# Exam Equation Sheet – Physics 3A (Bardoczi)

October 15, 2025

This sheet compiles all highlighted formulas from the lecture notes and will be provided on your midterms and final exam. You don't need to memorize them—only recognize and apply them. The sheet will expand as the course progresses.

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## Math Overview

### Vectors

$$\vec{A} = A_x\hat{i} + A_y\hat{j}$$
$$|\vec{A}| = \sqrt{A_x^2 + A_y^2}$$
$$A_x = |\vec{A}|\cos\theta$$
$$A_y = |\vec{A}|\sin\theta$$
$$\tan\theta = \frac{A_y}{A_x}$$
$$\vec{B} = B_x\hat{i} + B_y\hat{j}$$
$$\vec{A} + \vec{B} = (A_x + B_x, A_y + B_y)$$
$$\vec{A} \cdot \vec{B} = A_xB_x + A_yB_y = |\vec{A}||\vec{B}|\cos\phi$$

### Trigonometry

$$\sin\theta = \cos(90^\circ - \theta)$$
$$\cos\theta = \sin(90^\circ - \theta)$$
$$\sin(2\theta) = 2\sin\theta\cos\theta$$
$$F_x = |\vec{F}|\sin\theta$$
$$F_y = |\vec{F}|\cos\theta$$

### Geometry Essentials

$$c^2 = a^2 + b^2$$
$$C = 2\pi r; A = \pi r^2; s = r\theta$$
$$A = 4\pi r^2; V = \frac{4}{3}\pi r^3$$
$$V = \pi r^2 h$$

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## Diffusion and Proportional Reasoning

$$r_{\mathrm{rms}} = d\sqrt{mn}$$
$$r_{\mathrm{rms}}^2 = d^2mn$$
$$D = \tfrac{1}{2}vd$$
$$r_{\mathrm{rms}} = \sqrt{2mDt}$$

$$y = Cx$$
$$\frac{y_2}{y_1} = \frac{Cx_2}{Cx_1}$$

# Kinematics

$$\begin{aligned}
\Delta x &= v\Delta t \\
v_{\text{avg.}} &= \frac{\Delta x}{\Delta t} \\
a &= \frac{\Delta v}{\Delta t} \\
\Delta \vec{x} &= \tfrac{1}{2}\vec{a}t^2 + \vec{v}_0 t \\
\vec{v}_1 &= \vec{v}_0 + \vec{a}t \\
x(t) &= x_0 + vt \\
v(t) &= v_0 + at \\
x(t) &= x_0 + v_0 t + \frac{1}{2}at^2 \\
x(t) &= \int v(t)\,dt \\
v(t) &= \int a(t)\,dt \\
v(t) &= \frac{dx}{dt} \\
a(t) &= \frac{dv}{dt} \\
\frac{d}{dt}[t^n] &= nt^{n-1} \\
\int_{t_1}^{t_2} t^n\,dt &= \frac{t_2^{n+1} - t_1^{n+1}}{n+1} \\
y(t) &= v_{y0}t - \frac{1}{2}gt^2 \\
t_{\text{flight}} &= \frac{2v_{y0}}{g} \\
y_{\text{max}} &= \frac{v_{y0}^2}{2g} \\
x_{\text{final}} &= \frac{2v_{x0}v_{y0}}{g} \\
x_{1,2} &= \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \\
x_{\text{end}} &= \frac{v_{x0}}{g}\left(v_{y0} + \sqrt{v_{y0}^2 - 2gy_{\text{end}}}\right) \\
t_{\text{flight}} &= \frac{v_{y0} + \sqrt{v_{y0}^2 - 2gy_{\text{end}}}}{g} \\
v_y &= -\sqrt{v_{y0}^2 - 2gy_{\text{end}}}
\end{aligned}$$