

Appendix: AP[®] Physics 2 Equation Tables

ADVANCED PLACEMENT PHYSICS PHYSICS 2 IN PLAIN ENGLISH, EFFECTIVE 2017

CONSTANTS AND CONVERSION FACTORS			
Proton mass,	$m_p = 1.67 \times 10^{-27} \text{ kg}$	Electron charge magnitude,	$e = 1.60 \times 10^{-19} \text{ C}$
Neutron mass,	$m_n = 1.67 \times 10^{-27} \text{ kg}$	1 electron volt,	$1 \text{ eV} = 1.60 \times 10^{-19} \text{ J}$
Electron mass,	$m_e = 9.11 \times 10^{-31} \text{ kg}$	Speed of light,	$c = 3.00 \times 10^8 \text{ m/s}$
Avogadro's number,	$N_o = 6.02 \times 10^{23} \text{ mol}^{-1}$	Universal gravitational constant,	$G = 6.67 \times 10^{-11} \text{ m}^3/\text{kg} \cdot \text{s}^2$
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,	$k_B = 1.38 \times 10^{-23} \frac{\text{J}}{\text{K}}$		
1 unified atomic mass unit,		$1 \text{ u} = 1.66 \times 10^{-27} \text{ kg} = 931 \frac{\text{MeV}}{c^2}$	
Planck's constant,		$h = 6.63 \times 10^{-34} \text{ J} \cdot \text{s} = 4.14 \times 10^{-15} \text{ eV} \cdot \text{s}$	
		$hc = 1.99 \times 10^{-25} \text{ J} \cdot \text{m} = 1.24 \times 10^{-3} \text{ eV} \cdot \text{nm}$	
Vacuum permittivity,		$\epsilon_o = 8.85 \times 10^{-12} \frac{\text{C}^2}{\text{N} \cdot \text{m}^2}$	
Coulomb's law constant,		$k = \frac{1}{4\pi\epsilon_o} = 9.0 \times 10^9 \frac{\text{N} \cdot \text{m}^2}{\text{C}^2}$	
Vacuum permeability,		$\mu_o = 4\pi \times 10^{-7} \frac{\text{T} \cdot \text{m}}{\text{A}}$	
Magnetic constant,		$k' = \frac{\mu_o}{4\pi} = 1 \times 10^{-7} \frac{\text{T} \cdot \text{m}}{\text{A}}$	
1 atmosphere pressure,		$1 \text{ atm} = 1.0 \times 10^5 \frac{\text{N}}{\text{m}^2} = 1.0 \times 10^5 \text{ Pa}$	

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	Symbo l
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 θ	0	1/2	3/5	$\sqrt{2}/2$	4/5	$\sqrt{3}/2$	1
cos θ	1	$\sqrt{3}/2$	4/5	$\sqrt{2}/2$	3/5	1/2	0
tan θ	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.

MECHANICS		ELECTRICITY AND MAGNETISM	
$v_x = v_{x0} + a_x t$	a = acceleration	$ \vec{F}_E = \frac{1}{4\pi\epsilon_0} \frac{ q_1 q_2 }{r^2}$	A = area
$x = x_0 + v_{x0} t + \frac{1}{2} a_x t^2$	A = amplitude	$\vec{E} = \frac{\vec{F}_E}{q}$	B = magnetic field
$v_x^2 = v_{x0}^2 + 2a_x(x - x_0)$	d = distance	$ \vec{E} = \frac{1}{4\pi\epsilon_0} \frac{ q }{r^2}$	C = capacitance
$\vec{a} = \frac{\sum \vec{F}}{m} = \frac{\vec{F}_{net}}{m}$	E = energy	$\Delta U_E = q\Delta V$	d = distance
$ \vec{F}_f \leq \mu \vec{F}_n $	f = frequency	$V = \frac{1}{4\pi\epsilon_0} \frac{q}{r}$	E = electric field
$a_c = \frac{v^2}{r}$	F = force	$ \vec{E} = \left \frac{\Delta V}{\Delta r} \right $	\mathcal{E} = emf
$\vec{p} = m\vec{v}$	I = rotational inertia	$\Delta V = \frac{Q}{C}$	F = force
$\Delta\vec{p} = \vec{F}\Delta t$	K = kinetic energy	$C = \kappa\epsilon_0 \frac{A}{d}$	I = current
$K = \frac{1}{2}mv^2$	k = spring constant	$E = \frac{Q}{\epsilon_0 A}$	ℓ = length
$\Delta E = W = F_{\parallel}d = Fd \cos \theta$	L = angular momentum	$U_C = \frac{1}{2}Q\Delta V = \frac{1}{2}C(\Delta V)^2$	P = power
$P = \frac{\Delta E}{\Delta t}$	ℓ = length	$I = \frac{\Delta Q}{\Delta t}$	Q = charge
$\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$	m = mass	$R = \frac{\rho\ell}{A}$	q = point charge
$\omega = \omega_0 + \alpha t$	P = power	$P = I\Delta V$	R = resistance
$x = A \cos(\omega t) = A \cos(2\pi ft)$	p = momentum	$I = \frac{\Delta V}{R}$	r = separation
$x_{cm} = \frac{\sum m_i x_i}{\sum m_i}$	r = radius or separation	$R_s = \sum_i R_i$	t = time
$\vec{a} = \frac{\sum \vec{\tau}}{I} = \frac{\vec{\tau}_{net}}{I}$	T = period	$C_p = \sum_i C_i$	U = potential (stored) energy
$\tau = r_{\perp} F = rF \sin \theta$	t = time	$\frac{1}{R_p} = \sum_i \frac{1}{R_i}$	V = electric potential
$L = I\omega$	U = potential energy	$C_s = \sum_i C_i$	v = speed
$\Delta L = \tau\Delta t$	V = volume	$\frac{1}{C_s} = \sum_i \frac{1}{C_i}$	κ = dielectric constant
$K = \frac{1}{2}I\omega^2$	v = speed	$B = \frac{\mu_0 I}{2\pi R}$	ρ = resistivity
$ \vec{F}_s = k \vec{x} $	W = work done on a system	$\vec{F}_M = q\vec{v} \times \vec{B}$	θ = angle
$U_s = \frac{1}{2}kx^2$	x = position	$ \vec{F}_M = q\vec{v} \sin \theta \vec{B} $	Φ = flux
	y = height	$\vec{F}_M = \vec{I} \ell \times \vec{B}$	
	α = angular acceleration	$ \vec{F}_M = \vec{I} \ell \sin \theta \vec{B} $	
	μ = coefficient of friction	$\Phi_B = \vec{B} \cdot \vec{A}$	
	θ = angle	$\Phi_B = \vec{B} \cos \theta \vec{A} $	
	ρ = density	$\mathcal{E} = -\frac{\Delta\Phi_B}{\Delta t}$	
	τ = torque	$\mathcal{E} = B\ell v$	
	ω = angular speed		
	$\Delta U_g = mg\Delta y$		
	$T = \frac{2\pi}{\omega} = \frac{1}{f}$		
	$T_s = 2\pi\sqrt{\frac{m}{k}}$		
	$T_p = 2\pi\sqrt{\frac{\ell}{g}}$		
	$ \vec{F}_g = G \frac{m_1 m_2}{r^2}$		
	$\vec{g} = \frac{\vec{F}_g}{m}$		
	$U_g = G \frac{m_1 m_2}{r}$		

FLUID MECHANICS AND THERMAL PHYSICS	WAVES AND OPTICS
<p>$\rho = \frac{m}{V}$</p> <p>$P = \frac{F}{A}$</p> <p>$P = P_o + \rho gh$</p> <p>$F_b = \rho Vg$</p> <p>$A_1 v_1 = A_2 v_2$</p> <p>$P_1 + \rho gy_1 + \frac{1}{2} \rho v_1^2 = P_2 + \rho gy_2 + \frac{1}{2} \rho v_2^2$</p> <p>$\frac{Q}{\Delta t} = \frac{kA \Delta T}{L}$</p> <p>$PV = nRT = Nk_B T$</p> <p>$K = \frac{3}{2} k_B T$</p> <p>$W = -P\Delta V$</p> <p>$\Delta U = Q + W$</p> <p><i>A</i> = area <i>F</i> = force <i>h</i> = depth <i>k</i> = thermal conductivity <i>K</i> = kinetic energy <i>L</i> = thickness <i>m</i> = mass <i>n</i> = number of moles <i>N</i> = number of molecules <i>P</i> = pressure <i>Q</i> = energy transferred to a system by heating <i>T</i> = temperature <i>t</i> = time <i>U</i> = internal energy <i>V</i> = volume <i>v</i> = speed <i>W</i> = work done on a system <i>y</i> = height <i>ρ</i> = density</p>	<p>$\lambda = \frac{v}{f}$</p> <p>$n = \frac{c}{v}$</p> <p>$n_1 \sin \theta_1 = n_2 \sin \theta_2$</p> <p>$\frac{1}{s_i} + \frac{1}{s_o} = \frac{1}{f}$</p> <p>$M = \left \frac{h_i}{h_o} \right = \left \frac{s_i}{s_o} \right$</p> <p>$\Delta L = m\lambda$</p> <p>$d \sin \theta = m\lambda$</p> <p><i>d</i> = separation <i>f</i> = frequency or focal length <i>h</i> = height <i>L</i> = distance <i>M</i> = magnification <i>m</i> = an integer <i>n</i> = index of refraction <i>s</i> = distance <i>v</i> = speed <i>λ</i> = wavelength <i>θ</i> = angle</p>
<p style="text-align: center;">MODERN PHYSICS</p> <p>$E = hf$</p> <p>$K_{\max} = hf - \phi$</p> <p>$\lambda = \frac{h}{p}$</p> <p>$E = mc^2$</p> <p><i>E</i> = energy <i>f</i> = frequency <i>K</i> = kinetic energy <i>m</i> = mass <i>p</i> = momentum <i>λ</i> = wavelength <i>φ</i> = work function</p>	<p style="text-align: center;">GEOMETRY AND TRIGONOMETRY</p> <p>Rectangle $A = bh$</p> <p>Triangle $A = bh$</p> <p>Circle $A = \frac{1}{2}bh$</p> <p>Right triangle $c^2 = a^2 + b^2$ $\sin \theta = \frac{a}{c}$ $\cos \theta = \frac{b}{c}$ $\tan \theta = \frac{a}{b}$</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> 

