Trent University: **PHYS 1000H** ***Foundations of Physics***

Formula Sheet

1. Kinematics & Dynamics

A vector equation in 2D is actually <u>two</u> separate equations – one for each perpendicular axis. You get to choose (or may be told) which axes to use, and which direction is positive for each axis 😊.

$$\vec{v} = \frac{\Delta \vec{x}}{\Delta t} \tag{2.1}$$

$$\vec{a} = \frac{\Delta \vec{v}}{\Delta t} \tag{2.2}$$

$$\left.\begin{aligned} & x = x_0 + v_{av,x} t \\ & \quad \text{where } v_{av,x} = \frac{v_{0x} + v_x}{2} \\ & v_x = v_{0x} + a_x t \\ & x = x_0 + v_{0x} t + \frac{1}{2} a_x t^2 \\ & v_x{}^2 = v_{0x}{}^2 + 2 a_x \left(x - x_0 \right) \end{aligned}\right\} \text{...and sim. for } y \text{ cmpts} \tag{2.3}$$

$$\vec{R} = \vec{A} + \vec{B} \quad \Rightarrow \; R_x = A_x + B_x \;\; ; \;\; R_y = A_y + B_y \tag{3.1}$$

$$h = \frac{v_{0y}{}^2}{2g} \quad ; \quad R = \frac{v_0{}^2 \sin 2\theta_0}{g} \tag{3.2}$$

$$\vec{v}_{\text{plane rel to gnd}} = \vec{v}_{\text{plane rel to air}} + \vec{v}_{\text{air rel to gnd}} \tag{3.3}$$

$$\vec{F}_{\text{net}} = m\vec{a} \tag{4.1}$$

$$f_s \le \mu_s N \quad ; \quad f_k = \mu_k N \tag{5.1}$$

$$F_D = \frac{1}{2} C \rho A v^2 \tag{5.2}$$

$$F_S = 6\pi r \eta v \quad \text{if motion is slow or medium is dense} \tag{5.3}$$

$$F = k \Delta L \tag{5.4}$$

$$Y = \frac{F / A}{\Delta L / L_0} \tag{5.5}$$

$$S = \frac{F / A}{\Delta x / L_0} \tag{5.6}$$

$$B = \frac{F / A}{\Delta V / V_0} \tag{5.7}$$

$$\Delta\theta = \frac{\Delta s}{r} \tag{6.1}$$

$$\omega = \frac{\Delta\theta}{\Delta t} \quad \text{so} \quad \omega = \frac{2\pi}{T} \quad ; \quad v = r\omega \tag{6.2}$$

$$a_c = \frac{v^2}{r} = r\omega^2 \tag{6.3}$$

$$F_c = \frac{mv^2}{r} = mr\omega^2 \tag{6.4}$$

$$F_g = \frac{GMm}{r^2} \quad ; \quad g = \frac{GM}{r^2} \tag{6.5}$$

$$\frac{T_1^2}{T_2^2} = \frac{r_1^3}{r_2^3} \tag{6.6}$$

$$W = Fd\cos\theta \tag{7.1}$$

$$KE = \frac{1}{2} mv^2 \quad ; \quad PE_g = mgh \quad ; \quad PE_s = \frac{1}{2} kx^2 \tag{7.2}$$

$$W_{\text{net}} = \Delta KE_{\substack{\text{bulk} \\ \text{objects}}} + \Delta PE_{\substack{\text{bulk} \\ \text{objects}}} + \Delta E_{\substack{\text{thermal, from} \\ \text{friction between} \\ \text{bulk objects}}} + \Delta E_{\substack{\text{microscopic, from} \\ \text{chemical, food,} \\ \text{nuclear, etc.}}} \tag{7.3}$$

$$\text{where } \Delta E_{\substack{\text{thermal, from} \\ \text{friction between} \\ \text{bulk objects}}} = f_k d \tag{7.4}$$

$$P = \frac{\text{Energy } \textit{transferred} \text{ or } \textit{converted}}{\text{time taken}} \tag{7.5}$$

$$\vec{p} = m\vec{v} \tag{8.1}$$

$$\vec{F}_{\text{net}} = \frac{\Delta \vec{p}}{\Delta t} \tag{8.2}$$

$$\text{Impulse} = \vec{F}_{\text{net}} \Delta t = \Delta \vec{p} \tag{8.3}$$

$$a = \frac{v_e}{m} \frac{\Delta m}{\Delta t} - g \tag{8.4}$$

2. Mathematical Formulae

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \tag{M.1}$$

$$\sin\theta = \frac{\text{opp}}{\text{hyp}} \quad ; \quad \cos\theta = \frac{\text{adj}}{\text{hyp}} \quad ; \quad \tan\theta = \frac{\text{opp}}{\text{adj}} \tag{M.2}$$

$$a^2 = b^2 + c^2 - 2bc\cos\theta \tag{M.3}$$

3. Fundamental constants and physical properties:

usually given in the question, or in Urone, or ask invigilator

…and also: $g = 9.80 \text{ ms}^{-2}$; $\rho_{\text{water}} = 997 \text{ kg/m}^3$