

FORCES and Force Vectors



Force

- **The cause of an acceleration or change in an object's motion**
- **Any push or pull on an object caused by physical contact or force field**
- **A vector quantity**
- **SI unit: Newton (N)**
- **1 N accelerates a 1kg at 1 m/s²**
- **1 N = .225 lb**

Types of Forces

- **Contact Forces**

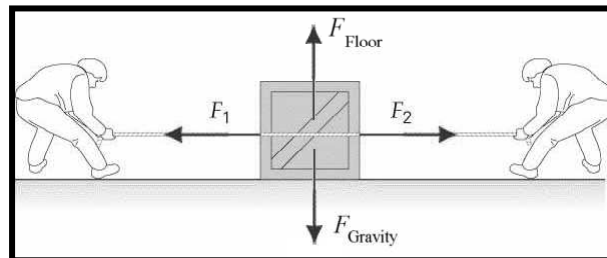
- FORCES THAT REQUIRE OBJECTS TO TOUCH
- PULLING A WAGON, PUSHING A LAWNMOWER

- **At a Distance Forces**

- FORCES THAT ARE FELT WITHOUT CONTACT
- GRAVITY, MAGNETS

Free-body Diagrams

- A diagram of an object showing only the forces effecting that object



Net Force

- **Definition**

- "SUM" OF ALL FORCES ACTING ON AN OBJECT

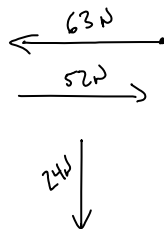
- **Result**

- AN ACCELERATION IN THE DIRECTION OF THE FORCE
 - IF ZERO, THE OBJECT MOVES AT A CONSTANT VELOCITY

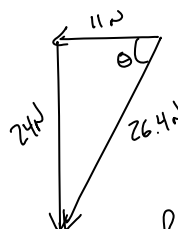
Net Force Sample Problem 1

- Three forces are applied to a crate. The first is 63 N to the west. The second force is 52 N to the east. The third is 24 N to the south.

What is the net force?



Forms
11 West
24 South



$$\theta = \tan^{-1}\left(\frac{24}{11}\right)$$
$$\theta = 65.4^\circ$$

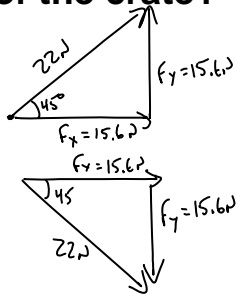
South of West

$$R = 26.4 \text{ N}$$

65.4° South of West

Net Force Sample Problem 2

- Two forces are applied to a 20 kg crate. The first is 22 N and is applied 45° north of east. The second is 22 N and is applied 45° south of east. What is the net force and acceleration of the crate?



TOTALS
 $F_x = 31.2 \text{ N}$
 $F_y = 0 \text{ N}$

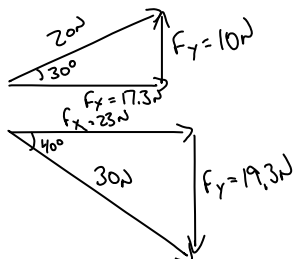
$$F_{\text{NET}} = 31.2 \text{ N, EAST}$$

$$F_{\text{NET}} = MA$$

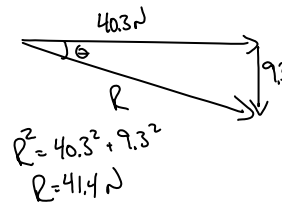
$$A = \frac{31.2 \text{ N}}{20 \text{ kg}} = 1.56 \text{ m/s}^2 \text{ EAST}$$

Net Force Sample Problem 3

- Two forces are applied to a 60 kg box. The first is 20 N and is applied 30° north of east. The second is 30 N and is applied 40° south of east. What is the net force and acceleration of the crate?



TOTALS
 $F_y = 9.3 \text{ South}$
 $F_x = 40.3 \text{ EAST}$



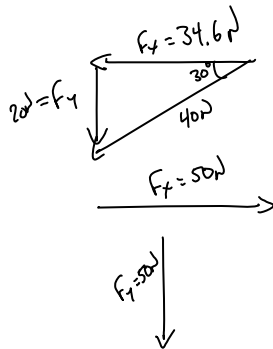
$$\theta = \tan^{-1} \left(\frac{9.3}{40.3} \right) = 13^\circ \text{ South of East}$$

$$A = \frac{41.4 \text{ N}}{60 \text{ kg}} = .69 \text{ m/s}^2$$

13° South of East

Net Force Sample Problem 4

- Three forces are applied to a ball. The first is 50 N to the east. The second force is 50 N to the south. The third is 40 N at 30° south of west. What is the net force?



TOTALS
 $F_x = 15.4 \text{ N EAST}$
 $F_y = 70 \text{ N SOUTH}$

A diagram showing a right-angled triangle representing the resultant force vector R. The horizontal leg is labeled 15.4 N and the vertical leg is labeled 70 N. The hypotenuse is labeled R. Below the diagram, the following calculations are shown:
 $R^2 = 15.4^2 + 70^2 = 71.7 \text{ N}$
 $\theta = \tan^{-1} \left(\frac{70}{15.4} \right) = 77.6^\circ$
 $R = 71.7 \text{ N}, 77.6^\circ \text{ SOUTH OF EAST}$

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