Clicker Question 1:
Three blocks each have a mass of 3 kg and are being pulled over a frictionless surface by a force of 20 N. What acceleration does block A have?

a) Zero m/s²
b) 2.22 m/s²
c) 6.67 m/s²
d) 60 m/s²
e) 180 m/s²

Clicker Question 2:
Three blocks each have a mass of 3 kg and are being pulled over a frictionless surface by a force of 20 N. What is the tension between blocks B and C, $T_{BC}$?

a) 3.32 N
b) 6.67 N
c) 13.34 N
d) 20 N
e) 26.7 N

Problem 11 - 47
A horizontal spring with $k = 100$ N/m is compressed by 0.20 m and launches a 2.5 kg block across a frictionless horizontal surface. After a bit the block encounters a rough surface with $\mu_k = 0.15$. How far will the box slide before coming to rest?

$$\frac{1}{2} k (0.2)^2 = \frac{1}{2} m v_0^2$$

$$v_B = 1.24 \text{ m/s}$$
Problem 11 - 47
A horizontal spring with \( k = 100 \text{ N/m} \) is compressed by 0.20 m and launches a 2.5 kg block across a frictionless horizontal surface. After a bit the block encounters a rough surface with \( \mu_k = 0.15 \). How far will the box slide before coming to rest?

\[
W_{	ext{ext}} = \Delta U = \frac{1}{2} k x^2 - \frac{1}{2} mg x^2

- W_{	ext{fric}} = F_r d = \mu_k mg d = \mu_k \frac{1}{2} x^2 - \frac{1}{2} mg x^2

- mg d = - \frac{1}{2} \frac{x^2}{m} x^2

d = \frac{1}{2} \frac{x^2}{m} = 0.55 \text{ m}
\]

Clicker Question 3:
Two blocks of mass \( m_1 \) and \( m_2 \) \((m_1 > m_2)\) slide on a frictionless floor and have the same velocity when they hit a long rough stretch \((\mu > 0)\), which slows them down to a stop. Which one goes farther?

a) \( m_1 \)
b) \( m_2 \)
c) they will go the same distance

Frictional force
- Car tires are very complicated
- Technically we only deal with friction of non-compressible objects, for tires it is a different story
- Friction in general is very complicated

\[ F = \mu n \]
Example

Three blocks are resting on a frictionless surface. Two blocks, one of mass $M_1 = 5$ kg and the other of $M_2 = 2$ kg, are held together, compressing a massless spring. When the constraints are removed, block 1 moves to the left with a velocity of 2 m/s. Block 2 moves to the right and collides with block 3, which has a mass of $M_3 = 5$ kg. These blocks stick together. (a) What is the magnitude of the final velocity of blocks 2 and 3?  (b) How much energy was stored in the spring initially?

Clicker Question 4:

Three blocks are resting on a frictionless surface. Two blocks, one of mass $M_1 = 5$ kg and the other of $M_2 = 2$ kg, are held together, compressing a massless spring. When the constraints are removed, block 1 moves to the left with a velocity of 2 m/s. Block 2 moves to the right and collides with block 3, which has a mass of $M_3 = 5$ kg. These blocks stick together. Which is true concerning the block 1-block 2-spring system before and after the spring acts (before the collision with block 3)?

(A) Mechanical energy is conserved
(B) Linear momentum in the x-direction is conserved
(C) Both (A) and (B)
(D) Neither (A) or (B)

Clicker Question 6:

Two identical pucks move toward each other with equal speeds on a frictionless air track. Assume no external forces act on the pucks.

The total momentum of the system consisting of the two pucks is zero.

(a) True
(b) False
(c) Not enough info

Clicker Question 7:

Two identical pucks move toward each other with equal speeds on a frictionless air track. Assume no external forces act on the pucks.

The total kinetic energy of the two pucks is zero.

(a) True
(b) False
(c) Not enough info
Clicker Question 8:
Two identical pucks move toward each other with equal speeds on a frictionless air track. Assume no external forces act on the pucks.

The mechanical energy of the system will be conserved during the collision.

(a) True
(b) False
(c) Not enough info

Conservation of Mechanical Energy, Pg 19

Clicker Question 9:
Two identical pucks move toward each other with equal speeds on a frictionless air track. Assume no external forces act on the pucks. After the two pucks collide the total momentum will not necessarily be the same as before the collision.

(a) True
(b) False
(c) Not enough info

Conservation of Mechanical Energy, Pg 20

Clicker Question 10:
Two identical pucks move toward each other with equal speeds on a frictionless air track. Assume no external forces act on the pucks. With no external horizontal forces acting on the system consisting of the two pucks, the net impulse delivered to each puck must be zero over the entire collision.

\[ J = F \Delta t = p_f - p_i \]

(a) True
(b) False
(c) Not enough info

Conservation of Mechanical Energy, Pg 21

Clicker Question 11:
Mike applied 10 N of force over 3 m in 10 seconds. Joe applied the same force over the same distance in 1 minute. Who did more work?

(a) Mike
(b) Joe
(c) both did the same work

Conservation of Mechanical Energy, Pg 22

Clicker Question 12:
In a baseball game, the catcher stops a 90-mph pitch. What can you say about the work done by the catcher on the ball?

(a) catcher has done positive work
(b) catcher has done negative work
(c) catcher has done zero work

Conservation of Mechanical Energy, Pg 23

Clicker Question 13:
A spring is compressed by a ball an amount \( x = 0.5 \) m. The system is released and the ball is shot out down a frictionless table. At the end of the table the ball encounters a hump that brings it up to a height of 0.6 m. If the mass of the ball is 10 kg and the \( k \) for the spring is 600 N/m what is the final speed of the ball?

(a) 2.33 m/s
(b) 4.56 m/s
(c) 3.45 m/s
(d) 1.79 m/s
(e) 5 m/s

Conservation of Mechanical Energy, Pg 24
Ef = Ei
Kf + Uf = Ki + Ui
½kx² + ½mv² + mgy = ½kx²' + ½mv²' + mgy'
½k(0)² + ½mv² + mg(6) = ½k(.5)² + ½m(0)² + mg(0)
½mv² + mg(6) = ½k(.5)²
½mv² = k(.5)² - mg(6)
v² = (k/m)(.5)² - 2g(6)
v = 1.79 m/s v² = 3.22 (m/s)²

Clicker Question 16:
A rifle bullet of mass m = 3.00 x 10⁻² kg traveling at v₀ = 240.0 m/s collides with and embeds itself in a pendulum of mass M = 2.88 kg, initially at rest and suspended vertically by massless strings of length L = 2.00 m. As the bullet collides with the block, what is conserved for the block/bullet system? (The bullet/block collision is so fast the pendulum does not have time to swing up until after the collision)
(a) Mechanical Energy
(b) Linear Momentum
(c) Both (a) and (b)
(d) Neither (a) or (b)

Clicker Question 17:
A rifle bullet of mass m = 3.00 x 10⁻² kg traveling at v₀ = 240.0 m/s collides with and embeds itself in a pendulum of mass M = 2.88 kg, initially at rest and suspended vertically by massless strings of length L = 2.00 m. After the bullet is imbedded in the block and the pendulum begins to swing, what is conserved for the block/bullet system?
(a) Mechanical Energy
(b) Linear Momentum
(c) Both (a) and (b)
(d) Neither (a) or (b)

Collision 3: a 2-D Collision
George is driving south along Spadina at 18.0 m/s in a flatbed truck heavily loaded with bluestone, while John is driving a VW Beetle at 42.0 m/s east along Bloor. Because John is texting on his cell phone, he does not see the red light and collides with the front of the truck. During the collision, the vehicles lock together.
If George's truck has a total mass of 8320 kg and John's Beetle has a total mass of 1220 kg, find the velocity of the interlocked vehicles immediately after the collision.

Collision 3: Initial
Initial
m₀ = 1220 kg
v₀ = 42 m/s
Beatle

Collision 3: Final
Final
m₁ = 9540 kg
v₁ = 18 m/s
Beatle

Clicker Question 16:
A rifle bullet of mass m = 3.00 x 10⁻² kg traveling at v₀ = 240.0 m/s collides with and embeds itself in a pendulum of mass M = 2.88 kg, initially at rest and suspended vertically by massless strings of length L = 2.00 m. As the bullet collides with the block, what is conserved for the block/bullet system? (The bullet/block collision is so fast the pendulum does not have time to swing up until after the collision)
(a) Mechanical Energy
(b) Linear Momentum
(c) Both (a) and (b)
(d) Neither (a) or (b)
**Clicker Question 14:**

After the accident, which is true about the angle of the velocity of the two cars relative to the eastward direction?

- a) \( \theta < 45^\circ \)
- b) \( \theta > 45^\circ \)
- c) \( \theta = 45^\circ \)

![Diagram showing the angle of the velocity vectors](image)

\[ m_{\text{tot}} = 9540 \text{ kg} \]

\[ v_f = ?? \]

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**Clicker Question 15:**

What is the correct equation for the x-direction momentum?

- a) \( m_B v_B = (m_T + m_B) v_{xf} \)
- b) \( m_T v_T = (m_T + m_B) v_{xf} \)
- c) \( m_B v_B + m_T v_T = (m_T + m_B) v_{xf} \)
- d) \( m_B v_B = (m_T + m_B) v_{f} \sin \theta \)

---

**Collision 3**

**x-direction**

\[ m_B v_B + m_T v_T = m_B v_{xf} + m_T v_{xf} \]

\[ m_B v_B = (m_B + m_T) v_{xf} \]

\[ v_{xf} = \frac{m_B v_B}{m_B + m_T} = \frac{(1220 \text{ kg})(42 \text{ m/s})}{9540 \text{ kg}} = 5.37 \text{ m/s} \]

**y-direction**

\[ m_B v_B + m_T v_T = m_B v_{yf} + m_T v_{yf} \]

\[ m_B v_B = (m_B + m_T) v_{yf} \]

\[ v_{yf} = \frac{m_B v_B}{m_B + m_T} = \frac{(8320 \text{ kg})(18 \text{ m/s})}{9540 \text{ kg}} = 15.7 \text{ m/s} \]

---

**2-D Collision**

**Final**

\[ m_{\text{tot}} = 9540 \text{ kg} \]

\[ v_j = 5.37 \text{ m/s} \]

\[ v_f = 15.7 \text{ m/s} \]

\[ v_f = \sqrt{(5.37 \text{ m/s})^2 + (15.7 \text{ m/s})^2} = 16.6 \text{ m/s} \]

\[ \theta = \arctan \left( \frac{15.7}{5.37} \right) = 71^\circ \]