

ADVANCED PLACEMENT PHYSICS C EQUATIONS

MECHANICS

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

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

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

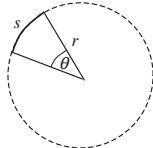
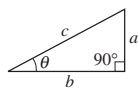
PREFIXES		
Factor	Prefix	Symbol
10 ⁹	giga	G
10 ⁶	mega	M
10 ³	kilo	k
10 ⁻²	centi	c
10 ⁻³	milli	m
10 ⁻⁶	micro	μ
10 ⁻⁹	nano	n
10 ⁻¹²	pico	p

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 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

GEOMETRY AND TRIGONOMETRY	CALCULUS!
<p>Rectangle $A = bh$</p> <p>Triangle $A = \frac{1}{2}bh$</p> <p>Circle $A = \pi r^2$ $C = 2\pi r$ $s = r\theta$</p> <p>Rectangular Solid $V = \ell wh$</p> <p>Cylinder $V = \pi r^2 \ell$ $S = 2\pi r \ell + 2\pi r^2$</p> <p>Sphere $V = \frac{4}{3}\pi r^3$ $S = 4\pi r^2$</p> <p>Right Triangle $a^2 + b^2 = c^2$ $\sin \theta = \frac{a}{c}$ $\cos \theta = \frac{b}{c}$ $\tan \theta = \frac{a}{b}$</p>  	<p>$\frac{df}{dx} = \frac{df}{du} \frac{du}{dx}$</p> <p>$\frac{d}{dx}(x^n) = nx^{n-1}$</p> <p>$\frac{d}{dx}(e^{ax}) = ae^{ax}$</p> <p>$\frac{d}{dx}(\ln ax) = \frac{1}{x}$</p> <p>$\frac{d}{dx}[\sin(ax)] = a \cos(ax)$</p> <p>$\frac{d}{dx}[\cos(ax)] = -a \sin(ax)$</p> <p>$\int x^n dx = \frac{1}{n+1} x^{n+1}, n \neq -1!$</p> <p>$\int e^{ax} dx = \frac{1}{a} e^{ax}$</p> <p>$\int \frac{dx}{x+a} = \ln x+a$</p> <p>$\int \cos(ax) dx = \frac{1}{a} \sin(ax)$</p> <p>$\int \sin(ax) dx = -\frac{1}{a} \cos(ax)$</p> <p>VECTOR PRODUCTS!</p> <p>$\vec{A} \cdot \vec{B} = AB \cos \theta$</p> <p>$\vec{A} \times \vec{B} = AB \sin \theta$</p>