

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

ADVANCED PLACEMENT PHYSICS 2 EQUATIONS

FLUID MECHANICS AND THERMAL PHYSICS	WAVES AND OPTICS
$\rho = \frac{m}{V}$ $P = \frac{F}{A}$ $P = P_0 + \rho gh$ $F_b = \rho Vg$ $A_1 v_1 = A_2 v_2$ $P_1 + \rho g y_1 + \frac{1}{2} \rho v_1^2 = P_2 + \rho g y_2 + \frac{1}{2} \rho v_2^2$ $\frac{Q}{\Delta t} = \frac{kA \Delta T}{L}$ $PV = nRT = Nk_B T$ $K = \frac{3}{2} k_B T$ $W = -P \Delta V$ $\Delta U = Q + W$	$\lambda = \frac{v}{f}$ $n = \frac{c}{v}$ $n_1 \sin \theta_1 = n_2 \sin \theta_2$ $\frac{1}{s_i} + \frac{1}{s_o} = \frac{1}{f}$ $ M = \left \frac{h_i}{h_o} \right = \left \frac{s_i}{s_o} \right $ $\Delta L = m\lambda$ $d \sin \theta = m\lambda$
<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><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>
MODERN PHYSICS	GEOMETRY AND TRIGONOMETRY
$E = hf$ $K_{\max} = hf - \phi$ $\lambda = \frac{h}{p}$ $E = mc^2$	<p><i>A</i> = area <i>C</i> = circumference <i>V</i> = volume <i>S</i> = surface area <i>b</i> = base <i>h</i> = height <i>ℓ</i> = length <i>w</i> = width <i>r</i> = radius</p> <p>Rectangle $A = bh$</p> <p>Triangle $A = \frac{1}{2}bh$</p> <p>Circle $A = \pi r^2$ $C = 2\pi r$</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 $c^2 = a^2 + b^2$ $\sin \theta = \frac{a}{c}$ $\cos \theta = \frac{b}{c}$ $\tan \theta = \frac{a}{b}$</p> 