Name: _____ Period: _____ Assigned on Friday, September 27, 2024

7.4 Newton's Second Law Problems with Guidance **Due Monday, September 30, 2024**

Solve each of the following problems. The answers are on the last page, but do not look at them until you solve the problems on your own. I used 9.8 m/s^2 for all problems.

1. What net force is required to keep a 500 kg object moving with a constant velocity of 10m/s? **(Need more help? Try Practice A on Monday)**

2. Ty Koon, whose mass is 80 kg, is skydiving. At one point during the jump, he has an instantaneous acceleration of 4 m/s^2 downward. (Important note: The force due to gravity on an object can be calculated using the equation $F_g = mg$. It ALWAYS acts straight down.) **(Need more help? Try practice B on Monday)**
   a) Draw a free-body diagram of Ty at this moment.
   b) What is the force that the air exerts on Ty?

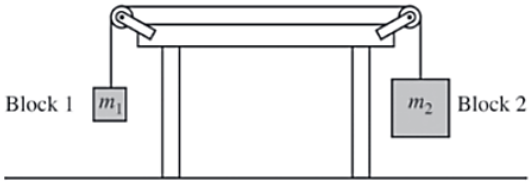
3. Carson has a mass of 65 kg and jumps from a 10. m high platform into a pool. Once he hits the water, Carson comes to a stop underwater in 0.80 seconds. **(Need more help? Try practice C on Monday.)**
   a) What is Carson's velocity the instant he hits the water? Ignore air resistance. (This is a kinematics problem)
   b) What is Carson's acceleration underwater? (This is a kinematics problem)
   c) Draw a free-body diagram of Carson underwater.
   d) What is the force that the water exerts on Carson?

4. Jason and Maddy are pushing a 100 kg box across an ice skating rink. The box is moving with an acceleration of 1.5 m/s^2. Jason can push on the box twice as hard as Maddy can. Friction is negligible. (Hint: Don't forget about the normal force which acts upward, perpendicular to the ground, and supports the box. In this case, it must be equal and opposite to the force of gravity since the box is not moving in the y-direction.) **(Need more help? Try practice D on Monday.)**
   a) Draw a free-body diagram of the box.
   b) What force is each person applying?

5. Felix is pushing a two block system as shown to the right. Friction is negligible. The block system is accelerating at 1.2 m/s^2. **(Need more help? Try practice E on Monday.)**

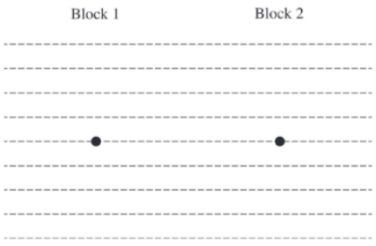
   a) How much force is Felix using to push the system?
   b) How much force is the 15 kg block pushing the 5 kg block with? (Remember: The acceleration of both blocks is the same, but the second block has less mass. Therefore there MUST be less force pushing it.)

6. Two blocks are connected by a string of negligible mass that passes over massless pulleys that turn with negligible friction, as shown in the figure to the right. The mass of block 1 is 0.50 kg and the mass of block 2 is 1.5 kg. The blocks are released from rest. **(Need more help? Try practice F on Monday.)**



Note: Figure not drawn to scale.

a) The dots to the right represent the two blocks. Draw free body diagrams showing and labeling the forces (not components) exerted on each block. Draw the relative lengths of all vectors to reflect the relative magnitudes of all the forces. (Important hint: The force exerted by the string is called "tension" and is labelled in free-body diagrams as "F_T" or just "T". In a massless string, the tension is the same everywhere in the string. This means that the upward force on both blocks must be the same.)



b) Calculate the magnitude of the acceleration of system. (Important hint: Since block 2 will be going down while block 1 goes up, it is important to use separate coordinate systems for each block so that their movements have the same sign [e.g., they both move in the positive direction, or they both move in the negative direction.] Therefore, use up as negative for block 1 and down as negative for block 2, or vice verse.)

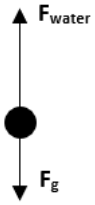
c) Calculate the tension in the string. (Hint: Just solve for the tension using one block since the tension is the same for both blocks.)

Answers

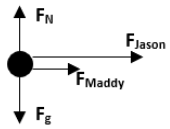
1. According to Newton's 1st Law, no net force is needed to keep an object in motion at constant velocity. According to Newton's 2nd Law, since there is no acceleration, there is no net force.

2. a) 

b) 464 N

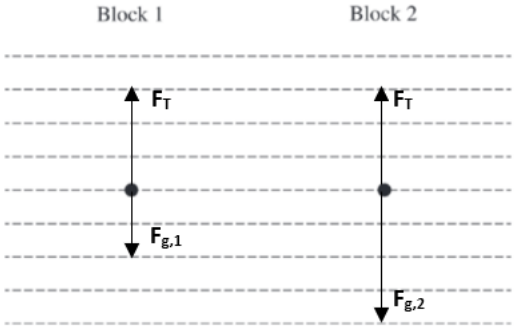
3. a) -14 m/s b) 17.5 m/s^2 c) 

d) 1137 N

4. a) 

b) F_{Jason} = 100 N and F_{Maddy} = 50 N

5. a) 24 N b) 6 N

6. a) 

b) 4.9 m/s^2

(Using - for up for block 1 and + for up for block 2. Notice that by using opposite coordinate systems, block one travels up which is negative in its coordinate system and block two travels down which is negative in its coordinate system. Since the question only asks for the magnitude of the acceleration, the positive value is given as the answer.)

c) 7.35 N