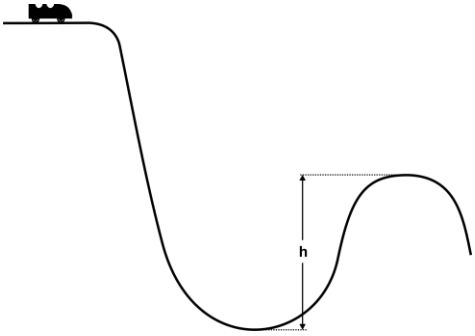
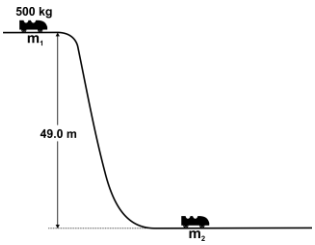
1. What is the maximal height for the second hump on a roller coaster if the roller coaster is traveling at 108 $\frac{km}{hr}$ just before climbing the second hump?



(A) 39.9 m
(B) 41.9 m
(C) 43.9 m
(D) 45.9 m
(E) 47.9 m

2. By accident, a roller coaster car with a mass of 500 kg breaks loose and rolls down an incline from a height of 49 meters.

It strikes another 500 kg roller coaster car sitting at the bottom of the incline and, together, they roll along the track. At what speed do they roll along the track?



(A) 15.5 $\frac{m}{sec}$
(B) 17.5 $\frac{\text{m}}{\text{sec}}$
(C) 18.5 $\frac{\text{m}}{\text{sec}}$
(D) 21.5 $\frac{\text{m}}{\text{sec}}$
(E) 23.5 $\frac{\text{m}}{\text{sec}}$

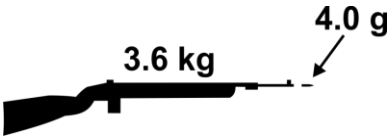
3. How much force is needed to stop a 10,000 kilogram truck in 4 seconds if the truck is traveling at 108 $\frac{km}{hr}$?

(A) 55,000 N
(B) 65,000 N
(C) 75,000 N
(D) 85,000 N
(E) 95,000 N

4. What is the minimal distance to stop a car traveling at 50 $\frac{km}{hr}$ with a coefficient of rubber on concrete of 0.8?

(A) 8.3 m
(B) 9.3 m
(C) 10.3 m
(D) 11.3 m
(E) 12.3 m

5. Shooting a rifle causes the rifle to kick back, or recoil, into your shoulder. What is the velocity of the recoil for a rifle weighing 3.6 kg and shooting a 4 g bullet at 900 m/s?

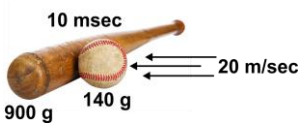


(A) $1.0\ \frac{m}{sec}$
(B) $2.0\ \frac{m}{sec}$
(C) $3.0\ \frac{m}{sec}$
(D) $4.0\ \frac{m}{sec}$
(E) $5.0\ \frac{m}{sec}$

6. Here are two blocks connected by a spring. One block has a mass of X and the other, a mass of Y. When pulled apart and then released, the two masses move toward each other with different velocities. After release, which block has more kinetic energy?

(A) the smaller block
(B) the larger block
(C) their kinetic energies are equal

7. If a 140 g baseball is thrown at 20 $\frac{m}{sec}$ and struck by a 900 gram bat for 10 msec, and the ball leaves that bat at 50 $\frac{m}{sec}$, how much force did the bat strike the ball with?

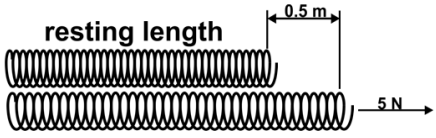


(A) 880 newtons
(B) 980 newtons
(C) 1080 newtons
(D) 1180 newtons
(E) 1280 newtons

8. How much energy did it take to hit the baseball and send it sailing off at $\frac{m}{sec}$?

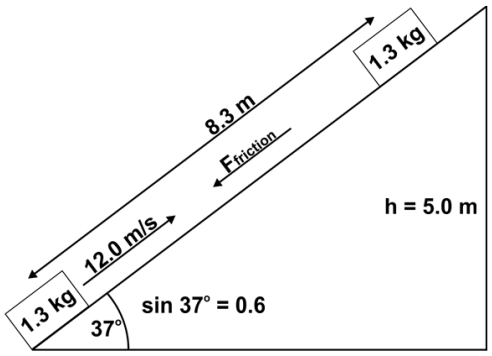
(A) 147 newton-meters
(B) 247 newton-meters
(C) 347 newton-meters
(D) 447 newton-meters
(E) 547 newton-meters

9. If it requires 5 newtons of force to stretch a spring 0.5 meter beyond its resting length, how much work will it take to stretch the spring 1.5 meters beyond its resting length?



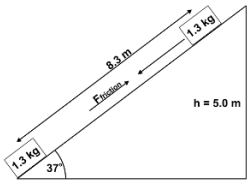
(A) 8.25 newton-meters
(B) 9.25 newton-meters
(C) 10.25 newton-meters
(D) 11.25 newton-meters
(E) 12.25 newton-meters

10. A 1.3 kg block of wood is kicked up a 37 degree incline at an initial velocity of 12 $\frac{m}{sec}$, traveling 8.3 meters up the incline before it stops. What was the force of friction acting on the block of wood?



(A) 1.6 newtons
(B) 2.6 newtons
(C) 3.6 newtons
(D) 4.6 newtons
(E) 5.6 newtons

11. If this same block of wood now slides back down the incline, what will its speed be when it reaches the bottom of the incline?



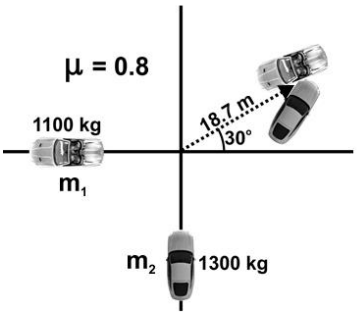
(A) 3.2 $\frac{m}{sec}$
(B) 4.2 $\frac{m}{sec}$
(C) 5.2 $\frac{m}{sec}$
(D) 6.2 $\frac{m}{sec}$
(E) 7.2 $\frac{m}{sec}$

12. Accident reconstruction is helpful in establishing whether one car was speeding.

Two cars approach an intersection with no stoplight, and collide. The car headed north claims that the car headed east was exceeding the posted speed limit of 100 $\frac{km}{hr}$ and is therefore responsible for the accident.

What's the truth? Was one car speeding, both speeding, or neither speeding?

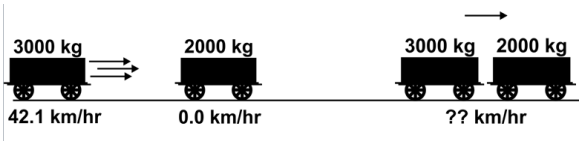
The facts are that the mass of the car headed east was 1100 kg and the mass of the car headed north was 1300 kg. After the cars collide, they come to a rest 18.7 meters from the intersection in a 30 degree direction. The coefficient of friction for rubber on asphalt is 0.8.



(A) The car headed north was speeding.
(B) The car headed east was speeding.
(C) Both were speeding
(D) Neither was speeding.

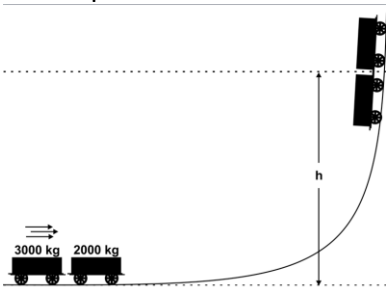
13. A railroad car weighing 3000 kilograms breaks loose from its train and smashes at 42.1 $\frac{km}{hr}$ into a 2000 kg railcar at rest. The railroad cars become attached and travel up a steep slope a distance, h.

What is the momentum of the two railroad cars just before impact, and what is the velocity of the two railroad cars immediately after impact?



Momentum Before Impact	Velocity After Impact
(A) 50,000 kg-m/sec	3.1 $\frac{m}{sec}$
(B) 110,000 kg-m/sec	4.8 $\frac{m}{sec}$
(C) 245,000 kg-m/sec	5.8 $\frac{m}{sec}$
(D) 310,000 kg-m/sec	6.6 $\frac{m}{sec}$
(E) 351,000 kg-m/sec	7.0 $\frac{m}{sec}$

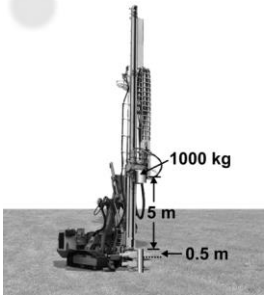
14. What is the kinetic energy of the railroad cars after collision? How high up the slope do the two railroad cars travel?



	Kinetic Energy After Impact	Height Attained
(A)	88,600 joules	1.1 meters
(B)	102,400 joules	1.5 meters
(C)	107,700 joules	1.7 meters
(D)	114,400 joules	2.1 meters
(E)	122,500 joules	2.5 meters

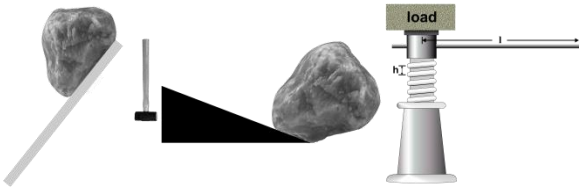
15. A pile driver is a machine that slams a heavy weight onto a concrete or steel column in order to drive the column into the ground, for example, to serve as a support column for a new building.

This pile driver pounds with a 1000 kg weight positioned 5 meters above a concrete column. When the pile drive is released, it drives the concrete column 0.5 meters into the ground. What was the force delivered by the pile driver?



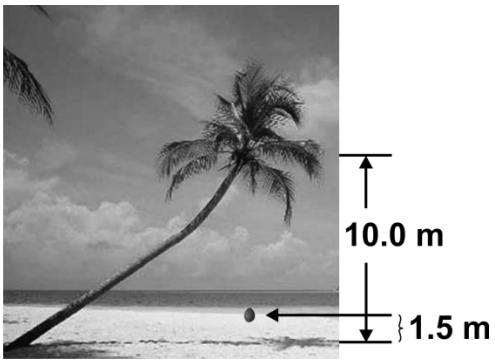
(A) 38, 900 $\frac{kg\ m}{sec^2}$
(B) 138, 900 $\frac{kg\ m}{sec^2}$
(C) 10,780 $\frac{kg\ m}{sec^2}$
(D) 107,800 $\frac{kg\ m}{sec^2}$
(E) 59,700 $\frac{kg\ m}{sec^2}$

16. What is the mechanical advantage of each?



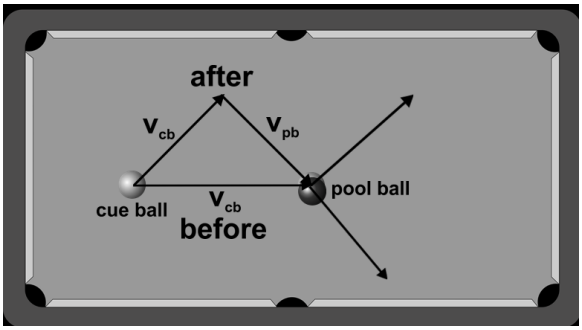
(A) inclined plane: s/h; wedge: s/h; jack screw: l/h
(B) inclined plane: s/h; wedge: l/h; jack screw: h/l
(C) inclined plane: s/h ; wedge: l/h; jack screw: 2πl/h
(D) inclined plane: s/l; wedge: s/h; jack screw: h/2πl
(E) inclined plane: l/s; wedge: h/s; jack screw: 2πh/l

17. A coconut falls from a height of 10 meters. What is its speed 1.5 meters from the ground?



(A) $12.9\ \frac{m}{sec}$
(B) $13.1\ \frac{m}{sec}$
(C) $13.5\ \frac{m}{sec}$
(D) $14.2\ \frac{m}{sec}$
(E) $15.6\ \frac{m}{sec}$

18. When trying to sink a pool ball, you have to keep in mind where the shooting ball will end up after impact. It's been said that if there's no English on the shooting ball, the shooting ball will always deflect away from the ball it strikes at a particular angle. That angle is:



(A) 30°
(B) 45°
(C) 60°
(D) 75°
(E) 90°

19. The efficiency of any engine is a measure of how much electrical or chemical or heat or nuclear energy you put into the engine, and how much work energy you get out. The energy that goes up the smokestack is wasted energy. If you know the amount of energy you put into the engine and the amount wasted, the energy ouput is simply energy in minus energy wasted.

The formula for engine efficiency is work energy produced by the engine divided by the amount of work put into the engine. If a gasoline engine burns 204.5 joules of energy and 153.3 joules of energy is lost out the tail pipe, what is its efficiency?

(A) 15%
(B) 20%
(C) 25%
(D) 30%
(E) 35%