Chapter 5
Displacement and Forces in Two Dimensions
Vectors:  

- Vectors have both ____________ and ____________.
- Vectors must be added using ____________ .
- You can add vectors ________________ as long as you ________________ their __________________________.
Measuring Angles

- GEOGRAPHICAL:
- MATHEMATICAL:
Vector Direction Examples

• 35 m/s, 40° E of N

• 10 N, 210°
Resultant Vector

- The ________________________________.
- Always drawn from the ____________________________ to the ____________________________.
- Direction should always be measured between the ____________________________ and the ____________________________.
Adding Vectors Method 1:

1. Scaled Vector Diagram/Graphically

• Decide on a _____________________________

• Using a ______ to measure the ___________ and a ______________ to measure __________________ draw the vectors tip to tail.

• Draw the ___________________ from the ______ of the first to the ______ of the last vector.

• Use a ruler to measure the __________________ of the resultant vector. Convert using __________________.

• Use a protractor to measure the __________________

_____________________________________________.
Resultant
22 m, 310°
1. Mathematical Method

- If the two vectors being added are at \[ \text{______________}, \]
  the magnitude can be found using the \[ \text{______________} \]
  and the direction can be found using \[ \text{______________}. \]
• If the two vectors being added are _______________ __________________, the magnitude can be found using the _____________________ and the direction can be found using ______________________
Trig Review:

Trig Functions

90°
Law of Cosines
Law of Sines
EX:

Add these vectors.

• 2.0 m/s, 90 deg
• 7.0 m/s, 0 deg
EX:

Add the following vectors.

- 3.0 m/s, 45 deg
- 5.0 m/s, 135 deg
Examples:

1. A person walks 100m N and loses all sense of direction. Without knowing the direction, she walks 100m again. Draw a vector representation and determine the range of her displacement.
2. You are traveling from SMCC to Jackson for the football game. You travel 30 km west, 20 km north, and 10 km west. Find your displacement (magnitude and direction) both graphically and mathematically.
3. A person jogs 15 km and then turns to the right at a 45 degree angle and continues to run 25 more kilometers. Find the resultant vector for the jogger.
Components of a Vector – the \[ \text{________________________} \] that make up the \[ \text{______________} \]

The plane’s northwest displacement is equivalent to a northward plus a westward displacement.

\[ \text{________} = \text{________} + \text{________} \]
Components

• You can use _______ to find the components.
*Be careful if the angle is bigger than ___ degrees. You may have to use a __________________ to find the components.
Method 3: Vector Resolution/Components

Two or more vectors can be added by:

• Resolving each vector into its _________
  ________________________.

• _____all the x-components to form the
  ________________________________:
  \[ R_x = A_x + B_x + C_x \ldots \]

• _____all the y-components to form the
  ________________________________:
  \[ R_y = A_y + B_y + C_y \ldots \]
• Use the ____________ _______ to find the __________ of the resultant R.

\[ R^2 = R_x^2 + R_y^2 \]

• Use _____________ to find the __________ of R.
Examples:

1. A bus travels 23 km on a straight road that is 30° N of E. What are east and north components of its displacement?
2. A hammer slides down a roof that makes a 40° angle with the horizontal. What are the magnitudes of the components of the hammer’s velocity at the edge of the roof if it is moving at a speed of 4.25 m/s?
EX:

Add the following three vectors using the component method: A is 4 m south, B is 7.3 m northwest, C is 6 m 30° south of west.
Example:

You’re a pilot & are instructed to go around a massive thunderstorm. The control tower tell you take a detour & follow these 3 paths:
100 km, 45° N of E,
65 km, 10° S of E
20 km, 5° S of E

What is the plane’s displacement from where it began its detour?
FRICTION

- _______________ friction force: the force exerted on __________________________ when the objects are in ________________
  EX:

  \[
  \mu = \text{“mu”} = ________________
  \]

  \[
  F_f \text{ is proportional to the force ____________}
  \]
FRICTION

- **friction force**: the force exerted on one surface by another surface when there is ____________ between the two surfaces.

EX:
FRICTION

• Eventually there is a ____________ to this static friction force – once the ____________ is ___________ than the _______________ ________________, the object will begin to ______________.

• Until this point, __________________ exactly _____________ the __________________.

• Maximum Static Friction Force:
FRICTION

• Besides the ________________, friction also depends on the ______ _______________ that are in contact.

• Different surfaces have ____________ ___________________________________________

• Table p.317
EX: You push a 25 kg wooden box across a wooden floor at a constant speed of 1 m/s. How much force do you exert on the box?
EX:

A small child is dragging a heavy, rubber-soled shoe by its laces across a sidewalk at a constant speed of 0.35 m/s. If the shoe has a mass of 1.56 kg, what is the horizontal component of the force exerted by the child?
EX:

- If the child pulls with an extra 2 N in the horizontal direction, what will be the acceleration of the shoe?
Inclined Planes

The force of ______________ acts in the ______________ direction.

The ______________ force acts in a direction ______________ to the surface.
Components

Analyzing forces on inclined planes will involve resolving the __________________ into _______________________________.

- one ________________ to the surface: _____
- one ________________ to the surface: _____

The ________________ force is the force that can cause an object to ____________________
Forces on an Inclined Plane

The ________________ always ___________ the angle between ___________ and ___________.

Use ________________ to find the components.
Practice

Diagram A

\[ F_{\text{norm}} = \_\_\_\_\_\_ N \]

\[ F_{\text{grav}} = \_\_\_\_\_\_ N \]

\[ \theta = 45^\circ \]

\[ m = 1000 \text{ kg} \]

\[ a = \_\_\_\_\_\_ \text{m/s/s} \]

\[ F_{\text{net}} = \_\_\_\_\_\_ N \]

Diagram B

\[ F_{\text{norm}} = \_\_\_\_\_\_ N \]

\[ F_{\text{grav}} = \_\_\_\_\_\_ N \]

\[ \theta = 60^\circ \]

\[ m = 1000 \text{ kg} \]

\[ a = \_\_\_\_\_\_ \text{m/s/s} \]

\[ F_{\text{net}} = \_\_\_\_\_\_ N \]
Example

A trunk weighing 562 N is resting on a plane inclined 30° above the horizontal. Find the normal and frictional forces.
Example

A 62 kg person on skis is going down a hill sloped at 37°. The coefficient of kinetic friction between the skis and the snow is 0.15. How fast is the skier going 5 s after starting from rest?
Equilibrant

Equilibrant – a ________________ that puts an object in ______________________.

To find the equilibrant:

- Find the _________________ of all the forces on the object.
- The equilibrant is the ________________ but ________________________.
EX: What is the equilibrant for an 8 N force applied at 0°, a 6 N force applied at 90°, and a 7 N force applied at 60°?
EX: What is the tension in each cable?