Relation between Energy and Mass

$E = mc^2$

Famous equation from Einstein,
Energy and matter are related

Review for Test #1 Sept 22nd

Topics:
- Foundations of Science - Scientific method, units, etc.
- Atoms - elements, electons, neutrons, protons, etc.
- Motion - intertia, equilibrium, velocity, acceleration, forces
- Momentum - conservation of, impulses
- Energy - conservation of, work, types of energy

Methods
- Conceptual Review and Practice Problems Chapters 0 - 5
- Review lectures (on-line) and know answers to clicker questions and homeworks.
- Go over practice test. Attend SI sessions.
- Bring:
- Banner ID and Two Number 2 pencils
- Simple calculator (no electronic notes)

Reminder: There are NO make-up tests for this class

Test #1 Review

How to take a multiple choice test
1) Before the Test:
- Study hard (~2 hours/day Friday through Wednesday)
- Get plenty of rest the night before

2) During the Test:
- Draw simple sketches to help visualize problems
- Solve numerical problems in the margin
- Come up with your answer first, then look for it in the choices
- If you can't find the answer, try process of elimination
- If you don't know the answer, Go on to the next problem and come back to this one later
- TAKE YOUR TIME, don't hurry
- If you don't understand something, ask me. This is not meant to be a vocabulary test.

Review

- 1st Law (Law of Inertia)
  - An object will continue to do what it is doing (remain at rest or in uniform motion in a straight line) unless acted upon by a force
- 2nd Law (Law of Acceleration)
  - The acceleration of an object is directly proportional to the net force acting on the object, is in the direction of the net force, and is inversely proportional to the mass of the object. ($a = F/m$)
- 3rd Law (Law of Action-Reaction)
  - Whenever one object exerts a force on a second object, the second object exerts an equal and opposite force on the first.

Review

- Apply Newton's three laws in different situations
  - Role of Inertia in each
- Relationships between speed, velocity, and acceleration and the role each plays in Newton's laws
- Free fall in a vacuum vs. free fall with air resistance
- Mechanical equilibrium, net force, and the motion of an object
  - with and without friction
- Relationships between momentum, impulse, and force
  - Conservation of momentum and energy

Test #1 Useful Equations

Relation between impulse and momentum: $Ft = mv$

Newton's laws, including: $F = ma$

Equations of motion: $d = v_0 t + 0.5\,a\,t^2$

Centripetal acceleration $a_c = v^2/r$

Gravitational Potential Energy = mgh
Kinetic Energy = $0.5\,mv^2$

Angular momentum = $L = I\omega = I\,v/r$
Moment of Inertia = $I = mr^2$ for a point mass m at distance r

Clicker Question:

How many seconds in an hour?

A: 6 s

B: 60 s

C: 360 s

D: 3600 s

Clicker Question:

How many meters in a mile?

A: 100 m

B: 400 m

C: 1600 m

D: 3600 m

Clicker Question:

How much is 10 m/s in mph?

A: 2.2 mph

B: 22 mph

C: 224 mph

D: 2237 mph

Clicker Question:

Suppose you throw a ball straight up into the air at a velocity of 20 m/s. How long does it take for the ball to come back to your hand?

A: 1 s

B: 2 s

C: 3 s

D: 4 s

Clicker Question:

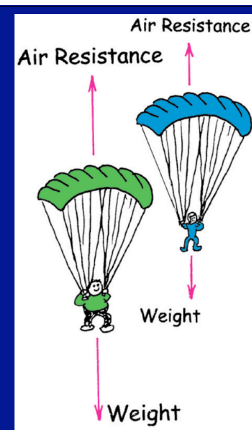
Two sky divers, Nicki and Ryan, have identical parachutes. If Ryan is twice as heavy, who reaches the ground first?

A: Ryan

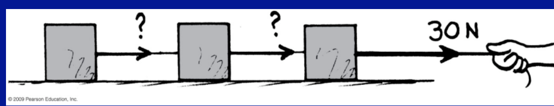
B: Nicki

C: same time

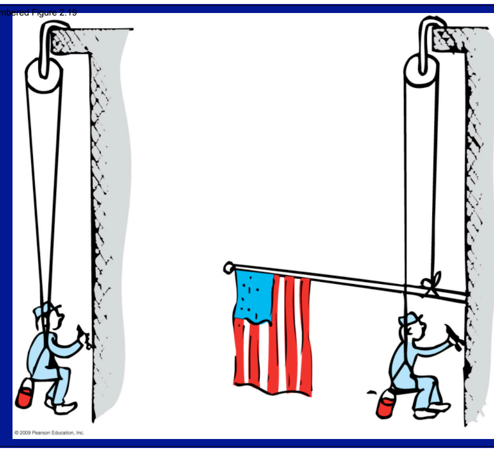
Figure 4.15



Unnumbered Figure 4.4



Unnumbered Figure 2.19



Clicker Question:

If you are driving at 80 mph, how much more distance do you need to stop yourself than if you were driving at 10 mph?:

A: same distance

B: 2 times as far

C: 8 times as far

D: 64 times as far

Clicker Question:

Suppose you start from rest at the top of a hill 45 m high and never touch your brakes. If there was no wind resistance how fast would you end up moving at the bottom?

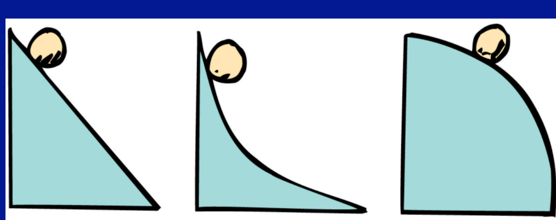
A: 10 m/s

B: 20 m/s

C: 30 m/s

D: 40 m/s

Unnumbered Figure 3.2



Clicker Question:

If the earth collided with a meteor that slowed it down in its orbit, what would happen:

A: It would maintain the same distance from the sun.

B: It would fall closer in to the sun.

C: It would move farther away from the sun.

D: Can't say.

Figure 5.25

Diagramming Forces

Which piece of the string breaks first?

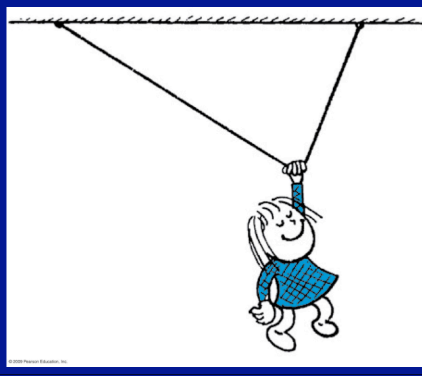


Figure 5.26

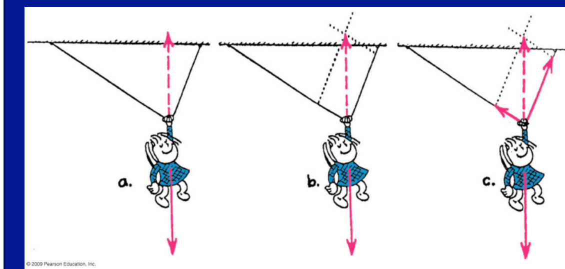
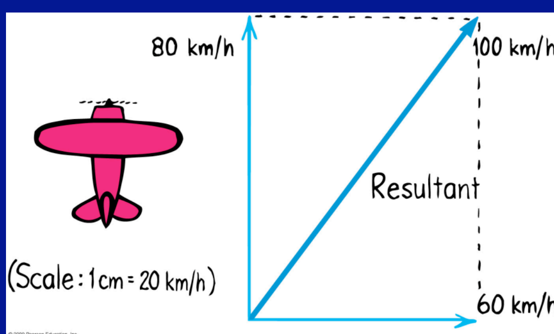


Figure 5.27



Unnumbered Figure 5.3

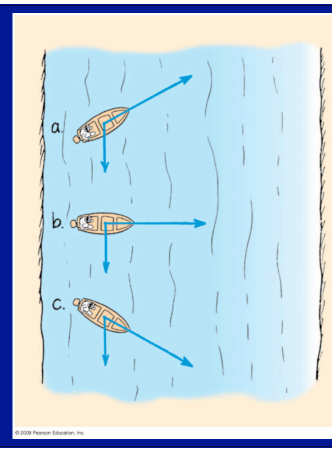
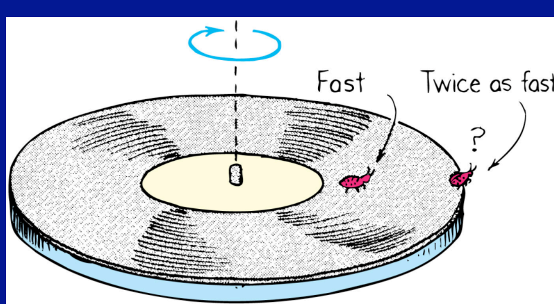
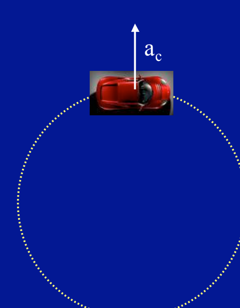


Figure 8.2



Diagramming Forces

Consider a car going around a bend. Show all the forces.



Diagramming Forces

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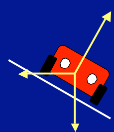
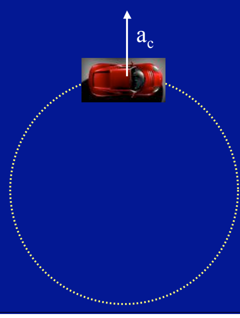




Diagramming Forces

What is the correct slope to pitch the road at for a given average speed?

$F_g = F_s \cos(\theta) = mg$

$F_c = F_s \sin(\theta) = mv^2/r$

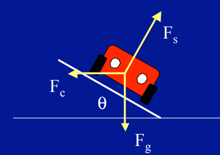
$= mg \tan(\theta)$

$mv^2/r = mg \tan(\theta)$

$v^2/r = g \tan(\theta)$

$v = \text{sqrt}[r\, g \tan(\theta)]$

Example: $r = 100$ m, $\theta = 10$ d
$v = 13$ m/s $= 28$ mph



changing momentum: Ft