Physics@Mac Online Physics Competition
December 5, 2018

1. Estimate how many liters of blood a human heart pumps in a lifetime.

   A. 10^5 L
   B. 10^8 L
   C. 10^{11} L
   D. 10^{14} L
   E. 10^{17} L

2. In a Young's double slit experiment like the one shown to the right, if everything else were held constant, which of the following changes would increase the separation between adjacent maxima on the screen?

   A. Increase the frequency, f, of the incident light.
   B. Increase the index of refraction, n, of the medium in which the setup is immersed.
   C. Increase the separation between the slits, d.
   D. Decrease the distance to the screen, L.
   E. None of the above.
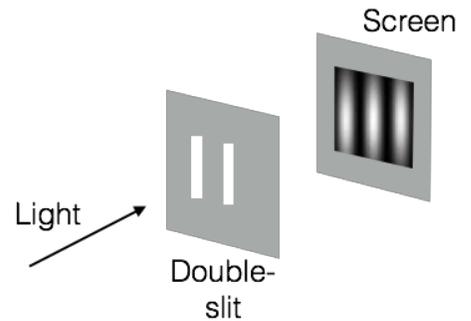
3. There is a collision between two identical cars. They are travelling towards each other at 50 km/h and hit head-on. The magnitude of the force of impact would be the same as hitting a hard concrete wall at a speed of:

   A. 100 km/h
   B. 75 km/h
   C. 66.67 km/h
   D. 50 km/h
   E. 25 km/h

4. 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. As a small amount of water is added to that already present, the beat frequency increases steadily to 5 Hz. What were the initial and final frequencies of the bottle?
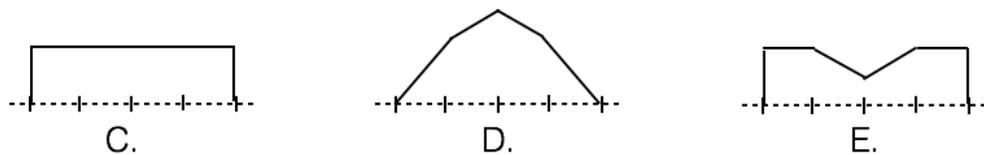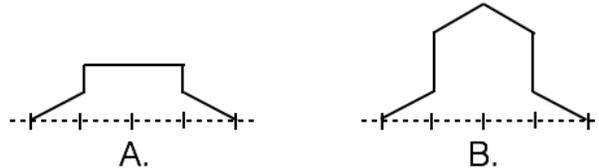
   A. 444 Hz, 445 Hz
   B. 436 Hz, 435 Hz
   C. 436 Hz, 445 Hz
   D. 439 Hz, 441 Hz
   E. 444 Hz, 435 Hz
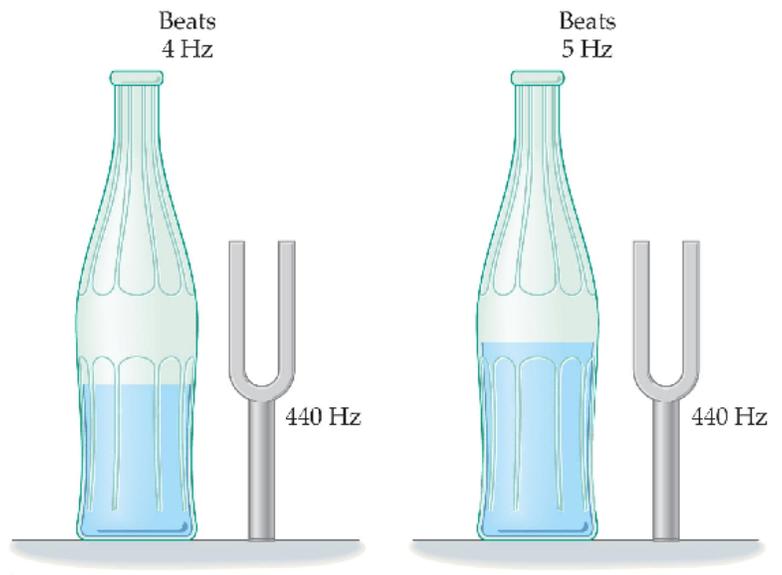
5. Two similar pulses on a string with opposite orientations approach each other at speeds of 1 m/s.

0 1 2 3 4 5 6 7 8 9 10m
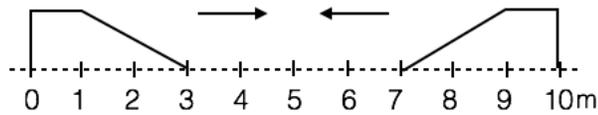
Which of the following best represents the shape of the pulse 4s later?

A.

B.

C.

D.

E.

6. A rock is dropped from a high tower. If we neglect air resistance, which one of the following statements is true concerning the rock as it falls?

   A. It will gain an equal amount of momentum during each second.
   B. It will gain an equal amount of kinetic energy during each second.
   C. It will gain an equal amount of speed for each meter through which it falls.
   D. It will gain an equal amount of momentum for each meter through which it falls.
   E. The amount of momentum it gains will be proportional to the amount of potential energy that it loses.

7. On the first day of Spring the daylight and dark portions of the day in Ontario are equal because:

   A. The Earth is at the point of its orbit that is halfway between its furthest and closest distances from the Sun.
   B. The rays from the Sun hit Ontario face-on, not at an angle.
   C. The rotation axis of the Earth is not tilted away from the Sun.
   D. The Earth spins fastest on the first day of Spring.
   E. None of the above.

8. You are viewing a book in a display case through a thick pane of glass. Compared to its actual location and size, the book appears:

   A. Closer and larger
   B. Further and smaller
   C. Closer and the same size
   D. Further and the same size
   E. At the same location and the same size

9. In the circuit diagram to the right, the grey rectangles are resistors of size R or 2R, and the circle is a light bulb. In the diagram, the switch S is open. When it is closed,

    A. The light bulb gets dimmer
    B. The light bulb gets brighter
    C. The light bulb stays the same
    D. The answer depends on the value of R
    E. The light bulb explodes
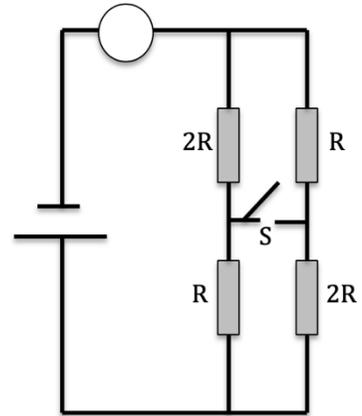
10. An electric dipole is released from rest in a uniform electric field with the orientation shown. Which entry in the table below correctly describes the net torque and the net force on the dipole?

	net torque	net force
A.	Clockwise	non-zero
B.	Counterclockwise	non-zero
C.	Zero	zero
D.	Counterclockwise	zero
E.	Clockwise	zero