EQUATIONS AND CONSTANTS–GRADE 11 PHYSICS

These equations are meant to make doing homework and exams a bit easier. They are **not** an excuse for not learning the course material. If you don't know what these equations mean and how to use them, they will not help you at all.

MOTION QUANTITIES:

$$\Delta\vec{d} = \vec{d}_2 - \vec{d}_1$$
$$\vec{v} = \frac{\Delta\vec{d}}{\Delta t}$$
$$\vec{a} = \frac{\Delta\vec{v}}{\Delta t}$$

KINEMATIC EQUATIONS (for constant acceleration):

$$\Delta d = v_1\Delta t + \frac{1}{2}a\Delta t^2 \qquad v_2 = v_1 + a\Delta t$$
$$\Delta d = v_2\Delta t - \frac{1}{2}a\Delta t^2 \qquad v_2^2 = v_1^2 + 2a\Delta d$$
$$\Delta d = \frac{v_1 + v_2}{2}\Delta t$$

NEWTON'S LAWS:

$$\vec{F}_{\text{net}} = m\vec{a}$$
$$\vec{F}_{\text{A on B}} = -\vec{F}_{\text{B on A}}$$

GRAVITY:

$$F_g = \frac{Gm_1m_2}{r^2}$$
$$\vec{F}_g = m\vec{g}$$

FRICTION:

Static: $\max F_s = \mu_s F_N$

Kinetic: $F_k = \mu_k F_N$

WORK:

$$W = Fd\cos\theta$$
$$W = \Delta E_k$$
$$W = \Delta E_g$$

MECHANICAL ENERGY:

$$E_k = \frac{1}{2}mv^2$$
$$E_g = mgh$$
$$E_g + E_k = \text{constant}$$

POWER & EFFICIENCY:

$$P = \frac{\Delta E}{\Delta t} = \frac{W}{\Delta t}$$
$$\eta = \frac{E_{\text{out}}}{E_{\text{in}}} = \frac{W_{\text{out}}}{W_{\text{in}}} \times 100\,\%$$

TEMPERATURE:

$$T \propto \sum E_k$$
$$T = T_C + 273.15$$
$$\Delta T = \Delta T_c$$

HEAT:

$$\Delta E = W + Q \qquad Q_{\text{melting}} = mL_f$$
$$Q = mc\Delta T \qquad Q_{\text{boiling}} = mL_v$$

VIBRATIONS:

$$T = \frac{\Delta t}{N}$$
$$f = \frac{N}{\Delta t}$$
$$f = \frac{1}{T}$$

WAVES:

$$v = f\lambda$$
$$v_{\text{string}} = \sqrt{\frac{F_T}{\mu}} = \sqrt{\frac{F_T L}{m}}$$

SOUND WAVES:

$$v_s = 331 + 0.59T_C$$
$$M = \frac{v}{v_s}$$
$$f' = \frac{v_s + v_{\text{ob}}}{v_s - v_{\text{src}}}f$$

BEAT FREQUENCIES:

$$f_{\text{beat}} = |f_2 - f_1|$$
$$f_{\text{harm},n} = nf_1$$

STRINGS, OPEN/CLOSED PIPES:

$$f_1 = \frac{v}{\lambda} = \frac{v_{\text{str}}}{2L}$$
$$f_{\text{res},n} = nf_1$$

SEMI-OPEN PIPES:

$$f_1 = \frac{v}{\lambda} = \frac{v_{\text{str}}}{4L}$$
$$f_{\text{res},n} = (2n-1)f_1$$

Use v_{str} for strings, and v_{sound} for pipes.

ELECTRICITY:

$$V = \frac{\Delta E_q}{q}$$
$$I = \frac{q}{\Delta t}$$
$$q = Ne$$
$$R = \rho\frac{L}{A}$$

CIRCUITS:

$$V = IR$$
$$R_s = R_1 + R_2 + \cdots + R_N$$
$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_N}$$
$$V_S = \mathcal{E} - V_{\text{int}}$$
$$P = IV = I^2R = \frac{V^2}{R}$$

MAGNETISM:

$$B = \frac{\mu_0 I}{2\pi r}$$
$$F_{\text{magnetic}} = BIL$$

USEFUL CONSTANTS:

Acceleration due to gravity	$g = 9.81\,\text{m/s}^2$ (near surface of Earth)
Universal Gravitational constant	$G = 6.674 \times 10^{-11}\,\text{N m}^2/\text{kg}^2$
Elementary charge	$e = 1.602 \times 10^{-19}\,\text{C}$
Permeability of free space	$\mu_0 = 4\pi \times 10^{-7}\,\text{T m/A}$

CONVERSION TO SI UNITS:

Kilowatt-hour	$1\,\text{kW h} = 3.6 \times 10^6\,\text{J}$
Kilometres per hour	$1\,\text{km/h} = 0.278\,\text{m/s}$, $1\,\text{m/s} = 3.6\,\text{km/h}$

MATHEMATICAL FORMULAS:

Circumference of a circle	$C = 2\pi r$
Area of a circle	$A = \pi r^2$
Volume of a sphere	$V = \frac{4}{3}\pi r^3$
Density	$\rho = m/V$

UNIT PREFIXES:

tera	10^{12}	T
giga	10^9	G
mega	10^6	M
kilo	10^3	k
centi	10^{-2}	c
milli	10^{-3}	m
micro	10^{-6}	μ
nano	10^{-9}	n