Physics with Synno – Motion-2 – Lesson 11

M.3.3 Newton's Second Law

When a constant force acts on a body we notice that the body undergoes constant acceleration.

If we change the size of the constant force the size of the acceleration changes, such that $F \propto a$.

Applying a given force to different objects results in differing accelerations.

The property of the object that causes this variation is the mass (m) and we have

$$F = m\,a$$

which strictly speaking should be written as

$$\Sigma \mathbf{F} = m\,\mathbf{a}$$

Force is a vector and behaves as any vector would.

Units Force has the unit of Newton (N)
mass has the unit of Kilogram (Kg)
acceleration has the unit of ms^{-2}

1 Newton ≈ weight of an apple

Note
1) Direction of $\vec{a}$ is direction of $\Sigma \vec{F}$
2) If $\vec{a} = 0$ then $\Sigma \vec{F} = 0$
3) If $\vec{a} = 0$ in any direction, then $\Sigma \vec{F}$ in that direction = 0

Example 1 A force of 6 N accelerates a mass of 3 Kg. What acceleration results?

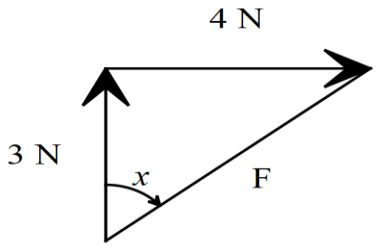
$\Sigma \mathbf{F} = m\,\mathbf{a}$
$6 = 3\,\mathbf{a}$
$a = 2\ m/s^2$

Example 2 A freestyle swimmer whose mass is 75 kg applies a force of 350 N as he begins a race. The water opposes his efforts to accelerate with a drag force of 200 N. What is his initial acceleration?

$\Sigma \mathbf{F} = m\,\mathbf{a}$
$350 - 200 = 75\,\mathbf{a}$
$150 = 75\,\mathbf{a}$
$a = 2\ m/s^2$

Example 3 A body is acted upon by two forces. 3 N north and 4 N east. If its mass is 6 Kg. What is the acceleration?

$\Sigma \mathbf{F} = m\,\mathbf{a}$



$\Sigma F^2 = 3^2 + 4^2$
$\Sigma F^2 = 9 + 16$
$\Sigma F = \sqrt{25}$
$\Sigma F = 5\ N$
$x = \tan^{-1}\left(\frac{4}{3}\right)$
$x = 53.1°$

Net Force is 5 N, N 53.1° E
$5 = 6\,\mathbf{a}$
$\mathbf{a} = 0.83\ m/s^2$ N 53.1° E

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