Question 1: In which one of the following situations does a car have a westward acceleration?

A. The car travels eastward and speeds up.
B. The car starts from rest and moves toward the east.
C. The car travels westward and slows down.
D. The car travels westward at constant speed.
E. The car travels eastward and slows down.

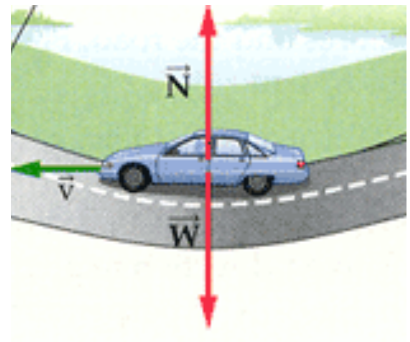
Question 2: An object starts from rest and accelerates uniformly in a straight line. After 10 seconds elapse, its speed is 70.0 m/s. What is the average velocity of the object during those 10 seconds?

A. –140 m/s
B. +70 m/s
C. +35 m/s
D. +3.5 m/s
E. +7.0 m/s

Question 3: Chris stands on the edge of a cliff and throws a stone vertically downward with an initial speed of 10.0 m/s. The instant before the stone hits the ground below, it is traveling at a speed of 30.0 m/s. If Chris were to throw the rock horizontally outward from the cliff instead, with the same initial speed of 10.0 m/s, what would the magnitude of the velocity of the stone be just before it hits the ground?

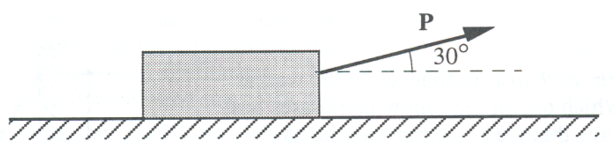
A. 20.0 m/s
B. 30.0 m/s
C. 40.0 m/s
D. 10.0 m/s
E. The height of the cliff must be specified to answer this question

Question 4: What is true about the gravitational force (weight) W and the normal force N on a car traveling at a constant speed as it drives through the bottom of a dip in the road?



A. N > W
B. N < W
C. N = W
D. Can't answer, depends on speed

Question 5: A block is pulled along a rough surface by a force **P** that makes an angle of 30^o as shown in the figure. Which one of the following actions will increase the frictional force on the block (assume the block stays on the surface and continues sliding for all cases)?

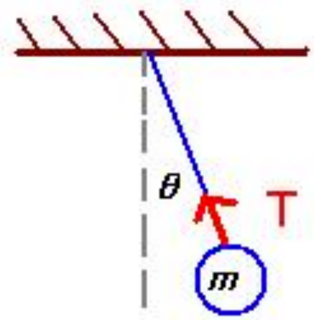


A. Decreasing the weight of the block
B. Increasing the angle
C. Increasing the magnitude of P
D. Decreasing the magnitude of P
E. None of the above

Question 6: The coefficient of friction between a block and the surface it slides on is 0.25. If the block starts out sliding with a speed of 10 m/s, how far will it travel before stopping? Assume g = 10 m/s^2.

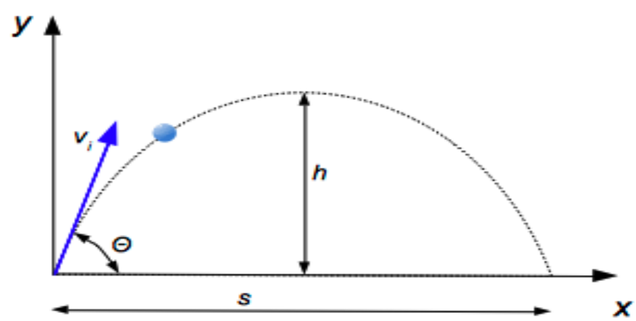
A. 10 m
B. 5 m
C. 250 m
D. 40 m
E. 20 m

Question 7: What is the magnitude of the tension T exerted by the string on a simple pendulum of mass m at an angle θ?



A. mg
B. mg $\sin(\theta)$
C. mg $\cos(\theta)$
D. mg $\tan(\theta)$
E. kx

Question 8: Morgan throws a ball at an angle of $\theta = 30°$ above horizontal (picture is not to scale), with an initial speed of $v_i = 20$ m/s. Assuming no air resistance, what is the maximum height h above the ground that the ball reaches at the top of its arc? Assume $g = 10\ m/s^2$.



A. 100 m
B. 5 m
C. 10 m
D. 20 m
E. 40 m

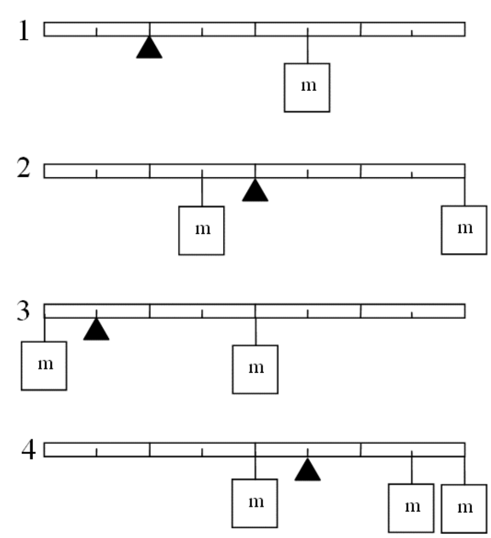
Question 9: Hannah attempts to knock down a large wooden bowling pin by throwing balls at it. Hannah has two balls of equal size and mass, one made of rubber and the other of putty. Both strike the pin with the same velocity. The rubber ball bounces back, while the ball of putty sticks to the pin. Which ball is most likely to topple the bowling pin?

A. The rubber ball
B. The ball of putty
C. It makes no difference
D. Need more information

Question 10: My son Grady, a 30 kg boy, is running at 4.0 m/s when he jumps onto a 10 kg sled, initially at rest on a frozen lake. What is the velocity of Grady and the sled, after he jumps on?

A. 1.5 m/s
B. 4.0 m/s
C. 2.0 m/s
D. 1.3333 m/s
E. 3.0 m/s

Question 11: A long board is free to rotate about the pivot shown in each of the four configurations shown. Weights are hung from the board as indicated. In which of the configurations, if any, is the net torque about the pivot axis the largest? Assume the mass of the board itself is negligible.



A. 1
B. 2
C. 3
D. 4
E. Same for all

Question 12: A merry-go-round starts from rest and undergoes a constant angular acceleration of 1.0 rad/s^2 as Jennifer pushes it around. When the merry-go-round has rotated 8 radians its angular velocity is:

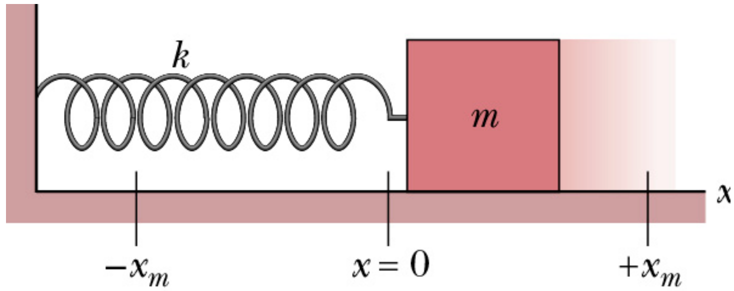
A. 8 rad/s
B. 2 rad/s
C. 1 rad/s
D. 80 rad/s
E. 4 rad/s

Question 13: Devin is riding his bicycle down the street. His (very large) front bicycle wheel has a mass of 1 kg and a radius of 0.5 m, with all of the mass at the rim. The wheel is spinning at 20 radians/s. Devin sees a group of children crossing the road and puts his front brakes on, thereby applying a constant torque of 10 N m to the front wheel. How far does the wheel rotate before the bike stops?

A. 1 radian
B. 20 radians
C. 10 radians
D. 100 radians
E. 5 radians

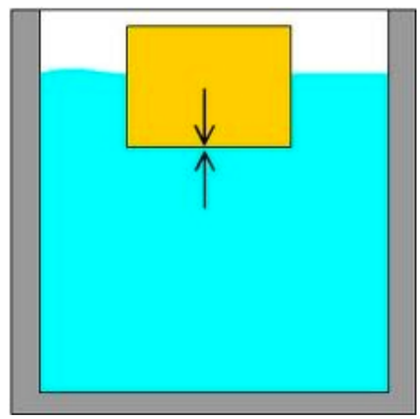
Question 14: In the figure below, the block has a kinetic energy of 3 J and the spring has an elastic potential energy of 2 J when the block is at $x = +2.0$ cm. What is the elastic potential energy when the block is at $x = -x_m$?

A. –5.0 J
B. 0 J
C. 2 J
D. 3 J
E. 5 J



Question 15: A block floats in a beaker of fluid with one third of its volume above the water. What is the density of the block as compared to the density of the fluid?

A. The same
B. 1/3 of the density of the fluid
C. 2/3 of the density of the fluid
D. Can't be determined without knowing the volume
E. 1.5 times the density of the fluid



Question 16: Dale boards a submarine with a total surface area of 10 m^2 and submerges it to a depth of 1 km (=1,000 m) below the surface of the ocean. How much total force is exerted on the entire exterior of the submarine at the 1 km depth? Assume $g = 10\ m/s^2$ and a density of 1000 kg/m^3 for water.

A. 10^8 N
B. 10^6 N
C. 10 N
D. 100 N
E. 1000 N

Question 17: A typical coefficient of linear expansion for metal is $\alpha = 1 \times 10^{-5}$/C°. A railroad track is made of individual rails of steel 1.0 km (=1000 m = 100,000 cm) in length. By what length would these rails change between a cold day when the temperature is –10 °C and a hot day at 30 °C?

A. 600 cm
B. 0.60 cm
C. 40 cm
D. 20 cm
E. 400 cm

Question 18: Which requires the most energy?

A. Raise the temperature of 1 gram of liquid water 100 ^oC.
B. Melt 1 gram of ice at T=0 ^oC.
C. Raise the temperature of 1 gram of ice 100 ^oC.
D. Vaporize 0.1 gram of water at T=100 ^oC.

Assume the following constants:
$c_{ice} = 0.50\ cal/(g\ ^oC)$,
$c_{water} = 1.00\ cal/(g\ ^oC)$,
$c_{steam} = 0.50\ cal/(g\ ^oC)$,
$L_{(ice\text{-}water)} = 80\ cal/g$,
$L_{(water\text{-}steam)} = 500\ cal/g$

Question 19: A sample of a monatomic ideal gas in a sealed container is at 27 °C. What is the temperature of the same sample of gas if the pressure is doubled and the volume of the container is reduced to one-fourth its initial value?

A. –123 °C
B. 13.5 °C
C. 54 °C
D. 327 °C
E. 80 °C

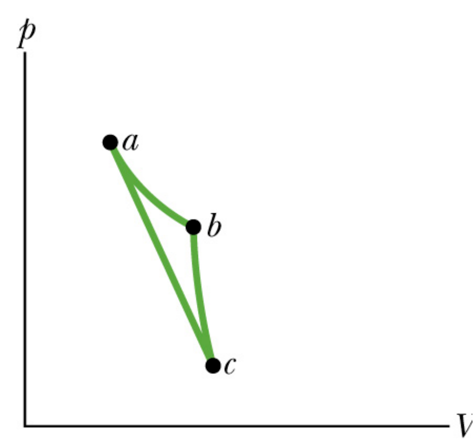
Question 20: An air bubble 20 m below the surface of a lake has a volume of 0.02 m^3. The bubble then rises to the surface, staying as a single coherent bubble and not breaking up or diffusing into the water. Assuming the temperature of the lake is uniform, what is the volume of the bubble just before it breaks through the surface? Assume atmospheric pressure = 10^5 Pa, density of water = 1000 kg/m^3, and g = 10 m/s^2.

A. 0.02 m^3
B. 0.10 m^3
C. 0.04 m^3
D. 0.08 m^3
E. 0.06 m^3

Question 21: Astrid spends four hours studying for her final and does 1100 J of work W. In the process, her internal energy U decreases by 2200 J. Determine the value of heat Q added to or subtracted from Astrid by the surrounding environment during this activity (including the sign).

A. +3300 J
B. –1100 J
C. –3300 J
D. +1100 J
E. –2200 J

Question 22: In the p-V diagram below, the gas does 5 J of work along isotherm **ab** and 4 J of work along adiabat **bc**. What is ΔU_{int} if the gas traverses the straight path from a to c?



A. –4 J
B. –1 J
C. 1 J
D. 4 J
E. 9 J

Question 23: A miniature heat engine is used to lift a 2-kg toy truck to a height of 2.0 m. In the lifting process, the engine received 200 J of heat from the fuel burned in its interior. What is the efficiency of the engine (as a fraction between 0 and 1, not a percentage)? Assume $g = 10\ m/s^2$.

A. 0.30
B. 0.20
C. 0.02
D. 0.40
E. 0.25

Question 24: If you compress a sealed sample of an ideal monatomic gas from a volume V_o to a smaller volume $V_o/2$ isobarically (maintaining the same pressure), what happens to the speed of sound in the gas?

A. It increase by a factor of 2
B. It decreases by a factor of 2
C. It increases by a factor of $\sqrt{2}$
D. It decreases by a factor of $\sqrt{2}$
E. It stays the same