Important Equations For Phys110 (Phys101)- A. Z. ALZAHRANI

(1) Units & Measurements

Physical Quantity	Name	Symbol
Length	meter	m
Mass	kilogram	kg
Time	second	s
Electric current	Ampere	A
Thermodynamic temperature	Kelvin	K
Amount of substance	mole	mol
Luminous intensity	candela	cd

(2) Vectors

Vector addition	$\mathbf{A} + \mathbf{B} = (A_x + B_x)\,\hat{\imath} + (A_y + B_y)\,\mathbf{j} + (A_z + B_z)\,\hat{k}$
Vector subtraction	$\mathbf{A} - \mathbf{B} = (A_x - B_x)\,\hat{\imath} + (A_y - B_y)\,\mathbf{j} + (A_z - B_z)\,\hat{k}$
Dot (scalar) product	$\mathbf{A}\cdot\mathbf{B} = AB\cos\theta$ $\mathbf{A}\cdot\mathbf{B} = A_xB_x + A_yB_y + A_zB_z$ $\mathbf{A}\cdot\mathbf{B} = \mathbf{B}\cdot\mathbf{A}$
Cross (vector) product	$\mathbf{A}\times\mathbf{B} = AB\sin\theta\,\hat{n}$ $\mathbf{A}\times\mathbf{B} = (A_yB_z - A_zB_y)\,\hat{\imath} + (A_zB_x - A_xB_z)\,\mathbf{j} + (A_xB_y - A_yB_x)\,\hat{k}$ $\mathbf{A}\times\mathbf{B} = -\mathbf{B}\times\mathbf{A}$
Special cases	**If** $\mathbf{A}\cdot\mathbf{B} = 0$ then **A** and **B** are perpendicular **If** $\mathbf{A}\times\mathbf{B} = 0$ then **A** and **B** are parallel or anti-parallel **If** $\lvert\mathbf{A}+\mathbf{B}\rvert = \lvert\mathbf{A}-\mathbf{B}\rvert$ then $\mathbf{A}\cdot\mathbf{B} = 0$

(3) Motion along a straight line

Displacement	$\Delta x = x_2 - x_1$
Average Speed	$\bar{v} = \frac{\Delta x}{\Delta t}$ $\bar{v} = \frac{1}{2}(v + v_0)$
Average acceleration	$\bar{a} = \frac{\Delta v}{\Delta t}$
Equations of motion (a=0)	$v = v_0$ $x = x_0 + v_0 t$
Equations of motion (a=constant)	$v = v_0 + at$ $x = x_0 + v_0 t + \frac{1}{2}at^2$ $v^2 = v_0^2 = 2a(x - x_0)$

Equation of motion (a = -g)	**Same as equations of motion with constant a by replacing a with -g**

(4) Motion in 2 and 3 dimensions

Position vector	$\mathbf{r} = x\mathbf{i} + y\mathbf{j} + z\mathbf{k}$
Velocity vector	$\mathbf{v} = v_x\mathbf{i} + v_y\mathbf{j} + v_z\mathbf{k}$
Acceleration vector	$\mathbf{a} = a_x\mathbf{i} + a_y\mathbf{j} + a_z\mathbf{k}$
Initial velocities	$v_{0x} = v_0 \cos\theta_0$ and $v_{0y} = v_0 \sin\theta_0$.
Vertical motion	$y - y_0 = v_{0y}t - \frac{1}{2}gt^2 = (v_0 \sin\theta_0)t - \frac{1}{2}gt^2$. $v_y^2 = (v_0 \sin\theta_0)^2 - 2g(y - y_0)$.
Horizontal motion	$x - x_0 = (v_0 \cos\theta_0)t$.
Equation of motion	$y = (\tan\theta_0)x - \frac{gx^2}{2(v_0 \cos\theta_0)^2}$
Horizontal range	$R = \frac{v_0^2}{g} \sin 2\theta_0$.
Maximum range	$R = \frac{v_0^2}{g}$
Maximum height	$H = \frac{v_0^2 \sin^2\theta_0}{2g}$

(5-1) Forces & Motion: Linear Motion

Newton's Second Law	$\vec{F} = m\vec{a}$
Newton's Third Law	$\vec{F}_{A\to B} = \vec{F}_{B\to A}$
Frictional Force	$\vec{F}_f = \mu\vec{N}$
Weight	$\vec{W} = m\vec{g}$

(5-2) Force & Motion: Circular Motion

Tangential Velocity	$v = \omega R$ $\omega = 2\pi f = 2\pi \frac{1}{T}$
Frequency	$f = \frac{1}{T}$
Centripetal Acceleration	$a_R = \frac{v^2}{r} = \omega^2 r$
Centripetal Force	$F_{centripetal} = m\frac{v^2}{r} = m\omega^2 r$
Centrifugal Force	$F_{centrifugal} = m\frac{v^2}{r} = m\omega^2 r$
Newton's Law of Universal Gravitation	$F = G\frac{m_1 m_2}{r^2}$

(6) Work & Energy

Work	$W = F\ x\ \cos\ \theta$
Kinetic Energy	$KE = \frac{1}{2}mv^2$
Work-Energy Theorem	$W = \frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2$
Gravitational Potential Energy	$PE_{gravitational} = mgy$
Elastic Potential Energy	$PE_{elastic} = \frac{1}{2}kx^2$
Power	$P = \frac{W}{T}$

(7) Momentum & Collisions

Linear Momentum	$\vec{p} = m\vec{v}$
Newton's Second Law	$\sum \vec{F} = \frac{\Delta\vec{p}}{\Delta t}$
Conservation of Momentum	$m_A\vec{v_A} + m_B\vec{v_B} = m_A\vec{v'_A} + m_B\vec{v'_B}$
Impulse	$F\Delta t$
Elastic Collision	$\frac{1}{2}m_A v_A^2 + \frac{1}{2}m_B v_B^2 = \frac{1}{2}m_A v_A'^2 + \frac{1}{2}m_B v_B'^2$
Inelastic Collision	$m_A\vec{v_A} + m_B\vec{v_B} = (m_A + m_B)\vec{v'}$
Center of Mass	$x_{CM} = \frac{\sum_i m_i x_i}{\sum_i m_i}$

(7) Rotational Motion

Angular Displacement	$\theta = \frac{l}{R}$
Angular Velocity	$\omega = \frac{v}{R}$
Angular Acceleration	$\alpha = \frac{a}{R}$
Centripetal Acceleration	$a_c = \omega^2 R$
Equations of motion (α=0)	$\omega = \omega_0$ $\theta = \theta_0 + \omega_0 t$
Equations of motion (α=constant)	$\omega = \omega_0 + \alpha t$ $\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$ $\omega^2 = \omega_0^2 = 2\alpha(\theta - \theta_0)$
Torque	$\tau = rF\ \sin\ \theta$
Moment of Inertia	$I = mR^2$