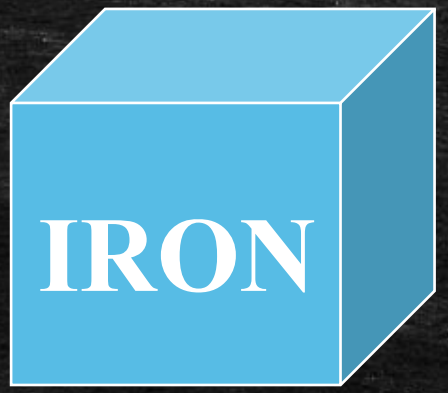
Scalars and Vectors

AS Level Physics
2016/5

1. Basic Concept



Scalars and Vectors

What are scalar quantities?

Definition:

A scalar is a physical quantity that has magnitude (size) only.

Examples:

- Mass (kg), Volume (cm^3), Energy (J)

What are vector quantities?

Definition:

A vector is a physical quantity that has both a magnitude and a direction.

Example:

- Force (N), Velocity (ms^{-1}), Acceleration (ms^{-2})

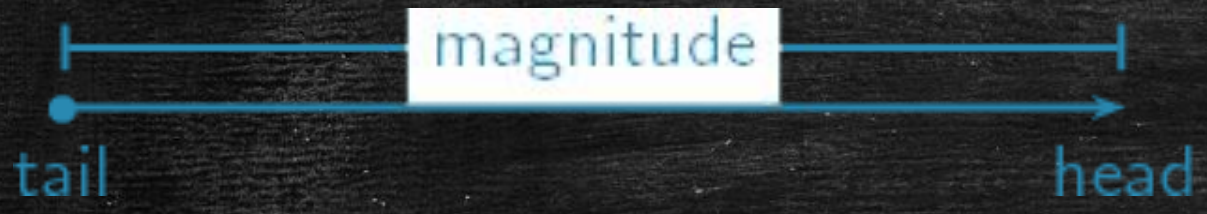
Exercise 1

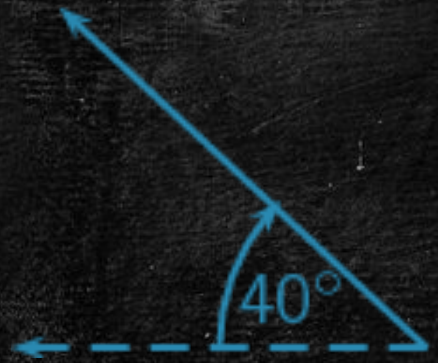
- Finish Table 1.
- Classify the following as vectors or scalars in table 1:
  - Length, Force, Direction, Height, Time, Speed, Temperature, Distance, Speed, Energy, Power, Work, Volume, Temperature, Mass, Displacement, Velocity, Acceleration, Weight, Area, Density, Momentum, Pressure…

Scalar Vs. Vector

Scalars		Vectors
Only have to compare the magnitude	**When comparing 2 values**	**Have to compare both the magnitude and the direction**
A scalar has magnitude only.	**Definition**	A vector quantity has magnitude and direction.
Distance, Speed, Length, Area, Volume, Energy, Power, Work, Temperature, Pressure, Mass, Density, Height	**Examples**	Displacement, Velocity, Acceleration, Momentum, Force (e.g. Weight)

Vector Diagram





40° North of West

1. Each vector is represented by an arrow
    1. Magnitude = Length of an arrow
    2. Direction = Direction of an arrow
2. 3 ways to represent direction: relative direction, compass directions, bearing

Drawing Tips:
The larger **scale** ☐ the greater precision

2. Add and Subtract Coplanar Vectors

Coplanar Vectors: Vectors lying in the same plane

Vectors at a same direction - Add

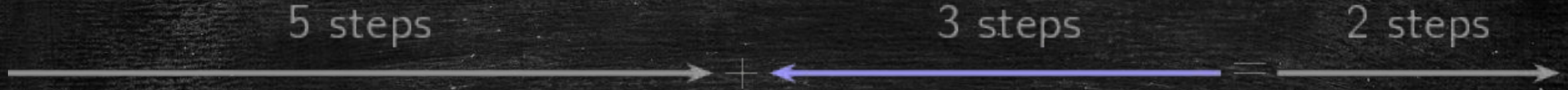
Displacement = 5 steps

- The two forces are in the *same* direction (i.e. forwards) and so the total force acting on the box is:

$$\overrightarrow{F_T} = \overrightarrow{F_1} + \overrightarrow{F_2}$$

Vectors at a same direction - Subtract

Displacement:

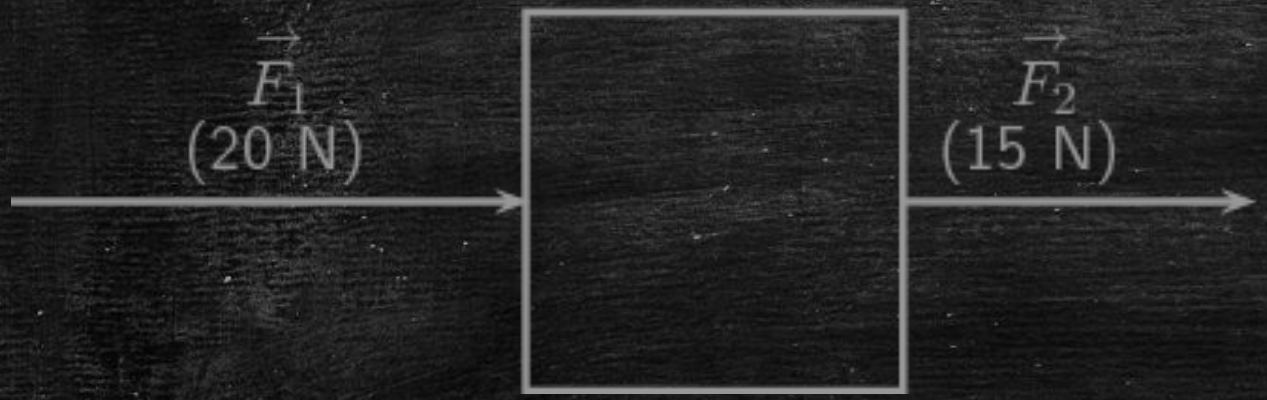


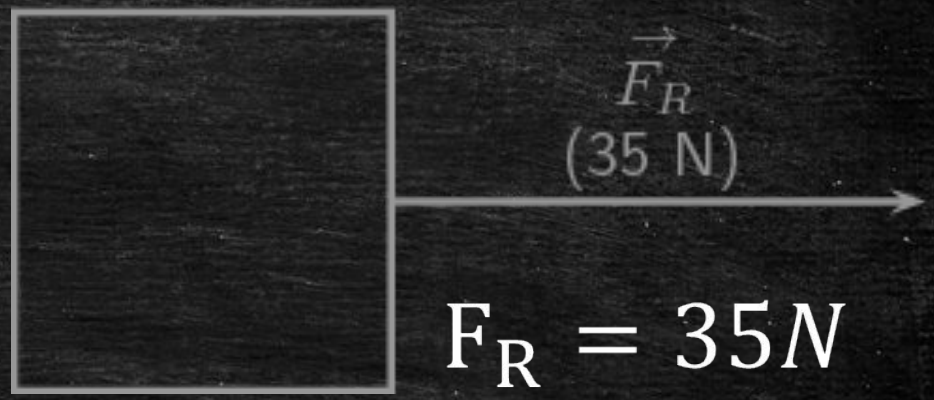
- In this case the two forces are in *opposite* directions.
- If we define the direction pulling in as *positive* then the force exerting must be *negative* since it is in the opposite direction.

$$\overrightarrow{F_T} = \overrightarrow{F_2} + \overrightarrow{F_1}$$

$$F_T = F_2 + (-F_1)$$

*The **resultant vector** is the single vector whose effect is the same as the individual vectors acting together.*



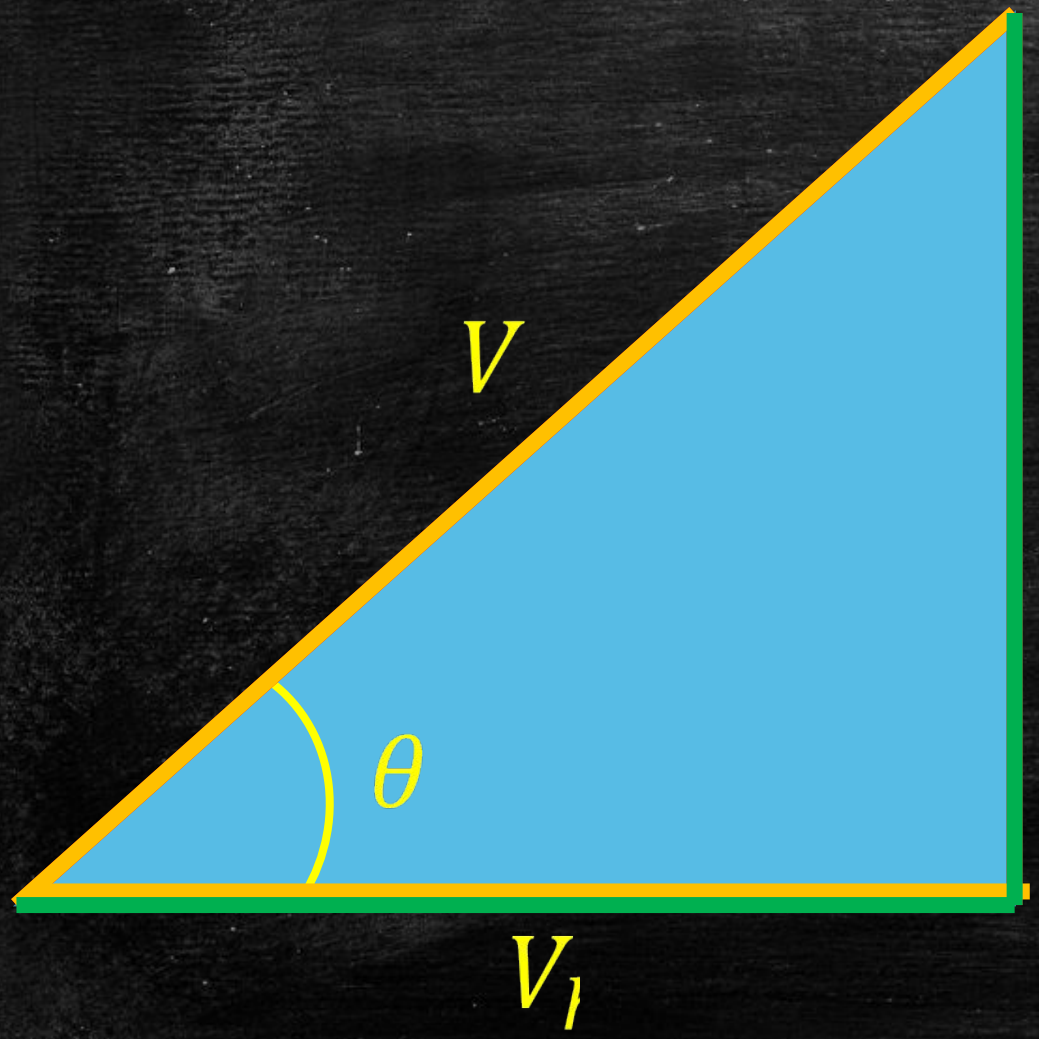


$F_R = 35N$

$F_R = -5N$

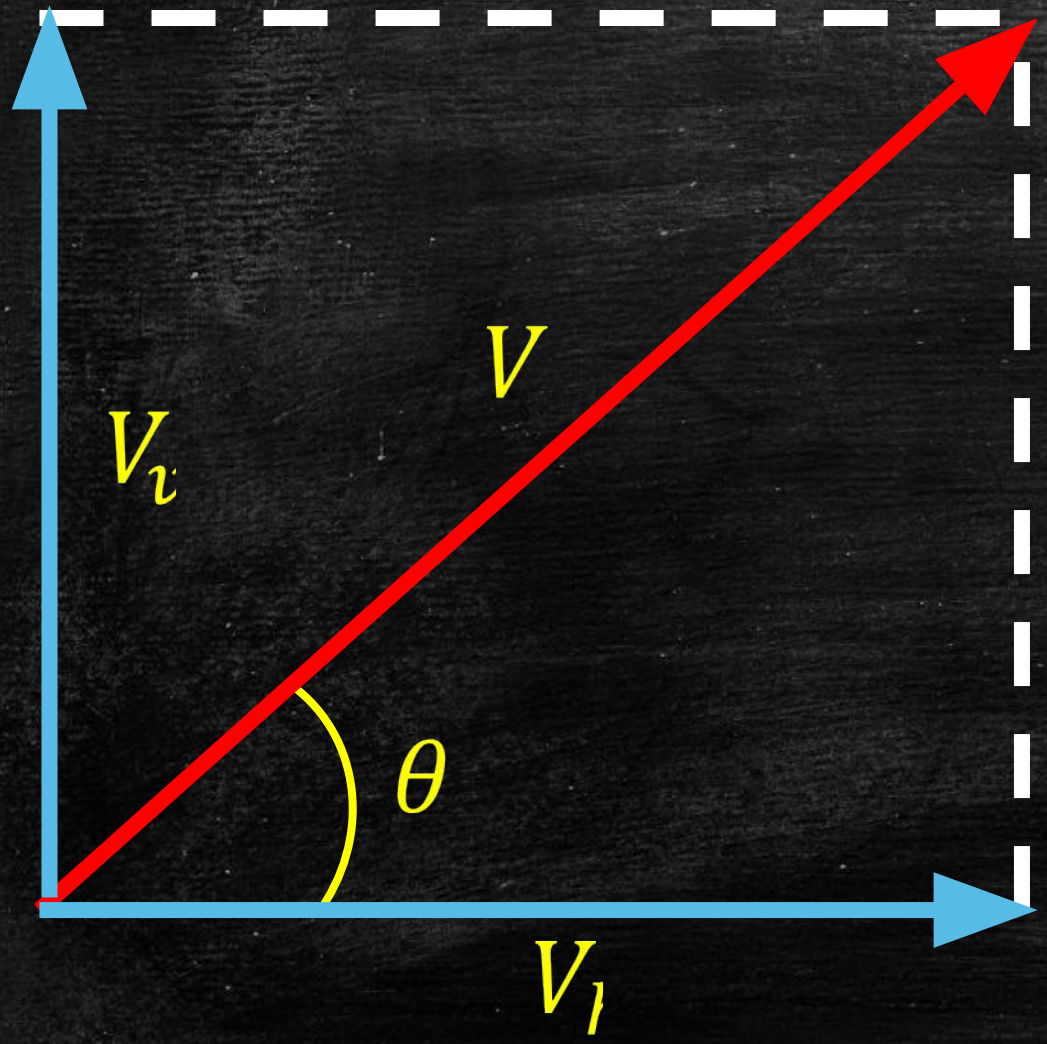
3. Resolving Vectors

Trigonometric functions



- $sin\theta = \frac{V_v}{V}$
- $cos\theta = \frac{V_h}{V}$
- $tan\theta = \frac{V_v}{V_h}$

Resolve into Vertical and Horizontal

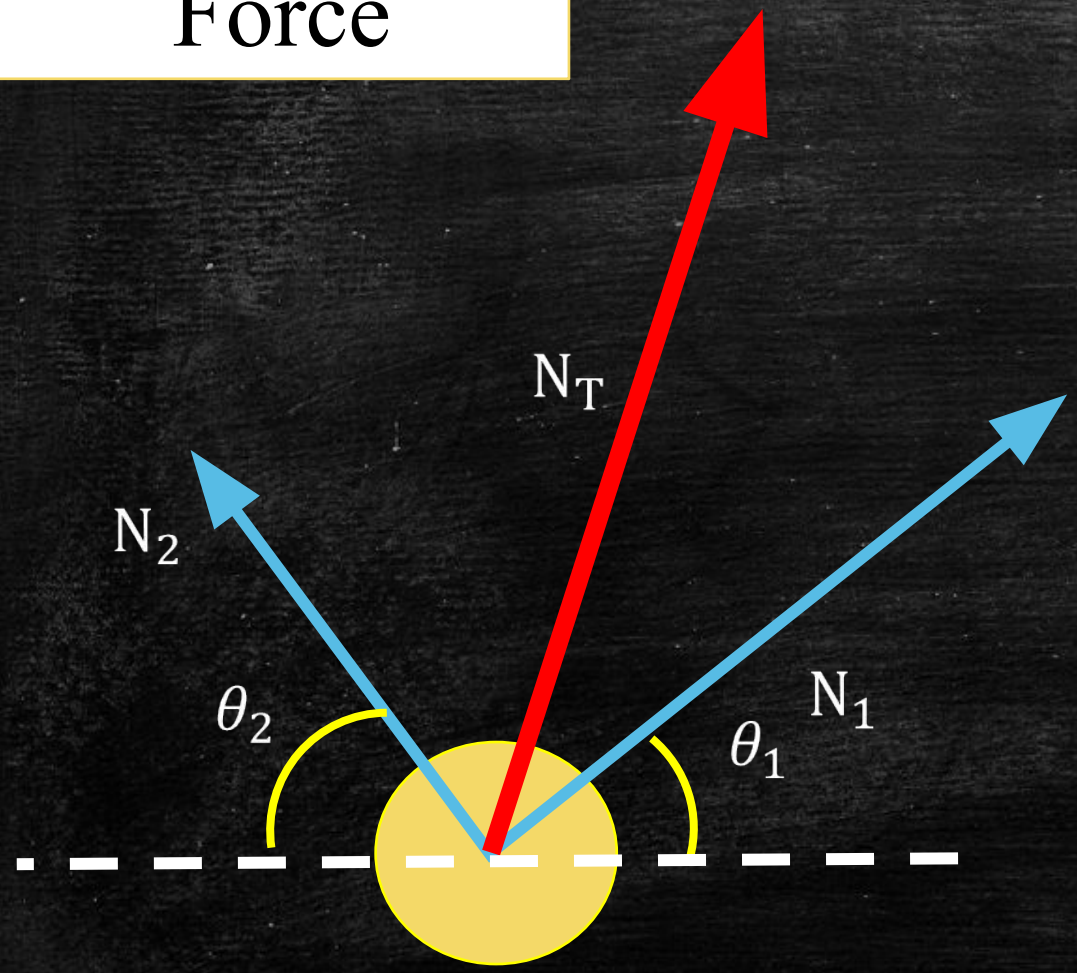


- Step 1: Draw a parallelogram.
- Step 2: Measure the angle
- Step 3:

$$V = V_v + V_h$$
$$V_v = V\sin\theta$$
$$V_h = V\cos\theta$$

Vectors with different angles – Find N_T

Force



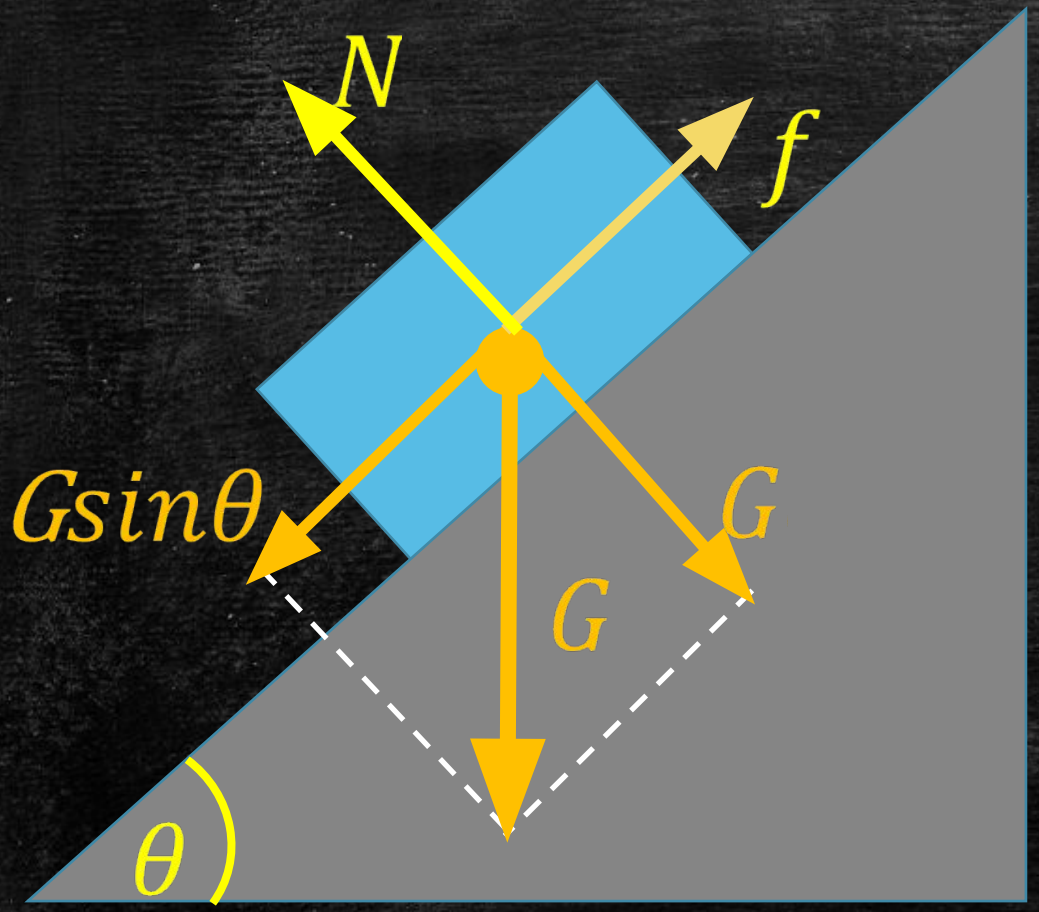
- Step 1: Measure the angle and resolve forces into vertical and horizontal components
- Step 2, horizontally and vertically…

$$N_V = N_{1v}sin\theta + N_{2v}sin\theta$$
$$N_h = N_{1v}cos\theta + N_{2v}cos\theta$$

- Step 3, combine $N_V + N_h$ to form N_T

$$N_T = N_1 + N_2$$

Example: What is the frictional force?



- Step 1: Identify the frictional force
- Step 2: Resolve the weight G into vertical and horizontal components
- Step 3: Determine the acceleration of the box (a=0?)
- Step 4: Equals the horizontal force to the frictional force, hence, get the answer:

$$\text{Frictional Force}, f = -Gsin\theta$$

Homework: All exercises provided

By next lesson