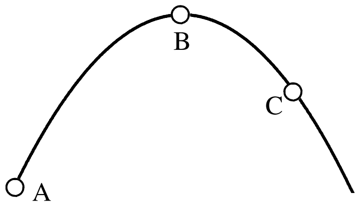
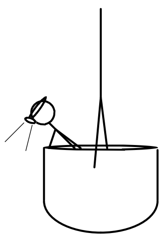
2011 PreAP Forces 13



1. The diagram shows a 2 kg projectile AFTER it has been shot.
   A, B, C or all 3?
   A. ___ Where is the vertical speed the greatest?
   B. ___ Where is the horizontal speed greatest?
   C. ___ Where is the force on the object greatest?
   D. ___ Where is the acceleration the greatest?

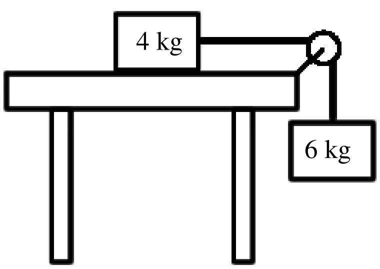
2. What is the net force acting on the object at the very top?



3. Slim Jim is also a cave explorer (known as a spelunker). A mining company asks our famous spelunker to explore part of their gold mine. Slim Jim is a slim 60 kg and the bucket is a hefty 980 kg.
   A. * Calculate the tension in the rope when he begins to accelerate downward at $-1.5\ m/s^2$.

   B. Calculate the tension in the rope when the bucket is lowered at constant speed.

   C. When it starts to slow down (just before it stops) it has an acceleration of $+2.4\ m/s^2$.
   Calculate the tension in the rope



4. Two objects are connected with a rope. Assume the table and pulley are frictionless.
   A. * Which way is positive for the 4 kg mass?
   B. * Which way is positive for the 6 kg mass?
   C. * Calculate the acceleration and tension of the system.

(*Notice the tension always cancels. This is because it is an internal force [internal to the "system"]. Only the external forces matter: the weight of the 6 kg mass. If there was friction on the table, that, too, would be an external force, since it acts on only the 4 kg mass.)*

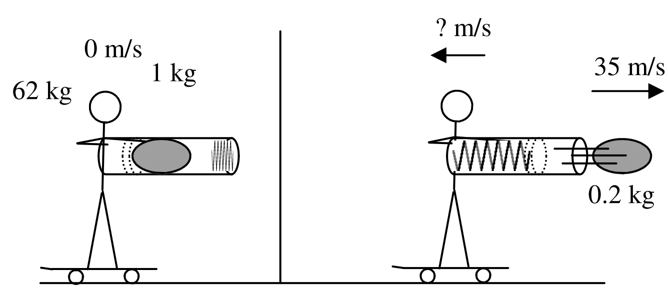
Need help with proportionality? See notes on back of page.

5. If the distance is doubled, by how much does the torque change? (*Hint: Start with the torque equation.)*

6. * If one of the masses is doubled and the distance is 1/3 as much, by how much does the gravitational force change?

7. That crazy Slim Jim shots a spring loaded potato gun (*I have no idea if the potato is loaded*), while on his skate board.

   A. What does the potato push on?
   B. Does Jim feel a force, too?
   C. Will Jim move faster or slower than the potato?
   D. Why?
   E. Draw a force diagram for Jim and the potato below:



*Ok, let's finally solve this misconception.. The spud feels ONE force pushing it to the right. Jim feels ONE force pushing him to the left. These forces **are equal** but THEY OCCUR ON DIFFERENT OBJECTS. That's the point of the 3rd Law, which doesn't talk about acceleration at all. This is not like two equal forces pushing on an object, causing equilibrium or constant speed. In that case there are two equal objects occurring on the SAME object. (O—and the potato doesn't actually push on Jim. Hmmm, what does????)*

3A) 8840N (mg_{total} = 10400 N)
4A) right 4B) down 4C) 6 m/s^2 6) see right:
7A) the spring

mult. by recipr.

$$\frac{2}{(1/3)^2} = \frac{2}{1/9} = 2\left(\frac{9}{1}\right) = 18$$

$$F_1 = G\frac{m_1 m_2}{r_1^2} \text{ and } F_2 = G\frac{m_1 m_2}{r_2^2}$$

Understanding proportionality.

Substitute $r_2 = 2r_1$ $$F_2 = G\frac{m_1 m_2}{(2r_1)^2} = G\frac{m_1 m_2}{4r_1^2}$$

Q: If the distance is doubled, by how much does gravity change? ($r_2 = 2r_1$)

Substitute $r_2 = 2r_1$ $$F_2 = G\frac{m_1 m_2}{(2r_1)^2} = G\frac{m_1 m_2}{4r_1^2}$$

Answer: The force is 1/4 as strong.

Pull out F_1 $$F_2 = \frac{1}{4}\left(G\frac{m_1 m_2}{r_1^2}\right) = \frac{1}{4}F_1$$

You should then be able to see that since the r is squared and in the denominator, then put a 2 in, gives a 4 on the bottom = 1/4.