

Formula Sheet: PHYS 221/221H

Vectors and math:

$$\vec{A} = A_x \hat{i} + A_y \hat{j} + A_z \hat{k} \quad \hat{A} = \vec{A} / A \quad d\vec{A} / dt = (dA / dt) \hat{A} + A(d\hat{A} / dt)$$

$$A = |\vec{A}| = \sqrt{A_x^2 + A_y^2 + A_z^2} \quad \vec{A} \cdot \vec{B} = AB \cos \theta = A_{\parallel B} B = AB_{\parallel A} = A_x B_x + A_y B_y + A_z B_z$$

$$\vec{A} \times \vec{B} = (A_y B_z - A_z B_y) \hat{i} + (A_z B_x - A_x B_z) \hat{j} + (A_x B_y - A_y B_x) \hat{k}$$

$$|\vec{A} \times \vec{B}| = AB \sin \theta = A_{\perp B} B = AB_{\perp A} \quad ax^2 + bx + c = 0 \Rightarrow x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$\sin(A \pm B) = \sin A \cos B \pm \sin B \cos A \quad \cos(A \pm B) = \cos A \cos B \mp \sin A \sin B$$

$$\frac{d}{dx} x^n = nx^{n-1} \quad \frac{d}{dx} \sin(ax + b) = a \cos(ax + b) \quad \frac{d}{dx} \cos(ax + b) = -a \sin(ax + b)$$

Geometry: Circle: Perimeter = $2\pi R$

Area = πR^2

Sphere: Surface area = $4\pi R^2$

Volume = $\frac{4}{3} \pi R^3$

Cylinder: Surface Area = $2\pi Rh + 2\pi R^2$

Volume = $\pi R^2 h$

1 revolution = 2π radians = 360°

Conversion factors:

1 yard = 3 feet = 36 inches

1 inch = 2.54 cm

1 cal = 4.186 J

1 mile = 1.609 km

1 lb = 4.448 N

1 food Cal = 1000 cal

1 gallon = 3.788 liters

1 m³ = 1000 liters

1 L · atm = 101.3 J

1 atm = 1.013×10^5 Pa = 760 mm Hg

Physical constants: $g = 9.81 \text{ m/s}^2$ $G = 6.67 \times 10^{-11} \text{ N} \cdot \text{m}^2/\text{kg}^2$ $M_E = 5.97 \times 10^{24} \text{ kg}$

$R_E = 6.38 \times 10^6 \text{ m}$ $R = 8.314 \frac{\text{J}}{\text{mol} \cdot \text{K}} = 0.08206 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}}$ $k = \frac{R}{N_A} = 1.381 \times 10^{-23} \text{ J/K}$

$N_A = 6.022 \times 10^{23} / \text{mol}$ $v_{\text{sound}(293)} = 343 \text{ m/s}$ at $T = 293 \text{ K}$ $\sigma = 5.67 \times 10^{-8} \text{ W/(m}^2 \cdot \text{K}^4)$

STP: 1 atm, 273.15 K

General kinematics: $\vec{v}_{\text{average}} = \frac{\Delta \vec{r}}{\Delta t}$ $\vec{v} = \frac{d\vec{r}}{dt}$ $\vec{a}_{\text{average}} = \frac{\Delta \vec{v}}{\Delta t}$ $\vec{a} = \frac{d\vec{v}}{dt}$

$$x(t) = x_0 + \int_0^t v_x(t') dt' \quad v_x(t) = v_{0x} + \int_0^t a_x(t') dt'$$

Constant acceleration:

$$\vec{r} = \vec{r}_0 + \vec{v}_0 t + \frac{1}{2} \vec{a} t^2$$

$$\vec{v} = \vec{v}_0 + \vec{a} t$$

$$v^2 - v_0^2 = 2 \vec{a} \cdot \Delta \vec{r}$$

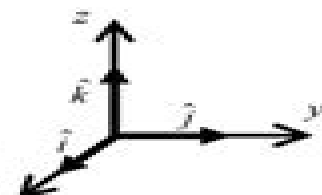
$$\vec{r} - \vec{r}_0 = \frac{1}{2} (\vec{v}_0 + \vec{v}) t$$

$$x = x_0 + v_{0x} t + \frac{1}{2} a_x t^2$$

$$v_x = v_{0x} + a_x t$$

$$v_x^2 - v_{0x}^2 = 2 a_x \Delta x$$

$$x - x_0 = \frac{1}{2} (v_{0x} + v_x) t$$



10^{-15}	femto- (f)
10^{-12}	pico- (p)
10^{-9}	nano- (n)
10^{-6}	micro- (μ)
10^{-3}	milli- (m)
10^{-2}	centi- (c)
10^3	kilo- (k)
10^6	mega- (M)
10^9	giga- (G)
10^{12}	tera- (T)

Lab Manual 221 Physics Iowa State University

Rosina Ehmman



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