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.

$$\underbrace{4 \cdot 4 \cdot 4 \cdot 4 \cdot 4}_{5 \text{ times}} = 4^5$$

"4 to the 5th *power*"

General Form of Exponents
$\underbrace{a \cdot a \cdot \ldots \cdot a \cdot a}_{n \text{ times}} = a^n$

- **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	$4^2 \times 4^1 = 4^{\_\_\_\_} = 4^{\_\_}$	$a^m \times a^n = a^{m+n}$	*Multiply* ***same bases*** ⇒ **ADD** exponents
Quotient Rule	$\frac{4^3}{4^1} = 4^{\_\_\_\_} = 4^{\_\_}$	$\frac{a^m}{a^n} = a^{m-n}$	*Divide* ***same bases*** ⇒ **SUBTRACT** exponents
Zero Exp. Rule	$\frac{4^2}{4^2} = 4^0 = 1$	$a^0 = 1$	ANYTHING to *zero* 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*** → flip to **BOTTOM** with pos exp Neg exp in ***bottom*** → flip to **TOP** with pos exp
Power Rule	$(4^2)^3 = 4^{\_\_\_\_} = 4^{\_\_}$	$(a^m)^n = a^{m \cdot n}$	*Power* to another power → **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**

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ALGEBRA
Solving Equations

- Use different operations ($+$, $-$, $\times$, $\div$) to __________ $\boldsymbol{x}$.
  - ***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/ $\boldsymbol{x}$ & constants on opposite sides
4) Isolate / solve for $\boldsymbol{x}$
5) Check solution by replacing $\boldsymbol{x}$ in original equation

Graphing

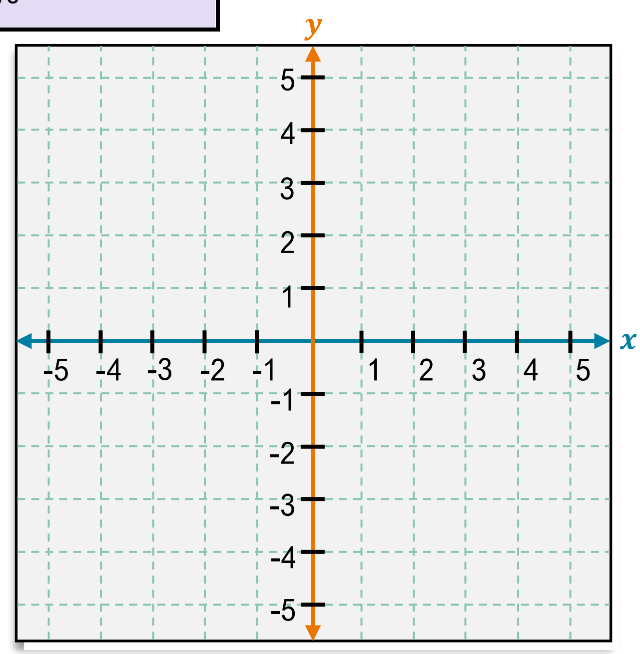
- Graphing in this course will usually involve *plotting* points/equations on the 2D/rectangular coordinate system.

GRAPHING EQ'NS BY PLOTTING POINTS

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

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

$\boldsymbol{x}$	$\boldsymbol{y=x^2-3x+2}$	$\boldsymbol{y}$	**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

ALGEBRA

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 $\boldsymbol{y}$ (or var easiest to solve for).
2) Plug the *right* side of EQ'n ***(A)*** in for $\boldsymbol{y}$ in EQ'n ***(B)***.
3) Solve the resulting EQ'n from **2)** for $\boldsymbol{x}$ (or other var.)
This is the _____ – value
4) Plug in $\boldsymbol{x}$ – value from **3)** into EQ'n ***(A)*** & solve for $\boldsymbol{y}$.
This is the _____ – value

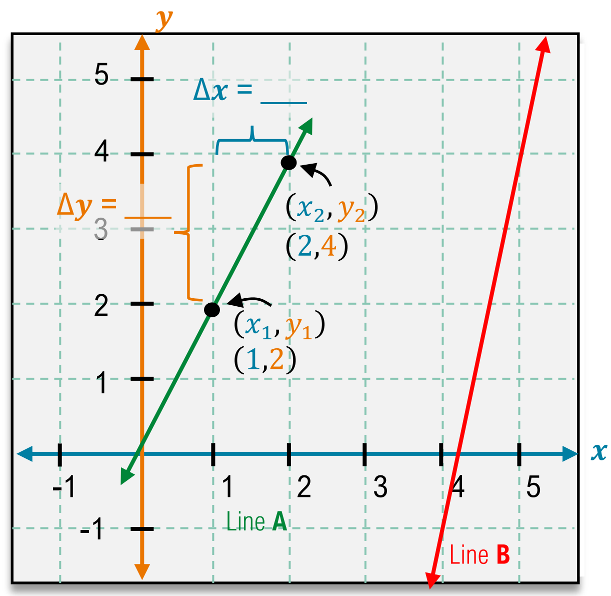
PHYSICS I: PRE – COURSE REVIEW
ALGEBRA
Slopes of Lines

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

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

Δ = "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

Δy = _______

Δx = _______

m = —— =

Line B

Δy = _______

Δx = _______

m = —— =

Graphing Linear Equations

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

$$y = mx + b$$

(Slope – Intercept Form)

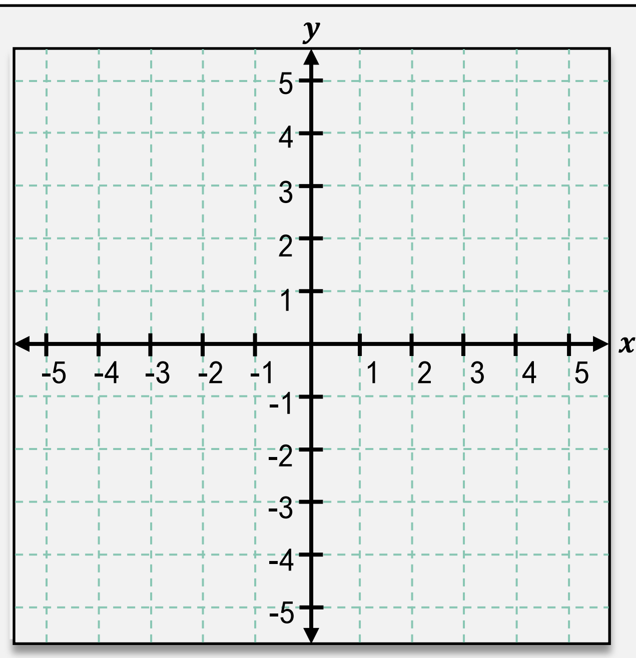
EXAMPLE: For the equation $y = 2x - 1$

(B) Identify the y – intercept & slope

b = ______

m = ______

(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

ALGEBRA

Quadratic Equations – Solving

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

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

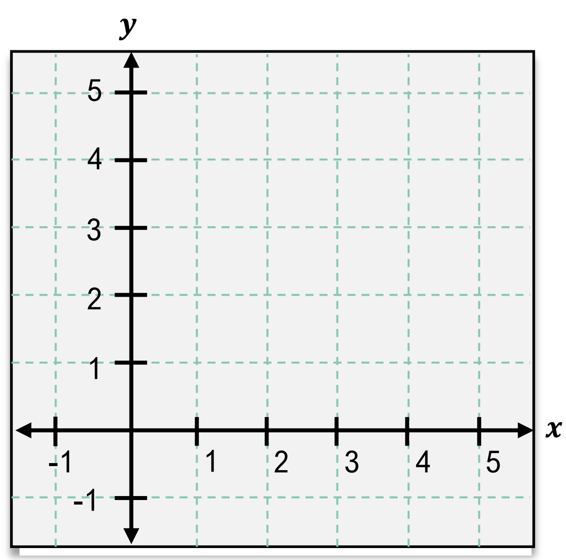
Quadratic Equations – Graphing

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

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

(*Vertex Form*)

	$\boldsymbol{y = -(x - 1)^2 + 4}$
TO GRAPH	**1)** Vertex (h, k): _______ [MIN | MAX] **2)** x-int(s)→ Solve y = 0: __________ **3)** y-int → Set x = 0: __________ **4)** Connect with smooth curve
FROM GRAPH	Increasing when x ______ Decreasing when x _______



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ALGEBRA

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

$$y = 2x$$

x	y
2	
1	
0	
-1	
-2	

As $x \uparrow$, y ____

As $x \downarrow$, y ____

INVERSELY PROPORTIONAL

$$y = \frac{1}{x}$$

x	y
5	
4	
3	
2	
1	

As $x \uparrow$, y ____

As $x \downarrow$, y ____

JOINTLY PROPORTIONAL

$$F = m \cdot a$$

m	a	F
5	2	
4	1	
3	0	
2	-1	
1	-2	

As $m \uparrow$ & $a \uparrow$, F ____

As $m \downarrow$ & $a \downarrow$, F ____

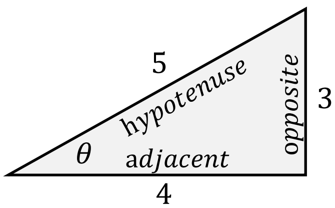
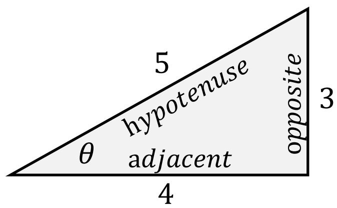
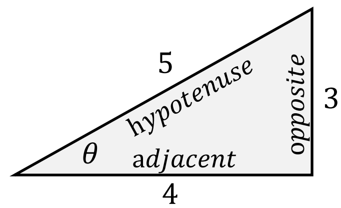
For constant F, $m \uparrow$ & $a \downarrow$

For constant F, $m \downarrow$ & $a \uparrow$

m	a	F
1	20	20
2	10	20
4	5	20

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.*)
		
$\sin(\theta) = \_\_\_\_$	$\cos(\theta) = \_\_\_\_$	$\tan(\theta) = \_\_\_\_$
$\sin(\theta) = \frac{opp}{hyp}$ $opp = hyp \cdot \sin(\theta)$	$\cos(\theta) = \frac{adj}{hyp}$ $adj = hyp \cdot \cos(\theta)$	$\tan(\theta) = \frac{opp}{adj}$

● Other helpful formulas:

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

(Pythagorean Theorem)

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

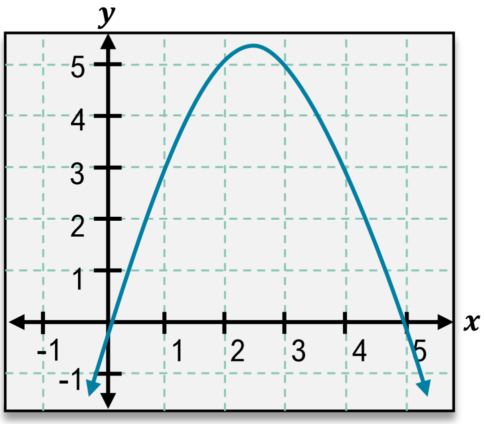
$$\tan(\theta) = \frac{\sin(\theta)}{\cos(\theta)}$$

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:

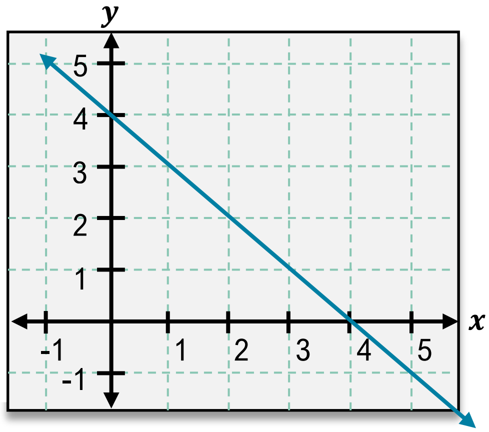
FUNCTION $f(x)$	DERIVATIVE $f'(x)$	EXAMPLE
$f(x) = c$ (constant)	$f'(x) = 0$	$f(x) = 3$ $f'(x) =$
$f(x) = c \cdot x$	$f'(x) = c$	$f(x) = -2x$: $f'(x) =$
$f(x) = x^n$	$f'(x) = nx^{n-1}$	$f(x) = x^2$ $f'(x) =$
$f(x) = g(x) + h(x)$	$f'(x) = g'(x) + h'(x)$	$f(x) = x^2 + 3x$ $f'(x) =$

PHYSICS I: PRE – COURSE REVIEW

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

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

(*Definite Integral*)

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

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