Mastering Physics Assignment 1

Deadline has been extended to October 1 because of difficulty with configuration of open-area computers on campus
(Flash, javascript errors - being fixed)
Try Firefox if no luck!

Mastering Physics Assignment 2

Is available on Mastering Physics website
Seven practice problems + six for credit
Due Wednesday, October 10 at 11 pm

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

Newton's Laws of Motion

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

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

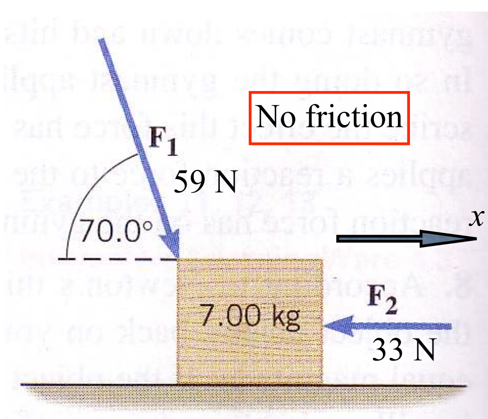
(2) Acceleration is proportional to the net force, inversely proportional to mass:

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

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 Second Law



4.11: What is the acceleration of the block in the horizontal direction?

Work out the components of forces in the x-direction.

$$F_x = F_{1x} + F_{2x}$$

$$= F_1 \cos 70^\circ - F_2 = -12.8 \text{ N}$$

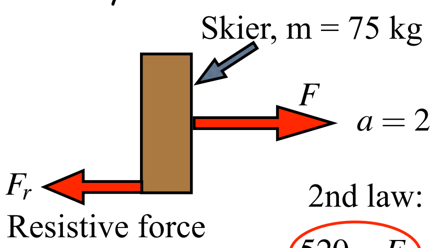
As $\vec{a} = \vec{F}/m$ then, $a_x = F_x/m = (-12.8 \text{ N})/(7 \text{ kg})$

$$= -1.83 \text{ m/s}^2$$

Newton's Second Law

4.-/88: A 75 kg water skier is pulled by a horizontal force of 520 N and has an acceleration of 2.4 m/s^2.

Assuming the resistive force from water and wind is constant, what force would be needed to pull the skier at constant velocity?



$a = 2.4\ \text{m/s}^2$ when $F = 520$ N

2nd law: $F_{net} = ma$ (in horizontal direction)

$520 - F_r = 75 \times 2.4 = 180$ N So, $F_r = 340$ N

If the pulling force is reduced to 340 N, the net force acting on the skier will be zero and his/her speed will be constant.

Newton's Second Law

4.-/4: A special gun is used to launch objects into orbit around the earth.

It accelerates a 5 kg projectile to 4 × 10^3 m/s by applying a net force of 4.9 × 10^5 N.

How much time is needed to accelerate the projectile?

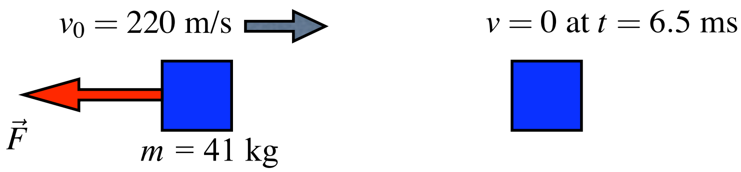
$$F = ma = m\Delta v/\Delta t$$

$$\text{So } \Delta t = m\Delta v/F = \frac{(5\ \text{kg}) \times (4 \times 10^3\ \text{m/s})}{4.9 \times 10^5\ \text{N}}$$

$$= 0.0408\ \text{s} = 41\ \text{ms}$$

Newton's Second Law

4.14: A 41 kg box is thrown at 220 m/s against a barrier. It is brought to a halt in 6.5 ms. What is the average net force that acts on the box?



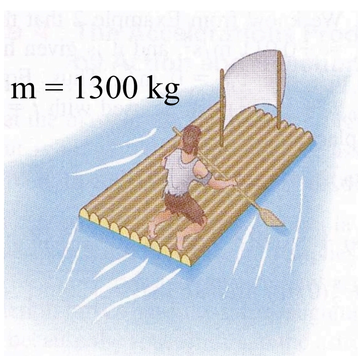
$F = ma$, but what is a?

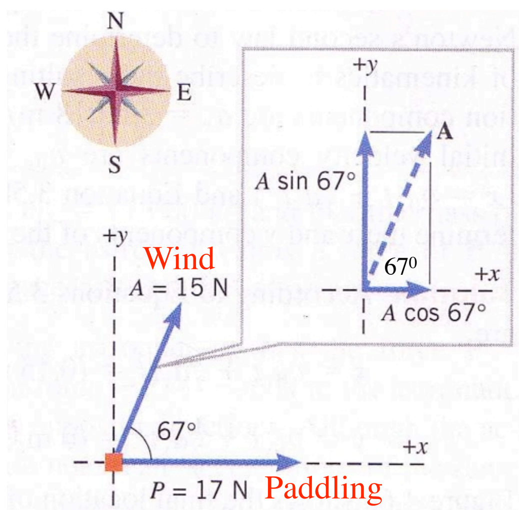
$v = v_0 + at$

$0 = (220 \text{ m/s}) + a \times (0.0065 \text{ s}) \rightarrow a = -220/0.0065 = -33,850 \text{ m/s}^2$

Then, $F = (41 \text{ kg}) \times (-33,850 \text{ m/s}^2) = -1.39 \times 10^6$ N

Newton's Second Law



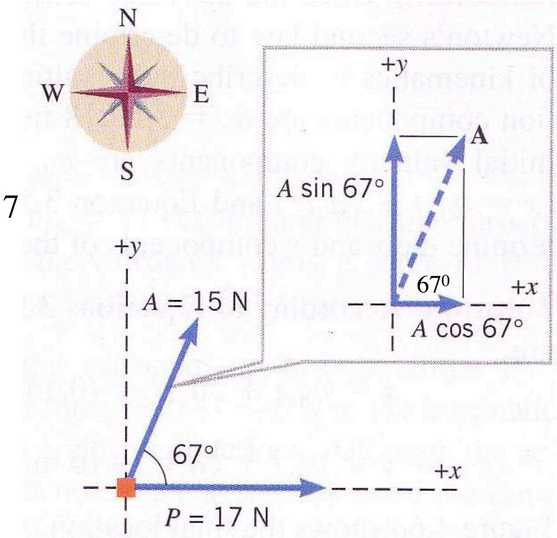


Free-body diagram of the raft

Paddling: force **P** of 17 N, to east
Wind: force **A** of 15 N, 67° north of east

Find a_x, a_y for the raft.

Net force is $\vec{F} = \vec{A} + \vec{P}$



Free-body diagram of the raft

Net force is $\vec{F} = \vec{A} + \vec{P}$

So $F_x = A_x + P_x = 15\cos 67^\circ + 17$

$F_y = A_y + P_y = 15\sin 67^\circ$

Then, $a_x = F_x/m$

$a_y = F_y/m$

$$a_x = \frac{(22.9\text{ N})}{(1300\text{ kg})} = 0.018\text{ m/s}^2$$

$$a_y = \frac{(13.8\text{ N})}{(1300\text{ kg})} = 0.011\text{ m/s}^2$$

Total acceleration: $a = \sqrt{a_x^2 + a_y^2} = 0.021\text{ m/s}^2$

$$\tan\theta = \frac{a_y}{a_x} \rightarrow \theta = 31^\circ,\ \text{N of E}$$

Newton's Second Law

4.17: A 325 kg sailboat is sailing 15.0^0 north of east at 2.00 m/s. 30 s later, it is sailing 35^0 north of east at 4.00 m/s.

Three forces act on the boat:

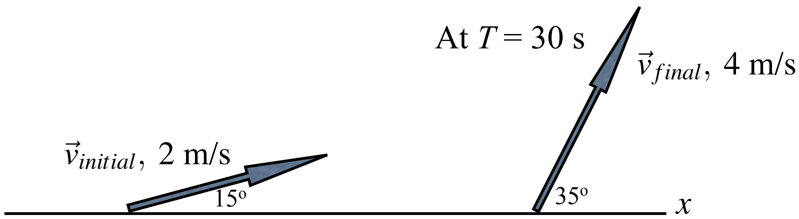
- 31 N at 15^o north of east $= \vec{F}_1$
- 23 N at 15^o south of west $= \vec{F}_2$
- $\vec{F}_w$, due to the wind $= \vec{F}_w$

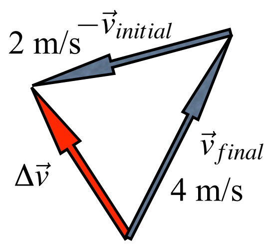
$$\vec{F}_1 + \vec{F}_2 + \vec{F}_w = m\vec{a}$$

Solve by working out the average acceleration, then calculate the missing force, F_w.

31 N at 15^0 north of east, 23 N at 15^0 south of west

$$\text{Average acceleration, } \vec{a} = \frac{\vec{v}_{final} - \vec{v}_{initial}}{T} = \frac{\vec{v}_{final} + (-\vec{v}_{initial})}{T} = \frac{\Delta\vec{v}}{T}$$





$$\Delta v_x = 4\cos 35^\circ - 2\cos 15^\circ = +1.345 \text{ m/s}$$

$$\Delta v_y = 4\sin 35^\circ - 2\sin 15^\circ = +1.777 \text{ m/s}$$

$$a_x = (1.345 \text{ m/s})/(30 \text{ s}) = +0.0448 \text{ m/s}^2$$

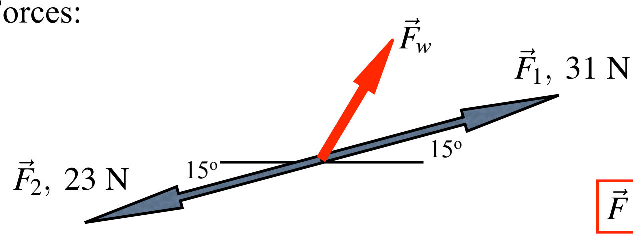
$$a_y = (1.777 \text{ m/s})/(30 \text{ s}) = +0.0592 \text{ m/s}^2$$

$$a_x = +0.0448 \text{ m/s}^2,\ a_y = +0.0592 \text{ m/s}^2$$

$$\text{So, } F_x = ma_x = (325 \text{ kg}) \times (0.0448 \text{ m/s}^2) = 14.56 \text{ N}$$

$$F_y = ma_y = (325 \text{ kg}) \times (0.0592 \text{ m/s}^2) = 19.24 \text{ N}$$

Forces:

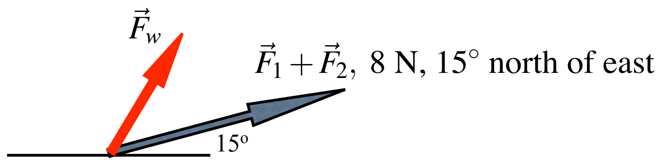


$$\vec{F} = \vec{F}_1 + \vec{F}_2 + \vec{F}_w$$

Simplification: $\vec{F}_2$ is directly opposite $\vec{F}_1$

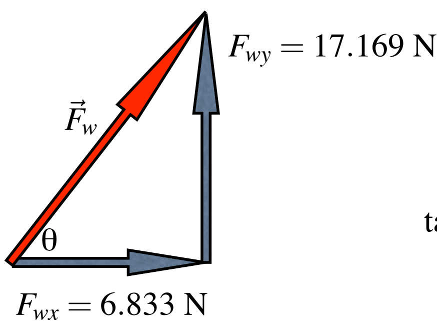
So, $\vec{F}_1 + \vec{F}_2 = 31 - 23 = 8$ N at 15° north of east

$F_x = 14.56$ N, $F_y = 19.24$ N



$$F_x = (8\text{ N}) \times \cos 15^\circ + F_{wx} = 14.56\text{ N} \;\rightarrow F_{wx} = 6.833\text{ N}$$

$$F_y = (8\text{ N}) \times \sin 15^\circ + F_{wy} = 19.24\text{ N} \;\rightarrow F_{wy} = 17.169\text{ N}$$



$$F_w = \sqrt{F_{wx}^2 + F_{wy}^2} = 18.5\text{ N}$$

$$\tan\theta = 17.169/6.833$$

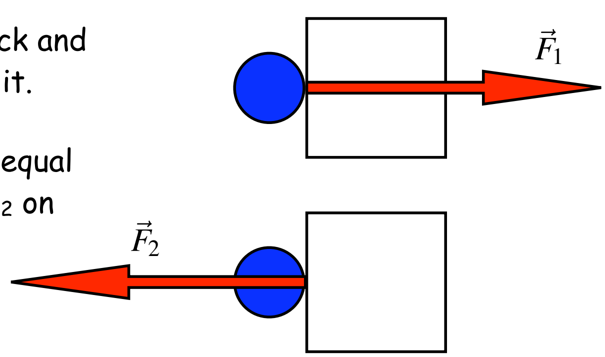
$$\rightarrow \theta = 68.3^\circ \text{ north of east}$$

Newton's Third Law of Motion

When you exert a force on an object, it exerts a force back on you (otherwise you fall over).

The ball hits the block and exerts a force F_1 on it.

The block exerts an equal and opposite force F_2 on the ball.

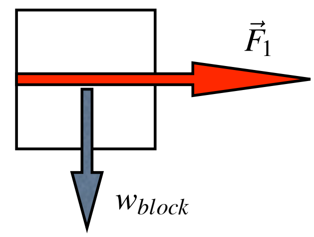


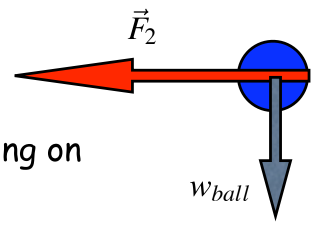
$$\boxed{\vec{F}_2 = -\vec{F}_1}$$

That is, action and reaction forces are equal and opposite

Action and reaction forces act on **DIFFERENT OBJECTS!**

All of the forces acting on the block





All of the forces acting on the ball

As action and reaction forces act on **different** objects, **the forces do not cancel**.

Action and Reaction Forces

- also for action at a distance

The earth exerts a gravitational force on the moon.

The moon exerts an equal and opposite force on the earth.

Implies that the force is proportional to the product of the masses:-

$$F \propto M_M M_E$$