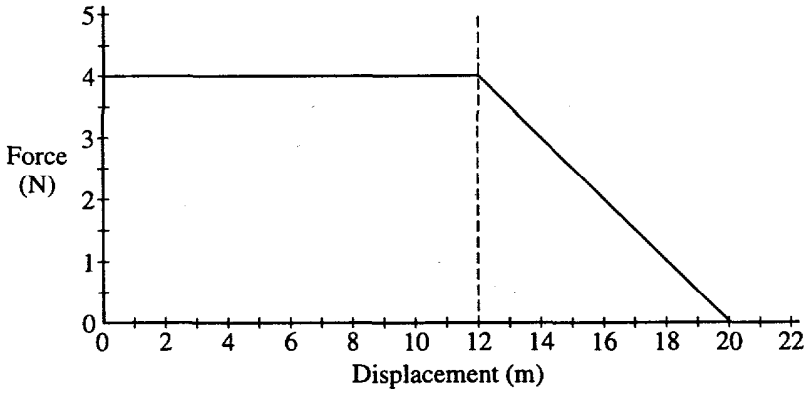
a. On the diagram below, draw and label (by type, not value) all of the forces acting on the package.



b. Derive a relationship for the tension in the rope and determine the value of the tension.

c. When the upward velocity of the helicopter is 30 m/s, the rope is cut and the helicopter continues to accelerate upward at 5.2 m/s^2. Determine the distance between the helicopter and the package 2.0 seconds after the rope is cut.

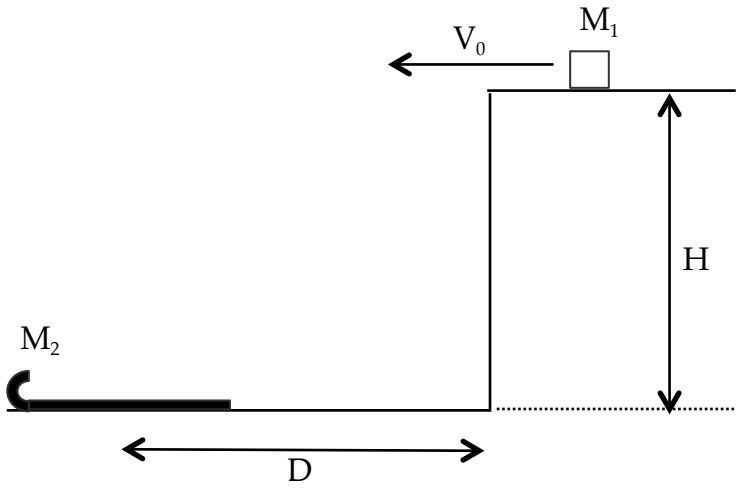
2.



A 0.20 kg object moves along a straight line. The net force acting on the object varies with the object's displacement as shown in the graph above. The object starts from rest at $x = 0$ at $t = 0$ and is displaced a total distance of 20 m. Determine each of the following.

a. The acceleration of the object when its displacement x is 6 m.
b. The time taken for the object to be displaced the first 12 m.
c. The amount of *work done* by the net force in displacing the object the first 12 m.
d. The speed of the object at displacement $x = 12$ m.
e. The final speed of the object at displacement $x = 20$ m.
f. The change in momentum of the object as it is displaced from $x = 12$ m to $x = 20$ m.

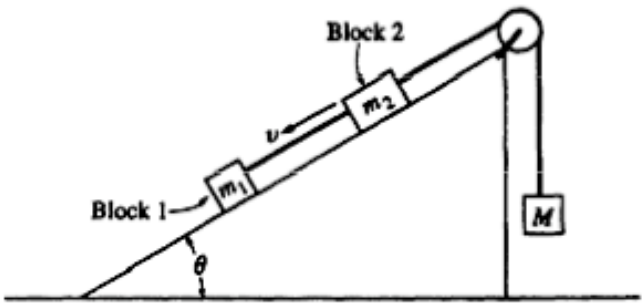
3.



A block of mass M_1 travels horizontally with a constant speed v_0 on a plateau of height H until it comes to a cliff. A toboggan of mass M_2 is positioned on level ground below the cliff as shown above. The center of the toboggan is a distance D from the base of the cliff.

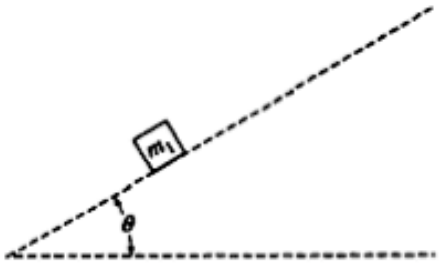
a. Determine D in terms of v_0, H, and *g* so that the block lands in the center of the toboggan.
b. The block sticks to the toboggan that is free to slide without friction. Determine the resulting velocity of the block and toboggan.
c. Determine the change in kinetic energy of the block-toboggan system as a result of the collision.

4.



Blocks 1 and 2 with masses m_1 and m_2, respectively, are connected by a light string, as shown above. These blocks are connected to a block of mass M by another light string that passes over a pulley of negligible mass and friction. Blocks 1 and 2 move with a constant velocity v down the incline which makes an angle θ with the horizontal. The frictional force on block 1 is f and that on block 2 is $2f$.

a. On the figure below, draw and label all the forces on block m_1.



Express your answers to each of the following in terms of m_1, m_2, g, θ and f.

b. Determine the coefficient of friction, μ, between the incline and block 1.

c. Determine the value of the suspended mass, M, that allows blocks 1 and 2 to move with a constant velocity.

d. The string between blocks 1 and 2 is now cut. Determine the acceleration of block 1 while it is on the incline.