

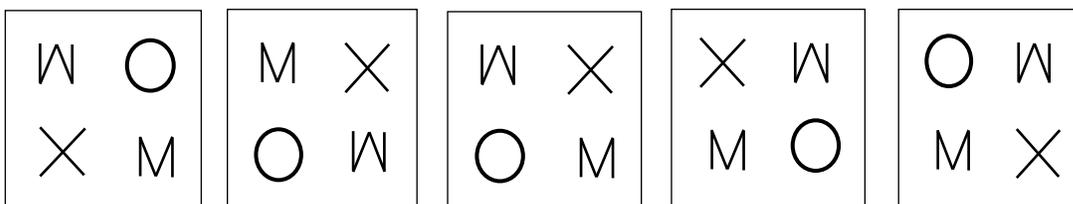
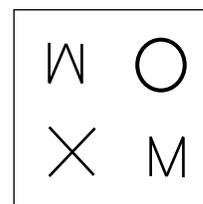
Physics@Mac Online Physics Competition  
December 4, 2019

1. You decide to pop kernels of corn to completely fill a standard bathtub with popcorn. How many kernels do you pop to make sure the bathtub is completely filled? Assume all kernels pop.

- A.  $10^5$
- B.  $10^7$
- C.  $10^9$
- D.  $10^{11}$
- E.  $10^{13}$



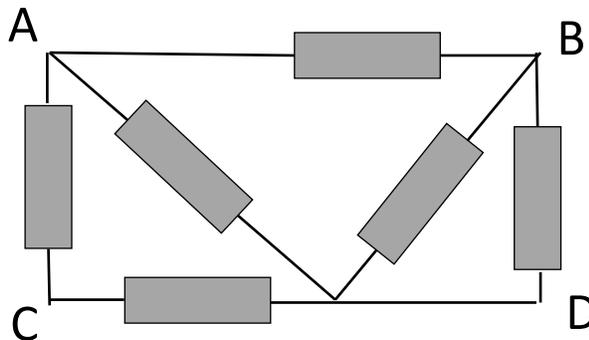
2. The diagram to the right shows a glass slide with writing on it. A convex lens is placed behind the glass slide, with its centre aligned with the centre of the glass slide. Behind the lens, a flat sheet of white paper is placed with its surface parallel to the glass slide. The sheet of paper is moved forward and backward until there is a sharp image on it. Which of the four diagrams below looks like the image?



- A.
- B.
- C.
- D.
- E.

3. The diagram shows resistors of various values as grey rectangles, and the copper wires connecting them as solid lines. The four corners of this network of resistors are labeled by letters. There is an effective total resistance between any two corners of the network. Between which two corners can this effective resistance NOT be found using only the rules for combining parallel and series resistors?

- A. Corners A and B
- B. Corners B and C
- C. Corners C and D
- D. Corners A and C
- E. Corners A and D

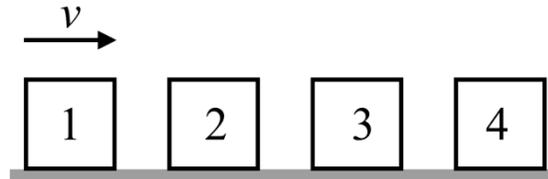


4. An alien student named Zyxblog is writing this same contest on a spaceship that is moving relative to you at a speed of  $0.60c$ . You measure that it takes you 100 minutes to write this contest. Zyxblog and her partner measures that it takes them 100 minutes to write this contest. Which of the following is true?

- A. You think Zyxblog takes 100 minutes and Zyblorg thinks you take 80 minutes.
- B. You think Zyxblog takes 80 minutes and Zyxblog thinks you take 80 minutes.
- C. You think Zyxblog takes 125 minutes and Zyxblog thinks you take 125 minutes.
- D. You think Zyxblog takes 80 minutes and Zyxblog thinks you take 125 minutes.
- E. You think Zyxblog takes 125 minutes and Zyxblog thinks you take 80 minutes.

5. Four carts are lined up in a row on a horizontal frictionless track as shown below. The carts all have a mass  $m$ . The first cart is given a velocity  $v$ . Assume that all the collisions are elastic, except for the collision between carts 2 and 3, which is perfectly inelastic. What is the final velocity of cart 4? [Neglect air resistance.] (correct answer:  $\frac{2}{3}v$  which was not an option)

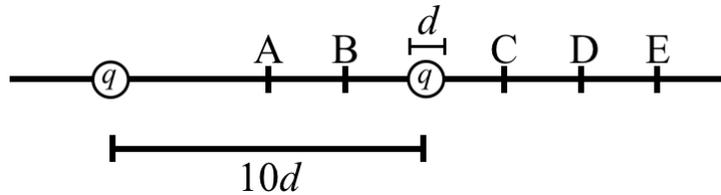
- ~~A.  $\frac{4v}{3}$~~
- ~~B.  $v$~~
- ~~C.  $\frac{v}{2}$~~
- ~~D.  $2v$~~
- ~~E.  $\sqrt{v}$~~



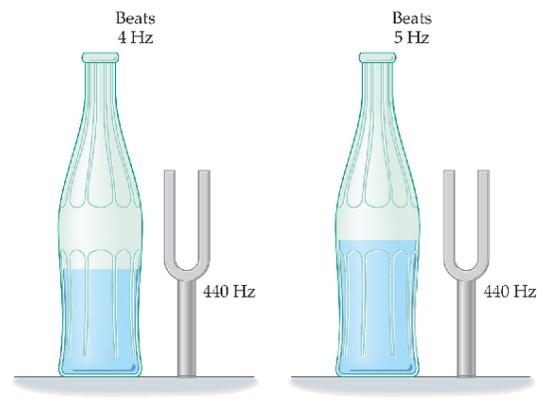
6. A car is travelling behind a truck along a straight level road. Both the car and the truck are travelling in the positive direction. It is observed that the distance between the truck and car is decreasing. Which one of the following statements concerning this situation is **always** true?

- A. The instantaneous velocity of the truck is greater than the instantaneous velocity of the car.
- B. The instantaneous velocity of the car is greater than the instantaneous velocity of the truck.
- C. The acceleration of the truck is greater than the acceleration of the car.
- D. The acceleration of the car is greater than the acceleration of the truck.
- E. None of the above statements are always true.

7. Suppose that we have two identical metal spheres which carry the same amount of positive electric charge. We position these spheres such that they are separated by a distance which is ten times greater than their diameters as shown below. Where will the observed electric field in the surrounding space be greatest?

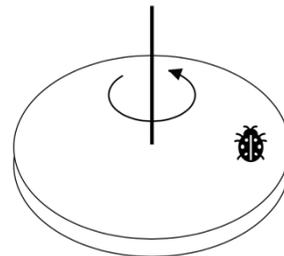


- A. At point A  
 B. At point B  
 C. At point C  
 D. At point D  
 E. At point E
8. An experimental way to tune a soda bottle is to compare its frequency with that of a 440 Hz tuning fork. Initially, a beat frequency of 4 Hz is heard. Some quantity of water is added to that already present and the beat frequency is now 5 Hz. What are the initial and final frequencies of the bottle?



- A. 436 Hz, 435 Hz  
 B. 436 Hz, 445 Hz  
 C. 444 Hz, 435 Hz  
 D. 444 Hz, 445 Hz  
 E. Either A or C above.
9. A ladybug is taking a stroll on a turntable turning at a constant frequency as shown below. The ladybug is a little nervous about getting spun off the turntable and decides to consult you on her best strategy to avoid falling off. She should:

- A. walk in the direction of the rotation  
 B. walk opposite the direction of the rotation  
 C. walk towards the centre  
 D. walk away from the centre  
 E. the direction of walking makes no difference



10. You are sitting in a wagon that is being pulled northward at a constant velocity along a horizontal sidewalk. Which of the following is a correct list of all the forces acting on you? [Neglect air resistance.]

- A. Gravity down, normal force up, and static friction northward.
- B. Gravity down, normal force up, and static friction southward.
- C. Gravity down, normal force up, and kinetic friction northward.
- D. Gravity down, normal force up, and kinetic friction southward.
- E. Gravity down and normal force up.