SCALAR AND VECTORS

PES 1000 – PHYSICS IN EVERYDAY LIFE

SCALAR VS. VECTOR

- When a quantity is measured in physics, it falls into one of two types
  - Scalar **Size**
    - This is simply a numerical value (with units)
    - It is a positive number or zero
    - There is no sign or direction associated with it
  - Vector

SCALAR VS. VECTOR

- When a quantity is measured in physics, it falls into one of two types
  - Scalar **Size**
  - Vector **Size + Direction**
    - This has both a numerical value (with units) and an associated direction
    - Direction can be shown as a signed value, or may be geographical (N, W, SE) or geometric (30^o) or another form
    - The vector can be considered to have a scalar part and a direction part
    - An arrow is drawn over the vector's variable to indicate it has direction (example: $\vec{r}$)

SCALAR QUANTITY EXAMPLES

- Mass:
  - The amount of substance in an object. It can't be less than zero (even for anti-matter!)

- Time
  - This progresses at the same rate and in the same direction (to the future!) for all of us, so it is in essence a scalar quantity.

- Length, width, height
  - Quantities that measure dimension are usually scalars. The length of a pen doesn't change no matter what direction it is pointing. Distance travelled along a path, or path length, is a scalar.

MORE SCALAR QUANTITY EXAMPLES

- Speed
  - How fast an object is moving, if direction is ignored, is a scalar. In a car, the speed-o-meter measures a scalar speed.

- Temperature
  - If the Kelvin scale is used, then there is an absolute zero, and all temperatures are either zero or positive.

- Pressure
  - Vacuum is zero pressure. Any other pressure is positive, and there is no direction associated with pressure.

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VECTOR QUANTITY EXAMPLES

- The force of weight
  - Weight, which is a force, is always directed downward, by definition. The size of the weight is its scalar part.

- Any force
  - Any of the other forces we deal with in this class will be vectors, and direction is important to their effect.

- Position
  - The word ‘position’ in this class implies a vector quantity, like the position of an object relative to a reference point or the position change when moving from point A to point B.
  - The scalar part is the straight-line distance between two points, and the direction is from starting point to ending point.

VECTOR QUANTITY EXAMPLES

- Velocity
  - This is the vector version of ‘speed’. When direction is associated with speed, it is referred to as ‘velocity’. If you include the compass heading along with your speedometer reading, it is then referred to as ‘velocity’.

- Acceleration
  - We use the same word, ‘acceleration’, to refer to both scalar and vector quantities. If a direction is given, then acceleration is a vector.

- Electric & magnetic fields
  - We will discuss these later, but we already know that magnets can attract or repel, so there is an associated direction. The same is true for electric charge.
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CONCLUSION

- Measurements in physics fall into two general types:
  - Scalars
    - Scalar quantities possess **size** or magnitude only
    - Scalars can't take on negative values
    - Examples: Mass, Speed, Time, Length, Temperature, Pressure, …
  - Vectors
    - Vector quantities possess both a **size** and a **direction**
    - Sign (negative and positive) can apply to a vector
    - Examples: Weight, Force, Position, Velocity, Acceleration, …