Clicker Quiz
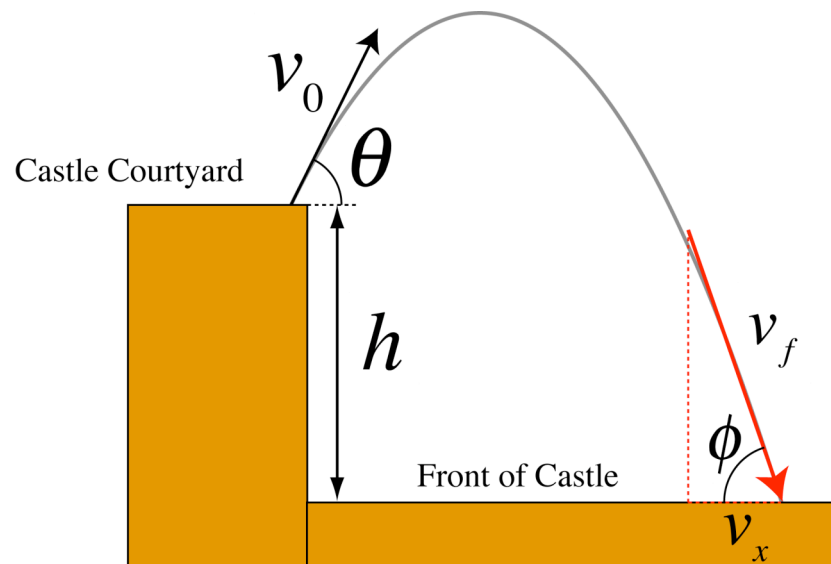
- Assume that the rock is launched with an angle of $\theta = 45°$. With what angle with respect to the horizontal does the rock strike the ground in front of the castle?

$$v_0 = 14.2 \text{ m/s}$$

$$v_f = 18.5 \text{ m/s}$$

a) 25.4°
b) 37.9°
c) 45.0°
d) 57.1°
e) 65.2°

Castle Courtyard

v_0

θ

h

v_f
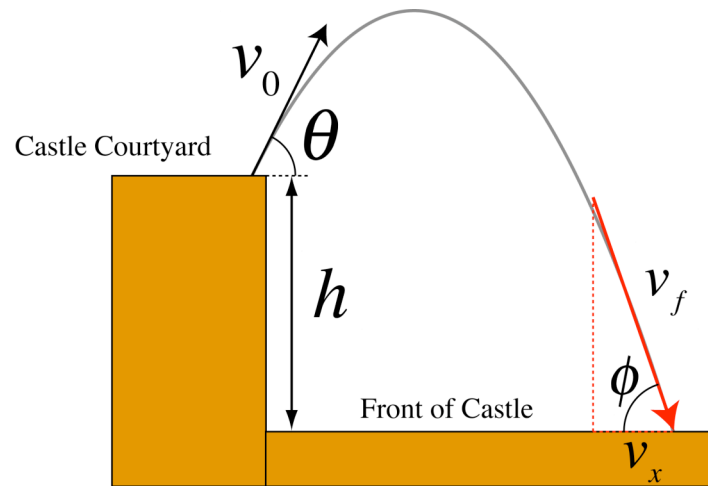
Front of Castle

ϕ

v_x

Clicker Quiz Solution

$$v_0 = 14.2 \text{ m/s}$$

$$v_f = 18.5 \text{ m/s}$$

$$\cos\phi = \frac{v_x}{v_f} = \frac{v_0 \cos\theta}{v_f}$$

$$\phi = \cos^{-1}\left(\frac{v_0 \cos\theta}{v_f}\right) = \cos^{-1}\left(\frac{(14.2 \text{ m/s})\cos 45°}{18.5 \text{ m/s}}\right)$$

$$\phi = 57.1°$$

Castle Courtyard

v_0

θ

h

Front of Castle

v_f

ϕ

v_x

Clicker Quiz

- A ball with mass *m* is thrown vertically into the air with an initial speed *v*.
- Which of the following equations correctly describes the maximum height *h* of the ball?

- A) $h = \sqrt{\dfrac{v}{2g}}$

- B) $h = \dfrac{g}{\frac{1}{2}v^2}$

- C) $h = 2mv / g$

- D) $h = \dfrac{mv^2}{g}$

- E) $h = \dfrac{v^2}{2g}$

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

$$\frac{1}{2}v^2 = gh$$

$$h = \frac{v^2}{2g}$$

Clicker Quiz

- A curling stone with mass 19.96 kg is given an initial velocity of 2.46 m/s. The stone slides on the ice with a coefficient of kinetic friction of 0.0109. How far does the stone slide before it stops?

  - a) 18.7 m
  - b) 28.3 m
  - c) 34.1 m
  - d) 39.2 m
  - e) 44.5 m

Clicker Quiz Solution

- A curling stone with mass 19.96 kg is given an initial velocity of 2.46 m/s. The stone slides on the ice with a coefficient of kinetic friction of 0.0109. How far does the stone slide before it stops?

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$$\Delta K = W$$

$$\frac{1}{2} mv^2 = \mu_k mgx$$

$$x = \frac{1}{2} \frac{v^2}{\mu_k g} = \frac{1}{2} \frac{(2.46 \text{ m})^2}{(0.0109)(9.81 \text{ m/s}^2)} = 28.3 \text{ m}$$

Clicker Quiz

- A ballistic pendulum is used to measure the speed of a bullet shot from a gun. The mass of the bullet is 50.0 g and the mass of the block is 20.0 kg. When the bullet strikes the block, the bullet/block system rises a vertical distance of 5.00 cm. What was the speed of the bullet as it struck the block?
  - a) 397 m/s.
  - b) 426 m/s.
  - c) 457 m/s.
  - d) 479 m/s.
  - e) 503 m/s.

Clicker Quiz Solution

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  - c) 457 m/s.
  - d) 479 m/s.
  - e) 503 m/s.

$$(m+M)gh = \tfrac{1}{2}\frac{m^2 v^2}{(m+M)}$$

$$v^2 = \frac{2gh(m+M)^2}{m^2}$$

$$v = \sqrt{\frac{2gh(m+M)^2}{m^2}}$$

$$v = \sqrt{\frac{2(9.81 \text{ m/s}^2)(0.05 \text{ m})(0.05 \text{ kg}+20.0 \text{ kg})^2}{(0.05 \text{ kg})^2}}$$

$$v = 397 \text{ m/s}$$

Clicker Quiz

- Assume we have two identical cars each with mass m. One is parked. The other car is moving with a speed of v and collides with the parked car head-on. The two cars stick together and slide a distance d. What is the coefficient of sliding friction between the tires and the road?

- A) $\mu_k = \dfrac{2mv}{g}$

- B) $\mu_k = \dfrac{v}{2mg}$

- C) $\mu_k = 2mgv^2$

- D) $\mu_k = \dfrac{v}{2gd^2}$

- E) $\mu_k = \dfrac{v^2}{8gd}$

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$$v_f = \frac{mv}{2m} = \frac{v}{2}$$

$$\frac{1}{2}(2m)v_f^2 = m\frac{v^2}{4}$$

$$\Delta K = W = m\frac{v^2}{4} = F_k d = \mu_k(2mg)d$$

$$\frac{v^2}{4} = 2\mu_k g d$$

$$\mu_k = \frac{v^2}{8gd}$$

Clicker Quiz

- The period of rotation of the Earth is 24 hours. At this angular velocity, the centripetal acceleration at the surface of the Earth is small compared with the acceleration of gravity. What would the period of rotation of the Earth be if the magnitude of the centripetal acceleration at the surface of the Earth at the equator due to the rotation of the Earth were equal to the magnitude of the acceleration of gravity?

  - A) 0.043 hours
  - B) 0.340 hours
  - C) 0.841 hours
  - D) 1.41 hours
  - E) 12.0 hours

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  - A) 0.043 hours
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  - C) 0.841 hours
  - D) 1.41 hours
  - E) 12.0 hours

$$a_c = \omega^2 r = \omega^2 R_{earth} = g$$

$$\omega = \sqrt{\frac{g}{R_{earth}}} = \sqrt{\frac{9.81 \text{ m/s}^2}{6.37 \cdot 10^6 \text{ m}}} = 0.00124098 \text{ rad/s}$$

$$T = \frac{2\pi}{\omega} = \frac{2\pi}{0.00124098 \text{ rad/s}} = 5063.08 \text{ s} = 1.41 \text{ hr}$$

Clicker Quiz

- In the previous roller coaster problem, what is the speed with which the roller coaster car has to enter at the bottom of the loop of 5.00 m radius in order to achieve the feeling of weightlessness at the top?

  - a) 7.00 m/s
  - b) 12.1 m/s
  - c) 13.5 m/s
  - d) 15.6 m/s
  - e) 21.4 m/s

Hint: Use energy conservation
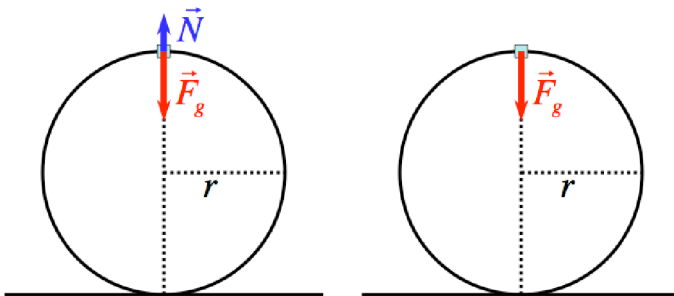
Clicker Quiz Solution

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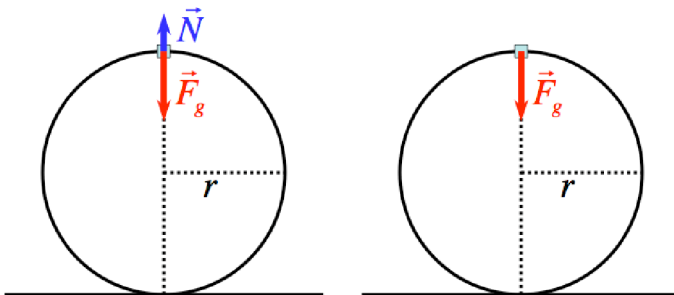 - e) 21.4 m/s

Hint: Use energy conservation

$$K_0 = K + U$$

$$U = mgh = mg(2R) = 2mRg$$

$$\frac{1}{2}mv_{bottom}^2 = 2mRg + \frac{1}{2}mv_{top}^2$$

$$v_{top}^2 = Rg$$

$$\frac{1}{2}mv_{bottom}^2 = 2mRg + \frac{1}{2}mRg$$

$$v_{bottom} = \sqrt{5Rg} = \sqrt{5(5.00 \text{ m})(9.81 \text{ m/s}^2)} = 15.6 \text{ m/s}$$

Clicker Quiz

- We want to design a curve in the road with a radius of 110.0 m such that a car can travel around the curve without friction. The car enters the curve with a speed of 31.3 m/s. What is the required bank angle?
  - a) 1.25°
  - b) 15.2°
  - c) 28.2°
  - d) 37.5°
  - e) 42.2°

Clicker Quiz Solution

- We want to design a curve in the road with a radius of 110.0 m such that a car can travel around the curve without friction. The car enters the curve with a speed of 31.3 m/s. What is the required bank angle?
  - a) $1.25°$
  - b) $15.2°$
  - c) $28.2°$
  - d) $37.5°$
  - e) $42.2°$

$$v = \sqrt{\frac{Rg(\sin\theta + \mu_s \cos\theta)}{\cos\theta - \mu_s \sin\theta}}$$

take $\mu_s = 0$

$$v = \sqrt{\frac{Rg \sin\theta}{\cos\theta}} = \sqrt{Rg \tan\theta}$$

$$\tan\theta = \frac{v^2}{Rg} = \frac{(31.3 \text{ m/s})^2}{(110.0 \text{ m})(9.81 \text{ m/s}^2)} = 0.90787$$
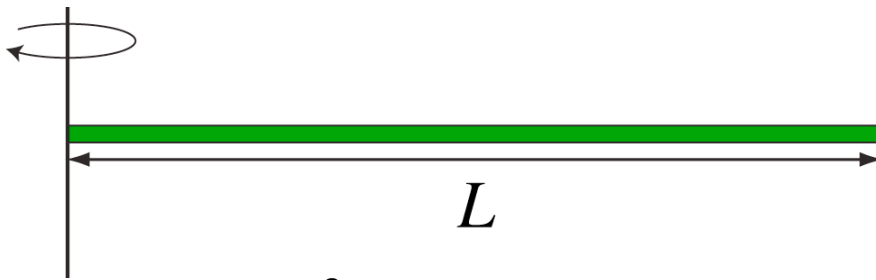
$$\theta = 42.2°$$

Could also start with components of the forces in the x-direction

$$mg \sin\theta = m \frac{v^2}{R} \cos\theta$$

Clicker Quiz Solution

- Consider a uniform rod with length L and mass M as shown below. What is the moment of inertia of this rod if rotated about one end?
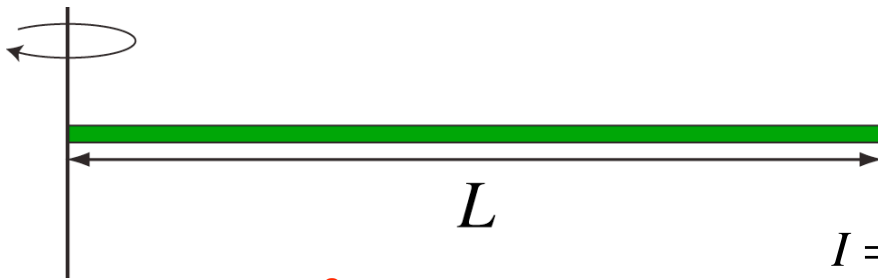

L

- A) $(1/3)ML^2$
- B) $(1/5)ML^2$
- C) $(1/6)ML^2$
- D) $(1/10)ML^2$
- E) $(1/12)ML^2$

Clicker Quiz Solution

- Consider a uniform rod with length L and mass M as shown below. What is the moment of inertia of this rod if rotated about one end?

$$I = \frac{M}{V} \int_V r_\perp^2 \, dV$$

$$V = AL$$

$$dV = A\,dx$$

$$r_\perp = x$$

- A) $(1/3)ML^2$
- B) $(1/5)ML^2$
- C) $(1/6)ML^2$
- D) $(1/10)ML^2$
- E) $(1/12)ML^2$

$$I = \frac{M}{AL} \int_L x^2 A\,dx = \frac{M}{L} \int_0^L x^2 \, dx = \frac{M}{L} \frac{L^3}{3}$$

$$I = \frac{1}{3} ML^2$$