Name: _____ Date: _____

PHYSICS
UNIT 1: LINEAR MOTION

VECTOR AND SCALAR MEASUREMENTS

Physics	The branch of science that investigates how objects move and how objects interact with each other through forces.
Motion	Movement, how objects move.
Dynamics	Forces, how objects interact by forces.
Scalar	A measurement or quantity that only requires a magnitude. Scalars do not need direction.
Vector	A measurement or quantity that requires magnitude and direction.
Magnitude	The number value. "How much" or "How many"

Physics is the branch of science that investigates how objects move (motion), how objects interact through forces (dynamics), and the transformations of energy that cause motion and forces. Physics investigates the physical world. The sampling of natural laws below help physical scientists understand processes in the observable universe.

Vector and Scalar Measurements

In science, many measurements are made to describe characteristics of objects. Measurement is when an investigator uses standardized tools to determine how much, how many, or to what degree of matter or energy. Some of the measured parameters are considered to be **scalar units** or parameters. Some of the measured parameters are considered to be **vector units** or parameters.

A **scalar** is a unit, measurement, or parameter that **has a magnitude but does not need a direction of influence**. All scalars are positive numbers. Conversely, a ***vector*** is a unit, measurement, or parameter than **has a magnitude and needs a direction of influence.** The word **magnitude** means "how much, how many, how big, the size". In other words, scalar units have a size but no given direction—direction is not considered. Vector units have both a size and a direction. Direction is important because we must know the direction of influence that the object is going, that the object is pushing, etc…

Table of Scalar measurements or variables and Vector measurements or variables

Scalar Parameters (Only have magnitude)			Vector Parameters (Magnitude and direction)	
Time	Speed	Energy	Displacement	Momentum
Temperature	Volume	Work	Velocity	Weight
Mass	Area		Acceleration	Magnetic field
Distance	Charge		Force	

Time, temperature, and mass are types of **scalar** parameters or measurements. They are represented by a number and unit (magnitude). They do not need a direction. All scalar measurements (except temperature in F and C) are positive and represent absolute values.

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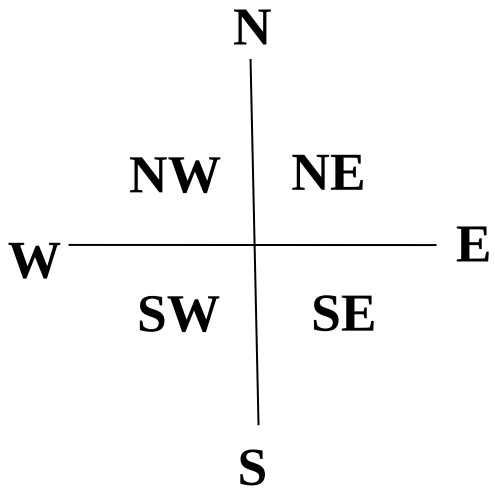
Time:	30 seconds	20 minutes	8.0 hours
Temperature:	45ºF	100ºC	20 K
Mass:	100 kg	90 g	2.0 kg

Displacement, velocity, and force are examples of **vector** parameters or measurements. They are represented by a number and unit (magnitude), AND a direction to indicate the direction of influence. The capitol letter or letters to the right of the magnitude and unit are directions.

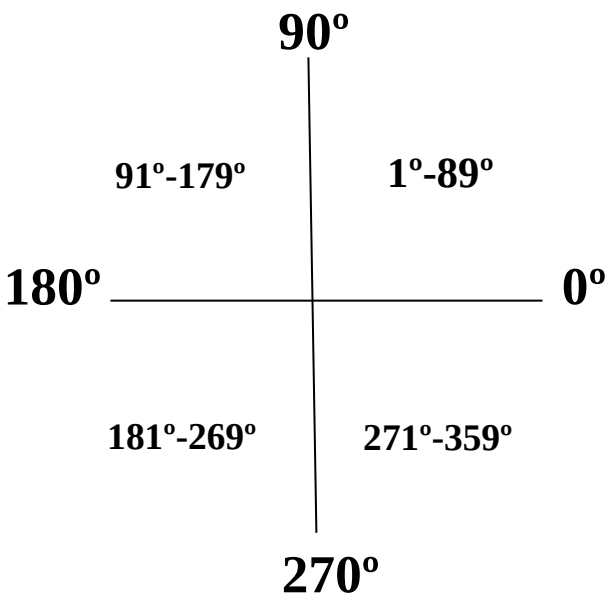
Displacement:	10 m E	300 m W	7.2 km SW
Velocity:	20 m/s S	150 m/s NE	2.4 m/s N
Force:	90 N N	340 N SE	1000 N W

Direction



Geographic coordinates are a grid that represents the geographic directions North, East, South, and West relative to an origin (where the axes of the coordinate system cross).

- Label the axes of North, East, South, and West with the letters N, E, S, and W.
- Always label the axes in sequence starting from the top and rotate clockwise.
- The grid is divided into 4 quadrants. The quadrant directions are the hybrid directions NE, SE, NW, SW.



Polar coordinates are a grid that represents direction based on orientation 0º to 359.9º of a circle.

- Label the axes of 0º, 90º, 180º, and 270º.
- Zero is equivalent to east
- Always label the axes in sequence starting from the 0º and rotate counterclockwise.
- The grid is divided into 4 quadrants. The quadrants contain the degree directions between the numbers on the axes.

By convention, some directions are positive and their opposite directions are negative. In Physics, a positive and negative do not indicate "getting bigger" or "getting smaller". In most circumstances, positive and negative values of measurements are directional.

• North N = (+) direction	South S = (-) direction
• East E = (+) direction	West W = (-) direction
• Right R = (+) direction	Left L = (-) direction
• Up = U (+) direction	Down D = (-) direction

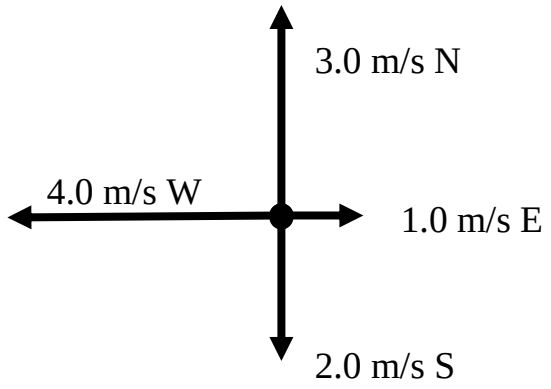
Martin ran with a **velocity of +2.0 m/s**. + is a direction indicating possibly north (N), east (E), or to the right (R).

Susan pushed the table with a **force of -60 <u>N</u>**. – is a direction indicating possibly south (S), west (W) or to the left (L).

Representing Vector Measurements

Vector measurements or variables are represented as arrows that (1) show direction of influence and (2) show magnitude. Vectors are represented as arrows as a simple way to show a process without drawing an overly detailed picture.

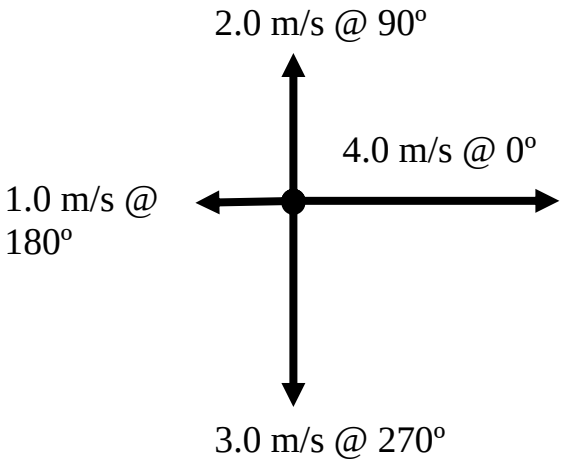
- The tip (pointy end) of the arrow points in the direction of influence.
- Arrow length should be proportional to the magnitude of the vector (number).
- The greater the magnitude, the longer the arrow.
- The smaller the magnitude, the shorter the arrow.
- Write the values of the vectors next to the arrows.



Example: Assume that you are measuring velocity of four people walking. Velocity is how fast an object is moving in a straight line with direction. Velocity is a vector. It has magnitude and direction.

- Person 1 has a velocity of 1.0 m/s east.
- Person 2 has a velocity of 2.0 m/s south.
- Person 3 has a velocity of 3.0 m/s north.
- Person 4 has a velocity of 4.0 m/s west.

The vectors are drawn as arrows. The directions are geographic directions. The longer the arrow, the faster the velocity . The 4.0 m/s W arrow is the longest because it has the largest magnitude. The 1.0 m/s E arrow is the shortest because it has the smallest magnitude.



Example: Assume that you are measuring velocity of three people walking. Velocity is how fast an object is moving in a straight line with direction. Velocity is a vector, therefore it has magnitude and direction.

- Person 1 has a velocity of 1.0 m/s @ 180º.
- Person 2 has a velocity of 2.0 m/s @ 270º
- Person 3 has a velocity of 3.0 m/s @ 90º
- Person 4 has a velocity of 4.0 m/s @ 0º.

- Draw the arrows representing the velocities of the people. Make the arrow lengths proportional to the size of the velocities.
- Write the values next to the vectors.

The vectors are drawn as arrows. The directions are polar coordinate directions. The longer the arrow, the faster the velocity . The 4.0 m/s @ 0º arrow is the longest because it has the largest magnitude. The 1.0 m/s @ 180º arrow is the shortest because it has the smallest magnitude.

Comparing Vectors

Vectors are measurements, variables, or parameters that require both a magnitude (number and unit) and direction. Two vectors are equal to each other if and only if the measurements have the same magnitude (number and unit) and the same direction. If the magnitude is different, or if the direction is different, or both are different, then the two measurements are two different vectors. When in doubt, draw the arrows representing the vectors and compare their lengths and the directions they point.

Car #1 moves with a velocity of 25 m/s E.
Car #2 moves with a velocity of 25 m/s E.
Car #1 and Car #2 have equal velocities. Car #1 and Car #2 have equal magnitudes (25 m/s) and move in the same direction (east), thus they are equal vectors (and velocity).

Horse #1 runs with a velocity of 5.0 m/s S.
Horse #2 runs with a velocity of 5.0 m/s W.
Horse #1 and Horse #2 have unequal velocities. They move with equal magnitudes (5.0 m/s), but have different directions. Thus, they are different velocities.

Betty walked 40 m N.
Susan walked 30 m N.
Betty and Susan have unequal displacements. They moved with unequal magnitudes (40 m and 30 m). Despite moving in the same direction (north), they moved with unequal displacements. They are different displacements.

Randolph pushed the bed with a force of 140 N SE.
Joshua pushed the sofa with a force of 180 N E.
Randolph and Joshua used unequal push forces. They pushed with different magnitudes (140 N and 180 N), and pushed in different directions (southeast and east). They are different forces.