

AP[®] PHYSICS 2 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 ⁻¹ 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, $G = 6.67 \times 10^{-11}$ m ³ /kg·s ² Acceleration due to gravity at Earth's surface, $g = 9.8$ m/s ²
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 ² /C ² 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 ² $h = 6.63 \times 10^{-34}$ J·s = 4.14×10^{-15} eV·s $hc = 1.99 \times 10^{-25}$ J·m = 1.24×10^3 eV·nm $\epsilon_0 = 8.85 \times 10^{-12}$ C ² /N·m ² $\mu_0 = 4\pi \times 10^{-7}$ (T·m)/A $1 \text{ atm} = 1.0 \times 10^5$ 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.

AP[®] PHYSICS 2 EQUATIONS

MECHANICS

$$v_x = v_{x0} + a_x t$$

$$x = x_0 + v_{x0} t + \frac{1}{2} a_x t^2$$

$$v_x^2 = v_{x0}^2 + 2a_x(x - x_0)$$

$$\vec{a} = \frac{\sum \vec{F}}{m} = \frac{\vec{F}_{net}}{m}$$

$$|\vec{F}_f| \leq \mu |\vec{F}_n|$$

$$a_c = \frac{v^2}{r}$$

$$\vec{p} = m\vec{v}$$

$$\Delta\vec{p} = \vec{F} \Delta t$$

$$K = \frac{1}{2} m v^2$$

$$\Delta E = W = F_{\parallel} d = F d \cos \theta$$

$$P = \frac{\Delta E}{\Delta t}$$

$$\theta = \theta_0 + \omega_0 t + \frac{1}{2} \alpha t^2$$

$$\omega = \omega_0 + \alpha t$$

$$x = A \cos(\omega t) = A \cos(2\pi f t)$$

$$x_{cm} = \frac{\sum m_i x_i}{\sum m_i}$$

$$\vec{\alpha} = \frac{\sum \vec{\tau}}{I} = \frac{\vec{\tau}_{net}}{I}$$

$$\tau = r_{\perp} F = r F \sin \theta$$

$$L = I \omega$$

$$\Delta L = \tau \Delta t$$

$$K = \frac{1}{2} I \omega^2$$

$$|\vec{F}_s| = k |\vec{x}|$$

a = acceleration
 A = amplitude
 d = distance
 E = energy
 F = force
 f = frequency
 I = rotational inertia
 K = kinetic energy
 k = spring constant
 L = angular momentum
 ℓ = length
 m = mass
 P = power
 p = momentum
 r = radius or separation
 T = period
 t = time
 U = potential energy
 v = speed
 W = work done on a system
 x = position
 y = height
 α = angular acceleration
 μ = coefficient of friction
 θ = angle
 τ = torque
 ω = angular speed
 $U_s = \frac{1}{2} k x^2$
 $\Delta U_g = m g \Delta y$
 $T = \frac{2\pi}{\omega} = \frac{1}{f}$
 $T_s = 2\pi \sqrt{\frac{m}{k}}$
 $T_p = 2\pi \sqrt{\frac{\ell}{g}}$
 $|\vec{F}_g| = G \frac{m_1 m_2}{r^2}$
 $\vec{g} = \frac{\vec{F}_g}{m}$
 $U_G = -\frac{G m_1 m_2}{r}$

ELECTRICITY AND MAGNETISM

$$|\vec{F}_E| = \frac{1}{4\pi\epsilon_0} \frac{|q_1 q_2|}{r^2}$$

$$\vec{E} = \frac{\vec{F}_E}{q}$$

$$|\vec{E}| = \frac{1}{4\pi\epsilon_0} \frac{|q|}{r^2}$$

$$\Delta U_E = q \Delta V$$

$$V = \frac{1}{4\pi\epsilon_0} \frac{q}{r}$$

$$|\vec{E}| = \left| \frac{\Delta V}{\Delta r} \right|$$

$$\Delta V = \frac{Q}{C}$$

$$C = \kappa \epsilon_0 \frac{A}{d}$$

$$E = \frac{Q}{\epsilon_0 A}$$

$$U_C = \frac{1}{2} Q \Delta V = \frac{1}{2} C (\Delta V)^2$$

$$I = \frac{\Delta Q}{\Delta t}$$

$$R = \frac{\rho \ell}{A}$$

$$P = I \Delta V$$

$$I = \frac{\Delta V}{R}$$

$$R_s = \sum_i R_i$$

$$\frac{1}{R_p} = \sum_i \frac{1}{R_i}$$

$$C_p = \sum_i C_i$$

$$\frac{1}{C_s} = \sum_i \frac{1}{C_i}$$

$$B = \frac{\mu_0 I}{2\pi r}$$

A = area
 B = magnetic field
 C = capacitance
 d = distance
 E = electric field
 \mathcal{E} = emf
 F = force
 I = current
 ℓ = length
 P = power
 Q = charge
 q = point charge
 R = resistance
 r = separation
 t = time
 U = potential (stored) energy
 V = electric potential
 v = speed
 κ = dielectric constant
 ρ = resistivity
 θ = angle
 Φ = flux
 $\vec{F}_M = q\vec{v} \times \vec{B}$
 $|\vec{F}_M| = |q\vec{v}| |\sin \theta| |\vec{B}|$
 $\vec{F}_M = I\vec{\ell} \times \vec{B}$
 $|\vec{F}_M| = |I\vec{\ell}| |\sin \theta| |\vec{B}|$
 $\Phi_B = \vec{B} \cdot \vec{A}$
 $\Phi_B = |\vec{B}| \cos \theta |\vec{A}|$
 $\mathcal{E} = -\frac{\Delta \Phi_B}{\Delta t}$
 $\mathcal{E} = B \ell v$

AP[®] PHYSICS 2 EQUATIONS

FLUID MECHANICS AND THERMAL PHYSICS

$\rho = \frac{m}{V}$ $P = \frac{F}{A}$ $P = P_0 + \rho gh$ $F_b = \rho Vg$ $A_1 v_1 = A_2 v_2$ $P_1 + \rho gy_1 + \frac{1}{2} \rho v_1^2 = P_2 + \rho gy_2 + \frac{1}{2} \rho v_2^2$ $\frac{Q}{\Delta t} = \frac{kA \Delta T}{L}$ $PV = nRT = Nk_B T$ $K = \frac{3}{2} k_B T$ $W = -P \Delta V$ $\Delta U = Q + W$	<p>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</p>
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MODERN PHYSICS

$E = hf$ $K_{\max} = hf - \phi$ $\lambda = \frac{h}{p}$ $E = mc^2$	<p>E = energy f = frequency K = kinetic energy m = mass p = momentum λ = wavelength ϕ = work function</p>
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WAVES AND OPTICS

$\lambda = \frac{v}{f}$ $n = \frac{c}{v}$ $n_1 \sin \theta_1 = n_2 \sin \theta_2$ $\frac{1}{s_i} + \frac{1}{s_o} = \frac{1}{f}$ $ 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>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</p>
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GEOMETRY AND TRIGONOMETRY

<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>A = area C = circumference V = volume S = surface area b = base h = height ℓ = length w = width r = radius</p>
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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

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

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

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

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

