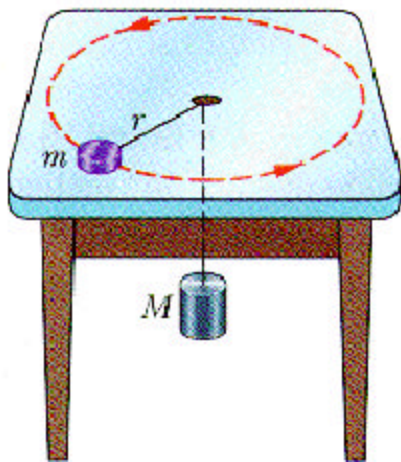


1. An archer pulls his bow string back 0.4 m by exerting a force that increases uniformly from zero to 230 N. The equivalent spring constant of the bow is:

- A. 115 N/m
- B. 575 N/m
- C. 1150 N/m
- D. 287.5 N/m
- E. 1437.5 N/m

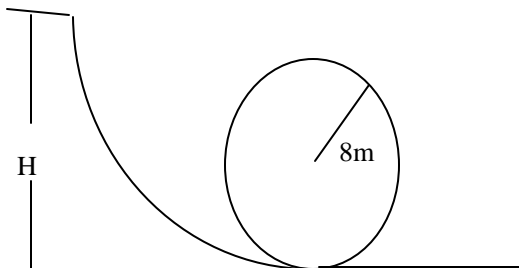
2. A mass m of 3.5 kg on a frictionless table is attached to a hanging mass M of 42.5 kg by a cord through a hole in the table. The radius of the circle is 1.4 m. The speed with which m must move in order for M to remain at rest is:



- A. 6.9 m/s
- B. 3.7 m/s
- C. 10.5 m/s
- D. 12.9 m/s
- E. 24.14 m/s

3. An old Chrysler with mass 3000 kg is moving along a stretch of road at 72 km/hr. It is followed by Ford with mass 2000 kg moving at 90 km/hr. How fast is the center of mass of the two cars moving?
- A. 81 km/hr
 - B. 90 km/hr
 - C. 79 km/hr
 - D. 72 km/hr
 - E. 83 km/hr
4. A mechanic pushes a 2500 kg car from rest to a speed of v doing 5000 J of work in the process. During this time the car moves 25 m. Ignoring friction, the final velocity of the car is:
- A. 100 m/s
 - B. 4 m/s
 - C. 122.5 m/s
 - D. 200 m/s
 - E. 2 m/s

5. The loop-the-loop rollercoaster consists of a loop that has a radius of 8m. How fast must the roller coaster be going at the top of the loop to ensure that no one falls out?

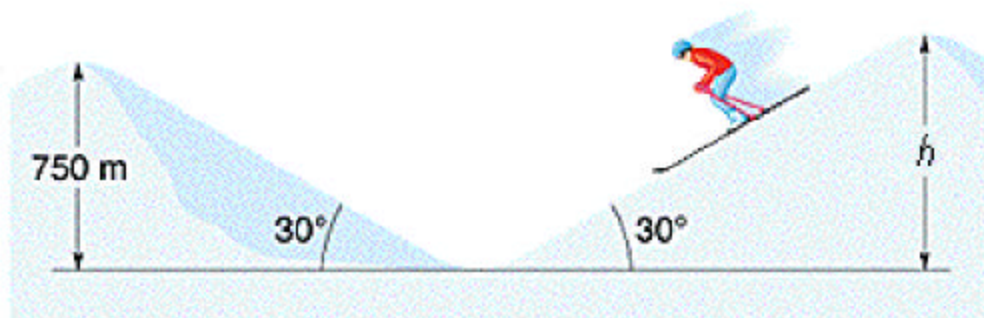


- A. 8.86 m/s
B. 78.4 m/s
C. 3.13 m/s
D. 2.83 m/s
E. 1.22 m/s
6. A slider of mass $10M$ is moving to the right with a velocity of 10 m/s on an air track. Another slider of mass M is moving to the left at 50 m/s . The two sliders collide and stick together making one slider of mass $11M$. What is the velocity of this resultant block (moving right is the $+$ direction)?
- A. -50 m/s
B. 50 m/s
C. -4.5 m/s
D. 0 m/s
E. 4.5 m/s

7. A man sits in the back of a canoe in still water. He then moves to the front of the canoe and sits there. Afterwards the canoe:

- A. is rearward of its original position and not moving.
- B. is rearward of its original position and moving backward.
- C. is forward of its original position and not moving.
- D. is forward of its original position and moving forward.
- E. is forward of its original position and moving backward.

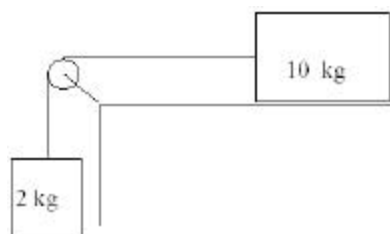
8. Two snowy peaks are $h = 850$ m and 750 m above the valley below. A ski run extends down from the top of the higher peak and then back up to the top of the lower one, with a total length of 3 km and an average slope of 30° . A skier starts from rest on the higher peak. If the snow is slick so that friction may be neglected, at what speed will he arrive at the top of the lower peak if he just coasts without using his poles?



- A. 31 m/s
- B. 129 m/s
- C. 66 m/s
- D. 44 m/s
- E. There is not enough information provided.

9. A trunk with a weight of 210 N rests on the floor. The coefficient of static friction between the trunk and the floor is 0.40, while the coefficient of kinetic friction is 0.16. The minimum magnitude for a horizontal force with which a person must push on the trunk to start it moving is:
- A. 117.6 N
 - B. 210.4 N
 - C. 33.6 N
 - D. 50.5 N
 - E. 84 N
10. A PSU linebacker of mass 119.0 *kg* sacks the Miami quarterback of mass 82.0 *kg*. Just after they collide, they are momentarily stuck together, and both are moving at a speed of 2.60 *m/s*. If the quarterback was at rest just before he was sacked, how fast was the linebacker moving just before the collision?
- A. 2.6 m/s
 - B. 1.6 m/s
 - C. 4.4 m/s
 - D. 1.3 m/s
 - E. 6.4 m/s
11. A 90 kg object is initially moving in a straight line with a speed of 40 m/s. It is brought to rest with a constant deceleration. The **magnitude** of the **work** done by the force responsible for this deceleration is:
- A. 1.44×10^5 J
 - B. 7.2×10^3 J
 - C. 1.8×10^3 J
 - D. 7.2×10^4 J
 - E. 3.6×10^3 J

12. A 10 kg block on a table is connected by a light massless cord through a frictionless and massless pulley to a 2 kg mass hanging over the edge of a table as shown. The blocks are free to accelerate, and there is a coefficient of kinetic friction of $\mu_K = 0.1$ between the 10 kg block and the table. What is the **tension** in the cord?



- A. 22.0 N
B. 18.0 N
C. 14.2 N
D. 19.6 N
E. 16.3 N
13. You are once again traveling at night on I-99 in your 1200 kg vehicle, driving at a legal 29.1 m/s (65 mi/hr). Suddenly, you see a deer in the middle of the road straight ahead of you, at a distance of 150 m (492 ft). What minimum force must be provided by the brakes to stop the vehicle before hitting the deer?
- A. 12,100 N
B. 3,390 N
C. 4,890 N
D. 7,520 N
E. 16,900 N

14. A 100 kg hunter on a frozen lake fires his gun horizontally. The bullet has a mass of 0.004 kg, and exits the gun barrel at 300 m/s. The hunter recoils on the frozen lake frictionlessly, with a velocity of:

- A. 0 m/s
- B. 0.12 m/s
- C. 0.0013 m/s
- D. 0.012 m/s
- E. 300 m/s

15. How long does it take a slide loving pig to slide 2 m down a 30° incline (the incline is measured from the horizontal) with a coefficient of static friction of 0.35 and a coefficient of kinetic friction of 0.30?

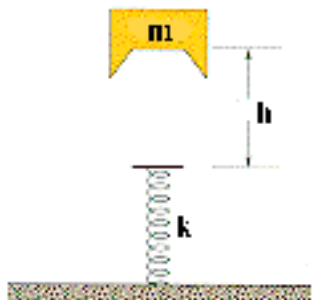


- A. 1.30 s
- B. 0.92 s
- C. 1.02 s
- D. 1.44 s
- E. 0.75 s

16. A block slides down an inclined plane that makes an angle θ with the horizontal. What must be the coefficient of kinetic, μ_k friction if the block slides at constant velocity?

- A. $\mu_k = \sin \theta$
- B. $\mu_k = \cot \theta$
- C. $\mu_k = \sec \theta$
- D. $\mu_k = \tan \theta$
- E. $\mu_k = \cos \theta$

17. A block of mass $m = 1.7$ kg is dropped onto a spring with a spring constant $k = 1750$ N/m from a height $h = 50$ cm above the uncompressed end of the spring, as shown in the figure. Find the **maximum distance** (from the uncompressed position) that the spring is compressed as the mass lowers to an eventual brief halt.



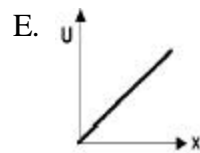
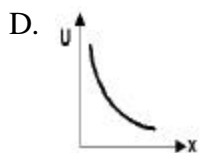
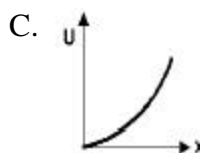
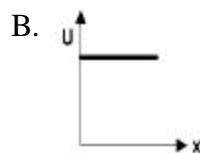
- A. 9.76 cm
- B. 7.90 cm
- C. 10.76 cm
- D. 8.85 cm
- E. 0.95 cm

18. In the figure, a cord runs around two mass-less, frictionless pulleys. A canister with mass $m = 12 \text{ kg}$ hangs from one pulley, and you exert a force \mathbf{F} on the free end of the cord. If you pull 10 cm on the free end of the cord, how much work have you done on the canister? Assume that the canister is at rest after you have pulled the 10 cm.



- A. 5.9 J
- B. 2.9 J
- C. 11.7 J
- D. 12.0 J
- E. 23.5 J

19. Which of the five graphs correctly shows the potential energy, U , of a spring as a function of its elongation x ?



20. A 0.16 kg baseball is thrown with a speed of 40 m/s. It is hit straight back at the pitcher with a speed of 80 m/s. What is the magnitude of the impulse exerted on the ball by the bat?

- A. 3.2 Ns
- B. 64 Ns
- C. 6.4 Ns
- D. 19 Ns
- E. 16 Ns