April 25, 2017

Work, Power, & Energy

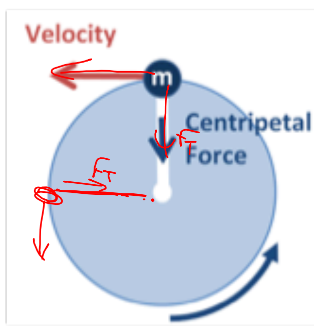
- Work measures the effectiveness of a force
- Also indicates changes in energy

$$\Delta E = W = F_{\parallel} d = F \cdot d \cdot \cos\theta$$

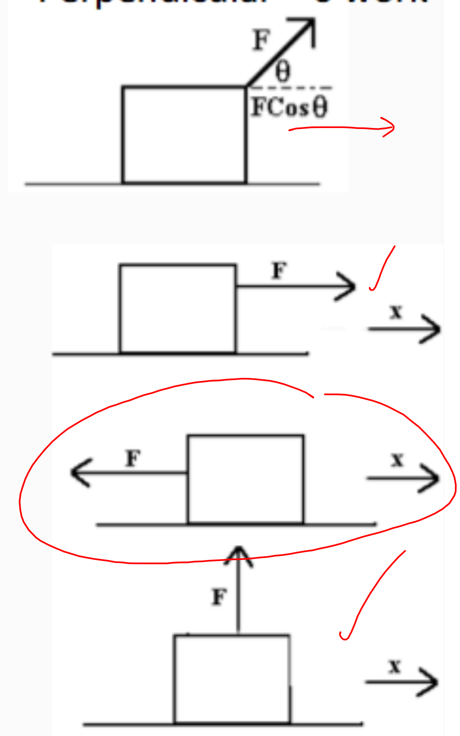
- Measured in Joules

- Positive work = increase of energy
- Negative work = decrease in energy
- 0 Work = no change

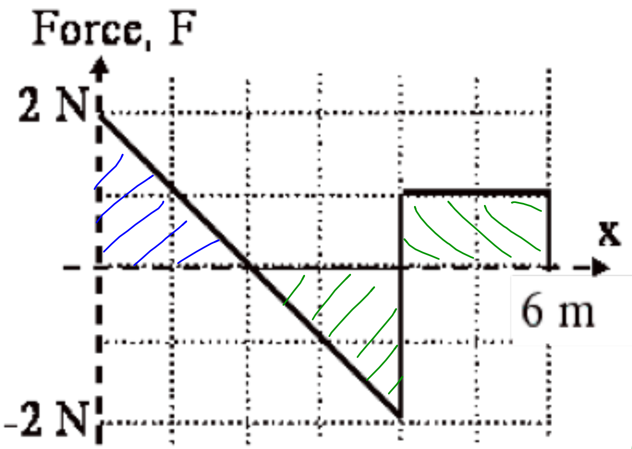
- Centripetal Forces always do 0 work



- Parallel = most effective
- Perpendicular = 0 work

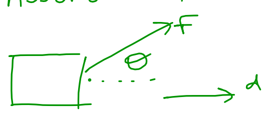


Work, Power, & Energy



- Graphs – Force vs. Displacement
  - Work done by a variable force

W = F · d · CosΘ
↳ Assume 0° = 1
W =



- Power = efficiency of a force
- Measured in Watts (W)

$$P = \frac{\Delta E}{t} = \frac{W}{t} = \frac{F \cdot d\cos\theta}{t} = Fv\cos\theta$$

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Work, Power, & Energy

- Energy
  - Kinetic ($KE = 1/2mv^2$)
  - Gravitational Potential ($U = mgh$) $U_g = \frac{-Gm_1m_2}{r}$
    - Gravitational – Celestial bodies
  - Elastic Potential ($U_s = 1/2kx^2$)
- Work Energy Theorem

$$\Delta KE = W$$

- Conservation of Energy

$$Energy_{end} = Energy_{before} - W_{nc}$$

- Conservative vs Non-Conservative Forces

'Store' energy: gravity → $U=mgh$; springs → $U=\frac{1}{2}kx^2$

'lose' energy

Work, Power, & Energy

A car of mass m slides across a patch of ice at a speed v with its brakes locked. It the hits dry pavement and skids to a stop in a distance d. The coefficient of kinetic friction between the tires and the dry road is μ.

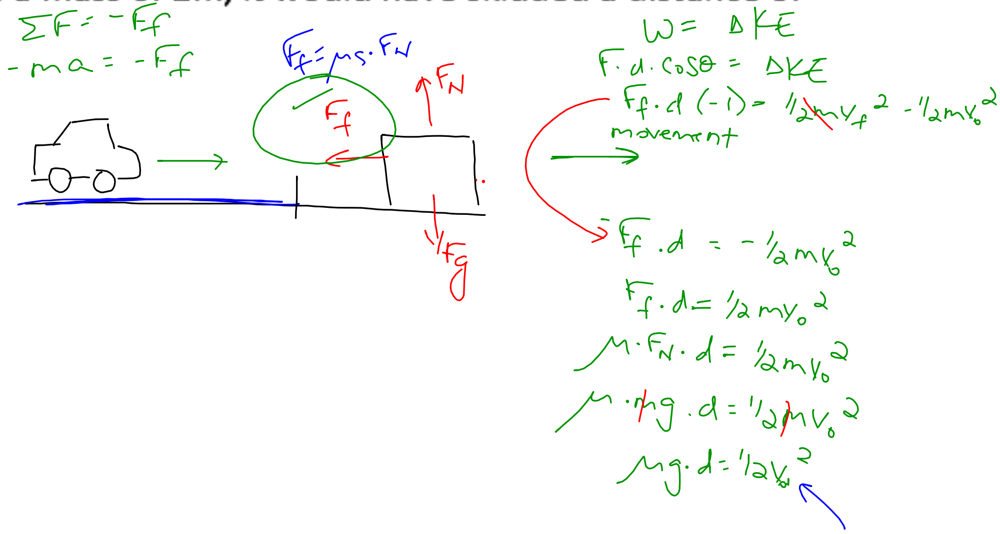
If the car has a mass of 2m, it would have skidded a distance of

A. 0.5 d

B. d

C. 1.41 d

D. 2 d



Work, Power, & Energy

A car of mass m slides across a patch of ice at a speed v with its brakes locked. It the hits dry pavement and skids to a stop in a distance d. The coefficient of kinetic friction between the tires and the dry road is μ.

If the car has a speed of 2v, it would have skidded a distance of

A. d

B. 1.41 d

C. 2 d

D. 4 d

Impulse, Momentum, Collisions

- Momentum – tendency of an object to continue moving after an applied force is removed

p = mv • Units $kg\cdot\frac{m}{s}$

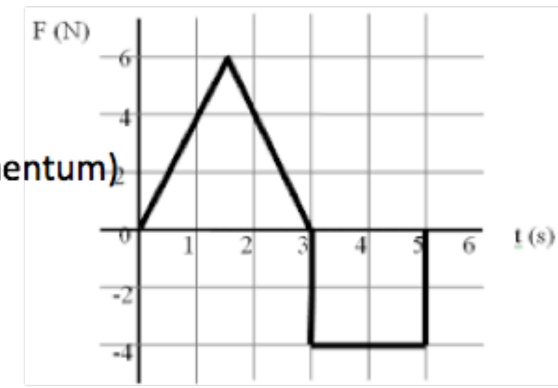
$v = \frac{2\pi r}{T}$

- *Linear and angular
- Impulse - All about ***how*** a force is applied = $F\cdot\Delta t$

$F\cdot\Delta t = \Delta p$

  - Impulse required to change an object's momentum

$$\Delta p = F\cdot\Delta t$$



- Area between line & axis of **force vs. time** = Impulse (& change in momentum)
- Impulse & Momentum are both vectors!

Impulse, Momentum, Collisions

- Conservation of momentum (in an isolated system, normally 2 objects)
  - Momentum before interaction = momentum after interaction

$$p_o = p_f$$

- Analyze one dimension at a time

$$*\ m_1 \cdot v_{1o} + m_2 \cdot v_{2o} = m_1 \cdot v_{1f} + m_2 \cdot v_{2f}$$

- Collisions

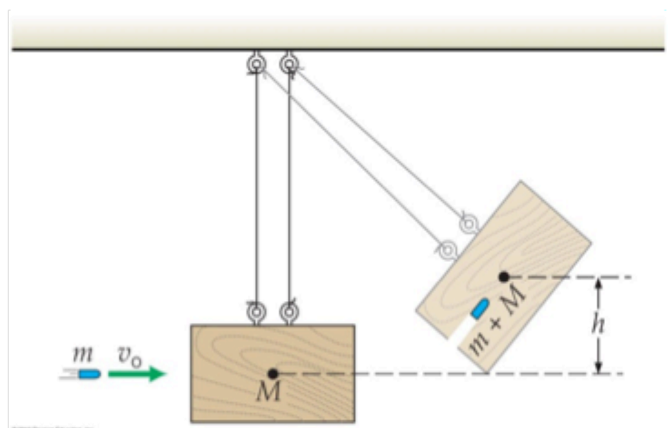
	Momentum Conserved	KE Conserved
– Elastic (perfect physics world)	Yes	Yes
– Inelastic (realistic physics world)	Yes	No
– * Total Inelastic (things stick together after collision)	Yes	No

Impulse, Momentum, & Collisions – Ballistic Pendulum

- A ballistic pendulum is a device used to measure the velocities of fast moving projectiles such as bullets. In this example, a 0.0500 kg bullet, initially travelling 150.0 m/s strikes and embeds itself into a wooden ballistic pendulum in a completely inelastic collision. The wood block has a mass of 6.80 kg and was initially at rest.

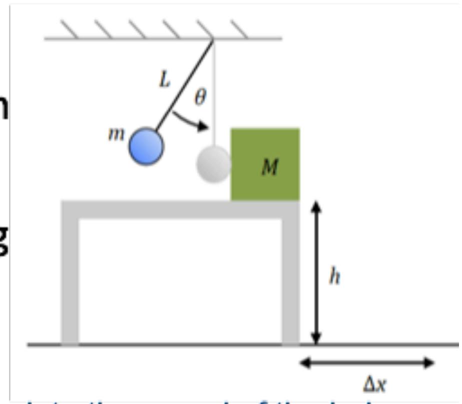
A. What is the common velocity of the bullet and block after their collision?

B. Using conservation of energy, find the change in vertical height after the bullet is embedded in the wood?



Impulse, Momentum, & Collisions
Collision + projectile motion

- A pendulum of length L = 1.0 meter and bob with mass m = 1.0 kg is released from rest at an angle θ = 30° from the vertical. When the pendulum reaches the vertical position, the bob strikes a mass M = 3.0 kg that is resting on a frictionless table that has a height h = 0.85m.



A. When the pendulum reaches the vertical position, calculate the speed of the bob just before it strikes the box.

B. Calculate the speed of the bob and the box just after they collide elastically.

C. Determine the impulse acting on the box during the collision.

D. Determine how far away from the bottom edge of the table, **Δx**, the box will the box strike the floor.