## Trajectory

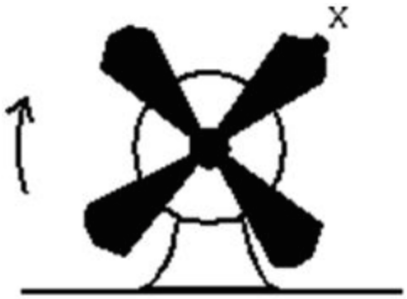
Identical guns fire identical bullets horizontally at the same speed from the same height above level planes, one on the Earth ($g_{earth} = 9.8 m \bullet s^{-1}$) and one on the Moon ($g_{moon} = 1.62 m \bullet s^{-1}$). Which of the following three statements is **NOT TRUE**? **Note:** only one correct answer.

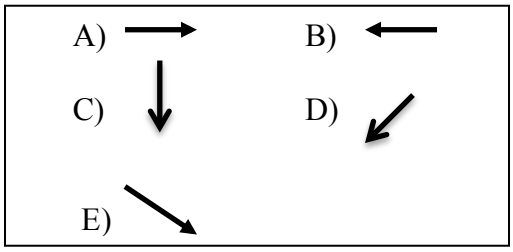
I. The horizontal distance traveled by the bullet is greater for the Moon.
II. The flight time is less for the bullet on the Earth.
III. The velocities of the bullets at impact with the ground are the same.

A rock is projected upward from the surface of the moon, at time $t$ = 0.0 s, with a velocity of 30 m/s. The acceleration due to gravity at the moon's surface is 1.62 m/s$^2$. The height of the rock when it is descending with a velocity of 20 m/ is closest to:
115 m  b) 155 m  c) 135 m  d) 125 m  e) 145 m

## Brain Teaser

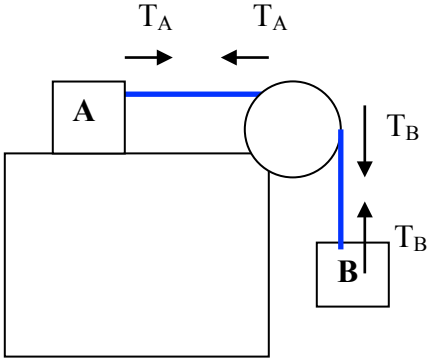
The fan shown has been turned on and is **speeding up** as it rotates **clockwise**. The **direction** of the **acceleration** of **point X** on the fan **could be**:




## Torque Problem:

Below Box A ($m_A$ = 3 kg) lies on a **frictionless table** attached to box B through a cylindrical pulley of radius 0.2 m and mass 2 kg ($I = 0.5\ M\ r^2$).




Box B is **accelerating downward** at a =1.2 m•s$^{-2}$. At the same time the rope is inducing a **rotation** of the pulley **without slipping**. In order for this to happen, it should be clear that $T_B > T_A$, so that there is a net torque that induces a CW angular acceleration, $\alpha$.

A) Draw a free-body diagram of all forces on block A. Use it to find $T_A$. B) Calculate the angular acceleration, $\alpha$, of the pulley. Draw a free-body diagram of all forces on pulley, and use it to find $T_B$. Do your work on the back.

# Wiley Plus Problem to try:

## Problem 71, Chapter 11

71. SSM

In Fig. 11-60, a constant horizontal force $\vec{F}_{app}$ of magnitude 12 N is applied to a uniform solid cylinder by fishing line wrapped around the cylinder. The mass of the cylinder is 10 kg, its radius is 0.10 m, and the cylinder rolls smoothly on the horizontal surface. (a) What is the magnitude of the acceleration of the center of mass of the cylinder? (b) What is the magnitude of the angular acceleration of the cylinder about the center of mass? (c) In unit-vector notation, what is the frictional force acting on the cylinder?

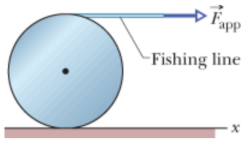



Figure 11-60 Problem 71

ANSWER

(a) 1.6 m/s$^2$; (b) 16 rad/s$^2$; (c) $(4.0\ \text{N})\hat{i}$

## Problem 9, Chapter 11

••9. GO

In Fig. 11-33, a solid ball rolls smoothly from rest (starting at height $H = 6.0$ m) until it leaves the horizontal section at the end of the track, at height $h = 2.0$ m. How far horizontally from point $A$ does the ball hit the floor?

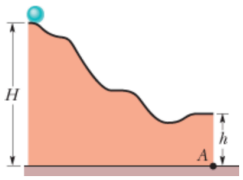



Figure 11-33 Problem 9

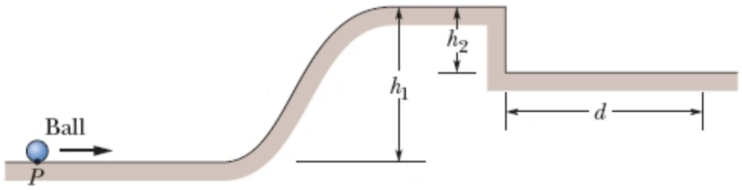
ANSWER

4.8 m

## Problem 14, Chapter 11

**Chapter 11, Problem 014**

In the figure here, a small, solid, uniform ball is to be shot from point $P$ so that it rolls smoothly along a horizontal path, up along a ramp, and onto a plateau. Then it leaves the plateau horizontally to land on a game board, at a horizontal distance $d$ from the right edge of the plateau. The vertical heights are $h_1$ = 5.5 cm and $h_2$ = 1.80 cm. With what speed must the ball be shot at point $P$ for it to land at $d$ = 7.5 cm?




$v_0$ = 1.52

m/s

## Random Multiple-Choice Below:

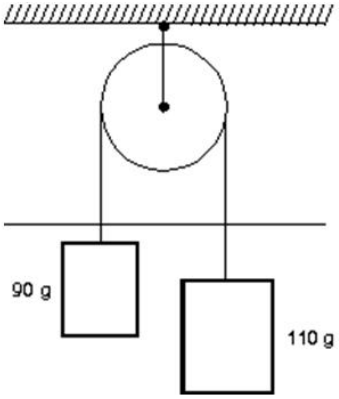
## Newton's law no friction

1. The standard 1-kg mass is attached to a compressed spring and the spring is released. If the mass initially has an acceleration of 5.6 m/s$^2$, the force of the spring has a magnitude of:
A) an undetermined amount B) 2.8 N C) 5.6 N D) 0 N E) 11.2 N

2. Acceleration is always in the direction:
a) of the final velocity B) of the net force C) opposite to the frictional force D) of the initial velocity E) of the displacement

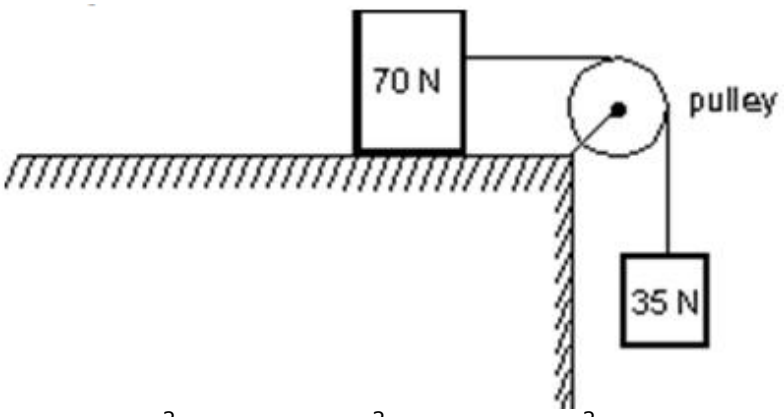
3. A ball with a weight of 1.5 N is thrown at an angle of 30° above the horizontal with an initial speed of 12 m/s. At its highest point, the net force on the ball is:
A) 1.5 N, down B) 9.8 N, 30° below horizontal C) 0 N D) 9.8 N down E) 9.8 N up

4. Two blocks are connected by a string and pulley as shown. Assuming that the string and pulley are massless, the magnitude of the acceleration of each block is:



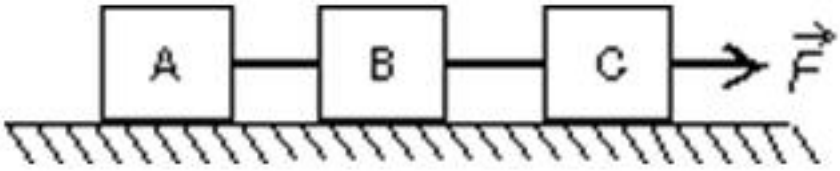

A) 0.98 m/s$^2$ B) 0.049 m/s$^2$ C) 0.0098 m/s$^2$ D) 0.54 m/s$^2$ E) 0.54 m/s$^2$

5. A 70-N block and a 35-N block are connected by a string as shown. If the pulley is massless and the surface is frictionless, the magnitude of the acceleration of the 35-N block is:




A) 1.6 m/s$^2$ B) 3.3 m/s$^2$ C) 4.9 m/s$^2$ D) 6.5 m/s$^2$ E) 9.8 m/s$^2$

6. Three blocks (A, B, C), each having the same mass *M*, are connected by strings as shown. Block C is pulled to the right by a force that causes the entire system to accelerate. Neglecting friction, the net force acting on block B is:




a) 0 b) $\vec{F}/3$ c) $\vec{F}/2$ d) $2\vec{F}/3$ e) $\vec{F}$

## Newton's law with friction

7. A 40-N crate rests on a rough horizontal floor. A 12-N horizontal force is then applied to it. If the coefficients of friction are $\mu_s$ = 0.5 and $\mu_k$ = 0.4, the magnitude of the frictional force on the crate is:
A) 8N B) 12 N C) 16N D) 20 N E) 40 N

8. A horizontal shove of at least 200-N is required to start moving an 800-N crate initially at rest on a horizontal floor. The coefficient of static friction is:
A) 0.125 B) 0.25 C) 0.50 D) 4.00 E) None of these

9. The speed of a 4.0-N hockey puck, sliding across a level ice surface, decreases at the rate of 0.61 m/s$^2$. The coefficient of kinetic friction between the puck and ice is:
A) 0.062 B) 0.25 C) 0.41 D) 0.62 E) 1.2

10. A horizontal force of 12 N pushes a 0.50-kg book against a vertical wall. The book is initially at rest. If the coefficients of friction are $\mu_s$ = 0.60 and $\mu_k$ = 0.50 which of the following is true?
A) The block will start moving and accelerate B) If started moving

downward, the block will accelerate C) The frictional force is 4.9 N D) The frictional force is 7.2 N E) The normal force is 4.9 N

11. A 5.0-kg crate is resting on a horizontal plank. The coefficient of static friction is 0.50 and the coefficient of kinetic friction is 0.40. After one end of the plank is raised so the plank makes an angle of 30° with the horizontal, the force of friction is:
A) 0N B) 17N C) 20 N D) 25N E) 49N
Kinetic!!!

12. A coin is placed on a horizontal phonograph turntable. Let $N$ be the normal force exerted by the turntable on the coin, $f$ be the frictional force exerted by the turntable on the coin, and $f_{s,\,max}$ be the maximum force of the static friction. The speed of the turntable is increased in small steps. If the coin does not slide, then
**A)** $N$ increases, $f$ increases, and $f_{s,\,max}$ stays the same; **B)** $N$ increases, $f$ increases, and $f_{s,\,max}$ increases; **C)** $f$ increases and both $N$ and $f_{s,\,max}$ stay the same; **D)** $N$, $f$, and $f_{s,\,max}$ all stay the same; **E)** $N$, $f$, and $f_{s,\,max}$ all increase

## Work and Kinetic Energy

13. An object is constrained by a cord to move in a circular path of radius 0.5 m on a horizontal frictionless surface. The cord will break if its tension exceeds 16 N. The maximum kinetic energy the object can have is:
A) 4J B) 8J C) 16J D) 32J E) 64J
14. A boy holds a 40-N weight at arm's length for 10 s. His arm is 1.5 m above the ground. The work done by the force of the boy on the weight while he is holding it is:
A) 0J B) 6.1J C) 40J D) 60J E) 90J

15. A 2-kg object is moving at 3 m/s. A 4-N force is applied in the direction of motion and then removed after the object has traveled an additional 5 m. The work done by this force is:
A) 9J B) 18 J C) 20J D) 29 J E) 38 J

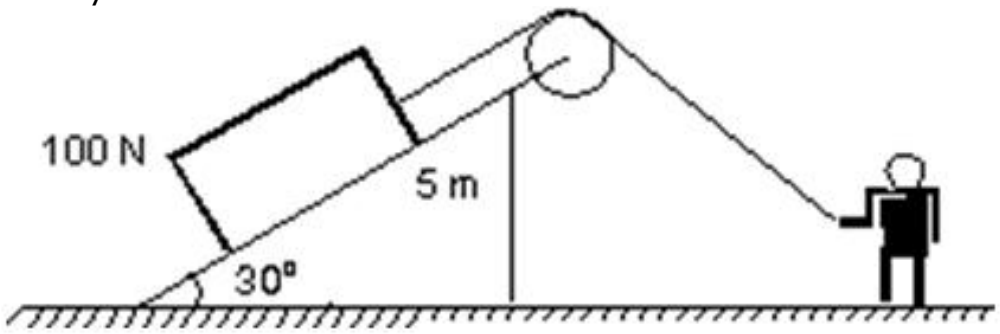
16. An object moves in a circle at constant speed. The work done by the centripetal force is zero because:
**A)** the magnitude of the acceleration is zero; **B)** there is no friction; **C)** the centripetal force is perpendicular to the velocity; **D)** the displacement for each revolution is zero; **E)** the average force for each revolution is zero

17. A 100-kg piano rolls down a 20° incline. A man tries to keep it

from accelerating, and manages to keep its acceleration to 1.2 m/s$^2$. If the piano rolls 5 m, what is the net work done on it by all the forces acting on it?
A) 60J B) 100J C) 600J D) 100J E) 490 J

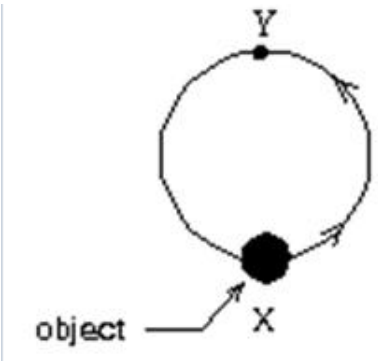
18. The velocity of a particle moving along the *x* axis changes from $v_i$ to $v_f$. For which values of $v_i$ and $v_f$ is the total work done on the particle positive?
**A)** $v_i$ = 5m/s, $v_f$ = -2m/s; **B)** $v_i$ = -5m/s, $v_f$ = -2m/s; **C)** $v_i$ = -5m/s, $v_f$ = 2m/s; **D)** $v_i$ = –2m/s, $v_f$ = –5m/s; **E)** $v_i$ = 5m/s, $v_f$ = 2m/s

19. The work done by gravity during the descent of a projectile is:
A) positive B) negative C) zero D) depends for its sign on the direction of the *y* axis E) depends for its sign on the direction of both the *x* and *y* axes
20. A man pulls a 100-N crate up a frictionless 30° slope 5 m high as shown. Assuming that the crate moves at constant speed, the work done by the man is:




A) -500J B) 500 J C) -250 J D) 250J E) 0J

21. A man moves the 10-g object shown in a vertical plane at a constant speed from position X to position Y along a circular track of radius 20 m. The process takes 0.75 min. The work done by the man is about:



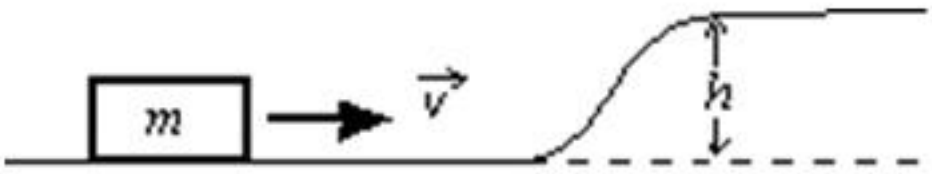

A) 1J  B) 2J  C) 4J  D) 6J  E) 12J

# ENERGY

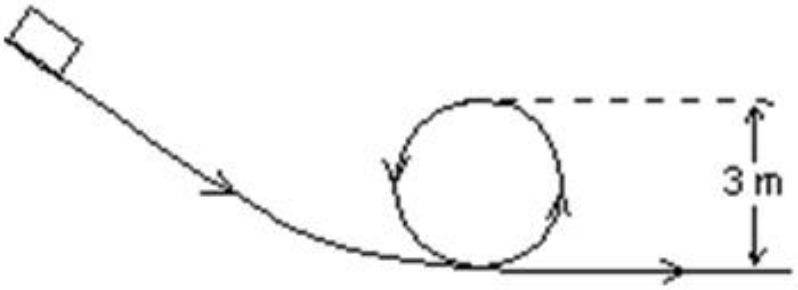
22. Only if a force on a particle is conservative:
A) does it obey Newton's third law B) does it obey Newton's second law C) does it do no work when the particle moves exactly once around any closed path D) it is not a frictional force E) does the work it does equal the change in the kinetic energy of the particle

23. A force of 10 N holds an ideal spring with a 20-N/m spring constant in compression. The potential energy stored in the spring is:
A) 0.5J B) 2.5J  C) 5J  D) 10J  E) 200J

24. For a block of mass *m* to slide without friction up the rise of height *h* shown, it must have a minimum initial kinetic energy of:
A) mgh/2  B) gh/2  C) gh  D) 2mgh  E) mgh




25. A small object slides along the frictionless loop-the-loop with a diameter of 3 m. What minimum speed must it have at the top of the loop in order to remain in contact with the loop?




A) 1.9 m/s  B) 3.8 m/s  C) 5.4 m/s  D) 15 m/s  E) 29 m/s

26. A stationary mass $m$ = 1.3 kg is hanging from a spring of spring constant $k$ = 1200 N/m. You raise the mass a distance of 10 cm above its equilibrium position. How much has the potential energy of the mass-spring system changed?
A) 1.3 J  B) 6.0J  C) 7.3 J D) 12J E) 13J

**Center-of-Mass and Momentum**

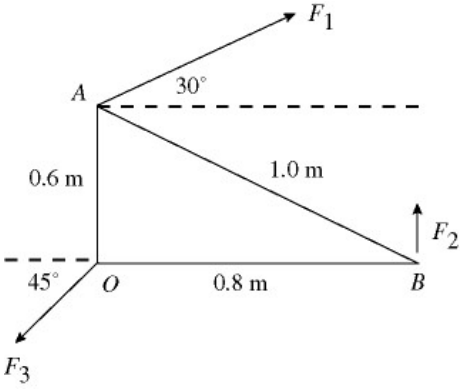
27. A 640-N hunter gets a rope around a 3200-N polar bear. They are stationary, 20 m apart, on frictionless level ice. When the hunter pulls the polar bear to him, the polar bear will move:
A) 1.0m  B) 3.3m  C) 10m  D) 12 m  E) 17m

28. Two boys with masses of 40 kg and 60 kg stand on a horizontal frictionless surface holding the ends of a light 10-m long rod. The boys pull themselves together along the rod. When they meet the 40-kg boy will have moved what distance?
A) 4 m  B) 5m  C) 6m  D) 10m
E) Need to know the forces they exert

29. A 10-kg block of ice is at rest on a frictionless horizontal surface. A 1.0-N force is applied in an easterly direction for 1.0 s. During this time interval, the block:
A) acquires a speed of 1 m/s;  B) moves 10 cm;  C) acquires a momentum of 1.0 kg·m/s;  D) acquires a kinetic energy of 0.1 J;
E) None of the above.

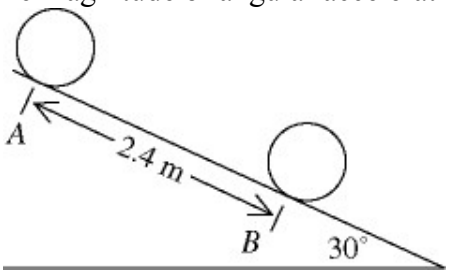
30. A 0.3 kg rubber ball is dropped from the window of a building. It strikes the sidewalk below at 30 m/s and rebounds up at 20 m/s. The magnitude of the impulse due to the collision with the sidewalk is:
A) 3.0 N-S B) 6.0 N-s  C) 9.0 N-s  D)  15 N-s  E) 29 N-s

31. A light triangular plate *OAB* is in a horizontal plane. Three forces, $F_1$ = 3 N, $F_2$ = 1 N, and $F_3$ = 9 N, act on the plate, which is pivoted about a vertical axes through point *O*. In Figure below, the magnitude of the torque due to force $F_1$ about the axis through point *O* is closest to:




**a)** 1.1 N•m
**b)** 1.4 N•m
**c)** 0.90 N•m
**d)** 1.8 N•m
**e)** 1.6 N•m

32. Below, the radius of a 3.0-kg wheel is 6.0 cm. The wheel is released from rest at point A on a 30 incline. The wheel rolls **without slipping** and moves 2.4 m to point B in 1.20 s. The magnitude of angular acceleration of the wheel is closest to:




a) 56$rad \cdot s^{-2}$ b) 48$rad \cdot s^{-2}$ c) 65$rad \cdot s^{-2}$ d) 73$rad \cdot s^{-2}$ e) 82$rad \cdot s^{-2}$