

ADVANCED PLACEMENT PHYSICS 2 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, $G = 6.67 \times 10^{-11}$ m ³ /kg·s 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 = $931 \text{ MeV}/c^2$
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^{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 PHYSICS 2 EQUATIONS

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
$x = x_0 + v_{x0} t + \frac{1}{2} a_x t^2$	d = distance	$\vec{E} = \frac{\vec{F}_E}{q}$	B = magnetic field
$v_x^2 = v_{x0}^2 + 2a_x(x - x_0)$	E = energy	$ \vec{E} = \frac{1}{4\pi\epsilon_0} \frac{ q }{r^2}$	C = capacitance
$\vec{a} = \frac{\sum \vec{F}}{m} = \frac{\vec{F}_{net}}{m}$	F = force	$\Delta U_E = q\Delta V$	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
$a_c = \frac{v^2}{r}$	h = height	$ \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
$K = \frac{1}{2} m v^2$	k = spring constant	$E = \frac{Q}{\epsilon_0 A}$	ℓ = length
$\Delta E = W = F_{\parallel} d = F d \cos \theta$	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
$x = A \cos(\omega t) = A \cos(2\pi f t)$	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
$\vec{\alpha} = \frac{\sum \vec{\tau}}{I} = \frac{\vec{\tau}_{net}}{I}$	T = period	$\frac{1}{R_p} = \sum_i \frac{1}{R_i}$	U = potential (stored) energy
$\tau = r_{\perp} F = r F \sin \theta$	t = time	$C_p = \sum_i C_i$	V = electric potential
$L = I \omega$	U = potential energy	$\frac{1}{C_s} = \sum_i \frac{1}{C_i}$	v = speed
$\Delta L = \tau \Delta t$	v = speed	$B = \frac{\mu_0 I}{2\pi r}$	ρ = resistivity
$K = \frac{1}{2} I \omega^2$	W = work done on a system	$\vec{F}_M = q\vec{v} \times \vec{B}$	θ = angle
$ \vec{F}_s = k \vec{x} $	x = position	$ \vec{F}_M = q\vec{v} \sin \theta \vec{B} $	Φ = flux
	α = angular acceleration	$\vec{F}_M = I \vec{\ell} \times \vec{B}$	
	μ = coefficient of friction	$ \vec{F}_M = I \vec{\ell} \sin \theta \vec{B} $	
	θ = angle	$\Phi_B = \vec{B} \cdot \vec{A}$	
	τ = torque	$\Phi_B = \vec{B} \cos \theta \vec{A} $	
	ω = angular speed	$\mathcal{E} = -\frac{\Delta \Phi_B}{\Delta t}$	
		$\mathcal{E} = B \ell v$	
	$U_s = \frac{1}{2} k x^2$		
	$\Delta U_g = mg \Delta y$		
	$T = \frac{2\pi}{\omega} = \frac{1}{f}$		
	$T_s = 2\pi \sqrt{\frac{m}{k}}$		
	$T_p = 2\pi \sqrt{\frac{\ell}{g}}$		
	$ \vec{F}_g = G \frac{m_1 m_2}{r^2}$		
	$\vec{g} = \frac{\vec{F}_g}{m}$		
	$U_G = -\frac{G m_1 m_2}{r}$		

ADVANCED PLACEMENT PHYSICS 2 EQUATIONS

FLUID MECHANICS AND THERMAL PHYSICS		WAVES AND OPTICS	
$\rho = \frac{m}{V}$ $P = \frac{F}{A}$ $P = P_0 + \rho gh$ $F_b = \rho Vg$ $A_1v_1 = A_2v_2$ $P_1 + \rho gy_1 + \frac{1}{2}\rho v_1^2$ $\quad = P_2 + \rho gy_2 + \frac{1}{2}\rho v_2^2$ $\frac{Q}{\Delta t} = \frac{kA \Delta T}{L}$ $PV = nRT = Nk_B T$ $K = \frac{3}{2}k_B T$ $W = -P \Delta V$ $\Delta U = Q + W$	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	$\lambda = \frac{v}{f}$ $n = \frac{c}{v}$ $n_1 \sin \theta_1 = n_2 \sin \theta_2$ $\frac{1}{s_i} + \frac{1}{s_o} = \frac{1}{f}$ $ 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
MODERN PHYSICS		GEOMETRY AND TRIGONOMETRY	
$E = hf$ $K_{\max} = hf - \phi$ $\lambda = \frac{h}{p}$ $E = mc^2$	E = energy f = frequency K = kinetic energy m = mass p = momentum λ = wavelength ϕ = work function	Rectangle $A = bh$ Triangle $A = \frac{1}{2}bh$ Circle $A = \pi r^2$ $C = 2\pi r$ Rectangular solid $V = \ell wh$ Cylinder $V = \pi r^2 \ell$ $S = 2\pi r \ell + 2\pi r^2$ Sphere $V = \frac{4}{3}\pi r^3$ $S = 4\pi r^2$	A = area C = circumference V = volume S = surface area b = base h = height ℓ = length w = width r = radius Right triangle $c^2 = a^2 + b^2$ $\sin \theta = \frac{a}{c}$ $\cos \theta = \frac{b}{c}$ $\tan \theta = \frac{a}{b}$

