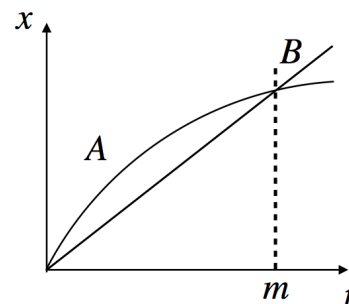


Physics@Mac Online Physics Competition  
December 6, 2017

1. The graph shows displacement as a function of time for two trains running on parallel tracks. Which of the following is true?

- a) At time  $m$ , both trains have the same velocity and the same position.
- b) Both trains speed up all the time and they meet at point  $B$ .
- c) Somewhere on the graph, both trains have the same acceleration.
- d) Both trains have the same velocity at some time before  $m$  and meet at point  $B$ .



2. A heavy object and a light object are sliding with equal speeds along a level frictionless surface. They then both slide up the same frictionless hill. Which object rises to a greater height?

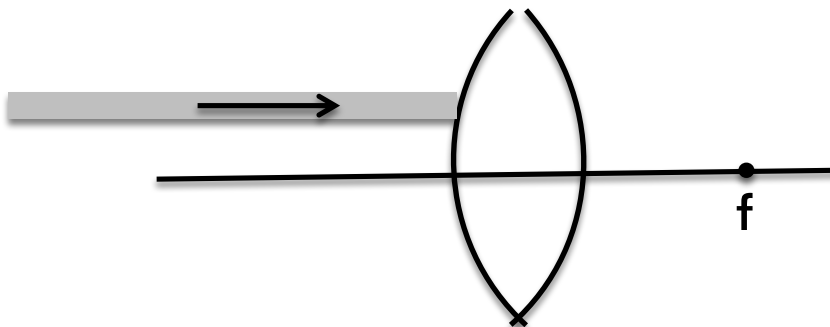
- a) The heavy object.
- b) The light object.
- c) They both slide to the same height.
- d) It is impossible to know with the given information.

3. If the hairs from a person's head were laid end to end in a straight line, how long would the line be? (Assume a younger person with no signs of baldness, with hair that is about shoulder length).

- a) 0.1 km
- b) 10 km
- c)  $10^3$  km
- d)  $10^5$  km

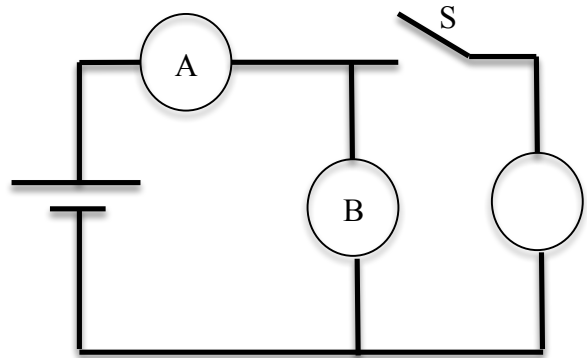
4. A glass lens has a positive focal length  $f$ . A narrow beam of light parallel to the central axis of the lens strikes the lens a distance  $d$  above its centre. The beam is focused at a position that is

- a) above the focal point.
- b) below the focal point.
- c) at the focal point.
- d) to the right of the focal point.



5. In the circuit to the right, the circles represent three identical light bulbs. The switch S is open to begin. After closing the switch,

- bulb A is dimmer and bulb B is brighter.
- bulb A is brighter and bulb B is dimmer.
- both bulbs A and B are brighter.
- both bulbs A and B are dimmer.

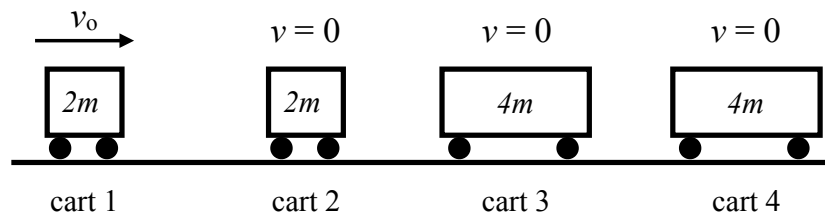


6. Two pennies are thrown from the top of a cliff, each with a different unknown velocity, one a few tenths of a second after the first. If air resistance is ignored, as they fall which statement below is always true:

- The vertical distance between them remains constant while they are both in the air.
- The vertical distance between them continually increases while they are both in the air.
- The horizontal distance between them remains constant while they are both in the air.
- None of the above.

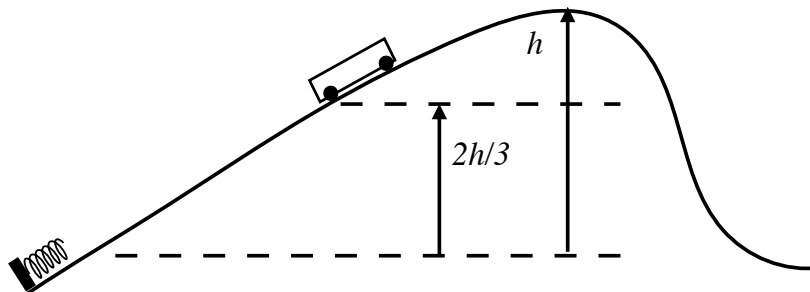
7. Four carts shown below have masses as indicated. Initially only cart 1 is moving. It has a speed  $v_0$  in the positive direction. The collision between cart 1 and cart 2 is *perfectly inelastic*. All other collisions are *perfectly elastic*. At the end of the collisions, what is the velocity of cart 4?

- $v_0/4$
- $v_0/2$
- $v_0$
- $2v_0$



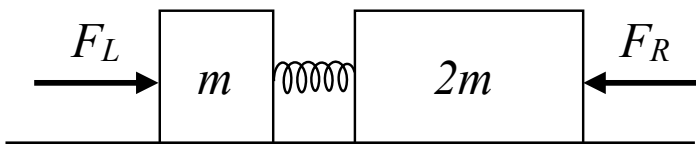
8. Physics Girl is sitting in a cart on a hill that has a height  $h$ . She has zero velocity at a height that is  $2h/3$ , and starts to roll down the hill towards a spring. Physics Girl and the cart have a combined mass of  $M$ . The spring is preloaded such that once they hit the spring, they are given enough energy to make it over the hill. Assuming that the track is frictionless, what is the minimum amount of energy that must be stored in the spring for Physics Girl and the cart to make it to the top of the hill?

- a)  $2Mgh/3$   
 b)  $4Mgh/9$   
 c)  $Mgh$   
 d)  $Mgh/3$



9. There are two boxes on a frictionless surface with masses  $m$  and  $2m$  with a spring between them as shown. You push on the boxes from the left side with a force  $F_L$ . As a result, both boxes slide and the spring compresses by  $x_L$ . You reset the system to the same initial state, and then repeat the experiment by pushing with the same magnitude but from the right,  $F_R$ . Again, both boxes slide and the spring now compresses by  $x_R$ . What is the ratio  $(x_L/x_R)$ ?

- a) 1  
 b) 2  
 c) 3  
 d)  $1/2$



10. You try to pull a car by tugging on a rope attached to it, but the car does not move. Which of the following is the most likely conclusion?

- a) The car's inertia prevents it from moving.  
 b) The car is at rest and can no longer be set into motion.  
 c) The rope is not transmitting the force to the car because it stretches.  
 d) There are other forces acting on the car besides the one you're exerting.