The study of motion involves the introduction of a variety of quantities which are used to describe the physical world.

Examples of such quantities include distance, displacement, speed, velocity, acceleration, force, mass, momentum, energy, work, power, etc. All these quantities can be divided into two categories, vectors and scalars.

A vector quantity is a quantity which is fully described by both magnitude and direction. On the other hand, a scalar quantity is a quantity which is described only by its magnitude.

Vectors are often used to graphically represent different quantities.

**Example:**

10 m/s east is a vector that could be represented by an arrow, drawn to scale, and pointing in the East direction.

*Scale:* 1 cm = 5 m/s

\[ \frac{2 \text{ cm}}{1 \text{ cm}} \]

**Example:**

15 m/s West is a vector that could be represented by an arrow, drawn to scale, and pointing in the West direction.

*Scale:* 1 cm = 5 m/s

\[ \frac{3 \text{ cm}}{1 \text{ cm}} \]

Vectors can have any size (magnitude) or point in any direction.

**Parts of a vector:**

- Body / Line Segment
- Tail / Toe
- Tip / Head
Adding and Subtracting Vectors

Question:
If a man walks 15 km North and then 10 km south. What is his final displacement?

Answer:
15 km - 10 km = +5 km
where the + represents the north direction

Vectors are used to represent different quantities such as velocity, force, displacement, etc. .......

If we are able to add and subtract all of these quantities then we must also be able to add and subtract vectors as well.

To do this we use a method called “tip to tail” this simply means that we place the tail of the second vector on the tip of the first vector.

The answer, or resultant vector, is made by drawing a vector that starts from the tail of the first vector and goes to the tip of the second vector.

Scale: 1cm = 5 km

Adding Vectors in Two Dimensions

Spherical chicken pushes on a box with the force of 30 N. While a square pig, who is located at 90° away from the spherical chicken, pushes on the same box with the force of 40 N. What is the net force acting on the box.

The method for adding vectors in two dimensions is the same as in one dimension, we simply use the tip to tail rule.

Scale: 1cm = 10 N

Do

Vector questions hand out
Concept Questions
Study Guide 6.1
The Analytical Method for adding Vectors

Every resultant vector is composed of two or more components.

We can also work backwards and split a resultant into its components. This is what is known as vector resolution.

First we need to form a right angle triangle using the resultant as the hypotenuse.

Then by knowing the angle of the resultant we can use trigonometry to find the sides of the right angle triangle.

Also if the two components are known the resultant can be found using Pythagoras's theorem.

Example:
Use vector resolution to find the components of a vector of magnitude 64 m and at an angle of 120 °.

\[ x = -32 \text{ m}, \ y = 55 \text{ m} \]

Example:
An airplane flying at 0° at 90 km/hr is being blown toward the 90 ° at 50 km/hr. What is the resultant velocity of the plane?

100 km/hr @ 30 °

Do #s 1-3 Pg 459 (pdf 61)

Do #s 7-10 of vector handout
**Example:**

Two ropes are pulling on a log with forces 12 N @ 10° and 8.0 N @ 120°. Find the net force on the log.

12 N @ 49°

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**Example:**

Three square pigs are pulling on a much larger spherical chicken (mass of 65 kg) with forces of

- 45 N @ E,
- 65 N @ 40° S of W
- 20 N @ 75° N of W

Use vector analysis to calculate the acceleration of the chicken.

0.38 m/s² @ 66° S of W

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**Equilibrium**

An object is said to be in equilibrium when the net force acting on the object is zero.

If the vector sum of the forces acting on an object is not zero but if the addition of another vector makes the vector sum zero then that force is said to be the equilibrant force. (A.K.A. the force that causes equilibrium)

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**Example:**

An object in equilibrium has 3 forces acting on it. The first is 33 N @ 90° and the second is 44 N @ 60°. Find the third?

74 N @ 253°

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**Example:**

A sign that weighs 150 N is supported equally by two ropes that form an angle of 140° with respect to each other.

a) What is the tension in the ropes?

220 N

b) If the angle was reduced to 90° wrt each other what would the new tension be?

106 N
c) At what angle would the ropes have to be at for the tension in each rope to equal the weight of the sign?

120° wrt each other
Do #’s 7-9 Pg 467 (pdf 61)

Do #’s 17-20 of vector handout

Do vector lab

Example:
A trunk weighing 562 N is resting on a frictionless plane inclined at 30° from horizontal.

a) Find the components of the weight parallel and perpendicular to the plane.
   Perpendicular 487 N parallel 281 N

b) If the same trunk is allowed to slide down the incline what would its acceleration be?
   4.9 m/s²

Example:
A coin is placed on the cover of a book and just begins to move when the cover is opened to an angle of 38° with horizontal. What is the coefficient of static friction between the cover and coin?

0.78

Example:
A worker places a large plastic waste container with a mass of 84 kg on the ramp of a loading dock. The ramp makes a 22° angle with horizontal. The worker turns to pick up another container before pushing the first one up the ramp.

a) If the coefficient of static friction is 0.47, will the crate slide down the ramp?
   No, it wont

b) If the worker starts to push it up the ramp with an applied force parallel to the plane, with what force will he be pushing when the crate begins to move?
   670 N

c) If the worker continues to push with the same force after the crate starts to move, and coefficient of kinetic friction is 0.25, at what rate will the container start to accelerate?
   2.0 m/s²

Inclined planes

The force of gravity can be resolved into two components. Together, these two components can replace the effect of the force of gravity.

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Do #’s 10-13 Pg 474 (pdf 61)

Do #’s 23 & 24 of vector handout