Name: _____

DUE: Tuesday, August 27, 2019

AP Physics 1

Ms. Christenson

Basic Math & Science Skills for Physics
REVIEW

In physics, we try to understand the relationships between the physical properties of objects and systems. We use mathematics to describe these relationships. So, while physics is not a math course, we do use math quite extensively. The following are representatives of the basic skills you will need to know to be successful in physics this year.

Directions: Answer each question below to the best of your ability. Please show your work in the space provided below each question and circle your final answers. Be sure to use units throughout your work and in final answers where necessary.

Skill 1 - Solving Equations

You will frequently need to manipulate an equation to solve for an unknown. Often the "givens" in AP Physics will not be numbers; rather they will be variables (letters). It is important that you know how to solve for any variable in an equation.

Example:

$$v_f = v_i + at^2$$

Solve the above equation above for t.

Answer:

$$t = \sqrt{\frac{v_f - v_i}{a}}$$

Directions: Solve the following equations for the variables listed below:

1. Solve for V_2. $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$$V_2 = \frac{P_1V_1T_2}{T_1P_2}$$

2. Solve for a. $y = V_0t + \frac{1}{2}at^2$

$$\frac{1}{2}at^2 = y - V_0t$$

$$a = \frac{2(y - V_0t)}{t^2}$$

3. Solve for L. $T = 2\pi\sqrt{\frac{L}{g}}$

$$T^2 = 4\pi^2 L/g$$

$$L = \frac{gT^2}{4\pi^2}$$

4. Solve for R_{eq}. $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$

$$\frac{1}{Req} = \frac{(R_2)\,1}{(R_2)\,R_1} + \frac{(R_1)\,1}{(R_1)\,R_2} = \frac{R_2 + R_1}{R_1R_2}$$

$$Req = \frac{R_1R_2}{R_2 + R_1}$$

5. Solve for r. $F = k\frac{Q_AQ_B}{r^2}$

$$r = \sqrt{\frac{kQ_AQ_B}{F}}$$

6. Solve for θ_2. $n_1 \sin\theta_1 = n_2 \sin\theta_2$

$$\sin\theta_2 = \frac{n_1 \sin\theta_1}{n_2}$$

$$\theta_2 = \sin^{-1}\left(\frac{n_1 \sin\theta_1}{n_2}\right)$$

Skill 2 - Describing Relationships

It is important that you understand what an equation **physically** means in this course. Therefore, you must be able to describe the relationships between given variables in a formula.

Example:

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

In the above equation, a_c equals the centripetal acceleration of an object moving in a circle with radius of r and moving around a circle with a tangential velocity of v.

(a) In the equation above, what is the relationship between centripetal acceleration and tangential velocity?

Answer: The centripetal acceleration of the object is directly proportional to the square of the object's tangential velocity. This means that the centripetal acceleration will increase as the tangential velocity increases.

(b) In the equation above, what is the relationship between centripetal acceleration and the radius of the circular path in which the object is traveling?

Answer: The centripetal acceleration of the object is inversely proportional to the radius of the circular path in which the object is traveling. This means that the centripetal acceleration will increase as the tangential velocity decreases.

Use the following for questions 7 – 9:

In the equation at the right, F equals the electric force between two charges placed a distance r apart. Q_A is the magnitude of the first charge, Q_B is the magnitude of the second charge and k is Coulomb's constant.

$$F = k\frac{Q_A Q_B}{r^2}$$

FYI: this symbol ∝ means "directly proportional to"

7. In the equation above, what is the relationship between the electric force and Coulomb's constant?

The electric force is directly proportional to Coulomb's Constant. This means that if k increased, F would also increase. $F \propto k$

8. In the equation above, what is the relationship between the electric force and the distance between the charges?

The electric force is inversely proportional to square of the distance between the charges. This means that as r increases, F decreases. $F \propto 1/r^2$

9. In the equation above, what is the relationship between the electric force and the magnitude of the first charge?

The electric force is directly proportional to the magnitude of the first charge. This means that if the size of Q_A increases, the F increases. $F \propto Q_A$

Skill 3 - Dimensional Analysis

It is important that you understand how to convert from one unit to another using conversion factors. You must know metric prefixes in order to do this. I have provided reference sheets in your summer work folder in case you have forgotten these.

Example:

Ex. How many centimeters are in 0.098 kilometers?

Answer:

100 cm = 1 m

1 km = 1000 m

$$\frac{0.098\cancel{km}}{1} \times \frac{1000\cancel{m}}{1\cancel{km}} \times \frac{100cm}{1\cancel{m}} = 9800cm$$

10. How many seconds are in 28 hours?

$$28\,\cancel{hrs} \times \frac{60\,\cancel{min}}{1\,\cancel{hrs}} \times \frac{60\,sec}{1\,\cancel{min}} = 100{,}800\,s$$

11. How many kiloliters are in 12,500 mL?

$$12{,}500\,\cancel{mL} \times \frac{1\,L}{1000\,\cancel{mL}} \times \frac{1\,kL}{1\,L} = 0.0125\,kL$$

12. Convert 45 km/hr to m/s.

$$\frac{45\,\cancel{km}}{1\,\cancel{hr}} \times \frac{1\,\cancel{hr}}{3600\,s} \times \frac{1000\,m}{1\,\cancel{km}} = 12.5\,m/s$$

Skill 4 - Scientific Notation

Scientific Notation - Part A: There are things in physics that are very, very large (like the mass of a planet in kilograms, for example) or very, very small (like the mass of an electron in kilograms, for example). You must be able to recognize that a number is in scientific notation and know how to deal with it.

*means the number before x10 must be between 1 and 10.

13. The following numbers are in scientific notation. Express them in standard notation.

+ exponent! move to the right

A. 6.370×10^{4} mg

63700 mg

− exponent! move to the left

B. 4.2×10^{-2} m

0.042 m

14. The following numbers are in standard notation. Express them in proper scientific notation.

A. 0.0000015 g

1.5×10^{-6} g

B. 763,420,000 cm

7.6342×10^{8} cm

Scientific Notation - Part B: You will be required to use scientific notation in calculations. *Hint: I am sure you have learned the "tricks" for multiplying and dividing exponents in math class... You may use those "tricks" here.*

15. Add or subtract as indicated.

A. 3.2×10^{5} cm + 4.8×10^{5} cm

3.2×10^{5} cm
+ 4.8×10^{5} cm

8.0×10^{5} cm

B. 3.29×10^{5} g - 2.8×10^{4} g

*bases must be the same to add or subtract!

$2.8 \times 10^{4} \rightarrow 0.28 \times 10^{5}$

3.29×10^{5} g
− 0.28×10^{5} g

3.01×10^{5} g

16. Multiply or divide as indicated.

A. $(4.0 \times 10^{-8}\text{cm}) \times (2.0 \times 10^{5}\text{cm})$

$4.0 \times 2.0 = 8.0$

*trick: When multiplying, ADD exponents!

$10^{(-8)} \times 10^{(5)}$

$-8+5=-3$, so

$8.0 \times 10^{-3}\text{cm}^2$

B. $(9.0 \times 10^{7}\text{m}) / (3.0 \times 10^{3}\text{s})$

$9.0/3.0 = 3.0$

*trick: when dividing, SUBTRACT exponents!

$10^{7} / 10^{3}$

$7-3=4$, so

3.0×10^{4} m/s

* be careful of order... subtract bottom from top!

Skill 5 - Significant Figures

Significant Figures - Part A: You must know what significant figures are and how to determine the number of significant figures in a measurement. I have included the rules for determining the number of sig figs in a measurement below in case you have not encountered this in any of your math or science classes yet.

READ THIS! →

What are significant figures?

In scientific work, all numbers are assumed to be derived from measurements and, therefore, the last digit in each number is uncertain. All certain digits plus the first uncertain digit are significant figures. Only numbers determined by definition or by counting are exact. Numbers determined by definition or counting are said to have an infinite number of significant figures.

Four Rules for Determining the Number of Sig Figs in a Measurement:

1. **Nonzero digits are always significant.** *(Ex. There are 3 sig figs in 568 cm and 2 sig figs in 1.4 seconds.)*
2. **All final zeros after a decimal point are significant.** *(Ex. There are 4 sig figs in 2.300 sec.)*
3. **Zeros between two other significant digits are always significant.** *(Ex. There are 3 sig figs in 203 m/s and 4 sig figs in 2.002 cm.)*
4. **Zeros solely used a placeholders are NOT significant.** *(Ex. There are 2 sig figs in 26,000 grams and only 1 sig fig in 0.000005 km)*

State the number of significant figures in each measurement:

17. 1405 kg 4

18. 0.0034 m 2

19. 5.80×10^6 kg 3

Significant Figures - Part B: You must know how to determine the number of significant figures that should be in your answer.

Rules for Determining the Number of Sig Figs in an Answer When Adding and/or Subtracting:

1. Determine the **precision** of each measurement. (Precision means how many places after the decimal for each measurement. Ex. 1.0 = one decimal place, 1.12 = two decimal places)
2. Make a note of the lowest number of decimal places. This is the least precise measurement.
3. Now add or subtract the measurements.
4. Round your answer so that it matches the precision of the measurement with the lowest number of decimal places.

Ex.
Add 1.02 s + 0.0003 s + 26.022 s = ?

1.02 has 2 decimal places

0.0003 has 4 decimal places

26.022 has 3 decimal places

So, 1.02 s is the least precise with only two decimal places - our answer must match this.

Add to find the answer:

1.02 s + 0.0003 s + 26.022 s = *27.0423 s*

Round to two decimal places:

So, our answer with the correct amount of sig figs is

27.04 s

Rules for Determining the Number of Sig Figs in an Answer When Multiplying and/or Dividing:

1. Determine the **# of sig figs** in each measurement. (Use the rules above.)
2. Make a note of the lowest number of sig figs.
3. Now multiply or divide the measurements.
4. Round your answer so that it has the same number of sig figs as the measurement with the least amount.

Ex.
Multiply 1.02 m x 0.0003 m x 26.022 m = ?

1.02 has 3 sig figs

0.0003 has 1 sig fig

26.022 has 5 sig figs

Note the lowest amount of sig figs: 1 sig fig

Multiply to find the answer:

1.02 m x 0.0003 m x 26.022 m = *0.007962732 m^3*

Round so that the answer only has 1 sig fig:

So, our answer with the correct amount of sig figs is

0.008 m^3

Perform the following operations. Use the correct number of significant figures in your answers.

Adding only - use precision rule!

20. (9.2 cm) + (0.0080 cm) + (8.30 cm)
1dp 4dp 2dp

17.5080 cm

* round to 1 decimal place

(17.5 cm)

mult/div - use sig. fig. rule!

21. 60.000 g ÷ (2.000 m x 3.00 m x 1.000 m)
5 sf 4sf 3sf 4sf

10 g/m³

* round to 3 sig. figs

(10.0 g/m³)

Skill 6 – Trigonometry

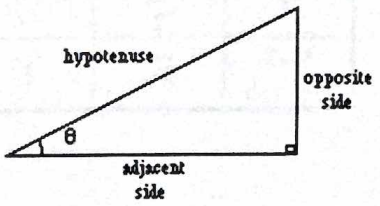
Not everything in physics is simply straight up and down or left and right. In the real world, we need to deal with angles. This is where trigonometry and the Pythagorean Theorem come in handy. I have the basics below in case you have not done this in your math classes yet.

There are 3 trig functions that you will use on a regular basis in physics problems: **sine**, **cosine** and **tangent**. An easy way to remember them is by using "SOH CAH TOA" Note: (See below) the opposite side is the side opposite the reference angle θ; the hypotenuse is the longest side opposite the right angle. The adjacent side is the one that makes up part of the reference angle θ and is not the hypotenuse.

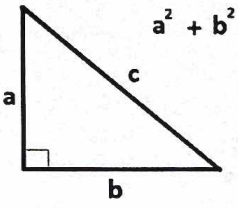
SOH $\sin\theta = \frac{\text{opposite}}{\text{hypotenuse}}$

CAH $\cos\theta = \frac{\text{adjacent}}{\text{hypotenuse}}$

TOA $\tan\theta = \frac{\text{opposite}}{\text{adjacent}}$

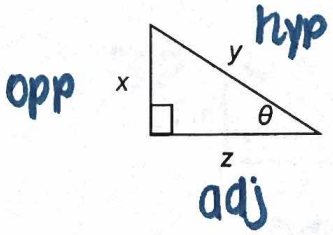


The **Pythagorean Theorem** is another formula that you will use frequently in physics. $a^2 + b^2 = c^2$



SOH CAH TOA !

22. For the triangle below, find:



A. $\sin\theta = \frac{x}{y}$

B. $\cos\theta = \frac{z}{y}$

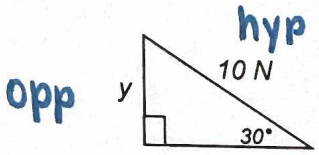
C. $\tan\theta = \frac{x}{z}$

Use the following trig table to answer questions 23+24. Do not use a calculator.

Ex. from table: sin(90) = 1

θ	0°	30°	45°	60°	90°
$\sin\theta$	0	$\frac{1}{2}$	$\frac{1}{\sqrt{2}}$	$\frac{\sqrt{3}}{2}$	1
$\cos\theta$	1	$\frac{\sqrt{3}}{2}$	$\frac{1}{\sqrt{2}}$	$\frac{1}{2}$	0
$\tan\theta$	0	$\frac{1}{\sqrt{3}}$	1	$\sqrt{3}$	Not defined

23. Calculate the value of *y* in the triangle below.



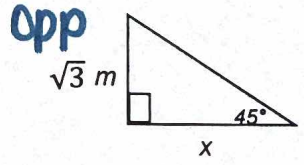
SOH $\quad \sin 30 = \frac{y}{10N}$

$y = 10N \cdot \sin 30$ ← use table above

$y = (10N)(0.5)$

$y = 5N$

24. Calculate the value of *x* in the triangle below.



adj

TOA

$\tan 45 = \frac{\sqrt{3}}{x}$

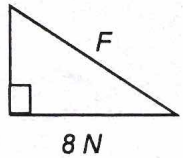
$x = \frac{\sqrt{3}}{\tan 45} = \frac{\sqrt{3}}{1}$

↑ use table above ↗

$x = \sqrt{3}$

*if you know about special triangles, this should make sense

25. Calculate the value of *F* in the triangle below.



2 sides are known!

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

pythagorean theorem!

$F^2 = (6N)^2 + (8N)^2$

$F^2 = 100N^2$

$F = \sqrt{100N^2}$

$F = 10N$