GENERAL PHYSICS I: PHYS 1020

Schedule - Fall 2007
(lecture schedule is approximate)

3	M	17	5			Errors Lecture
	W	19	6	Chapter 3	Kinematics in two dimensions	
	F	21	7			
4	M	24	8			Experiment 1: Measurement of Length and Mass
	W	26	9	Chapter 4	Forces and Newton's laws	
	F	28	10			
5	M	**Oct 1**	11			Tutorial and Test 1 (chapters 1, 2, 3)
	W	3	12	Chapter 5	Uniform circular motion	
	F	5	13			

Week of September 24
Experiment 1, measurement of length and mass

Week of October 1
Tutorial and test 1 on chapters 1, 2, 3

Mastering Physics Assignment 1

Deadline has had to be extended to October 1
because of difficulty with configuration of open-area
computers on campus
(Flash, javascript errors - being fixed)

Mastering Physics Assignment 2

On chapter 3, likely available this evening
(Wednesday, September 26)
Several practice problems + a number (6?) for credit
Due in 2 weeks - watch web site and/or MP

Tutorial 1 – problems to be covered

(Under "Schedule" on the web page, click on "Tutorial & Test 1" link)

Tutorial and test # 1 (Week of Oct. 2 - 6)

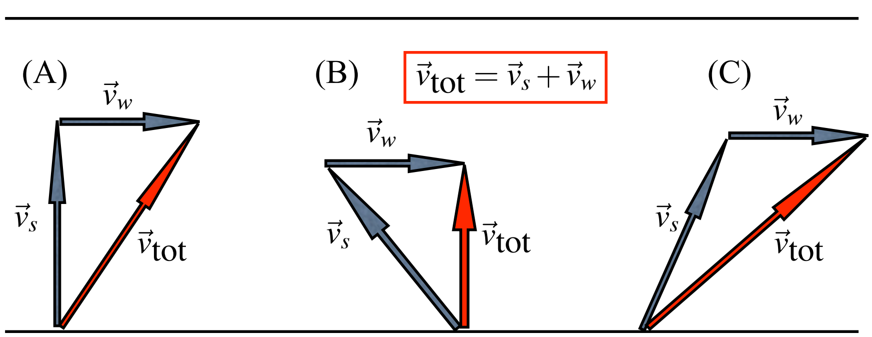
Chapters 1, 2, 3.

	Edition 7	Edition 6
Conceptual	1.4, 1.16*, 3.8	1.4, 1.16*, 3.8
Calculational	1.59*, 2.7, 2.55*, 3.29*, 3.30, 3.51*	1.47*, 2.7, 2.55*, 3.17*, 3.31, 3.47*

* First choices, do others as time permits

From last time...

3.C16: Strategies for swimming across the river in the shortest time. Which is fastest? The swimmers swim at the same speed v_s relative to the water. The water flows at speed v_w.

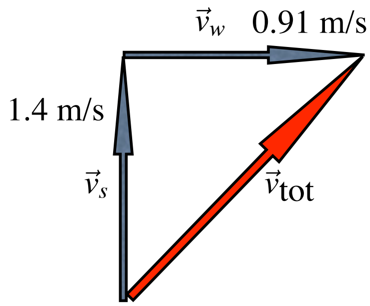


(A) Head straight across, get carried downstream

(B) Head upstream to end at closest point on far bank

(C) Head downstream to take advantage of the current

Relative Velocity

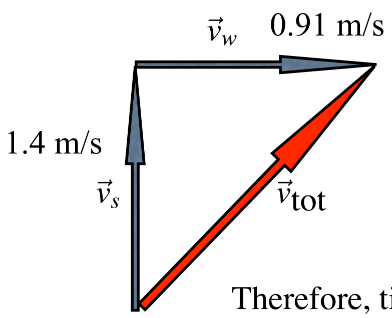


$$\vec{v}_{tot} = \vec{v}_s + \vec{v}_w$$

3.47/51: A swimmer swims directly across a river that is 2.8 km wide. He can swim at 1.4 m/s in still water (v_s), i.e. at 1.4 m/s relative to the water. The river flows at 0.91 m/s (v_w), i.e. at 0.91 m/s relative to the riverbank.

How long to cross the river?
Where does he end up on the other bank?

Relative Velocity contd



As he's swimming directly across the river, his speed toward the other bank is 1.4 m/s.

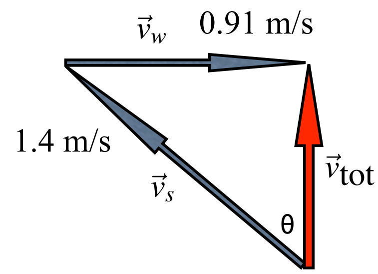
Therefore, time to cross the river is $\frac{2800 \text{ m}}{1.4 \text{ m/s}} = 2000 \text{ s}$

In this time, the current will carry him downstream by:

$$(0.91 \text{ m/s}) \times (2000 \text{ s}) = 1820 \text{ m}$$

Relative Velocity contd

Alternative strategy: he heads upstream a little so as to swim directly across the river - the most direct route.



$$\vec{v}_{tot} = \vec{v}_s + \vec{v}_w$$

Pythagoras:

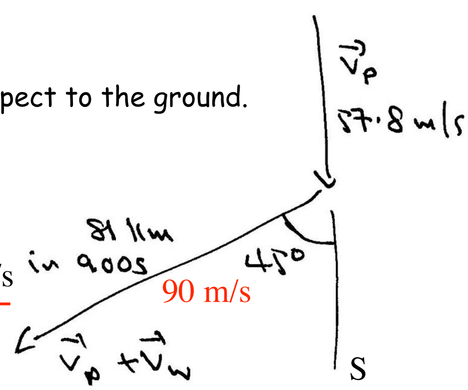
$$v_s^2 = v_w^2 + v_{tot}^2$$

So, $v_{tot} = \sqrt{v_s^2 - v_w^2} = \sqrt{1.4^2 - 0.91^2} = 1.064 \text{ m/s}$ Or, $v_{tot} = v_s \cos\theta$

Takes $\dfrac{2800 \text{ m}}{1.064 \text{ m/s}} = \underline{2630 \text{ s to cross the river}}$ $\sin\theta = \dfrac{0.91}{1.4} \rightarrow \theta = 41^\circ$

3.69/57: An aircraft is headed due south with a speed of 57.8 m/s relative to still air. Then, for 900 s a wind blows the plane so that it moves in a direction 45^0 west of south, even though the plane continues to point due south. The plane travels 81 km with respect to the ground in this time.

Determine the velocity of the wind with respect to the ground.



To south:

$$(v_p)_S + (v_w)_S = 90\cos 45^\circ$$
$$57.8 + (v_w)_S = 63.64 \rightarrow \underline{(v_w)_S = 5.84 \text{ m/s}}$$

To west:

$$(v_p)_W + (v_w)_W = 90\sin 45^\circ$$
$$0 + (v_w)_W = 63.64 \rightarrow \underline{(v_w)_W = 63.64 \text{ m/s}}$$

$$v_w = \sqrt{5.84^2 + 63.64^2} = 63.9 \text{ m/s} \qquad \tan\theta_w = \frac{63.84}{5.84} \rightarrow \theta_w = 84.8^\circ$$

west of south

Chapter 3 Summary

- The laws of motion can be applied separately to motions in x and y (negligible air resistance).
- The time for a projectile to move up and down is the same as the time for it to move sideways.
- Relative velocity is an application of the subtraction of vectors covered in chapter 1.
- If A travels at $\vec{v}_A$ and B travels at $\vec{v}_B$ the velocity of B relative to A is $\vec{v}_B - \vec{v}_A$

Chapter 4: Forces and Newton's Laws

- Force, mass and Newton's three laws of motion
- Newton's law of gravity
- Normal, friction and tension forces.
- Apparent weight, free fall
- Equilibrium

Force and Mass

Forces have a magnitude and direction – forces are vectors

Types of force –

- Contact – example, a bat hitting a ball
- Noncontact or "action at a distance" – eg, gravitational force

Mass: two types –

- Inertial mass – what is the acceleration when a force is applied?
- Gravitational mass – what gravitational force acts on the mass?

Inertial and gravitational masses are equal

Newton's Laws of Motion

(1) Velocity is constant if a zero net force acts

$$\vec{a} = 0 \text{ if } \vec{F} = 0$$

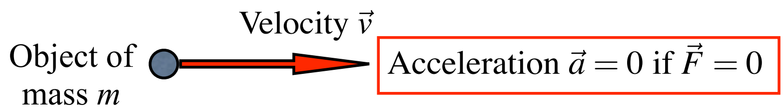
(2) Acceleration is proportional to the net force, inversely proportional to mass:

$$\vec{a} = \vec{F}/m, \quad \text{so } \vec{F} = m\vec{a}$$

The acceleration is in the same direction as the force

(3) Action and reaction forces are equal in magnitude and opposite in direction

Newton's First Law (law of inertia)



The velocity is constant if a zero net force acts on the mass.

That is, if a number of forces act on the mass and their vector sum is zero:

$$\vec{F} = \vec{F}_1 + \vec{F}_2 + \ldots = 0$$

then the acceleration is zero and the mass remains at rest or has constant velocity

Newton's First Law

Was a revolutionary idea that objects continue to move if no force acts:

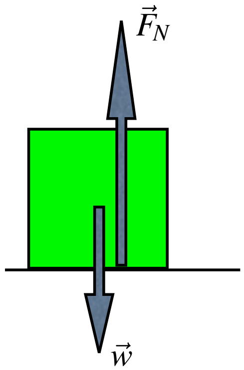
- experience shows that a force is needed to keep objects moving (friction)

- was believed that some cosmic force keeps the planets moving in their orbits

In the absence of friction, objects continue to move at constant velocity if net force is otherwise zero.

If the net force, including the force due to friction, is zero, objects move at constant velocity.

Newton's First Law



A crate is at rest on the ground –

$\vec{v} = 0,\ \vec{a} = 0$

What forces act on the crate?

– the weight $\vec{w}$

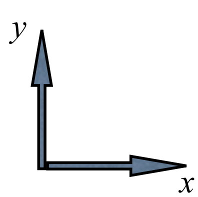
According to Newton's first law, there must be another force so the net force acting on the crate is zero –

–the normal force of the ground acting on the crate, $\vec{F}_N$

$\vec{F}_N + \vec{w} = 0 \quad \rightarrow \vec{F}_N = -\vec{w}$ so crate remains at rest

Inertial Reference Frame

Reference frame – a coordinate system, (*x, y, z*)



Can be defined anywhere –

- right here
- in your car...

An inertial reference frame is one that is **not** accelerated (moves at constant velocity, including zero velocity).

- the law of inertia (first law) applies in an inertial frame – objects at rest remain at rest if no net force acts on them.
- law of inertia does not apply in an accelerated (noninertial) frame.

Example: driving around a corner – velocity changes, force has to be applied *to keep objects from moving*. A noninertial frame.

Newton's Second Law of Motion

Says what happens if the net force acting on a mass is not zero.

The mass accelerates:

Acceleration, $\vec{a} \propto \vec{F}_{net}$ $\vec{F}_{net} =$ net force acting on the mass

proportional to

Introduce the mass:

$$\vec{a} = \frac{\vec{F}_{net}}{m} \qquad \text{or } \vec{F}_{net} = m\vec{a}$$

Units: m in kilograms (kg) a in m/s^2 F_{net} in Newtons (N)

m is the "inertial mass", a measure of how difficult it is to accelerate an object.

Clickers!

All of the following, except one, cause the acceleration of an object to double. Which one is it?

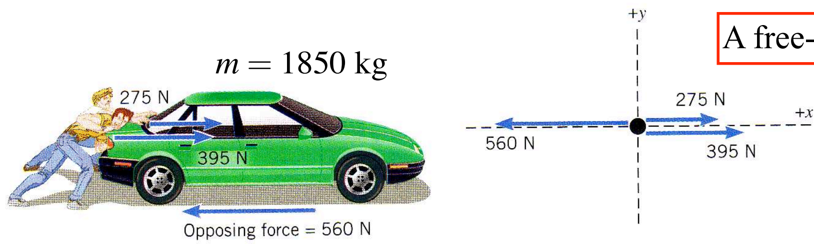
A) All forces acting on the object double

B) The net force acting on the object doubles

C) Both the net force acting on the object and the mass of the object double

D) The mass of the object is reduced by a factor of two

Newton's Second Law of Motion



(a) (b) Free-body diagram of the car

A free-body diagram

Shows only the forces acting on the car

Two people push a car against an opposing force of 560 N.

One exerts 275 N, the other 395 N of force on the car.

$$F_{net} = 275 + 395 - 560 \text{ N } = 110 \text{ N, to the right}$$

$$\text{Acceleration, } a = F_{net}/m = (110 \text{ N})/(1850 \text{ kg}) = \underline{0.059 \text{ m/s}^2}$$

Newton's Second Law of Motion

A catapult on an aircraft carrier accelerates a 13,300 kg plane from 0 to 56 m/s in 80 m. Find the net force acting on the plane.

$$F_{net} = ma \text{ (acceleration along a straight line)}$$

What is a?

$$v^2 = v_0^2 + 2ax$$

$$\text{or, } 56^2 = 0 + 2a \times 80$$

$$\text{So, } a = 56^2/160 = 19.6 \text{ m/s}^2$$

$$\text{Therefore, } F_{net} = (13,300 \text{ kg}) \times (19.6 \text{ m/s}^2) = 261,000 \text{ N}$$