AP® Physics 2 Information & Summer Assignment 2017

Introduction

Welcome to Mr. Bigler's AP® Physics 2 course. It is my hope that you will find course to be fun and rewarding.

If you are coming into AP® Physics 2 from AP® Physics 1, you will probably find this year's course to be a little less stressful, because there are fewer topics and because the topics in AP® Physics 2 overlap much less than the topics in AP® Physics 1. This means that AP® Physics 2 problems will for the most part be less complex than the worst of the AP® Physics 1 problems. However, each individual topic is more complex than those in AP® Physics 1, and it will be more challenging to figure out which equations to apply and how to apply them than in AP® Physics 1.

If you are coming into AP® Physics 2 from regular Physics 1, you will find the complexity of the problems and the math required to be a significant step up from regular Physics 1. I will do as much as I can to help you with the problem solving and the math, but you should expect a significant increase in the level of challenge.

Course & Contact Information

Course information: http://www.mrbigler.com/AP-Physics-2

Mr. Bigler's email: biglerj@lynnschools.org, mrbigler@mrbigler.com

You can download just about everything you need (including replacement copies of this summer assignment and reference tables) from the website. I will read and respond to email sent to either address throughout the summer and the school year.

About the Summer Assignment

The goal of this summer assignment is to mostly cover the AP® Physics 2 topic fluid mechanics (which was covered toward the end of the year in Physics 1) by the end of summer, in order to make the schedule for the rest of the year less frantic. These problems are due on **Monday September 11, 2017**.* If you do not complete the assignment, *I reserve the right to contact your guidance counselor and recommend that you be switched out of the class*.

* If the class does not meet on that day, the assignment will be due on the next class day. For students who switch into AP® Physics 2 after the last day of the 2016–17 school year, the assignment will be due two weeks later.

Required Supplies

The following supplies are required for AP® Physics 2:

- **Scientific or graphing calculator**. A $15 scientific calculator is sufficient. If you already have a graphing calculator, you can use it.
- **Laboratory notebook**. This must be a composition book *with graph paper pages*. They cost about $1.50–2.00 from stationery stores. (Students in past years have used lab notebooks without graph paper pages, and have lost points as a result of not plotting graphs accurately on graph paper.)

Recommended Supplies

I recommend the following supplies for AP® Physics 2:

- **AP® Physics 2 Class Notes**. These are the same notes that I will project on the SMART board and use in class. These will be revised over the summer and available for download and/or purchase in the fall. You can download an electronic copy (PDF) for free from my website. Most of my former students highly recommend purchasing a printed copy, so you can write directly in it throughout the year and take it with you when you go to college. Look for the heading "AP® Physics 2 Class Notes" on the class web page, and follow the links for the electronic version and/or the print version.
- **5 Steps to a 5 AP® Physics 2 exam review book**. This is an excellent book with short reviews of each topic and sample questions. I have copies to issue, but if you want to write in yours and keep it, you can buy one for about $10.
- **500 AP® Physics 2 Questions to Know by Test Day.** This book contains AP questions from every topic, and will be a valuable review for tests during the year as well as the AP exam. I have copies to issue, but if you want to write in yours and keep it, you can buy one for about $10.
- ***Physics Fundamentals* textbook**, by Vincent P. Coletta. This is an optional textbook, which you can use to supplement the class notes and discussion. I can issue you a book if you want to sign one out. You can also download a PDF version of the book for free by following the link from the class web page. The username is my last name, and the password is my favorite phrase (all lower case, and including the space).
- ***The Cartoon Guide to Physics***, by Larry Gonick and Art Huffman. This book is an easy read and it provides excellent visual explanations of the topics in AP® Physics 2.

Warning about Copying and Other Forms of Cheating

Almost all students copy homework assignments, tests, and anything else they can get away with from each other and from the Internet. AP students do this *more* than most, because grade-wise, you have the most at stake. However, the more you cheat, the more you limit your learning to only low-level application of equations. If you get through the year by copying from other students or the Internet, it is virtually certain that you will get a 1 on the AP exam, and you will complain that you learned nothing from your AP® Physics 2 class.

If I catch you cheating or plagiarizing on a test or major assignment, a parent or legal guardian will have to give me permission to let you re-take the test or re-submit the assignment (in either case, for reduced credit). You will not be allowed to re-take or re-submit until I have a voice conversation (either by phone or in person) with your parent or guardian first.

Note that, as with college courses, knowingly *or unknowingly* allowing someone to copy your work and submit it as their own is also considered cheating, and will incur the same penalty. It is *your responsibility* to protect your work and prevent others from copying it.

Summer Assignment Part 1: Problems

These problems are from the fluids section of my class notes. You probably did most or all of these problems at the end of the 2016–17 school year. Because the answers are provided, you need to show work to get credit.

Pressure

1. A person wearing snow shoes does not sink into the snow of the tundra, whereas the same person without snow shoes sinks into the snow. Explain.

2. A carton of paper has a mass of 22.7 kg. The area of the bottom is 0.119 m^2. What is the pressure between the carton and the floor?

   Answer: 1 908 Pa

3. A 1000 kg car rests on four tires, each inflated to 2.2 bar. What surface area does *each* tire have in contact with the ground? (Assume the weight is evenly distributed on each wheel.)

   Answer: 0.011 4 m^2

4. A student with a mass of 50. kg is lying on the floor of the classroom. The area of the student that is in contact with the floor is 0.6 m^2. What is the pressure between the student and the floor? Express your answer both in pascals and in bar.

   Answer: 833 Pa or 0.00833 bar

5. The same student, with a mass of 50 kg, is lying on a single nail, with a point that has a cross-sectional area of $0.1\,\text{mm}^2 = 1\times 10^{-7}\ \text{m}^2$. What is the pressure (in bar) that the student exerts on the head of the nail?

   Answer: 5×10^9 Pa = 50 000 bar

6. The same student, with a mass of 50 kg, is lying on a bed of nails of the same size as in question #5 above. If the student is in contact with 1 800 nails, what is the pressure (in bar) between the student and each nail?

   Answer: 28 bar

Hydraulic Pressure

7. A student who weighs 700. N stands on a hydraulic lift. The lift has a lever, which you push down in order to lift the student. The cross-sectional area of the piston pressing on the fluid under the student is 1 m^2, and the cross-sectional area of the piston pressing on the fluid under the lever is 0.1 m^2. How much force is needed to lift the student?

   Answer: 70 N

8. Mr. Bigler's hovercraft is made from a circle of plywood and a wet/dry vacuum cleaner. The nozzle of the vacuum cleaner where the air comes out has a cross-sectional area of $5\times 10^{-4}\ \text{m}^2$ and applies a force of 7.5 N. The radius of the plywood base is 0.5 m. How much weight (in newtons) can the hovercraft theoretically lift?

   Answer: 11 780 N (That's more than 2 600 lbs.!)

Hydrostatic Pressure

For all problems, assume that the density of fresh water is $1000\,\frac{\text{kg}}{\text{m}^3}$.

9. A diver dives into a swimming pool and descends to a maximum depth of 3.0 m. What is the pressure on the diver due to the water at this depth? Give your answer in both pascals (Pa) and in bar.

   Answer: 30 000 Pa or 0.3 bar

10. The wet/dry vacuum cleaner that Mr. Bigler used for his hovercraft can apply a suction force of 7.5 N through a nozzle that has a cross-sectional area of $5\times 10^{-4}\ \text{m}^2$.

    a. How much pressure can the vacuum cleaner apply?

       Answer: 15 000 Pa

    b. If you want to use the vacuum cleaner to vacuum up water from your basement, what is the maximum height above the water level that this vacuum cleaner can operate?

       Answer: 1.5 m

11. A standard water tower is 40 m above the ground. What is the resulting water pressure at ground level? Express your answer in pascals, bar, and pounds per square inch. (1 bar = 14.5 psi)

    Answer: 400 000 Pa, 4 bar, or 58.8 psi

Buoyancy

12. A block is 0.12 m wide, 0.07 m long and 0.09 m tall and has a mass of 0.50 kg. The block is floating in water with a density of $1000\,\frac{\text{kg}}{\text{m}^3}$.

    a. What volume of the block is below the surface of the water?

       Answer: $5\times10^{-4}\ \text{m}^3$

    b. If the entire block were pushed under water, what volume of water would it displace?

       Answer: $7.56\times10^{-4}\ \text{m}^3$

    c. How much additional mass could be piled on top of the block before it sinks?

       Answer: 0.256 kg

13. An empty box is 0.11 m per side. It will slowly be filled with sand that has a density of $3500\,\frac{\text{kg}}{\text{m}^3}$. What volume of sand will cause the box to sink in water? (Assume water has a density of $1000\,\frac{\text{kg}}{\text{m}^3}$. You may neglect the weight of the box.)

    Answer: $3.80\times10^{-4}\ \text{m}^3$

Gas Laws

For these problems, note that the gas constant $R = 8.31\,\frac{\text{J}}{\text{mol}\cdot\text{K}}$ and that 1 bar = 100 000 Pa.

14. A sample of 1 mole of oxygen at 50.0°C and 98 600 Pa occupies what volume?

    Answer: 0.0272 m^3

15. A gas cylinder with a volume of 0.0045 m^3 contains 80 moles of argon gas at a temperature of 25.0°C.

    a. What is the pressure in the gas cylinder?

       Answer: 440 bar

    b. If the cylinder is rated for a maximum pressure of 500. bar, what is the maximum safe temperature at which it can be stored?

       Answer: 338 K or 65°C

16. A sample of oxygen gas occupies a volume of 0.250 m^3 at a pressure of 1.75 bar. What volume will it occupy at 2.50 bar?

    Answer: 0.175 m^3

17. H_2 gas was cooled from 150.°C to 50.°C. Its new pressure is 75 000 Pa. What was its original pressure?

    Answer: 98 220 Pa

18. A scuba diver's 10. L air tank is filled to a pressure of 210 bar at a dockside temperature of 32.0°C. The water temperature is 8.0°C, the diver is swimming at a depth of 11.3 m, and the barometric (atmospheric) pressure is 1.013 bar. The density of sea water is $1025\,\frac{\text{kg}}{\text{m}^3}$.

    a. What is the gauge pressure on the diver?

       Answer: 115 825 Pa or 1.16 bar

    b. How many liters of air does the diver use?

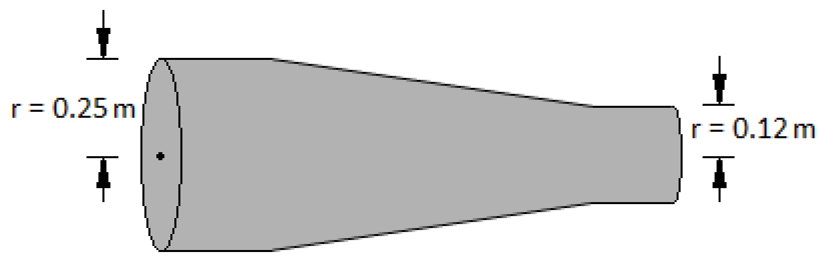
       Answer: 1 670 L

    c. If the diver uses air at the rate of 20. L/min., how long will the diver's air last?

       Answer: 83.5 min.

Bernoulli's Law

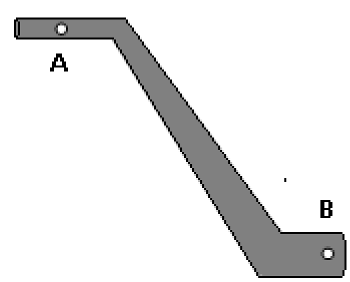
19. A pipe has a radius of 0.25 m at the entrance and a radius of 0.12 m at the exit, as shown in the figure below:



    If the fluid in the pipe is flowing at $5.2\,\frac{\text{m}}{\text{s}}$ at the inlet, then how fast is it flowing at the outlet?

    Answer: $22.6\,\frac{\text{m}}{\text{s}}$

20. At point A on the pipe to the right, the water's speed is $4.8\,\frac{\text{m}}{\text{s}}$ and the pressure is 52.0 kPa. The water drops 14.8 m to point B, where the pipe's cross sectional area is twice that at point A.



    a. Calculate the velocity of the water at point B.

       Answer: $2.4\,\frac{\text{m}}{\text{s}}$

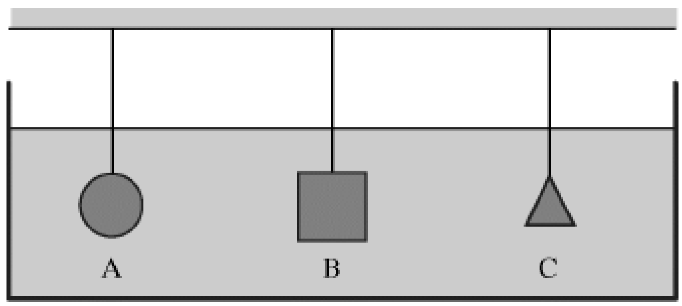
    b. Calculate the pressure at point B.

       Answer: 208 640 Pa or 208.6 kPa

Summer Assignment Part 2: AP Problems

These two fluids problems have appeared on past AP® Physics exams. Please attempt to solve them yourself. (The purpose of the summer assignment is to get your brain back into the mindset of dealing with AP® problems. If you simply copy the answers from the Internet, the assignment will fail to achieve its goal, and ultimately so will you.)

1. Three objects that have identical masses are attached to strings and suspended in an unknown liquid, as shown below. Object A is a sphere; object B is a cube, and object C is a tetrahedron (triangular pyramid).



(Assume that the picture is drawn to scale; the objects do not necessarily have the same volumes.)

a. Must all three strings have the same tension? Justify your answer.

Object A has a volume of $1.0 \times 10^{-5}\ \text{m}^3$ and a density of $1300\ \frac{\text{kg}}{\text{m}^3}$. The tension in the string to which object A is attached is 0.0098 N.

b. Calculate the buoyant force on object A.
c. Calculate the density of the liquid.

Some of the liquid is now removed from the tank, until only half of object A is submerged.

d. What happens to the tension in the string to which object A is attached? Does it increase, decrease, or remain the same? Justify your answer.

2. A diver descends to the ocean floor at a depth of 35 m below the surface. The density of ocean water is $1025\,\frac{\text{kg}}{\text{m}^3}$.

    a. Calculate the gauge pressure on the diver on the ocean floor.

    b. Calculate the absolute pressure on the diver on the ocean floor.

    The diver finds a rectangular aluminum plate having dimensions 1.0 m × 2.0 m × 0.03 m. A hoisting cable is lowered from the ship and the diver connects it to the plate. The density of aluminum is $2700\,\frac{\text{kg}}{\text{m}^3}$. You may ignore the effects of viscosity.

    c. Calculate the tension in the cable if it lifts the plate upward at a slow, constant velocity.

    d. Will the tension in the hoisting cable increase, decrease, or remain the same if the plate accelerates upward at $0.05\,\frac{\text{m}}{\text{s}^2}$? Explain your reasoning.

ADVANCED PLACEMENT AP® PHYSICS 2 EQUATIONS, EFFECTIVE 2016

CONSTANTS AND CONVERSION FACTORS			
Proton mass,	$m_p = 1.67\times10^{-27}$ kg	Electron charge magnitude,	$e = 1.60\times10^{-19}$ C
Neutron mass,	$m_n = 1.67\times10^{-27}$ kg	1 electron volt,	$1\text{ eV} = 1.60\times10^{-19}$ J
Electron mass,	$m_e = 9.11\times10^{-31}$ kg	Speed of light,	$c = 3.00\times10^{8}\ \text{m/s}$
Avogadro's number,	$N_o = 6.02\times10^{23}\ \text{mol}^{-1}$	Universal gravitational constant,	$G = 6.67\times10^{-11}\ \text{m}^3/\text{kg}\cdot\text{s}^2$
Universal gas constant,	$R = 8.31\ \frac{\text{J}}{\text{mol}\cdot\text{K}}$	Acceleration due to gravity at Earth's surface,	$g = 9.8\ \text{m/s}^2$
Boltzmann's constant,	$k_B = 1.38\times10^{-23}\ \frac{\text{J}}{\text{K}}$		

1 unified atomic mass unit,	$1\text{ u} = 1.66\times10^{-27}\text{ kg} = 931\ \frac{\text{MeV}}{c^2}$
Planck's constant,	$h = 6.63\times10^{-34}\text{ J}\cdot\text{s} = 4.14\times10^{-15}\text{ eV}\cdot\text{s}$
	$hc = 1.99\times10^{-25}\text{ J}\cdot\text{m} = 1.24\times10^{-3}\text{ eV}\cdot\text{nm}$
Vacuum permittivity,	$\varepsilon_o = 8.85\times10^{-12}\ \frac{\text{C}^2}{\text{N}\cdot\text{m}^2}$
Coulomb's law constant,	$k = 1/4\pi\varepsilon_o = 9.0\times10^{9}\ \frac{\text{N}\cdot\text{m}^2}{\text{C}^2}$
Vacuum permeability,	$\mu_o = 4\pi\times10^{-7}\ \frac{\text{T}\cdot\text{m}}{\text{A}}$
Magnetic constant,	$k' = \mu_o/4\pi = 1\times10^{-7}\ \frac{\text{T}\cdot\text{m}}{\text{A}}$
1 atmosphere pressure,	$1\text{ atm} = 1.0\times10^{5}\ \frac{\text{N}}{\text{m}^2} = 1.0\times10^{5}\text{ Pa}$

UNIT SYMBOLS								
	meter,	m	mole	mol	watt,	W	farad,	F
	kilogram,	k	hertz,	Hz	coulomb,	C	tesla,	T
	second,	s	newton,	N	volt,	V	degree Celsius,	°C
	ampere,	A	pascal,	Pa	ohm,	Ω	electron volt,	eV
	kelvin,	K	joule,	J	henry,	H		

PREFIXES

Factor	Prefix	Symbol
10^{12}	tera	T
10^{9}	giga	G
10^{6}	mega	M
10^{3}	kilo	k
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p

VALUES OF TRIGONOMETRIC FUNCTIONS FOR COMMON ANGLES

θ	0°	30°	37°	45°	53°	60°	90°
$\sin\theta$	0	1/2	3/5	$\sqrt{2}/2$	4/5	$\sqrt{3}/2$	1
$\cos\theta$	1	$\sqrt{3}/2$	4/5	$\sqrt{2}/2$	3/5	1/2	0
$\tan\theta$	0	$\sqrt{3}/3$	3/4	1	4/3	$\sqrt{3}$	∞

The following conventions are used in this exam.

I. The frame of reference of any problem is assumed to be inertial unless otherwise stated.
II. In all situations, positive work is defined as work done **on** a system.
III. The direction of current is conventional current: the direction in which positive charge would drift.
IV. Assume all batteries and meters are ideal unless otherwise stated.
V. Assume edge effects for the electric field of a parallel plate capacitor unless otherwise stated.
VI. For any isolated electrically charged object, the electric potential is defined as zero at infinite distance from the charged object.

ADVANCED PLACEMENT AP® PHYSICS 2 EQUATIONS, EFFECTIVE 2016

MECHANICS

$v_x = v_{xo} + a_x t$

$x = x_o + v_{xo}t + \frac{1}{2}a_x t^2$

$v_x^2 = v_{xo}^2 + 2a_x(x - x_o)$

$\vec{a} = \frac{\sum \vec{F}}{m} = \frac{\vec{F}_{net}}{m}$

$|\vec{F}_f| \le \mu |\vec{F}_n|$

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

$\vec{p} = m\vec{v}$

$\Delta\vec{p} = \vec{F}\Delta t$

$K = \frac{1}{2}mv^2$

$\Delta E = W = F_{||}d = Fd\cos\theta$

$P = \frac{\Delta E}{\Delta t}$

$\theta = \theta_o + \omega_o t + \frac{1}{2}\alpha t^2$

$\omega = \omega_o + \alpha t$

$x = A\cos(\omega t) = A\cos(2\pi ft)$

$x_{cm} = \frac{\sum m_i x_i}{\sum m_i}$

$\vec{\alpha} = \frac{\sum \vec{\tau}}{I} = \frac{\vec{\tau}_{net}}{I}$

$\tau = r_\perp F = rF\sin\theta$

$L = I\omega$

$\Delta L = \tau\Delta t$

$K = \frac{1}{2}I\omega^2$

$|\vec{F}_s| = k|\vec{x}|$

$U_s = \frac{1}{2}kx^2$

$\Delta U_g = mg\Delta y$

$T = \frac{2\pi}{\omega} = \frac{1}{f}$

$T_s = 2\pi\sqrt{\frac{m}{k}}$

$T_p = 2\pi\sqrt{\frac{\ell}{g}}$

$|\vec{F}_g| = G\frac{m_1 m_2}{r^2}$

$\vec{g} = \frac{\vec{F}_g}{m}$

$U_g = G\frac{m_1 m_2}{r}$

a = acceleration
A = amplitude
d = distance
E = energy
f = frequency
F = force
I = rotational inertia
K = kinetic energy
k = spring constant
L = angular momentum
ℓ = length
m = mass
P = power
p = momentum
r = radius or separation
T = period
t = time
U = potential energy
V = volume
v = speed
W = work done on a system
x = position
y = height
α = angular acceleration
μ = coefficient of friction
θ = angle
ρ = density
τ = torque
ω = angular speed

ELECTRICITY

$|\vec{F}_E| = \frac{1}{4\pi\varepsilon_o}\frac{|q_1 q_2|}{r^2}$

$\vec{E} = \frac{\vec{F}_E}{q}$

$|\vec{E}| = \frac{1}{4\pi\varepsilon_o}\frac{|q|}{r^2}$

$\Delta U_E = q\Delta V$

$V = \frac{1}{4\pi\varepsilon_o}\frac{q}{r}$

$|\vec{E}| = \left|\frac{\Delta V}{\Delta r}\right|$

$\Delta V = \frac{Q}{C}$

$C = \kappa\varepsilon_o\frac{A}{d}$

$E = \frac{Q}{\varepsilon_o A}$

$U_C = \frac{1}{2}Q\Delta V = \frac{1}{2}C(\Delta V)^2$

$I = \frac{\Delta Q}{\Delta t}$

$R = \frac{\rho\ell}{A}$

$P = I\Delta V$

$I = \frac{\Delta V}{R}$

$R_s = \sum_i R_i$

$\frac{1}{R_p} = \sum_i \frac{1}{R_i}$

$C_p = \sum_i C_i$

$\frac{1}{C_s} = \sum_i \frac{1}{C_i}$

$B = \frac{\mu_o}{2\pi}\frac{I}{R}$

A = area
B = magnetic field
C = capacitance
d = distance
E = electric field
$\mathcal{E}$ = emf
F = force
I = current
ℓ = length
P = power
Q = charge
q = point charge
R = resistance
r = separation
t = time
U = potential (stored) energy
V = electric potential
v = speed
κ = dielectric constant
ρ = resistivity
θ = angle
Φ = flux

$\vec{\boldsymbol{F}}_M = q\vec{\boldsymbol{v}} \times \vec{\boldsymbol{B}}$

$|\vec{\boldsymbol{F}}_M| = |q\vec{\boldsymbol{v}}||\sin\theta||\vec{\boldsymbol{B}}|$

$\vec{\boldsymbol{F}}_M = \vec{\boldsymbol{I}}\ell \times \vec{\boldsymbol{B}}$

$|\vec{\boldsymbol{F}}_M| = |\vec{\boldsymbol{I}}\ell||\sin\theta||\vec{\boldsymbol{B}}|$

$\Phi_B = \vec{\boldsymbol{B}} \bullet \vec{\boldsymbol{A}}$

$\Phi_B = |\vec{\boldsymbol{B}}|\cos\theta|\vec{\boldsymbol{A}}|$

$\mathcal{E} = -\frac{\Delta\Phi_B}{\Delta t}$

$\mathcal{E} = B\ell v$

ADVANCED PLACEMENT AP® PHYSICS 2 EQUATIONS, EFFECTIVE 2016

FLUID MECHANICS AND THERMAL PHYSICS

$\rho = \frac{m}{V}$

$P = \frac{F}{A}$

$P = P_o + \rho g h$

$F_b = \rho V g$

$A_1 v_1 = A_2 v_2$

$P_1 + \rho g y_1 + \frac{1}{2}\rho v_1^2 = P_2 + \rho g y_2 + \frac{1}{2}\rho v_2^2$

$\frac{Q}{\Delta t} = \frac{k A \, \Delta T}{L}$

$PV = nRT = N k_B T$

$K = \frac{3}{2} k_B T$

$W = -P\Delta V$

$\Delta U = Q + W$

- A = area
- F = force
- h = depth
- k = thermal conductivity
- K = kinetic energy
- L = thickness
- m = mass
- n = number of moles
- N = number of molecules
- P = pressure
- Q = energy transferred to a system by heating
- T = temperature
- t = time
- U = internal energy
- V = volume
- v = speed
- W = work done on a system
- y = height
- ρ = density

MODERN PHYSICS

$E = hf$

$K_{max} = hf - \phi$

$\lambda = \frac{h}{p}$

$E = mc^2$

- E = energy
- f = frequency
- K = kinetic energy
- m = mass
- p = momentum
- λ = wavelength
- ϕ = work function

WAVES AND OPTICS

$\lambda = \frac{v}{f}$

$n = \frac{c}{v}$

$n_1 \sin\theta_1 = n_2 \sin\theta_2$

$\frac{1}{s_i} + \frac{1}{s_o} = \frac{1}{f}$

$|M| = \left|\frac{h_i}{h_o}\right| = \left|\frac{s_i}{s_o}\right|$

$\Delta L = m\lambda$

$d \sin\theta = m\lambda$

- d = separation
- f = frequency or focal length
- h = height
- L = distance
- M = magnification
- m = an integer
- n = index of refraction
- s = distance
- v = speed
- λ = wavelength
- θ = angle

GEOMETRY AND TRIGONOMETRY

Rectangle
$A = bh$

Triangle
$A = bh$

Circle
$A = \frac{1}{2}bh$

Rectangular solid
$V = \ell w h$

Cylinder
$V = \pi r^2 \ell$
$S = 2\pi r \ell + 2\pi r^2$

Sphere
$V = \frac{4}{3}\pi r^3$
$S = 4\pi r^2$

- A = area
- C = circumference
- V = volume
- S = surface area
- b = base
- h = height
- ℓ = length
- w = width
- r = radius

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

$\sin\theta = \frac{a}{c}$

$\cos\theta = \frac{b}{c}$

$\tan\theta = \frac{a}{b}$