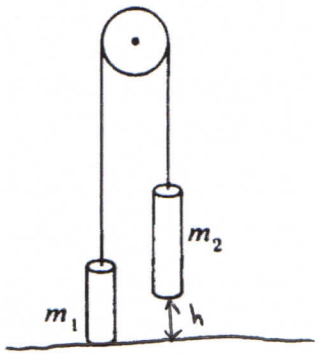
ENERGY, WORK, & MOMENTUM PRACTICE MULTIPLE CHOICE

1984:

8. An object of mass m is lifted at ~~constant velocity~~ a vertical distance H in time T. The power supplied by the lifting force is (A) mgHT (B) mgH/T (C) mg/HT (D) mgT/H (E) zero

Power = F_v → mg, $\frac{H}{T}$



A system consists of two objects having masses m_1 and m_2 ($m_1 < m_2$). The objects are connected by a massless string, hung over a pulley as shown above, and then released.

13. When the speed of ~~each object is~~ v, the magnitude of the total linear momentum of the system is (A) $(m_1 + m_2)$ v (B) $(m_2 - m_1)$ v (C) $\frac{1}{2}(m_1+m_2)v$ (D) $\frac{1}{2}(m_2 - m_1)v$ (E) m_2v

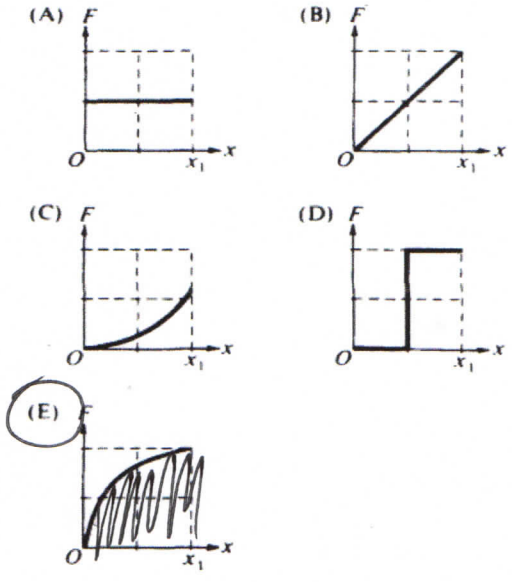
going opp. direction so one velocity is negative

14. ~~When~~ the object of mass m_2 has descended a distance h, the potential energy of the system has decreased by (A) $(m_2 - m_1)gh$ (B) m_2gh (C) $(m_1 + m_2)gh$ (D) $\frac{1}{2}(m_1 + m_2)gh$ (E) 0

$(m_2gh + 0) - (0 + m_1gh) = m_2gh - m_1gh = (m_2 - m_1)gh$

before after

15. The following graphs, all drawn to the same scale, represent the net force F as a function of displacement x for an object that moves along a straight line. Which graph represents the force that will cause the greatest change in the kinetic energy of the object from x = 0 to x = x_1?



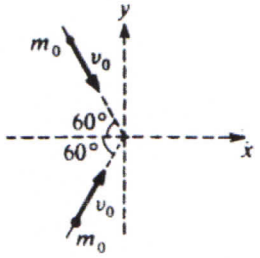
Largest integral

y-direction will cancel out

$m_0 v_0 \left(\frac{1}{2}\right) + m_0 v_0 \left(\frac{1}{2}\right) = 2 m_0 v_f$

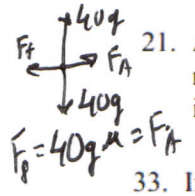
$m_0 v_0 = 2 m_0 v_f$

$v_f = \frac{v_0}{2}$



17. Two particles of equal mass m_o, moving with equal speeds v_O along paths inclined at 60° to the x-axis as shown above, collide and stick together. Their velocity after the collision has magnitude

(A) $\frac{v_0}{4}$ (B) $\frac{v_0}{2}$ (C) $\frac{\sqrt{2}v_0}{2}$ (D) $\frac{\sqrt{3}v_0}{2}$ (E) v_o



21. A person pushes a box across a horizontal surface at a constant speed of 0.5 meter per second. The box has a mass of 40 kilograms, and the coefficient of sliding friction is 0.25. The power supplied to the box by the person is (A) 0.2 W (B) 5 W (C) 50 W (D) 100 W (E) 200 W

$P = 40g\mu v = 50\text{W}$

33. If a particle moves in such a way that its position x is described as a function of time t by $x = t^{3/2}$, then its kinetic energy is proportional to

(A) t^2 (B) $t^{3/2}$ (C) t (D) $t^{1/2}$ (E) t^0 (i.e., kinetic energy is constant)

$KE = \frac{1}{2}mv^2$

$\frac{dx}{dt} = v = \frac{2}{3}t^{1/2}$

$\frac{1}{2}m\left(\frac{2}{3}t^{1/2}\right)^2$

$(t^{1/2})^2 = t$

34. From the top of a 70-meter-high building, a 1-kilogram ball is thrown directly downward with an initial speed of 10 meters per second. If the ball reaches the ground with a speed of 30 meters per second, the energy lost to friction is most nearly (A) 0J (B) 100 J (C) 300 J (D) 400 J (E) 700 J

1993:

$mgh + \frac{1}{2}mv^2$

$(1)(10)(70) + \frac{1}{2}(1)(10^2) = 750$

$\frac{1}{2}(1)(900) = 450$

$750 - 450 = 300\text{J}$

6. A ball is thrown upward. At a height of 10 meters above the ground, the ball has a potential energy of 50 joules (with the potential energy equal to zero at ground level) and is moving upward with a kinetic energy of 50 joules. Air friction is negligible. The maximum height reached by the ball is most nearly
(A) 10 m (B) 20 m (C) 30 m (D) 40 m (E) 50 m

10. During a certain time interval, a constant force delivers an average power of 4 watts to an object. If the object has an average speed of 2 meters per second and the force acts in the direction of motion of the object, the magnitude of the force is (A) 16 N (B) 8 N (C) 6 N (D) 4N (E) 2N

14. A weight lifter lifts a mass m at constant speed to a height h in time t How much work is done by the weight lifter? (A) mg (B) mh (C) mgh (D) mght (E) mgh/t

*Email talk2shreyas@gmail.com or text 630-815-8510 for explanations of mc answers.

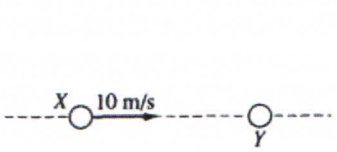


Figure I

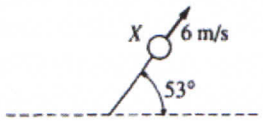
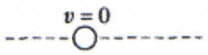
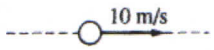
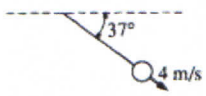


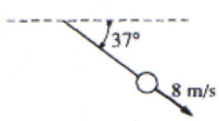
Figure II

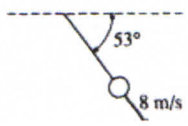
11. Two balls are on a frictionless horizontal tabletop. Ball X initially moves at 10 meters per second, as shown in Figure I above. It then collides elastically with identical ball Y. which is initially at rest. After the collision, ball X moves at 6 meters per second along a path at 53^0 to its original direction, as shown in Figure II above. Which of the following diagrams best represents the motion of ball Y after the collision?

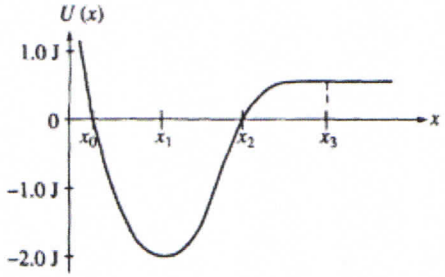
(A)


(B)


(C)


(D)


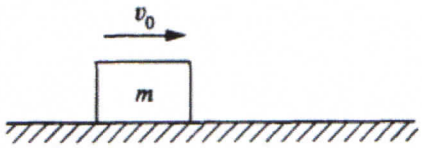
(E)




15. A conservative force has the potential energy function U(x), shown by the graph above. A particle moving in one dimension under the influence of this force has kinetic energy 1.0 joule when it is at position x_1 Which of the following is a correct statement about the motion of the particle?
(A) It oscillates with maximum position x_2 and minimum position x_0.
(B) It moves to the right of x_3 and does not return.
(C) It moves to the left of x_0 and does not return.
(D) It comes to rest at either x_0 or x_2.
(E) It cannot reach either x_0 or x_2.

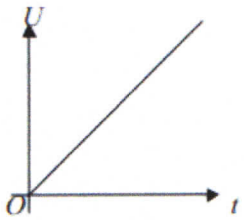
17. If one knows only the constant resultant force acting on an object and the time during which this force acts, one can determine the
(A) change in momentum of the object (B) change in velocity of the object
(C) change in kinetic energy of the object (D) mass of the object (E) acceleration of the object

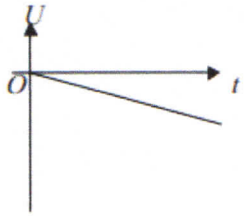
18. When an object is moved from rest at point A to rest at point B in a gravitational field, the net work done by the field depends on the mass of the object and
(A) the positions of A and B only
(B) the path taken between A and B only
(C) both the positions of A and B and the path taken between them
(D) the velocity of the object as it moves between A and B
(E) the nature of the external force moving the object from A to B

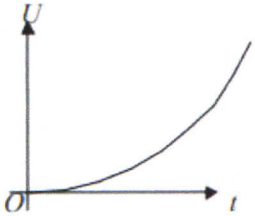


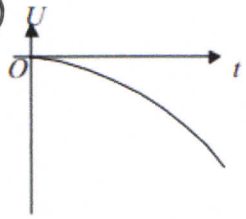
21. An object of mass m is moving with speed v_0 to the right on a horizontal frictionless surface, as shown above, when it explodes into two pieces. Subsequently, one piece of mass 2/5 m moves with a speed $v_0/2$ to the left. The speed of the other piece of the object is
(A) $v_o/2$ (B) $v_o/3$ (C) $7v_o/5$ (D) $3v_o/2$ (E) $2v_o$

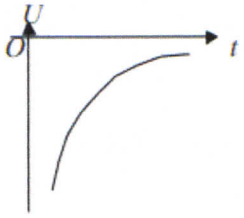
31. A small mass is released from rest at a very great distance from a larger stationary mass. Which of the following graphs best represents the gravitational potential energy U of the system of the two masses as a function of time t?

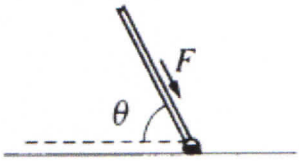
(A)


(B)


(C)


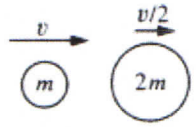
(D)


(E)




1. A force F is exerted by a broom handle on the head of the broom, which has a mass m. The handle is at an angle θ to the horizontal, as shown above. The work done by the force on the head of the broom as it moves a distance d across a horizontal floor is
(A) Fd sin θ (B) Fd cosθ (C) Fm cosθ (D) Fm tanθ (E) Fmd sinθ

12. The graph above shows the force on an object of mass M as a function of time. For the time interval 0 to 4 s, the total change in the momentum of the object is
(A) 40 kg m/s (B) 20 kg m/s (C) 0 kg m/s (D) -20 kg m/s
(E) indeterminable unless the mass M of the object is known



Top View

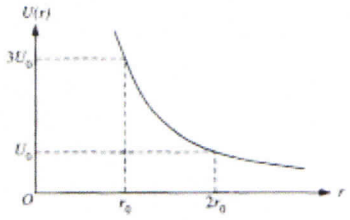
13. As shown in the top view above, a disc of mass m is moving horizontally to the right with speed v on a table with negligible friction when it collides with a second disc of mass 2m The second disc is moving horizontally to the right with speed v/2 at the moment of impact The two discs stick together upon impact The speed of the composite body immediately after the collision is
(A) v/3 (B) v/2 (C) 2v/3 (D) 3v/2 (E) 2v


Top View

A spring has a force constant of 100 N/m and an unstretched length of 0.07 m. One end is attached to a post that is free to rotate in the center of a smooth table, as shown in the top view above. The other end is attached to a 1 kg disc moving in uniform circular motion on the table, which stretches the spring by 0.03 m. Friction is negligible.

15. What is the work done on the disc by the spring during one full circle?
(A) 0 J (B) 94 J (C) 186 J (D) 314 J (E) 628 J

Questions 16-17 refer to the following graph, which represents a hypothetical potential energy curve for a particle of mass m.



17. If the potential energy function is given by $U(r) = br^{-3/2} + c$, where b and c are constants, which of the following is an expression for the force on the particle?

(A) $\frac{3b}{2}r^{-5/2}$ (B) $\frac{3b}{2}r^{-1/2}$ (C) $\frac{3}{2}r^{-1/2}$ (D) $2br^{-1/2} + cr$ (E) $A\frac{2b}{5}r^{-5/2} + cr$

24. Two people are initially standing still on frictionless ice. They push on each other so that one person, of mass 120 kg, moves to the left at 2 m/s, while the other person, of mass 80 kg, moves to the right at 3 m/s. What is the velocity of their center of mass?

(A) Zero (B) 0.5 m/s to the left (C) 1 m/s to the right (D) 2.4 m/s to the left (E) 2.5 m/s to the right

27. To stretch a certain nonlinear spring by an amount x requires a force F given by $F = 40x - 6x^2$, where F is in newtons and x is in meters. What is the change in potential energy when the spring is stretched 2 meters from its equilibrium position? (A) 16 J (B) 28 J (C) 56 J (D) 64 J (E) 80 J

28. When a block slides a certain distance down an incline, the work done by gravity is 300 J. What is the work done by gravity if this block slides the same distance up the incline?

(A) 300 J (B) Zero (C) -300 J
(D) It cannot be determined without knowing the distance the block slides.
(E) It cannot be determined without knowing the coefficient of friction.

31. An object having an initial momentum that may be represented by the vector above strikes an object that is initially at rest. Which of the following sets of vectors may represent the momenta of the two objects after the collision?

(A)

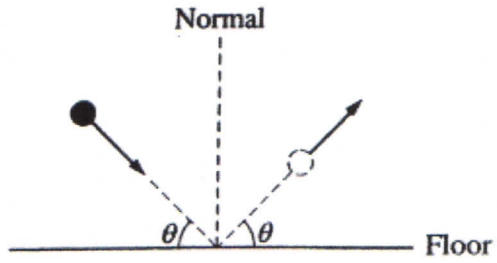
(B)

(C)

(D)

(E)

2004:



3. A 2 kg ball collides with the floor at an angle θ and rebounds at the same angle and speed as shown above. Which of the following vectors represents the impulse exerted on the ball by the floor?

(A) 

(B) 

(C)

(D) 

(E) 

13. The momentum p of a moving object as a function of time t is given by the expression $p = kt^3$, where k is a constant. The force causing this motion is given by the expression

(A) $3kt^2$

(B) $\frac{3kt^2}{2}$

(C) $\frac{kt^2}{3}$

(D) kt^4

(E) $\frac{kt^4}{4}$

15. A student holds one end of a string in a fixed position. A ball of mass 0.2 kg attached to the other end of the string moves in a horizontal circle of radius 0.5 m with a constant speed of 5 m/s. How much work is done on the ball by the string during each revolution?

(A) 0 J
(B) 0.5 J
(C) 1.0 J
(D) 2π J
(E) 5π J

21. For a particular nonlinear spring, the relationship between the magnitude of the applied force F and the resultant displacement x from equilibrium is given by the equation $F = kx^2$. What is the amount of work done by stretching the spring a distance x_0?

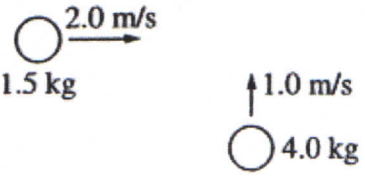
(A) kx_0^3

(B) $\frac{1}{2}kx_0$

(C) $\frac{1}{2}kx_0^3$

(D) $\frac{1}{3}kx_0^2$

(E) $\frac{1}{3}kx_0^3$



Two pucks moving on a frictionless air table are about to collide, as shown above. The 1.5 kg puck is moving directly east at 2.0 m/s. The 4.0 kg puck is moving directly north at 1.0 m/s.

22. What is the total kinetic energy of the two-puck system before the collision?

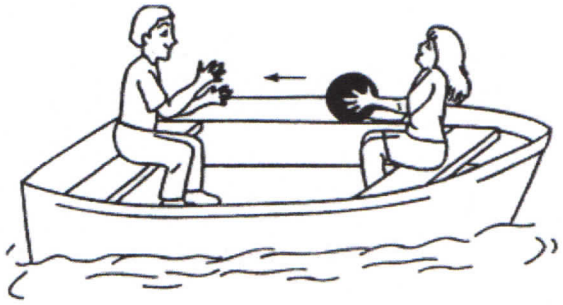
(A) $\sqrt{13}$ J
(B) 5.0 J
(C) 7.0 J
(D) 10 J
(E) 11 J

23. What is the magnitude of the total momentum of the two-puck system after the collision?

(A) 1.0 kg·m/s
(B) 3.5 kg·m/s
(C) 5.0 kg·m/s
(D) 7.0 kg·m/s
(E) $5.5\sqrt{5}$ kg·m/s

30. A 1000 W electric motor lifts a 100 kg safe at constant velocity. The vertical distance through which the motor can raise the safe in 10 s is most nearly

(A) 1 m
(B) 3 m
(C) 10 m
(D) 32 m
(E) 100 m



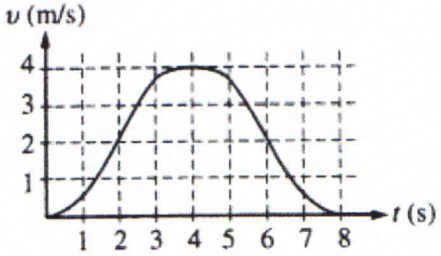
25. As shown above, two students sit at opposite ends of a boat that is initially at rest. The student in the front throws a heavy ball to the student in the back. What is the motion of the boat at the time immediately after the ball is thrown and, later, after the ball is caught? (Assume that air and water friction are negligible.)

	Immediately After the Throw	After the Catch
(A)	Boat moves forward	Boat moves forward
(B)	Boat moves forward	Boat moves backward
(C)	Boat moves forward	Boat does not move
(D)	Boat moves backward	Boat does not move
(E)	Boat moves backward	Boat moves forward

2009:

3. All of the following are units of power EXCEPT

(A) watts
(B) joules per second
(C) electron volts per second
(D) newton meters per second
(E) kilogram meters per second



13. The velocity v of an elevator moving upward between adjacent floors is shown as a function of time t in the graph above. At which of the following times is the force exerted by the elevator floor on a passenger the least?

(A) 1 s
(B) 3 s
(C) 4 s
(D) 5 s
(E) 6 s

20. A 2000 kg car, initially at rest, is accelerated along a horizontal roadway at 3 m/s^2. What is the average power required to bring the car to a final speed of 20 m/s?

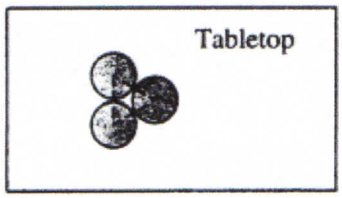
(A) 6×10^3 W
(B) 2×10^4 W
(C) 3×10^4 W
(D) 4×10^4 W
(E) 6×10^4 W

15. A disc of mass m slides with negligible friction along a flat surface with a velocity v. The disc strikes a wall head-on and bounces back in the opposite direction with a kinetic energy one-fourth of its initial kinetic energy. What is the final velocity of the disc?

(A) $v/4$
(B) $v/2$
(C) $-v$
(D) $-v/2$
(E) $-v/4$

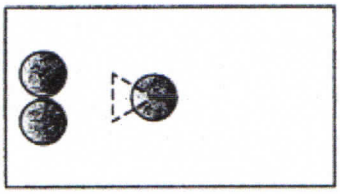
26. Objects 1 and 2 have the same momentum. Object 1 can have more kinetic energy than object 2 if, compared with object 2, it

(A) has more mass
(B) has the same mass
(C) is moving at the same speed
(D) is moving slower
(E) is moving faster

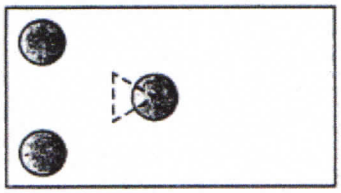


32. Three identical disks are initially at rest on a frictionless, horizontal table with their edges touching to form a triangle, as shown in the top view above. An explosion occurs within the triangle, propelling the disks horizontally along the surface. Which of the following diagrams shows a possible position of the disks at a later time? (In these diagrams, the triangle is shown in its original position.)

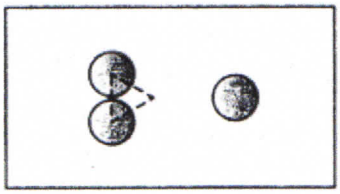
(A)



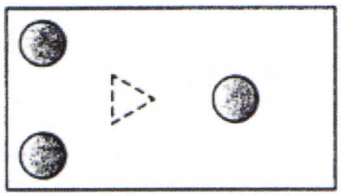
(B)



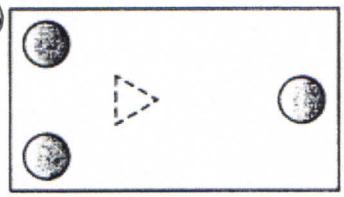
(C)



(D)



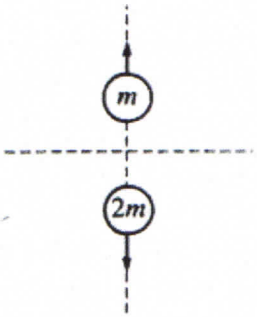
(E)



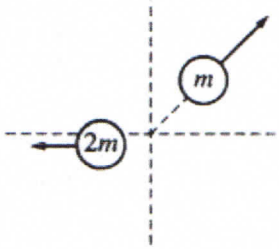
Top View

28. Two balls with masses m and $2m$ approach each other with equal speeds v on a horizontal frictionless table, as shown in the top view above. Which of the following shows possible velocities of the balls for a time soon after the balls collide?

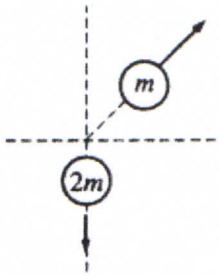
(A)



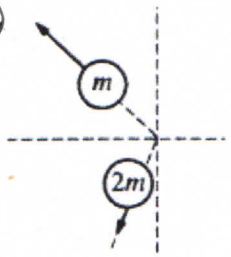
(B)



(C)



(D)



(E)