



## Table of Information and Equation Tables for AP Physics C Exams

The accompanying Table of Information and Equation Tables will be provided to students when they take the AP Physics C Exams. Therefore, students may NOT bring their own copies of these tables to the exam room, although they may use them throughout the year in their classes in order to become familiar with their content. **Check the Physics course home pages on AP Central for the latest versions of these tables ([apcentral.collegeboard.org](http://apcentral.collegeboard.org)).**

### Table of Information

For both the Physics C: Mechanics and Physics C: Electricity and Magnetism Exams, the Table of Information is printed near the front cover of both the multiple-choice and free-response sections. The tables are identical for both exams.

### Equation Tables

For both the Physics C: Mechanics and Physics C: Electricity and Magnetism Exams, the equation tables for each exam are printed near the front cover of both the multiple-choice and free-response sections, directly following the table of information. The equation tables may be used by students when taking both the multiple-choice and free-response sections of both exams.

The equations in the tables express the relationships that are encountered most frequently in AP Physics C courses and exams. However, the tables do not include all equations that might possibly be used. For example, they do not include many equations that can be derived by combining other equations in the tables. Nor do they include equations that are simply special cases of any that are in the tables. Students are responsible for understanding the physical principles that underlie each equation and for knowing the conditions for which each equation is applicable.

The equation tables are grouped in sections according to the major content category in which they appear. Within each section, the symbols used for the variables in that section are defined. However, in some cases the same symbol is used to represent different quantities in different tables. It should be noted that there is no uniform convention among textbooks for the symbols used in writing equations. The equation tables follow many common conventions, but in some cases consistency was sacrificed for the sake of clarity.

Some explanations about notation used in the equation tables:

1. The symbols used for physical constants are the same as those in the Table of Information and are defined in the Table of Information rather than in the right-hand columns of the tables.
2. Symbols with arrows above them represent vector quantities.
3. Subscripts on symbols in the equations are used to represent special cases of the variables defined in the right-hand columns.
4. The symbol  $\Delta$  before a variable in an equation specifically indicates a change in the variable (i.e., final value minus initial value).
5. Several different symbols (e.g.,  $d$ ,  $r$ ,  $s$ ,  $h$ ,  $\ell$ ) are used for linear dimensions such as length. The particular symbol used in an equation is one that is commonly used for that equation in textbooks.

## ADVANCED PLACEMENT PHYSICS C TABLE OF INFORMATION

### CONSTANTS AND CONVERSION FACTORS

Proton mass, $m_p = 1.67 \times 10^{-27}$ kg Neutron mass, $m_n = 1.67 \times 10^{-27}$ kg Electron mass, $m_e = 9.11 \times 10^{-31}$ kg Avogadro's number, $N_0 = 6.02 \times 10^{23}$ mol <sup>-1</sup> Universal gas constant, $R = 8.31$ J/(mol·K) Boltzmann's constant, $k_B = 1.38 \times 10^{-23}$ J/K	Electron charge magnitude, $e = 1.60 \times 10^{-19}$ C 1 electron volt, $1 \text{ eV} = 1.60 \times 10^{-19}$ J Speed of light, $c = 3.00 \times 10^8$ m/s Universal gravitational constant, $G = 6.67 \times 10^{-11}$ (N·m <sup>2</sup> )/kg <sup>2</sup> Acceleration due to gravity at Earth's surface, $g = 9.8$ m/s <sup>2</sup>
1 unified atomic mass unit, Planck's constant, Vacuum permittivity, Coulomb's law constant, $k = 1/(4\pi\epsilon_0) = 9.0 \times 10^9$ (N·m <sup>2</sup> )/C <sup>2</sup> Vacuum permeability, Magnetic constant, $k' = \mu_0/(4\pi) = 1 \times 10^{-7}$ (T·m)/A 1 atmosphere pressure,	$1 \text{ u} = 1.66 \times 10^{-27}$ kg = 931 MeV/c <sup>2</sup> $h = 6.63 \times 10^{-34}$ J·s = 4.14 × 10 <sup>-15</sup> eV·s $hc = 1.99 \times 10^{-25}$ J·m = 1.24 × 10 <sup>3</sup> eV·nm $\epsilon_0 = 8.85 \times 10^{-12}$ C <sup>2</sup> /(N·m <sup>2</sup> ) $\mu_0 = 4\pi \times 10^{-7}$ (T·m)/A $1 \text{ atm} = 1.0 \times 10^5$ N/m <sup>2</sup> = 1.0 × 10 <sup>5</sup> Pa

UNIT SYMBOLS	meter, m	mole, mol	watt, W	farad, F
	kilogram, kg	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 <sup>9</sup>	giga	G
10 <sup>6</sup>	mega	M
10 <sup>3</sup>	kilo	k
10 <sup>-2</sup>	centi	c
10 <sup>-3</sup>	milli	m
10 <sup>-6</sup>	micro	μ
10 <sup>-9</sup>	nano	n
10 <sup>-12</sup>	pico	p

VALUES OF TRIGONOMETRIC FUNCTIONS FOR COMMON ANGLES							
$\theta$	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 assumptions are used in this exam.

- I. The frame of reference of any problem is inertial unless otherwise stated.
- II. The direction of current is the direction in which positive charges would drift.
- III. The electric potential is zero at an infinite distance from an isolated point charge.
- IV. All batteries and meters are ideal unless otherwise stated.
- V. Edge effects for the electric field of a parallel plate capacitor are negligible unless otherwise stated.

**ADVANCED PLACEMENT PHYSICS C EQUATIONS**

**MECHANICS**

$v_x = v_{x0} + a_x t$	$a$ = acceleration
$x = x_0 + v_{x0} t + \frac{1}{2} a_x t^2$	$E$ = energy
$v_x^2 = v_{x0}^2 + 2a_x(x - x_0)$	$F$ = force
$\bar{a} = \frac{\sum \vec{F}}{m} = \frac{\vec{F}_{net}}{m}$	$f$ = frequency
$\vec{F} = \frac{d\vec{p}}{dt}$	$h$ = height
$\vec{J} = \int \vec{F} dt = \Delta\vec{p}$	$I$ = rotational inertia
$\vec{p} = m\vec{v}$	$J$ = impulse
$ \vec{F}_f  \leq \mu  \vec{F}_N $	$K$ = kinetic energy
$\Delta E = W = \int \vec{F} \cdot d\vec{r}$	$k$ = spring constant
$K = \frac{1}{2} m v^2$	$\ell$ = length
$P = \frac{dE}{dt}$	$L$ = angular momentum
$P = \vec{F} \cdot \vec{v}$	$m$ = mass
$\Delta U_g = mg\Delta h$	$P$ = power
$a_c = \frac{v^2}{r} = \omega^2 r$	$p$ = momentum
$\vec{\tau} = \vec{r} \times \vec{F}$	$r$ = radius or distance
$\bar{\alpha} = \frac{\sum \vec{\tau}}{I} = \frac{\vec{\tau}_{net}}{I}$	$T$ = period
$I = \int r^2 dm = \sum mr^2$	$t$ = time
$x_{cm} = \frac{\sum m_i x_i}{\sum m_i}$	$U$ = potential energy
$v = r\omega$	$v$ = velocity or speed
$\vec{L} = \vec{r} \times \vec{p} = I\vec{\omega}$	$W$ = work done on a system
$K = \frac{1}{2} I \omega^2$	$x$ = position
$\omega = \omega_0 + \alpha t$	$\mu$ = coefficient of friction
$\theta = \theta_0 + \omega_0 t + \frac{1}{2} \alpha t^2$	$\theta$ = angle
	$\tau$ = torque
	$\omega$ = angular speed
	$\alpha$ = angular acceleration
	$\phi$ = phase angle
	$\vec{F}_s = -k\Delta\vec{x}$
	$U_s = \frac{1}{2} k (\Delta x)^2$
	$x = x_{max} \cos(\omega t + \phi)$
	$T = \frac{2\pi}{\omega} = \frac{1}{f}$
	$T_s = 2\pi \sqrt{\frac{m}{k}}$
	$T_p = 2\pi \sqrt{\frac{\ell}{g}}$
	$ \vec{F}_G  = \frac{Gm_1 m_2}{r^2}$
	$U_G = -\frac{Gm_1 m_2}{r}$

**ELECTRICITY AND MAGNETISM**

$ \vec{F}_E  = \frac{1}{4\pi\epsilon_0} \left  \frac{q_1 q_2}{r^2} \right $	$A$ = area
$\vec{E} = \frac{\vec{F}_E}{q}$	$B$ = magnetic field
$\oint \vec{E} \cdot d\vec{A} = \frac{Q}{\epsilon_0}$	$C$ = capacitance
$E_x = -\frac{dV}{dx}$	$d$ = distance
$\Delta V = -\int \vec{E} \cdot d\vec{r}$	$E$ = electric field
$V = \frac{1}{4\pi\epsilon_0} \sum_i \frac{q_i}{r_i}$	$\mathcal{E}$ = emf
$U_E = qV = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r}$	$F$ = force
$\Delta V = \frac{Q}{C}$	$I$ = current
$C = \frac{\kappa\epsilon_0 A}{d}$	$J$ = current density
$C_p = \sum_i C_i$	$L$ = inductance
$\frac{1}{C_s} = \sum_i \frac{1}{C_i}$	$\ell$ = length
$I = \frac{dQ}{dt}$	$n$ = number of loops of wire per unit length
$U_C = \frac{1}{2} Q\Delta V = \frac{1}{2} C (\Delta V)^2$	$N$ = number of charge carriers per unit volume
$R = \frac{\rho \ell}{A}$	$P$ = power
$\vec{E} = \rho\vec{J}$	$Q$ = charge
$I = Nev_d A$	$q$ = point charge
$I = \frac{\Delta V}{R}$	$R$ = resistance
$R_s = \sum_i R_i$	$r$ = radius or distance
$\frac{1}{R_p} = \sum_i \frac{1}{R_i}$	$t$ = time
$P = I\Delta V$	$U$ = potential or stored energy
	$V$ = electric potential
	$v$ = velocity or speed
	$\rho$ = resistivity
	$\Phi$ = flux
	$\kappa$ = dielectric constant
	$\vec{F}_M = q\vec{v} \times \vec{B}$
	$\oint \vec{B} \cdot d\vec{\ell} = \mu_0 I$
	$d\vec{B} = \frac{\mu_0}{4\pi} \frac{I d\vec{\ell} \times \hat{r}}{r^2}$
	$\vec{F} = \int I d\vec{\ell} \times \vec{B}$
	$B_s = \mu_0 n I$
	$\Phi_B = \int \vec{B} \cdot d\vec{A}$
	$\mathcal{E} = \oint \vec{E} \cdot d\vec{\ell} = -\frac{d\Phi_B}{dt}$
	$\mathcal{E} = -L \frac{dI}{dt}$
	$U_L = \frac{1}{2} L I^2$

# ADVANCED PLACEMENT PHYSICS C EQUATIONS

## GEOMETRY AND TRIGONOMETRY

Rectangle

$$A = bh$$

Triangle

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

Circle

$$A = \pi r^2$$

$$C = 2\pi r$$

$$s = r\theta$$

Rectangular Solid

$$V = \ell wh$$

Cylinder

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

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

Sphere

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

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

Right Triangle

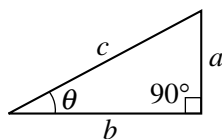
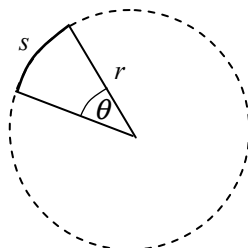
$$a^2 + b^2 = c^2$$

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

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

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

$A$  = area  
 $C$  = circumference  
 $V$  = volume  
 $S$  = surface area  
 $b$  = base  
 $h$  = height  
 $\ell$  = length  
 $w$  = width  
 $r$  = radius  
 $s$  = arc length  
 $\theta$  = angle



## CALCULUS

$$\frac{df}{dx} = \frac{df}{du} \frac{du}{dx}$$

$$\frac{d}{dx}(x^n) = nx^{n-1}$$

$$\frac{d}{dx}(e^{ax}) = ae^{ax}$$

$$\frac{d}{dx}(\ln ax) = \frac{1}{x}$$

$$\frac{d}{dx}[\sin(ax)] = a \cos(ax)$$

$$\frac{d}{dx}[\cos(ax)] = -a \sin(ax)$$

$$\int x^n dx = \frac{1}{n+1} x^{n+1}, n \neq -1$$

$$\int e^{ax} dx = \frac{1}{a} e^{ax}$$

$$\int \frac{dx}{x+a} = \ln|x+a|$$

$$\int \cos(ax) dx = \frac{1}{a} \sin(ax)$$

$$\int \sin(ax) dx = -\frac{1}{a} \cos(ax)$$

## VECTOR PRODUCTS

$$\vec{A} \cdot \vec{B} = AB \cos \theta$$

$$|\vec{A} \times \vec{B}| = AB \sin \theta$$