A cube of side $2a$ and mass M is sliding on a frictionless surface with uniform velocity v_0, as shown in the right Fig. a. It hits a small obstacle at the end of the table, which causes the cube to tilt as in Fig. b. Find the minimum value of v_0 such that the cube will fall off the table (g is the gravitational acceleration constant on earth). (A) $\sqrt{2ag(\sqrt{2}-1)}$ (B) $\sqrt{\frac{16}{3}ag(\sqrt{2}-1)}$ (C) $\sqrt{4ag(\sqrt{2}-1)}$ (D) $\sqrt{\frac{3}{4}ag(\sqrt{2}-1)}$ (E) $\sqrt{\frac{8}{3}ag(\sqrt{2}-1)}$

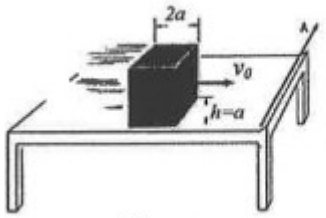


Fig. a

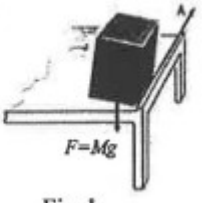


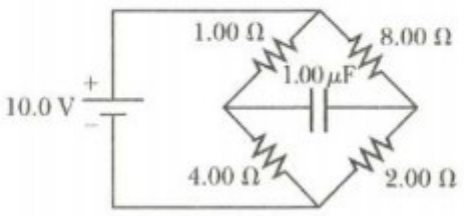
Fig. b

Which of the following is a consequence of (or is implied by) the second law of thermodynamics: (A) for all cyclic processes we have $\Delta Q/T < 0$ (B) work cannot be completely converted to heat energy (C) heat energy cannot be completely converted to work (D) the reason all heat engine efficiencies are less than 100% is friction, which is unavoidable (E) in the Carnot engine, $\Delta S > 0$ for each cycle

The circuit in figure below has been connected for a long time. (10%)

① What is the potential difference across the capacitor?

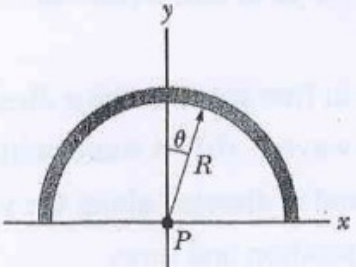
② If the battery is disconnected from the circuit, over what time interval does the capacitor discharge to one-tenth its initial voltage?



The moment of inertia of a solid sphere is $2MR^2/5$, hollow sphere is $2MR^2/3$, solid cylinder is $MR^2/2$, and hollow cylinder is MR^2. All of the same mass M and the same outer radius R. If these four objects are released from rest at the top of an incline and start rolling without sliding. Which one will the last arrive at the bottom? (A) solid sphere, (B) hollow sphere, (C) solid cylinder, (D) hollow cylinder.

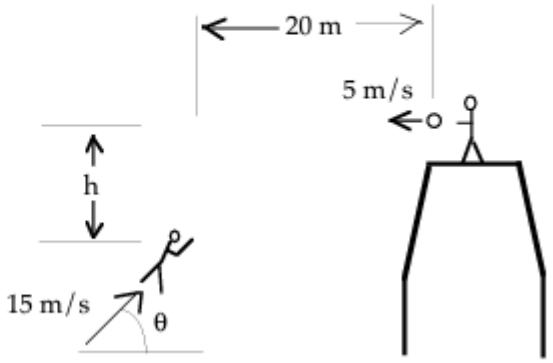
Which function does not represent traveling wave. (A) $A*\sin^2[\pi(t-x/v)]$, (B) $A*\cos(kx-\omega t)^2$, (C) $A*(x+vt)^3$, (D) $A*\sin[(kx)^2-(\omega t)^2]$.

A line of positive charge is formed into a semicircle of radius $R = 60.0$ cm as shown in Figure below. The charge per unit length along the semicircle is described by the expression $\lambda = \lambda_0 \cos\theta$. The total charge on the semicircle is 12.0 μC. Calculate the total force on a charge of 3.00 μC placed at the center of curvature P.

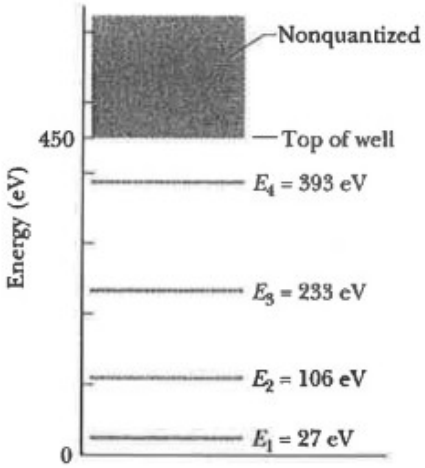


A circus acrobat is launched by a catapult at a speed of 15 $^{m}/_{s}$ at an angle of $\theta = 40°$ above the horizontal as shown. At a distance of 20 m away, her partner is standing on a platform at a height of h meters. At the instant that the acrobat is launched, her partner throws a basketball towards her horizontally at a speed of 5 $^{m}/_{s}$. Ignore air resistance in solving this problem.

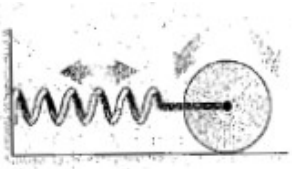
a) Write equations for the horizontal and vertical positions as functions of time for both the acrobat and the basketball. Be consistent in your choice of origin.
b) When will the performer and basketball be at the same horizontal position?
c) Find the value of h for which the acrobat will catch the ball. Assume that she and the ball must be at the same height for her to catch it.
d) Find the magnitude of the velocity of the ball relative to the acrobat at the instant that she catches it.



The figure shows the energy levels for an electron in a finite potential energy well. If an electron in the $n = 2$ state absorbs a photon of wavelength 2.0 nm, what happens to the electron? (A) It makes a transition to the $n = 3$ state. (B) It makes a transition to the $n = 4$ state. (C) It escapes the well with a kinetic energy of 280 eV. (D) It escapes the well with a kinetic energy of 730 eV. (E) Nothing; this photon does not have an energy corresponding to an allowed transition so it is not absorbed.



8. A solid cylinder of mass M and radius R is mounted on a axle through its center, The axle is attached to a horizontal spring of constant k, and the cylinder rolls back and forth without slipping (as shown in the figure). The angular frequency of the motion is



(a) $\sqrt{\frac{3k}{2M}}$ (b) $\sqrt{\frac{2k}{3M}}$ (c) $\sqrt{\frac{2M}{3k}}$ (d) $\sqrt{\frac{3M}{2k}}$ (e) $\sqrt{\frac{k}{M}}$