Dynamics Quiz Review

For each problem, draw a separate labelled free-body diagram for every object involved. Show your force equations, algebra, and calculations. Include units and directions where appropriate. Assume light, inextensible ropes and frictionless pulleys. Neglect air resistance unless otherwise stated.

MILD

1. Consider the following situations:
   a) A book rests motionless on a horizontal table. Draw and label all the forces acting on the book.
   b) A hockey puck slides to the right across rough, level ice after the hockey stick is no longer touching it. Draw and label all the forces acting on the puck. State the direction of the net force acting on each object.

2. A 12 kg equipment cart moves across a horizontal floor. A motor pushes it to the right with a force of $92\ N$, while a resistive force of $20\ N$ acts to the left.
   a) Determine the magnitude and direction of the net horizontal force acting on the cart.
   b) Calculate the cart's acceleration.

3. A winch lifts a bucket vertically upward. The cable pulls upward with a tension of $120\ N$, causing the bucket to accelerate upward at $2.2\ m/s^2$. Determine the mass of the bucket.

MEDIUM

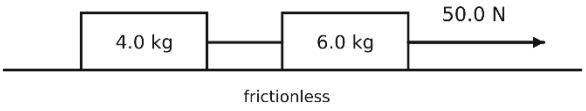
4. A 15.0 kg crate rests on a horizontal floor. The coefficient of static friction between the crate and the floor is $\mu_s = 0.40$.
   a) Determine the maximum available static frictional force between the crate and the floor.
   b) A student pushes horizontally to the right with $45\ N$, but the crate remains stationary. Determine the actual frictional force, including its direction.
   c) If the student increases the horizontal push to $65\ N$, will the crate begin moving? Justify your answer.

5. A 5.0 kg box is already sliding right across a rough horizontal floor. A student pushes it horizontally to the right with a constant force of $34.5\ N$, producing an acceleration of $2.0\ m/s^2$ to the right.
   a) Determine the magnitude of the kinetic frictional force.
   b) Calculate the coefficient of kinetic friction between the box and the floor.

6. A 10.0 kg crate is already sliding right across a rough horizontal floor. A student pushes it horizontally right with a constant force of $80.0\ N$. The coefficient of kinetic friction is $\mu_k = 0.25$.
   a) Determine the acceleration of the crate.
   b) A second student now pulls vertically upward on the crate with $20.0\ N$, while the first continues pushing with $80.0\ N$. The crate remains in contact with the floor. Determine the new normal force.
   c) Calculate the crate's new acceleration.

7. A 60.0 kg passenger stands on a scale inside an elevator. The elevator is travelling upward but slowing uniformly at 1.5 m/s^2.
   a) Determine the passenger's apparent weight while the elevator is slowing down.
   b) Determine the scale reading if the elevator instead travels upward at constant velocity.

8. Two blocks of masses 4.0 kg and 6.0 kg are connected by a light rope on a frictionless horizontal floor. A person pulls the 6.0 kg block to the right with a constant force of 50.0 N.

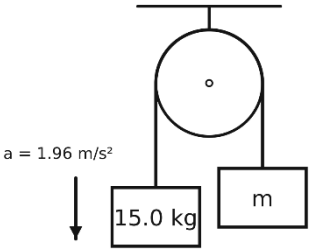


   a) Determine the magnitude and direction of the acceleration of the system.
   b) Calculate the tension in the connecting rope.

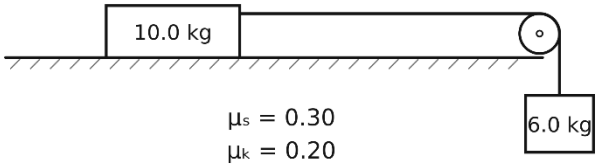
SPICY

9. A 0.16 kg hockey puck slides to the right across level ice at 7.0 m/s. It travels another 50.0 m before coming to rest. Assume kinetic friction is the only horizontal force acting on the puck and remains constant.
   a) Determine the acceleration of the puck, including its direction.
   b) Calculate the coefficient of kinetic friction between the puck and the ice.

10. Two masses are connected by a light rope passing over a frictionless pulley. One mass is 15.0 kg, while the other has an unknown mass m. The 15.0 kg mass accelerates downward at 1.96 m/s^2.
   a) Determine the tension in the rope.
   b) Calculate the unknown mass.

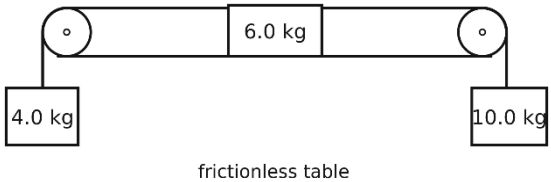


11. A 10.0 kg block rests on a rough horizontal table. It is connected by a light rope over a frictionless pulley to a hanging 6.0 kg mass. The coefficients of friction between the table and the block are $\mu_s = 0.30$ and $\mu_k = 0.20$. The system is initially at rest.



   a) Determine whether the system will begin moving. Justify your answer with calculations.
   b) If the system moves, determine the magnitude and direction of its acceleration.
   c) Calculate the tension in the rope while the blocks are sliding.

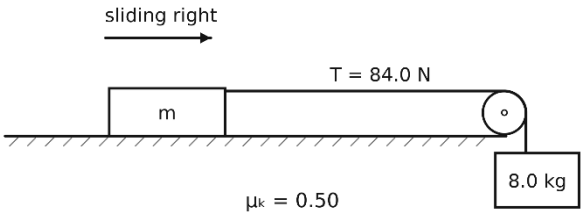
12. Three masses are connected by two separate ropes passing over frictionless pulleys. A 4.0 kg mass hangs on the left, a 6.0 kg block rests on a frictionless horizontal table, and a 10.0 kg mass hangs on the right. The system is released from rest.



   a) Determine the magnitude and direction of the system's acceleration.
   b) Calculate the tension in the left rope.
   c) Calculate the tension in the right rope.

EXTRA-SPICY

13. A block of unknown mass m is given a brief push to the right across a rough horizontal table. After the push ends, the block continues sliding right. A light rope passes over a frictionless pulley on the right and connects it to a hanging 8.0 kg mass. The coefficient of kinetic friction is $\mu_k = 0.50$. While the block is sliding right, the tension in the connecting rope is $84.0\ N$.



a) Determine the magnitude and direction of the system's acceleration.
b) Calculate the unknown mass m.
c) Is the block on the table speeding up or slowing down? Explain using its motion and acceleration.