Physics I – First Quarter Formulas

Chapter 1 – A Physics Toolkit

Linear $y = mx + b$

Quadratic $y = ax^2 + bx + c$

Inverse $y = \frac{a}{x}$

Slope of a Line

$$m = \frac{rise}{run} = \frac{y_2 - y_1}{x_2 - x_1}$$

Chapter 2 – Representing Motion

Time Interval $\Delta t = t_f - t_i$

Displacement $\Delta d = d_f - d_i$

Average Velocity $\bar{v} = \frac{\Delta d}{\Delta t} = \frac{d_f - d_i}{t_f - t_i}$

Motion Equation for Average Velocity

$$d = \bar{v}t + d_i$$

Chapter 3 – Accelerated Motion

Average Acceleration $\bar{a} = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{t_f - t_i}$

Final Velocity $v_f = v_i + \bar{a}\,t$

Position $d_f = d_i + v_i t + \frac{1}{2}\bar{a}\,t^2$

Velocity with Constant Acceleration

$$v_f^2 = v_i^2 + 2\,\bar{a}\,(d_f - d_i)$$

Physical Constants

Gravitational acceleration	$g = 9.8\ ^{m}/_{s^2}$ ***down***
Speed of Light (vacuum)	$c = 3 \times 10^8\ ^{m}/_{s}$
Speed of Sound (20°C)	$v = 343\ ^{m}/_{s} \approx 340\ ^{m}/_{s}$
Specific Heat for Water	$C_{H_2O} = 4186\ ^{J}/_{kg \cdot ^\circ C} \approx 4180\ ^{J}/_{kg \cdot ^\circ C}$
Gravitational constant	$G = 6.67 \times 10^{-11}\ ^{N \cdot m^2}/_{kg^2}$
Coulomb's Law constant	$k_c = 9 \times 10^9\ ^{N \cdot m^2}/_{C^2}$
Planck's constant	$h = 6.63 \times 10^{-34}\ J \cdot s$
Electron charge	$e^- = -1.602 \times 10^{-19}\ C$
Proton charge	$p^+ = +1.602 \times 10^{-19}\ C$
Mass of electron	$m_e = 9.11 \times 10^{-31}\ kg$
Mass of proton	$m_p = 1.67 \times 10^{-27}\ kg$
Mass of neutron	$m_n = 1.67 \times 10^{-27}\ kg$
Atomic mass unit	$u = 1.66 \times 10^{-27}\ kg$
Electron volt	$1eV = 1.6 \times 10^{-19}\ J$

Commonly Used Metric Prefixes

femto-	***f***	10^{-15}	*milli-*	***m***	10^{-3}
pico-	***p***	10^{-12}	*centi-*	***c***	10^{-2}
nano-	***n***	10^{-9}	*kilo-*	***k***	10^{3}
micro-	***μ***	10^{-6}	*mega-*	***M***	10^{6}

Chapter 4 – Forces in One Dimension

Newton's 2nd Law $a = \frac{F_{net}}{m}$ *or* $F_{net} = ma$

Newton's 3rd Law $F_{A\ on\ B} = -F_{B\ on\ A}$

Chapter 5 – Forces in Two Dimensions

Pythagorean Theorem $R^2 = A^2 + B^2$

Angle of the Resultant $\theta = \tan^{-1}\left(\frac{R_y}{R_x}\right)$

Law of Cosines $R^2 = A^2 + B^2 - 2AB\cos\theta$

Law of Sines $\frac{R}{\sin\theta} = \frac{A}{\sin\alpha} = \frac{B}{\sin\beta}$

Sine $\sin\theta = \frac{opposite}{hypotenuse}$

Cosine $\cos\theta = \frac{adjacent}{hypotenuse}$

Tangent $\tan\theta = \frac{opposite}{adjacent}$

Static Friction $F_{static} \le \mu_s F_N$

Kinetic Friction $F_{kinetic} = \mu_k F_N$

Chapter 6 – Motion in Two Dimensions

Projectile Height $\Delta y = (v_i \sin\theta)t + \frac{1}{2}g\,t^2$

Projectile Range $\Delta x = (v_i \cos\theta)t$

Centripetal Acceleration $a_c = \frac{v^2}{r}$

Centripetal Force $F_c = m a_c = \frac{mv^2}{r}$

Relative Velocity

$$v_{a/b} + v_{b/c} = v_{a/c}$$

Chapter 7 - Gravitation

Kepler's 3rd Law $\left(\frac{T_A}{T_B}\right)^2 = \left(\frac{r_A}{r_B}\right)^3$

Law of Universal Gravitation $F = G\frac{m_1 m_2}{r^2}$

Period of Orbit $T = 2\pi\sqrt{\frac{r^3}{Gm_{central}}}$

Satellite Speed $v = \sqrt{\frac{Gm_{central}}{r}}$

Gravitational Field $g = \frac{GM}{r^2}$

Inertial Mass $m_{inertial} = \frac{F_{net}}{a}$

Gravitational Mass $m_{grav} = \frac{r^2 F_{grav}}{Gm}$

Solar System Data

Name	*Average Radius (m)*	*Mass (kg)*	*Mean Distance From Sun (m)*
Sun	6.96×10^8	1.99×10^{30}	—
Mercury	2.44×10^6	3.30×10^{23}	5.79×10^{10}
Venus	6.05×10^6	4.87×10^{24}	1.08×10^{11}
Earth	6.38×10^6	5.98×10^{24}	1.50×10^{11}
Mars	3.40×10^6	6.42×10^{23}	2.28×10^{11}
Jupiter	7.15×10^7	1.90×10^{27}	7.78×10^{11}
Saturn	6.03×10^7	5.69×10^{26}	1.43×10^{12}
Uranus	2.56×10^7	8.68×10^{25}	2.87×10^{12}
Neptune	2.48×10^7	1.02×10^{26}	4.50×10^{12}
Pluto	1.20×10^6	1.25×10^{22}	5.87×10^{12}

Physics I – Second Quarter Formulas

Chapter 8 – Rotational Motion

Angular Velocity
$$\omega = \frac{\Delta\theta}{\Delta t}$$

Angular Acceleration
$$\alpha = \frac{\Delta\omega}{\Delta t}$$

Torque
$$\tau = Fr\sin\theta$$

Linear Displacement
$$d = \theta r$$

Linear Velocity
$$v = \omega r$$

Linear Acceleration
$$a = \alpha r$$

Chapter 9 – Momentum

Momentum
$$p = mv$$

Impulse
$$Impulse = F\Delta t$$

Impulse-Momentum
$$F\Delta t = \Delta p = mv_f - mv_i$$

Cons. of Momentum (Elastic)
$$m_A v_{A,i} + m_B v_{B,i} = m_A v_{A,f} + m_B v_{B,f}$$

Cons. of Momentum (Inelastic)
$$m_A v_{A,i} + m_B v_{B,i} = (m_A + m_B) v_f$$

Conservation of Momentum (Recoil)
$$m_A v_{A,f} = -m_B v_{B,f}$$

Chapter 10 – Work and Energy

Kinetic Energy
$$KE = \tfrac{1}{2}mv^2$$

Work
$$W = Fd\cos\theta$$

Power
$$P = \frac{W}{\Delta t}$$

Work-Kinetic Energy Theorem
$$W = \Delta KE = \tfrac{1}{2}mv_f^2 - \tfrac{1}{2}mv_i^2$$

Chapter 11 – Conservation of Energy

Potential Energy
$$PE = mgh$$

Rest Energy
$$E_o = mc^2$$

Mechanical Energy
$$ME = KE + PE$$

Cons. of ME
$$\tfrac{1}{2}mv_i^2 + mgh_i = \tfrac{1}{2}mv_f^2 + mgh_f$$

Cons. of ME (v_i=0 and h_f=0)
$$v_f = \sqrt{2gh_i}$$

Chapter 12 – Thermal Energy

Specific Heat
$$Q = mC\Delta T = mC(T_f - T_i)$$

Latent Heat$_{Fusion}$
$$Q = mH_f$$

Latent Heat$_{Vaporization}$
$$Q = mH_v$$

Internal Energy
$$\Delta U = Q - W$$

Heat Engine Efficiency
$$eff = \left(1 - \frac{Q_{out}}{Q_{in}}\right) \times 100\%$$

Entropy
$$\Delta S = \frac{Q}{T_{Kelvins}}$$

°C → K
$$K = C + 273.15$$

°C → °F
$$F = \tfrac{9}{5}C + 32$$

°F → °C
$$C = \tfrac{5}{9}(F - 32)$$

Chapter 14 – Periodic Motion and Waves

Hooke's Law
$$F_{sp} = -kx$$

Spring PE
$$PE_{sp} = \tfrac{1}{2}kx^2$$

Pendulum Period
$$T = 2\pi\sqrt{\frac{l}{g}}$$

Frequency
$$f = \frac{1}{T}$$

Wave Velocity
$$v = f\lambda$$

Chapter 15 - Sound

Doppler Effect
$$f_{detected} = f_{source}\left(\frac{v - v_d}{v - v_s}\right)$$

Chapter 16 - Light

Illuminance
$$E = \frac{P}{4\pi r^2}$$

Speed of Light
$$c = f\lambda$$

Doppler Shift (frequency)
$$f_{obs} = f\left(1 \pm \frac{v}{c}\right)$$

Doppler Shift (wavelength)
$$\Delta\lambda = (\lambda_{obs} - \lambda) = \pm\frac{v}{c}\lambda$$

Chapter 20 – Electrostatics

Coulomb's Law
$$F_{electric} = k_c\frac{q_1 q_2}{r^2}$$

Chapter 21 – Electric Fields

Electric Field (test charge)
$$E = \frac{F_{on\,q'}}{q'}$$

Electric Field (central charge)
$$E = k_c\frac{q_{central}}{r^2}$$

Chapter 27 – Quantum Theory

Photon Energy
$$E = hf = \frac{hc}{\lambda}$$

Photoelectron Max KE
$$KE_{max} = hf - hf_0$$

De Broglie Wave
$$\lambda = \frac{h}{p} = \frac{h}{mv}$$

Chapter 30 – Nuclear Physics

Mass Defect Energy
$$E = mc^2$$

Half-Life (t half lives)
$$remaining = original\left(\frac{1}{2}\right)^t$$

Physics Quotes

"Research is what I'm doing when I don't know what I'm doing".
~Wernher Von Braun

"The scientist is not a person who gives the right answers; he's one who asks the right questions"
~Claude Lévi-Strauss

"If it's green or wriggles, it's biology.
If it stinks, it's chemistry.
If it doesn't work, it's physics."
~Handy Guide to Science

"All science is either physics or stamp collecting."
~Ernest Rutherford

"Gravity cannot be held responsible for people falling in love".

"Imagination is more important than knowledge".

"If we knew what it was we were doing, it would not be called research, would it?"
~Albert Einstein