2. Newton's Laws of Motion and Gravitation

Newton's first law of motion:

A body will remain at rest or continue its uniform motion in a straight line unless compelled to change by forces acting on it. It follows from this that when a body is in equilibrium the resultant force, $\underline{R} = (R_x, R_y, R_z)$, of all the forces acting on it, is zero. Thus

$$\underline{R} = \underline{0},\ R_x = 0,\ R_y = 0,\ R_z = 0$$

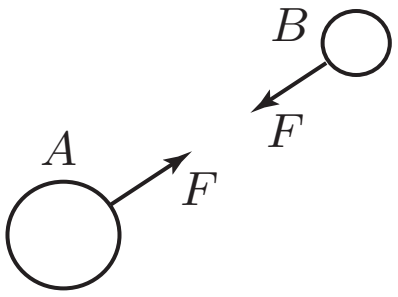
where R_x, R_y and R_z are the net sums of the x, y and z scalar components of the forces, respectively.

Newton's second law of motion:

If a body of mass m is moving with velocity $\underline{v}$, and so has **momentum** $m\underline{v}$, then the rate of change of momentum of the body is directly proportional to the resultant applied force, $\underline{F}$, acting on it: $\underline{F} = \dfrac{d}{dt}(m\underline{v})$. For a body with acceleration $\underline{a}$ and of *constant* mass m, this becomes $\underline{F} = m\dfrac{d\underline{v}}{dt} = m\underline{a}$. This vector equation is equivalent to the scalar equations: $F_x = ma_x$, $F_y = ma_y$, $F_z = ma_z$ where $\underline{F} = (F_x, F_y, F_z)$ and $\underline{a} = (a_x, a_y, a_z)$.

Newton's third law of motion:

To every action there is an equal and opposite reaction. Thus forces come in pairs when bodies interact. Whenever body A exerts a force, $\underline{F}$, of magnitude F, on body B, B exerts a force, $-\underline{F}$, on body A.



Newton's Law of Universal Gravitation:

Every body in the universe attracts every other body with a force which is directly proportional to the product of the masses and inversely proportional to the square of the distance between them. Thus $F_g = G\dfrac{m_1 m_2}{r^2}$ where F_g is the magnitude of the gravitational force on either body, m_1 and m_2 are their masses, r is the distance between them. G is called the gravitational constant. Its accepted value is $G = 6.673 \times 10^{-11}\,\mathrm{m^3\,kg^{-1}s^{-2}}$.

3. Units

The SI system uses the following units:

Quantity	**Unit**	**Symbol**
Mass	kilogram	kg
Length	metre	m
Time	second	s
Force	newton	N ($1\,\mathrm{N} = 1\,\mathrm{kg\,m\,s^{-2}}$)
Work	joule	J ($1\,\mathrm{J} = 1\,\mathrm{N\,m}$)
Power	watt	W ($1\,\mathrm{W} = 1\,\mathrm{J\,s^{-1}}$)
Velocity	metre per second	$\mathrm{m\,s^{-1}}$
Acceleration	metre per second per second	$\mathrm{m\,s^{-2}}$
Energy	joule	J
Momentum	newton second	N s
Impulse	newton second	N s
Angular Velocity/ Angular Frequency	radians per second	rad $\mathrm{s^{-1}}$