Name: _____

Class: _____

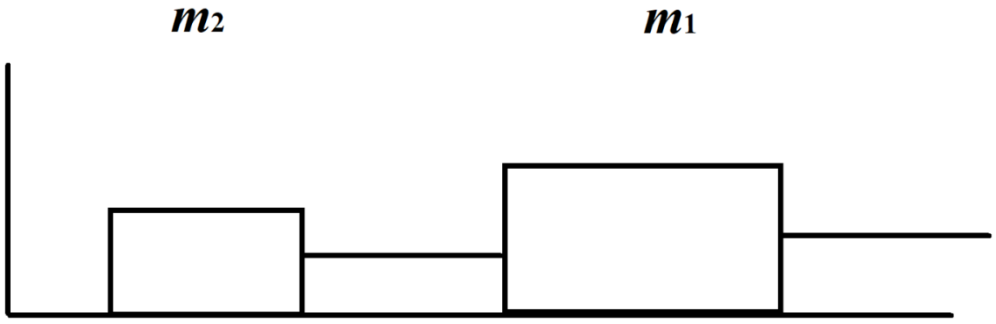
Due Date: _____

Physics Topic 11B – Applying Newton's Second Law of Motion to Coupled Systems

Answer the following questions. The solutions to this worksheet can be found on the YouTube channel Go Physics Go.

1. E: A block with a mass $m_2 = 20.0$ kg is on a rough horizontal surface with a coefficient of friction of $\mu = 0.400$. Attached to the right of m_2 is a massless string which is pulling m_2 to the right with a force of tension F_T. Attached to the right of the massless string is another block of mass $m_1 = 30.0$ kg. Attached to the right of m_1 is another massless string which pulls the whole system with a constant pulling force $F_{pull} = 800.$ N and constant acceleration a.

   a. Draw a free body diagram.

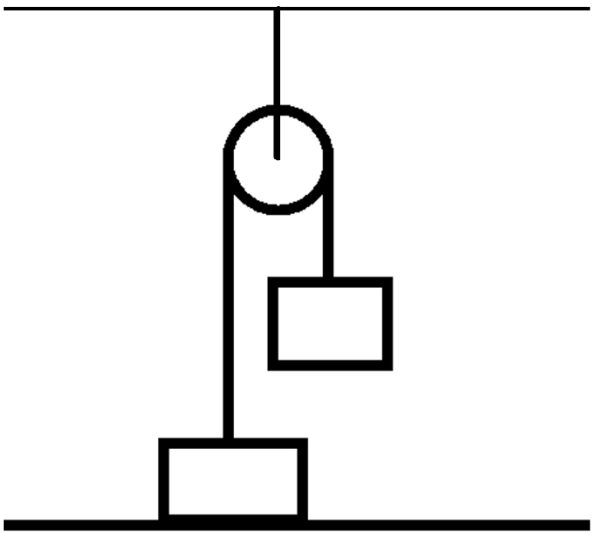


   b. Find the acceleration of the whole system a.

   c. Find the force of tension F_T of the massless string which attaches both masses.

2. E: Atwood's machine. A massless frictionless pulley is attached to a ceiling. Mass $m_1 = 16.0$ kg is at rest on the ground. It is attached to a massless string which goes over the massless frictionless pulley and is attached to another mass $m_2 = 46.0$ kg which is also initially at rest in the air. m_2 is released from rest and both masses accelerate at a constant rate.

   a. Draw a free body diagram.

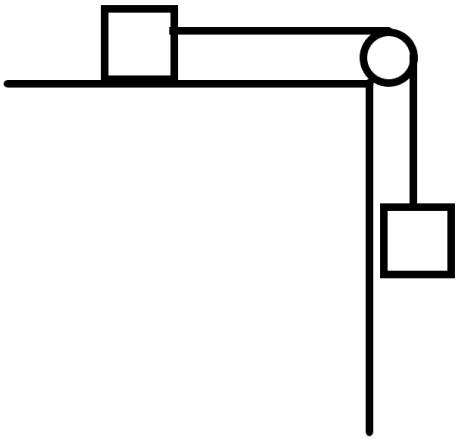


   b. Find the common acceleration of the system.

   c. Find the force of tension F_{tension} of the massless string.

3. E: A block of mass $m_1 = 12.0$ kg sits at rest on a horizontal surface with $\mu = 0.240$. Mass m_1 is attached to a massless string which goes over a massless pulley which is attached to another block of mass $m_2 = 36.0$ kg.

   a. Draw a free body diagram.

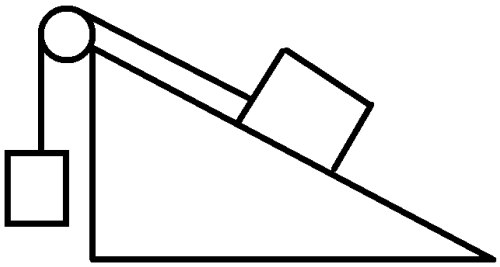


   b. Determine the common acceleration of the blocks.

   c. Determine the force of tension on the string.

4. E: A 4.00 kg mass m_1 is initially at rest on a $\theta = 30.0°$ incline. The surface has a coefficient of friction $\mu = 0.400$. The 4.00 kg mass has a massless string attached to it which goes over the top of the incline above a frictionless pulley to another mass m_2 of 18.0 kg which is hanging in the air. Both objects are released from rest and move with a constant acceleration. m_2 moves down while m_1 moves up the incline.

   a. Draw a free body diagram.

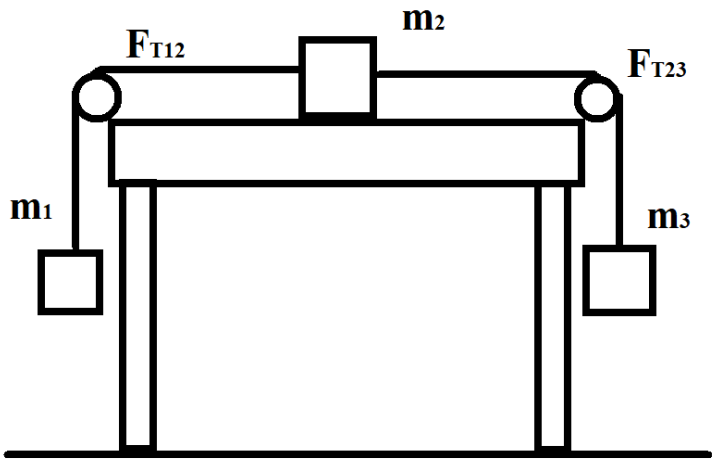


   b. Calculate the common acceleration of each object.

   c. Calculate the force of tension on the string.

5. E: A block with mass $m_2 = 8.00$ kg is held at rest on a rough horizontal table which has a coefficient of friction of $\mu = 0.200$. It is attached by a string to a mass $m_3 = 14.0$ kg which hangs to the right of the table and another string to a mass $m_1 = 2.00$ kg which hangs to the left of table as shown below. Mass m_2 is released from rest and the whole system accelerates with a constant rate.

   a. Draw a free body diagram.

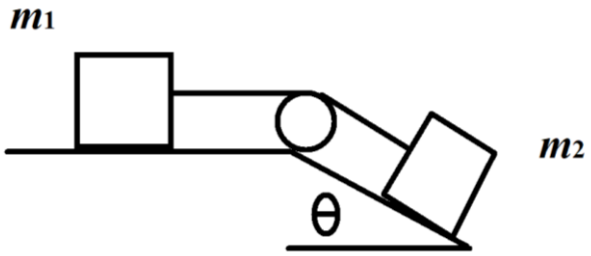


   b. Determine the acceleration of the system.

   c. Determine the force of tension of string F_{T12} and the force of tension of string F_{T23}.

6. E: An object of mass $m_1 = 2.00$ kg is sitting in a horizontal plane. It is connected to another object with mass $m_2 = 9.00$ kg by a massless string which goes over a massless pulley. The coefficient of friction between the two masses and the surface is $\mu = 0.150$. Mass m_2 is on an inclined plane which is 30.0° below the horizontal.

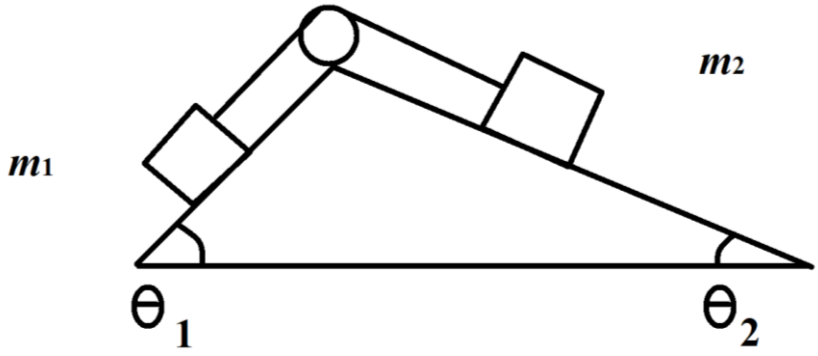
   a. Label the forces on each object.



   b. Determine the common acceleration of the two blocks and the force of tension in the massless string.

7. E: An object of mass $m_1 = 2.00$ kg is sitting in an inclined plane in which $\theta_1 = 45.0°$. It is connected to another object with mass $m_2 = 14.00$ kg by a massless string which goes over a frictionless massless pulley. The coefficient of friction between the two masses and the surface is $\mu = 0.150$. Mass m_2 is on an inclined plane in which $\theta_2 = 30.0°$.

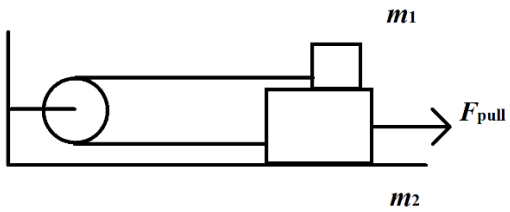
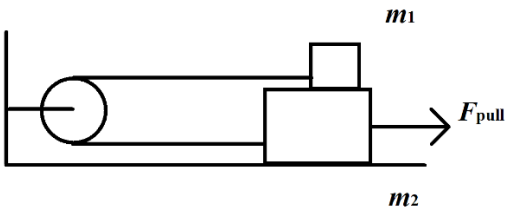
   a. Label the forces on each object.



   b. Determine the common acceleration of the two blocks and the force of tension in the massless string.

8. A block with mass m_2 is pulled to the right with a force of F_{pull}. Another block with mass m_1 sits above m_2. The coefficient of dynamic friction between the two blocks are $\mu_{1,2}$ and the coefficient of dynamic friction between m_2 and the surface is $\mu_{2,\text{s}}$.

   a. Label the forces on each object:

For m_1:	For m_2:
	

   b. Determine equations for the common magnitude of the acceleration of each block and the force of tension in the massless string in terms of m_1, m_2, $\mu_{1,2}$, $\mu_{2,\text{s}}$, F_{pull}, and g.