

PHYSICS FORMULAS

$$\mathbf{A} = A_x \mathbf{i} + A_y \mathbf{j} \qquad |\mathbf{A}| = \sqrt{(A_x)^2 + (A_y)^2} \qquad \Phi = \tan^{-1} \left(\frac{A_y}{A_x} \right)$$

$$\mathbf{A} + \mathbf{B} = (A_x + B_x) \mathbf{i} + (A_y + B_y) \mathbf{j} \qquad \mathbf{A} \cdot \mathbf{B} = A_x B_x + A_y B_y + A_z B_z = |\mathbf{A}| |\mathbf{B}| \cos(\mathbf{A}, \mathbf{B})$$

linear motion $\mathbf{v} = \mathbf{v}_0 + \mathbf{a}t$ $x - x_0 = \mathbf{v}_0 t + \frac{1}{2} \mathbf{a}t^2$ $2\mathbf{a}(x - x_0) = v^2 - v_0^2$
 $x - x_0 = \frac{1}{2} (v + v_0)t$

projectile motion $v_x = v_{x0} = |v_0| \cos \theta_0$ $v_{y0} = |v_0| \sin \theta_0$ $v_y = |v_0| \sin \theta_0$
 - gt
 $x - x_0 = v_0 \cos \theta_0 t$ $y - y_0 = v_0 \sin \theta_0 t - \frac{1}{2} g t^2$ $x - x_0 = (v_0^2 \sin(2\theta)) / g$
 $(-2g)(x - x_0) = v_y^2 - v_{y0}^2$

circular motion $a_r = v^2 / r$ $a_r = r(2\pi/T)^2$ $T = 1/f$ $F_r = m v^2 / r$

Newton laws: $\mathbf{F}_{net} = \Sigma \mathbf{F} = \mathbf{m} \mathbf{a}$ $\Sigma \mathbf{F}_x = \mathbf{m} \mathbf{a}_x$ $\Sigma \mathbf{F}_y = \mathbf{m} \mathbf{a}_y$ $\mathbf{w} = \mathbf{m} \mathbf{g}$
 $\mathbf{F}_{smax} = \mu_s \mathbf{N}$ $\mathbf{F}_k = \mu_k \mathbf{N}$

Hook's Law $\mathbf{F} = -k\mathbf{x}$

Work $\mathbf{W} = \mathbf{F} \cdot \mathbf{d} = |\mathbf{F}| |\mathbf{d}| \cos(\mathbf{F}, \mathbf{d}) = F_x d_x + F_y d_y$ $W_s = -\frac{1}{2}(x_f^2 - x_0^2)$ $\mathbf{W}_{net} = (\Sigma \mathbf{F}) \cdot \mathbf{d}$
 $\Delta U_s = -W_s$

Energy $K = \frac{1}{2} m v^2$ $U_g = mgy$ $U_s = \frac{1}{2} kx^2$ $\Delta K = K_f - K_i = W_{net}$
 $\Delta U_g = -W_g$ $E = K + U$ $\Delta E = \Delta K + \Delta U = 0$

Power $P = dW/dt = \mathbf{F} \cdot \mathbf{v} = |\mathbf{F}| |\mathbf{v}| \cos(\mathbf{F}, \mathbf{v})$ $P_{avg} = \Delta W / \Delta t$

$$U_{gi} + U_{si} + K_i = U_{gf} + U_{sf} + K_f \qquad U_{gi} + U_{si} + K_i = U_{gf} + U_{sf} + K_f + \Delta E_{th} \qquad \Delta E_{th} = f \cdot d$$

momentum: $\mathbf{p} = m\mathbf{v}$; $\mathbf{F}_{net} \Delta t = \mathbf{I} = m\mathbf{v}_f - m\mathbf{v}_i$; $\mathbf{P}_i = \mathbf{P}_f$; $m_1 \mathbf{v}_{i1} + m_2 \mathbf{v}_{i2} = m_1 \mathbf{v}_{f1} + m_2 \mathbf{v}_{f2}$;

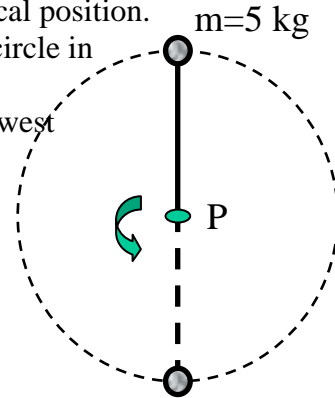
elastic: $\mathbf{v}_1' = \frac{m_1 - m_2}{m_1 + m_2} \mathbf{v}_1 + \frac{2m_2}{m_1 + m_2} \mathbf{v}_2$; $\mathbf{v}_2' = \frac{2m_1}{m_1 + m_2} \mathbf{v}_1 + \frac{m_2 - m_1}{m_1 + m_2} \mathbf{v}_2$, perf. Inelastic: $m_1 \mathbf{v}_{i1} + m_2 \mathbf{v}_{i2} = (m_1 + m_2) \mathbf{v}_f$

$\mathbf{R}_{com} = (m_1 \mathbf{r}_1 + m_2 \mathbf{r}_2 + \dots + m_n \mathbf{r}_n) / (m_1 + m_2 + \dots + m_n)$

1. An automobile moves on a level horizontal road in a circle of radius 30 m. The coefficient of friction between tires and road is 0.50. The maximum speed with which this car can round this curve is:

- A) 3.0 m/s
- B) 4.9 m/s
- C) 9.8 m/s
- D) 12 m/s
- E) 13 m/s

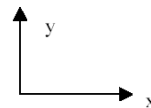
2. A 5-kg ball is attached to a thin rod, 2 m long. The other end of the rod is pivoted without friction at the point **P**. The ball is released from the vertical position. Due to the influence of the gravity, the ball is moving around a circle in the vertical plane as shown in the drawing. What is the tension force in the thin rod when the ball is at the lowest point with velocity 8.8 m/s?



- A) 49 N
- B) 98 N
- C) 147 N
- D) 196 N
- E) 245 N

3. Consider a two-dimensional system of coordinates with the x -axis pointing right and the y -axis pointing up as shown in the figure below. In vector component notation, $\mathbf{a} = \mathbf{i} + \mathbf{j}$ and $\mathbf{b} = \mathbf{i} - \mathbf{j}$. The sum of these vectors, $\mathbf{a} + \mathbf{b}$, points

- A) up
- B) down
- C) left
- D) right
- E) is zero (no direction)



4. For the previous problem (*Problem 3*), the *difference* of the two vectors, $\mathbf{a} - \mathbf{b}$, points

- A) up
- B) down
- C) left
- D) right
- E) is zero (no direction)

5.

The angle between vectors $\vec{a} = 3\hat{i} - 2\hat{j}$ and $\vec{c} = 3\hat{i} + 2\hat{j}$, is equal to

- A) 180°
- B) 0°
- C) 34°
- D) 45°
- E) 67°

6. A heavy object with mass m is dropped from a plane, which is moving horizontally with a constant speed v at a height h above the ground. If one neglects air friction, at the instant when the object hits the ground the plane will be

- A) in front of the object
- B) right above the object
- C) depends on v
- D) depends on v and h
- F) depends on v , h and m

7. In the previous problem (*Problem 6*), the time for the object to hit the ground

- A) depends on v only
- B) depends on v and h
- C) depends on v , h and m
- D) depends on h only
- E) depends on m only

8. For the same problem (*Problem 6*), calculate the horizontal distance which the object will travel before hitting the ground, if $h = 490$ m, $v = 360$ km/h and $m = 1000$ kg.

- A) 100 m
- B) 1000 m
- C) 10000 m
- D) 3600 m
- E) 7200 m

8A.

If the coefficient of static friction between the tires and road on a rainy day is 0.50, what is the fastest speed at which a car can make a turn with a radius of 80.0 meters?

- A) 7.0 m/s
- B) 11.0 m/s
- C) 14.1 m/s
- D) 20.0 m/s
- E) 25.0 m/s

9. A hockey puck sliding on a frozen lake comes to rest after traveling 200m. If its initial velocity is 10 m/s, what is the magnitude of its acceleration if that acceleration is assumed constant?

- A) 0.25 m/s²
- B) 0.5 m/s²
- C) 0.75 m/s²
- D) 1.0 m/s²
- E) 1.20 m/s²

How long does it take for the puck to come to stop?

10. 1 mile=1609 m. 10m/s is equivalent to the speed of:

- A) 2.2 mph
- B) 22 mph
- C) 2200 mph
- D) 36mph
- E) 3.6 mph

11. Volume of the cube with side 2.54 m is equivalent to(1in=2.54 cm):

- A) 10^3 in^3
- B) 10^4 in^3
- C) 10^4 cm^3
- D) 10^3 cm^3
- E) 10^6 in^3

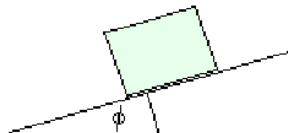
11A. A projectile is launched from a level plane at 30° from horizontal with an initial velocity of 1500 m/s. What is the maximum height above the plane the projectile will reach?

- A. 20 km
- B. 30 km
- C. 60 km
- D. 80 km
- E. 120 km

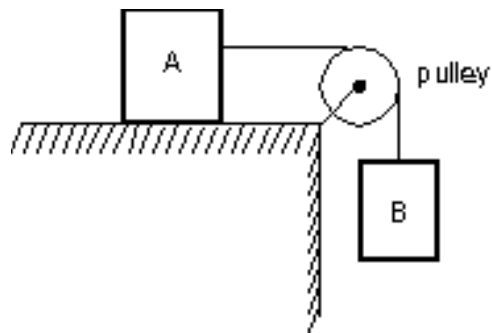
11B.

A block is at rest on a horizontal plank of wood. The plank is slowly lifted at one end while the other end stays on the floor. If the coefficient of static friction between the block and the plank is 0.5, what is the steepest angle the plank can have before the block begins to slide without being pushed?

- A) 27°
- B) 37°
- C) 45°
- D) 53°
- E) 59°

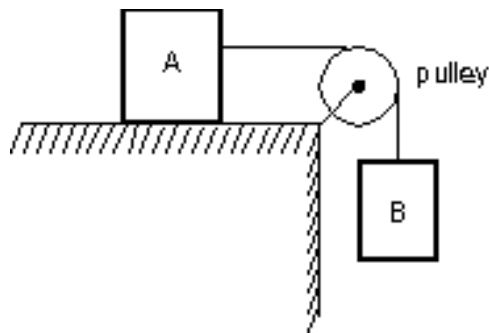


- 12 Block A, with a mass of 50 kg, rests on a horizontal table top. The coefficient of static friction is 0 A horizontal string is attached to A and passes over a massless, frictionless pulley as shown, mass $m_B = 10 \text{ kg}$ of block B, $g = 10 \text{ m/s}^2$ the tension in the cord is:



- A) 100 N
 B) 250 N
 C) 10 N
 D) 50 N
 E) 500 N

- 12 Block A, with a mass of 50 kg, rests on a horizontal table top. The coefficient of static friction is 0 A horizontal string is attached to A and passes over a massless, frictionless pulley as shown, mass $m_B = 10 \text{ kg}$ of block B, $g = 10 \text{ m/s}^2$ the tension in the cord is:



- A) 100 N
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 C) 10 N
 D) 50 N
 E) 500 N

- 13 . If $\vec{F} = (2N)\hat{i} + (6N)\hat{j}$ and $\vec{d} = (4m)\hat{i} + (2m)\hat{j}$, then the work $\vec{F} \cdot \vec{d}$ done by the force is

- A) $(8Nm)\hat{i} + (12Nm)\hat{j}$
 B) $(12Nm)\hat{i} - (14Nm)\hat{j}$
 C) 20 Nm
 D) 14 Nm
 E) none of the above

- 14 . A 5 kg ball is initially at rest and is dropped from a height of 4.1 m above a table. What is the velocity of the ball just before impact with the table?

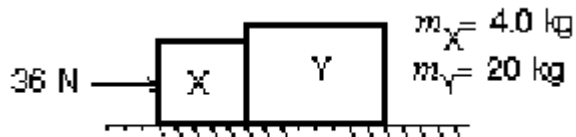
- A) 5 m/s

- B) 9 m/s
- C) 20 m/s
- D) 41 m/s
- E) 80 m/s

15. A car moves horizontally with a constant acceleration of 3 m/s^2 . A ball is suspended by a string from the ceiling of the car; the ball does not swing, being at rest with respect to the car. What angle does the string make with the vertical?
- A) 17°
 - B) 35°
 - C) 52°
 - D) 73°
 - E) Cannot be found without knowing the length of the string

16. A football is thrown toward a receiver with an initial speed of 20 m/s at an angle of 25° above the horizontal. At what horizontal distance the receiver should be to catch the football at the level at which it was thrown?
- A) Impossible to solve; need the mass of the football
 - B) 11 m;
 - C) 21 m
 - D) 31 m
 - E) 41 m

17. Two blocks (X and Y) are in contact on a horizontal frictionless surface. A 36-N constant force is applied to X as shown. The magnitude of the force exerted by Y on X is:

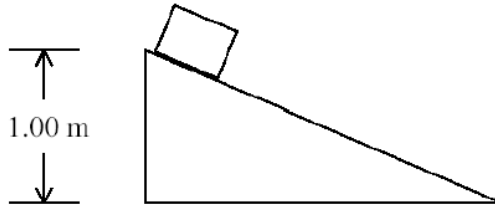


- A) 1.5 N
- B) 6.0 N
- C) 29 N
- D) 30 N
- E) 36 N

Ans: 1d, 2e, 3d, 4a, 5e, 6b, 7d, 8b, 9a, 10b, 11e, 12b, 13c, 14b, 15a, 16d, 17d

18. A block moves from rest down a frictionless plane. The final speed v_f of the block at the bottom of the plane is most nearly

- A) $\sqrt{2.00}$ m/s
- B) $\sqrt{5.00}$ m/s
- C) $\sqrt{19.6}$ m/s
- D) 4.95 m/s
- E) 9.81 m/s



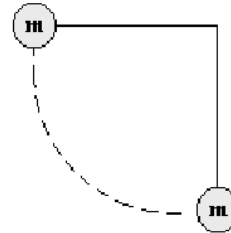
19. A 0.2-kg rubber ball is dropped from the window of a building. It strikes the sidewalk below

at 30m/s and rebounds up at 20m/s. The impulse on the ball during the collision is:

- A. 10N · s upward
- B. 10N · s downward
- C. 2.0N · s upward
- D. 2.0N · s downward
- E. 9.8N · s upward

20. A 0.5-kg ball is attached to a string, 0.8 m long. The ball is released from the horizontal position as shown in the drawing. What is the speed of the ball at the lowest point?

- A) 4.0 m/s
- B) 8.0 m/s
- C) 16 m/s
- D) 20 m/s



21. A 5-kg cart is moving horizontally at 6 m/s. In order to change its speed to 10 m/s, the net work done on the cart must be:

- A) 40 J
- B) 90 J
- C) 160 J
- D) 400 J
- E) 550 J

22. What magnitude impulse will give a 2.0-kg object a momentum change of magnitude + 50 kg · m/s?

- A. +25N · s
- B. -25N · s
- C. +50N · s
- D. -50N · s
- E. +100N · s

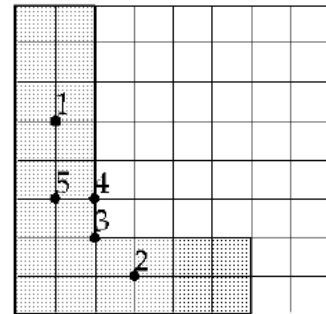
23. A vertical spring stretches 8 cm when a 1.6 kg block is hung from its end. What is the spring constant of this spring?

- A) 2 N/m
- B) 196 N/m
- C) 890 N/m
- D) 2200 N/m
- E) 8000 N/m

What is the Elastic Potential Energy of the spring?

24. An L-shaped piece, represented by the shaded area on the figure, is cut from a metal plate of uniform thickness. The point that corresponds to the center of mass of the L-shaped piece is

- A) 1
- B) 2
- C) 3
- D) 4
- E) 5



25. A cue stick strikes a stationary pool ball, with an average force of 50 N over a time of 10 ms. If the ball has mass 0.20 kg, what speed does it have just after impact?

26. A 150 g baseball pitched at a speed of 40 m/s is hit straight back to the pitcher at a speed of 60 m/s. What is the magnitude of the average force on the ball from the bat if the bat is in contact with the ball for 5.0 ms?

27. A force that averages 1200 N is applied to a 0.40 kg steel ball moving at 14 m/s in a collision lasting 27 ms. If the force is in a direction opposite the initial velocity of the ball, find the final speed and direction of the ball.

28. In the overhead view of Fig. 10-30, a 300 g ball with a speed v of 6.0 m/s strikes a wall at an angle θ of 30° and then rebounds with the same speed and angle. It is in contact with the wall for 10 ms. (a) What is the impulse on the ball from the wall? (b) What is the average force on the wall from the ball?

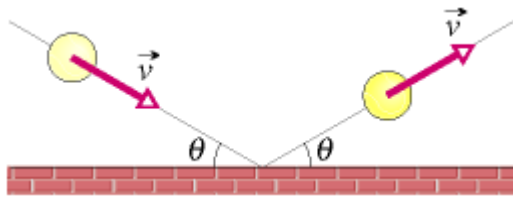
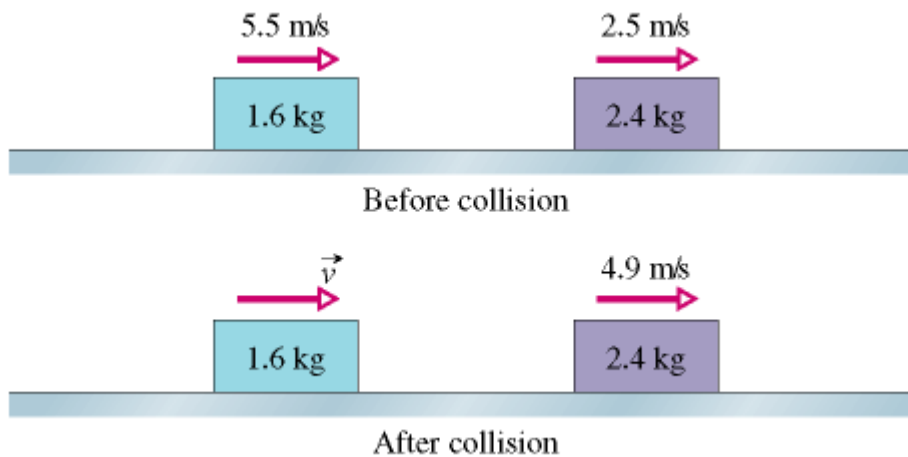


Fig. 10-30 Problem 17.

- a) 1.8 N·s, upward in figure; (b) 180 N, downward in figure

29. A bullet of mass 10 g strikes a ballistic pendulum of mass 2.0 kg. The center of mass of the pendulum rises a vertical distance of 12 cm. Assuming that the bullet remains embedded in the pendulum, calculate the bullet's initial speed.

30. Find velocity v 1.6 kg block after collision.

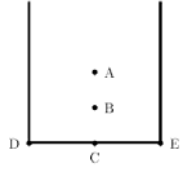


31. 4.0-N puck is traveling at 3.0m/s. It strikes a 8.0-N puck, which is stationary. The two pucks stick together. Their common final speed is:

- A. 1.0m/s
- B. 1.5m/s
- C. 2.0m/s
- D. 2.3m/s
- E. 3.0m/s

ans: A

32. A thick uniform wire is bent into the shape of the letter "U" as shown. Which point indicates



the location of the center of mass of this wire?