

AP PHYSICS B SUMMER ASSIGNMENT 2006

The AP Physics B course next school year will be a continuation of what was studied in the Physics Honors class this year. We will complete **Electricity & Magnetism**, and then study **Waves & Optics**, some basic **Atomic & Nuclear Physics**, some basic **Thermal Physics** and finally some basic **Fluid Mechanics**. Please read the “Content Outline for Physics B” (below) for a listing of the AP Physics B topics outlined by The College Board for AP Physics B.

Our summer review work will focus on a thorough review of units we've already studied: **Newtonian Mechanics** and **Electrostatics**. There is nothing new! **Newtonian Mechanics** is VERY important and will be a MAJOR part (35%) of the actual AP Physics B examination next May. A few copies of this assignment are in the Guidance Office and Principal's Office.

The AP Physics B summer assignment is organized into three (3) phases:

1. THE MEMORIZATION

Using the attached sheets, make **92** “Flashcards” – one for each prefix/equation/concept with prompts on one side of a 3 x 5 “ index card and the values/relationships/responses on the other. See the example below.

electrical potential at a point in space near a point charge, q q -----r-----• P

$V = k q / r$ V: electrical potential, V k: Coulomb's constant q: charge, C r: distance from charge, m
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Use these cards to memorize the 11 **metric prefixes**, the 51 **Newtonian Mechanics** concepts, the 17 **Electrostatics** relationships, and finally the 13 **Geometry and Trigonometry** relationships/concepts. We are using symbols based on the Giancoli textbook, but be aware that *unfortunately* different symbols may be used for the same concepts by different authors. The “Flashcards” will be extremely useful in organizing and assisting you to master your Physics principles and to apply them to problems.

2. **THE BOOK AND THE REVIEW** Please buy the Physics review book: **Cracking the AP Physics B&C 2006-2007 Edition** written by Steven A. Leduc and published by The Princeton Review through Random House. The book's **ISBN-10** number is **0-375-76540-2**. We will be using it as our primary review book. The book costs **\$19** and is available at any good bookstore, such as Barnes and Noble. It is a good book to take to college as a reference for any college physics course you may take.

Read the "Introduction" carefully. We are only responsible for the **AP Physics B** topics and you may skip any **Physics C** topics (if you wish). I would suggest reviewing only one chapter during one study session, but certainly do whatever works for you. Concentrate on understanding the physics rather than pure memorization. **Answer** the Chapter Review Questions, **and then** check your work in the "Solutions to the Chapter Review Questions" in the back of the book. *If anything gives you trouble or seems confusing, immediately look at the solution.*

Be sure to take the book with you whenever you expect to have some "free" time!

Carefully read/study/review the material dealing with **Mechanics** (Chapters 1 - 8), but in Chapter 6 only concentrate on "torque," "angular momentum of a point mass," and "conservation of angular momentum."

Review **Electrostatics** (Chapters 10 & 11).

3. THE ASSESSMENTS

When we return in September, there will be a series of

six (6) assessments based on the summer assignment:

- **one** grade based on evidence of your making the **92** “Flashcards”,
- **one** quiz grade based on your successful memorization of the 92 key prefixes and key relationships/concepts, and
- **four** quiz grades based on your using these relationships to solve related physics problems.

These six assessments will be your first AP Physics B “grades” next September!

If you have any questions, feel free to e-mail me at the e-mail address below. I will periodically check my e-mail messages left at school throughout the summer, and I will respond to you as quickly as possible.

Enjoy your summer and your PHYSICS REVIEW WORK!

I will be doing the same thing – but in a different way!

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Content Outline for AP Physics B

(This is based on College Board guidelines.)

- I. Newtonian Mechanics
 - A. Kinematics (including vectors, vector algebra, components of vectors, coordinate systems, displacement, velocity, acceleration)
 - 1. Motion in one dimension
 - 2. Motion in two dimensions, including projectile motion
 - B. Newton's laws of motion (including friction and centripetal force)
 - 1. Static equilibrium (first law)
 - 2. Dynamics of a single particle (second law)
 - 3. Systems of two or more bodies (third law)
 - C. Work, energy, power
 - 1. Work and the work-energy theorem
 - 2. Conservative forces and potential energy
 - 3. Conservation of energy
 - 4. Power
 - D. Systems of particles, linear momentum
 - 1. Impulse and momentum
 - 2. Conservation of linear momentum, collisions
 - E. Circular motion and rotation
 - 1. Uniform circular motion
 - 2. Torque and rotational statics
 - F. Oscillations and gravitation
 - 1. Simple harmonic motion (dynamics and energy relationships)
 - 2. Mass on a spring
 - 3. Pendulum and other oscillations
 - 4. Newton's law of gravity
 - 5. Orbits of planets and satellites - Circular

II. Fluid Mechanics and Thermal Physics

A. Fluid Mechanics

1. Hydrostatic pressure
2. Buoyancy
3. Fluid flow continuity
4. Bernoulli's equation

B. Temperature and heat

1. Mechanical equivalent of heat
2. Heat transfer and thermal expansion

B. Kinetic theory and thermodynamics

1. Ideal gases
 - a. Kinetic model
 - b. Ideal gas law
2. Laws of thermodynamics
 - a. First law (including processes and pV diagrams)
 - b. Second law (including heat engines)

III. Electricity and Magnetism

A. Electrostatics

1. Charge, field, and potential
2. Coulomb's law and field and potential of point charges
3. Fields and potentials of other charge distributions - Planar

B. Conductors, capacitors, dielectrics

1. Electrostatics with conductors
2. Capacitors - Parallel plate

C. Electric circuits

1. Current, resistance, power
2. Steady-state direct current circuits with batteries and resistors only
3. Capacitors in circuits - Steady state

D. Magnetostatics

1. Forces on moving charges in magnetic fields
2. Forces on current-carrying wires in magnetic fields
3. Fields of long current-carrying wires

E. Electromagnetism

1. Electromagnetic induction (including Faraday's law and Lenz's law)

IV. Waves and Optics

- A. Wave motion (including sound)
 - 1. Properties of traveling waves
 - 2. Properties of standing waves
 - 3. Doppler effect
 - 4. Superposition
- B. Physical optics
 - 1. Interference and diffraction
 - 2. Dispersion of light and the electromagnetic spectrum
- C. Geometric optics
 - 1. Reflection and refraction
 - 2. Mirrors
 - 3. Lenses

V. Atomic and Nuclear Physics

- A. Atomic physics and quantum effects
 - 1. Photons and the photoelectric effect
 - 2. Atomic energy levels
 - 3. Wave-particle duality
- B. Nuclear physics
 - 1. Nuclear reactions (including conservation of mass number and charge)
 - 2. Mass-energy equivalence

Laboratory and experimental situations: Each examination will include one or more questions or parts of questions posed in a laboratory or experimental setting.

Miscellaneous: Each examination may include occasional questions that overlap several major areas, or questions on miscellaneous topics such as identification of vectors and scalars, vector mathematics, graphs of functions, history of physics, or contemporary topics in physics.

Some Important METRIC PREFIXES

The following 11 metric (SI) prefixes **must be memorized**:

giga	G	1×10^9
mega	M	1×10^6
kilo	k	1×10^3
hecto	h	1×10^2
deka	da	1×10^1
deci	d	1×10^{-1}
centi	c	1×10^{-2}
milli	m	1×10^{-3}
micro	μ	1×10^{-6}
nano	n	1×10^{-9}
pico	p	1×10^{-12}

AP: Some Important NEWTONIAN MECHANICS Relationships

centripetal acceleration

$$a_c = v^2 / r$$

period of a simple pendulum

$$T = 2 \pi \sqrt{L / g}$$

final velocity squared

$$v^2 = v_o^2 + 2 a (x - x_o)$$

work (definition)

$$W = F d \cos \theta$$

period of a mass vibrating on a spring

$$T = 2 \pi \sqrt{m / k}$$

gravitational potential energy near the surface of the Earth (or any celestial body)

$$\Delta PE_G = \Delta U_G = m g h$$

impulse and its effect on momentum

$$\mathbf{F} \Delta t = \Delta \mathbf{p} = m \mathbf{v} - m \mathbf{v}_o$$

final velocity

$$v = v_o + a t$$

Newton's second law of motion !

$$\mathbf{F}_{\text{net}} = \Sigma \mathbf{F} = m \mathbf{a}$$

gravitational potential energy for masses separated by a large distance

$$PE_G = U_G = G m_1 m_2 / r$$

power as a function of force and velocity

$$P = F v \cos \theta$$

force of kinetic (sliding) friction	$F_{fr} \text{ (kinetic)} = \mu_k F_N$
force of static (at rest) friction	$F_{fr} \text{ (static)} \leq \mu_s F_N$
translational kinetic energy	$KE = \frac{1}{2} m v^2$
period and frequency of vibration	$T = 1 / f$
period of vibration (definition)	the time it takes an object to make one complete vibration or oscillation; usually measured in s
frequency of vibration (definition)	the number of complete vibrations or oscillations of the object per unit time; usually measured in hertz, Hz
Newton's law of universal gravitation	$F_G = G m_1 m_2 / r^2$
torque (magnitude & definition)	torque = $\tau = r F \sin \theta$
Hooke's law (magnitude form)	$F = k \Delta x = k \Delta d$
Hooke's law (vector form)	$\mathbf{F} = -k \Delta \mathbf{x} = k \Delta \mathbf{d}$
final position	$x = x_0 + v_0 t + \frac{1}{2} a t^2$
momentum (definition)	$\mathbf{p} = m \mathbf{v}$

impulse (definition)

$$\mathbf{J} = \mathbf{F} \Delta t$$

power (basic definition)

$$P_{\text{avg}} = W / \Delta t$$

elastic potential energy as a function of the spring constant and displacement

$$PE_s = U_s = \frac{1}{2} k \Delta x^2 = \frac{1}{2} k \Delta d^2$$

average acceleration (basic definition)

$$a = \Delta v / \Delta t = (v - v_o) / (t - t_o)$$

average velocity (basic definition)

$$v = \Delta x / \Delta t = (x - x_o) / (t - t_o)$$

centripetal force

$$F_c = m v^2 / r$$

Work-Energy principle (for kinetic energy)

$$W = \Delta KE = KE_2 - KE_1$$

object on a string in vertical circular motion: forces on the object at the top of its motion

$$-T - mg = -F_c$$

(or better yet... $+T + mg = +F_c$)

object on a string in vertical circular motion: forces on the object at the bottom of its motion

$$T - mg = +F_c$$

Conservation of Mechanical Mechanical Energy (no non-conservative forces acting)

$$KE_1 + PE_1 = KE_2 + PE_2$$

an elastic collision

p is conserved,
KE is conserved

an inelastic collision

p is conserved,
KE is not conserved

an object is in **simple harmonic motion**:
net force, velocity, acceleration . . .

net force, velocity, and
acceleration **all vary** in
magnitude and direction
with time

speed of an object in
uniform circular motion

$$v = 2 \pi r / T$$

angular momentum of a particle
(point mass) moving in a circle

$$\mathbf{L} = m \mathbf{v} r$$

position-time graph: slope

slope represents velocity

velocity-time graph: slope;
area between the curve
and the time axis

slope represents acceleration;
this area represents the
displacement of object

projectile motion: characteristics
of its vertical velocity with time

v_y changes with time

projectile motion: characteristics
of its horizontal velocity with time

neglecting air resistance,
 v_x remains constant with time

an object is in translational equilibrium

net **F**= 0; object is at rest
or moving at constant velocity

an object is in rotational equilibrium

net **torque**= 0; object is at
rest or rotating at a constant rate
about a fixed axis

an object is in both translational and rotational equilibrium

$$\text{net } \mathbf{F} = 0 \text{ and net torque} = 0$$

the “net” work done on an object due to several forces

$$\text{net } W = \Sigma W_i$$

Conservation of Energy
(including dissipative,
non-conservative forces)

$$KE_1 + PE_1 = KE_2 + PE_2 + W_{NC}$$

Kepler’s first law of
planetary motion (in words)

The planets move in elliptical orbits with the Sun at one focus.

Kepler’s second law
of planetary motion (in words)

A line from the Sun to any planet sweeps out equal areas in equal time intervals.
(The speed of a planet changes.)

Kepler’s third law
of planetary motion
(as an equation)

$$T_A^2 / T_B^2 = r_A^3 / r_B^3$$

(A and B are different planets orbiting the Sun.)

force-displacement graph:
area between the curve
and the displacement axis

the area represents the work done by the force during a particular displacement

AP: Some Important ELECTROSTATICS Relationships

work to move a charge
through a potential difference

$$W = q \Delta V$$

electrical potential energy
between two point charges

$$PE_E = U_E = k q_1 q_2 / r$$

electrical potential energy
stored on a charged capacitor

$$PE_C = U_C = \frac{1}{2} Q V = \frac{1}{2} C V^2$$

electrical potential at a point in
space near a point charge (q)

$$V = k q / r$$

net electrical potential at a point
in space near several point charges

$$\text{net } V = \sum V_i = \sum k q_i / r_i$$

electric force between
two point charges (magnitude)

$$F = k q_1 q_2 / r^2$$

capacitance of a capacitor as a
function of its physical characteristics

$$C = K \epsilon_0 A / d$$

equivalent capacitance of several
capacitors connected in series

$$1 / C_s = 1 / C_1 + 1 / C_2 + \dots$$

charge on a given “charged” capacitor

$$Q = C V$$

equivalent capacitance of several
capacitors connected in parallel

$$C_P = C_1 + C_2 + \dots$$

the electric field strength between
two oppositely charged plates

$$E = \Delta V / d$$

electric field strength at a point in space in terms of the force acting on a charge (q) placed at that particular point

$$\mathbf{E} = \mathbf{F} / q$$

the electric field at a point in space near a point charge (q)

$$\mathbf{E} = k q / r^2 \quad (\text{a vector})$$

the net electric field at a point in space near several point charges

$$\text{net } \mathbf{E} = \sum \mathbf{E}_i = \sum k q_i / r_i^2 \quad (\text{vectors})$$

electrical potential at a point in space as a function of a charge placed at that point and the electrical potential energy of the charge

$$V = PE_E / q = U_E / q$$

dielectric constant value used for both a vacuum and air

$$1.0000$$

Coulomb's constant for a vacuum / air

$$k = 9.0 \times 10^{+9} \text{ C}^2 / \text{Nm}^2$$
$$k = 1 / 4 \pi \epsilon_0$$

AP: Some Important GEOMETRY and TRIGONOMETRY Relationships

consider a right triangle:
a, **b** are its legs and
c is its hypoteneuse;
angle θ is opposite side **a**
Pythagorean theorem ?
 $\sin \theta$?
 $\cos \theta$?
 $\tan \theta$?

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

$$\sin \theta = a / c$$

$$\cos \theta = b / c$$

$$\tan \theta = a / b$$

volume of a sphere
as a function of its radius

$$V = 4/3 \pi r^3$$

surface area of a sphere of radius r

$$S = 4 \pi r^2$$

volume of a parallelepiped
(rectangular solid)

$$V = L w h$$

area of a circle as a function of its radius

$$A = \pi r^2$$

circumference of a circle
as a function of its radius

$$C = 2 \pi r$$

area of a triangle

$$A = \frac{1}{2} b h$$

area of a rectangle

$$A = L w = b h$$

volume of a right circular cylinder

$$V = \pi r^2 L$$

surface area of a cylinder

$$S = 2 \pi r L + 2 \pi r^2$$