

PHYSICS I: PRE – COURSE REVIEW

ALGEBRA

Simplifying Expressions

- Write long algebraic expressions in a simpler way by reducing the # of terms.

$$4x + 6 - 3(x + 2)$$

↓
Simplifies to
↓

EXAMPLE: Simplify the algebraic expression.

$$2x + 3 + 4(x + 2)$$

SIMPLIFYING ALG. EXPRESSIONS

- 1) Distribute constants/variables into parentheses (if any)
- 2) Group like terms by writing them next to each other
- 3) Combine like terms by adding/subtracting

Exponents in Expressions

- Exponents represent repeated multiplication.

$$\underbrace{4 \cdot 4 \cdot 4 \cdot 4 \cdot 4}_{5 \text{ times}} = 4^5 \quad \text{"4 to the 5th power"}$$

General Form of Exponents

$$\underbrace{a \cdot a \cdot \dots \cdot a \cdot a}_{n \text{ times}} = a^n$$

- Base**: Number and/or variable being multiplied
- Exponent** or **Power**: How many times the **base** is multiplied

EXPONENT RULES

Name	Example	Rule	Description
Product Rule	$4^2 \times 4^1 = 4^{\quad} = 4^{\quad}$	$a^m \times a^n = a^{m+n}$	Multiply same bases $\Rightarrow$ ADD exponents
Quotient Rule	$\frac{4^3}{4^1} = 4^{\quad} = 4^{\quad}$	$\frac{a^m}{a^n} = a^{m-n}$	Divide same bases $\Rightarrow$ SUBTRACT exponents
Zero Exp. Rule	$\frac{4^2}{4^2} = 4^0 = 1$	$a^0 = 1$	ANYTHING to <u>zero</u> exp. = 1
Neg. Exp. Rule	$\frac{4^1}{4^3} = 4^{-2} = \frac{1}{4^2}$	$a^{-n} = \frac{1}{a^n}$ OR $\frac{1}{a^{-n}} = a^n$	Neg exp in top $\rightarrow$ flip to BOTTOM with pos exp Neg exp in bottom $\rightarrow$ flip to TOP with pos exp
Power Rule	$(4^2)^3 = 4^{\quad} = 4^{\quad}$	$(a^m)^n = a^{m \cdot n}$	Power to another power $\rightarrow$ MULTIPLY exponents
Power of a Product	$(3 \cdot 4)^2$	$(a \cdot b)^m = a^m \cdot b^m$	Distribute exponent to each term in parentheses
Power of a Quotient	$\left(\frac{12}{4}\right)^2$	$\left(\frac{a}{b}\right)^m = \frac{a^m}{b^m}$	Distribute exponent to numerator & denominator

PHYSICS I: PRE – COURSE REVIEW

ALGEBRA

Solving Equations

- Use different operations (+, −, ×, ÷) to _____ x .
 - **ALWAYS** do operations to _____ sides of the equation.

EXAMPLE: Solve the equation.

$$2(x - 3) = 0$$

$$\frac{1}{4}x + 5 = -3$$

Simplifying
Algebraic
Expressions

SOLVING LINEAR EQUATIONS

- 1) Distribute constants
- 2) Combine like terms
- 3) Group terms w/ x & constants on opposite sides
- 4) Isolate / solve for x
- 5) Check solution by replacing x in original equation

Graphing

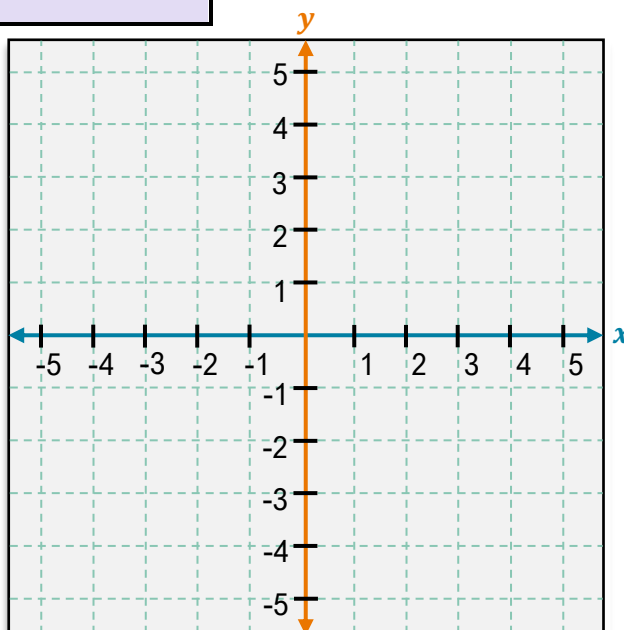
- Graphing in this course will usually involve plotting points/equations on the 2D/rectangular coordinate system.

GRAPHING EQ'NS BY PLOTTING POINTS

- 1) Isolate y to left side: $y = \dots$
- 2) Calculate y -values from 3-5 chosen x -values
- 3) Plot (x, y) points from Step 2
- 4) Connect points with line/curve

EXAMPLE: Graph $y = x^2 - 3x + 2$ by plotting points.

x	$y = x^2 - 3x + 2$	y	Ordered Pair
0	$(0)^2 - 3(0) + 2$	2	(,)
1	$(1)^2 - 3(1) + 2$	0	(,)
2	$(2)^2 - 3(2) + 2$	0	(,)
3	$(3)^2 - 3(3) + 2$	2	(,)
4	$(4)^2 - 3(4) + 2$	6	(,)



PHYSICS I: PRE – COURSE REVIEW

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Systems of Equations – Solving

- When you have multiple equations, find solution(s) that work for both by substituting one into the other.

EXAMPLE: Find (x, y) solutions that satisfy both equations.

(A) $y = 3x - 6$

$2x + y = 4$ **(B)**

SOLVING SYSTEMS OF EQ'NS BY SUBSTITUTING

1) Solve one EQ'n **(A)** for y (or var easiest to solve for).

2) Plug the right side of EQ'n **(A)** in for y in EQ'n **(B)**.

3) Solve the resulting EQ'n from **2)** for x (or other var.)

This is the _____ – value

4) Plug in x – value from **3)** into EQ'n **(A)** & solve for y .

This is the _____ – value

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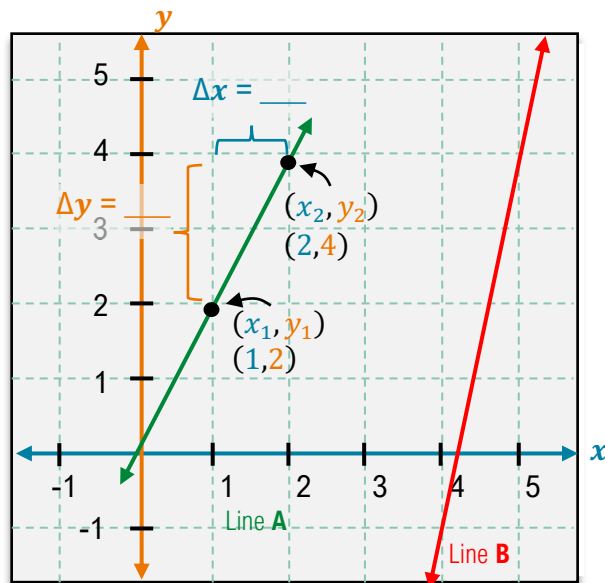
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Slopes of Lines

- **Slope:** A number representing how _____ a line is; how much **y changes** divided by how much **x changes**.

$$m = \frac{\text{rise}}{\text{run}} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{\Delta y}{\Delta x} \quad \Delta = \text{"change in"}$$

(x_2, y_2) & (x_1, y_1) are 2 points



EXAMPLE: Find the slopes of **Line A** and **Line B** in the graph.

Line A

$$\Delta y = \underline{\hspace{2cm}}$$

$$\Delta x = \underline{\hspace{2cm}}$$

$$m = \underline{\hspace{2cm}} = \underline{\hspace{2cm}}$$

Line B

$$\Delta y = \underline{\hspace{2cm}}$$

$$\Delta x = \underline{\hspace{2cm}}$$

$$m = \underline{\hspace{2cm}} = \underline{\hspace{2cm}}$$

Graphing Linear Equations

- A line equation in **Slope-Intercept** form tells you everything you need to graph it!

$$y = mx + b$$

(Slope – Intercept Form)

EXAMPLE: For the equation $y = 2x - 1$

(B) Identify the **y – intercept** & **slope**

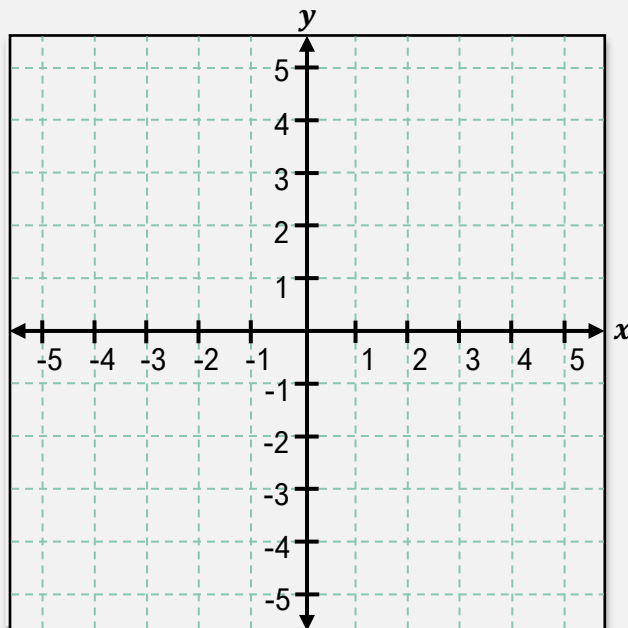
$$b = \underline{\hspace{2cm}}$$

$$m = \underline{\hspace{2cm}}$$

(C) Graph the equation.

Graphing Lines From Equations

- 1) Plot **y – intercept** $(0, b)$
- 2) Plot next point using **slope**
- 3) Connect points with a line



PHYSICS I: PRE – COURSE REVIEW

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Quadratic Equations – Solving

- Here are the two most common methods to solve quadratic equations in Physics:

SOLVING QUADRATIC EQUATIONS		
$ax^2 + bx + c = 0$ <i>(Standard Form)</i>		
	<u>SQ. ROOT PROPERTY</u>	<u>QUADRATIC FORMULA</u>
USE IF	$(x + \#)^2 = [\text{constant}]$ OR - No middle term ($b = 0$)	- Can't easily factor - Unsure what method to use
STEPS	- Isolate squared expression - Take + & – square root - Solve for x (Optional) Check solutions	- Write eq'n in standard form - Plug a, b, c in quad. form $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ - Compute & simplify solutions
EXAMPLE	$(x + 1)^2 = 4$	$x^2 + 2x - 3 = 0$

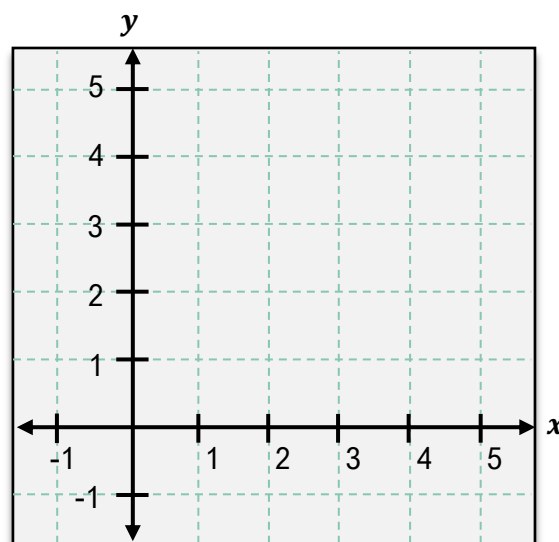
Quadratic Equations – Graphing

- In physics, you'll identify key info from the graphs of quadratic equations.

$$y = a(x - h)^2 + k$$

(Vertex Form)

$y = -(x - 1)^2 + 4$	
TO GRAPH	- Vertex (h, k): _____ [MIN MAX] - x-int(s) → Solve $y = 0$: _____ - y-int → Set $x = 0$: _____ - Connect with smooth curve
FROM GRAPH	Increasing when x _____ Decreasing when x _____



PHYSICS I: PRE – COURSE REVIEW

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Proportional Reasoning

- Many questions in physics will ask how a variable changes when another variable in the equation changes.

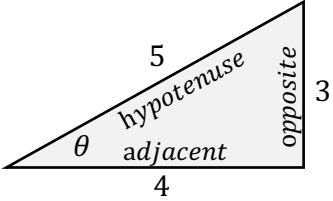
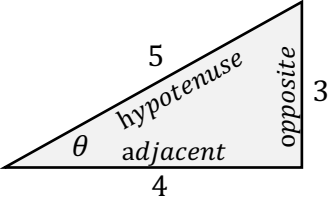
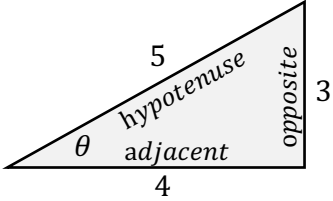
▪ **Proportional Reasoning:** Analyzing how one quantity increases or decreases with another

DIRECTLY PROPORTIONAL	INVERSELY PROPORTIONAL	JOINTLY PROPORTIONAL																																																						
$y = 2x$ <table><tr><th>x</th><th>y</th></tr><tr><td>2</td><td></td></tr><tr><td>1</td><td></td></tr><tr><td>0</td><td></td></tr><tr><td>-1</td><td></td></tr><tr><td>-2</td><td></td></tr></table> As $x \uparrow$, y ____ As $x \downarrow$, y ____	x	y	2		1		0		-1		-2		$y = \frac{1}{x}$ <table><tr><th>x</th><th>y</th></tr><tr><td>5</td><td></td></tr><tr><td>4</td><td></td></tr><tr><td>3</td><td></td></tr><tr><td>2</td><td></td></tr><tr><td>1</td><td></td></tr></table> As $x \uparrow$, y ____ As $x \downarrow$, y ____	x	y	5		4		3		2		1		$F = m \cdot a$ <table><tr><th>m</th><th>a</th><th>F</th></tr><tr><td>5</td><td>2</td><td></td></tr><tr><td>4</td><td>1</td><td></td></tr><tr><td>3</td><td>0</td><td></td></tr><tr><td>2</td><td>-1</td><td></td></tr><tr><td>1</td><td>-2</td><td></td></tr></table> As $m \uparrow$ & $a \uparrow$, F ____ As $m \downarrow$ & $a \downarrow$, F ____ For constant F , $m \uparrow$ & $a \downarrow$ For constant F , $m \downarrow$ & $a \uparrow$ <table><tr><th>m</th><th>a</th><th>F</th></tr><tr><td>1</td><td>20</td><td>20</td></tr><tr><td>2</td><td>10</td><td>20</td></tr><tr><td>4</td><td>5</td><td>20</td></tr></table>	m	a	F	5	2		4	1		3	0		2	-1		1	-2		m	a	F	1	20	20	2	10	20	4	5	20
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PHYSICS I: PRE – COURSE REVIEW

TRIGONOMETRY

- The functions Sine, Cosine, and Tangent relate angles & sides of a right triangle.

SINE (S.O.H.)	COSINE (C.A.H.)	TANGENT (T.O.A.)
 $\sin(\theta) = \text{---}$ $\sin(\theta) = \frac{\text{opp}}{\text{hyp}}$$\text{opp} = \text{hyp} \cdot \sin(\theta)$	 $\cos(\theta) = \text{---}$ $\cos(\theta) = \frac{\text{adj}}{\text{hyp}}$$\text{adj} = \text{hyp} \cdot \cos(\theta)$	 $\tan(\theta) = \text{---}$ $\tan(\theta) = \frac{\text{opp}}{\text{adj}}$

- Other helpful formulas:

$$a^2 + b^2 = c^2$$

(Pythagorean Theorem)

$$\sin^2(\theta) + \cos^2(\theta) = 1$$

$$\tan(\theta) = \frac{\sin(\theta)}{\cos(\theta)}$$

PHYSICS I: PRE – COURSE REVIEW

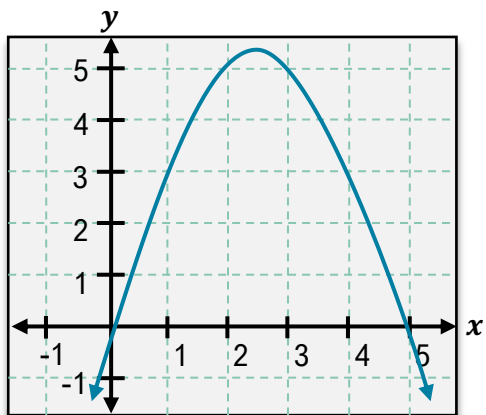
CALCULUS

Derivatives

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

(Slope)

- **Derivative** of a function = **Instantaneous** rate of change
 - Graphically represents the slope of a **tangent line** at a certain point (tangent lines touch the graph only once).



Common Derivatives

- To determine the *exact* derivative from a given equation or function, use the following rules:

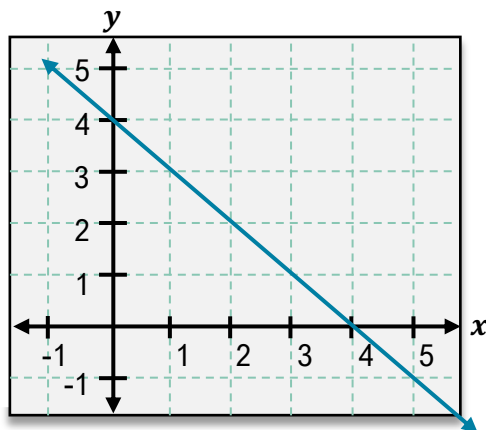
FUNCTION $f(x)$	DERIVATIVE $f'(x)$	EXAMPLE
$f(x) = c$ (constant)	$f'(x) = 0$	$f(x) = 3$ $f'(x) =$
$f(x) = c \cdot x$	$f'(x) = c$	$f(x) = -2x$: $f'(x) =$
$f(x) = x^n$	$f'(x) = nx^{n-1}$	$f(x) = x^2$ $f'(x) =$
$f(x) = g(x) + h(x)$	$f'(x) = g'(x) + h'(x)$	$f(x) = x^2 + 3x$ $f'(x) =$

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CALCULUS

Integrals

- Graphically, the **integral** of a function is the **area** under the curve.
 - You can approximate integrals by *adding* the areas of many rectangles under the curve.



Rules for Integrals

- Mathematically, integrals are the reverse of derivatives.
 - To determine *exact* integrals equations/functions, use the following rules:

$$\int_a^b f(x) = F(b) - F(a)$$

(Definite Integral)

FUNCTION $f(x)$	INTEGRAL $F(x) = \int f(x)$	EXAMPLE
$f(x) = c$ (constant)	$F(x) = cx + C$	$\int_1^3 3 =$
$f(x) = x^n$	$F(x) = \frac{x^{n+1}}{n+1} + C$	$\int_1^3 x^2 =$
$f(x) = cx^n$	$F(x) = c \cdot \frac{x^{n+1}}{n+1} + C$	$\int_1^3 -2x =$
$f(x) = g(x) + h(x)$	$F(x) = G(x) + H(x) + C$	$\int_1^3 x^2 + 2x =$