# ADVANCED PLACEMENT PHYSICS 1 TABLE OF INFORMATION & EQUATIONS

| 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 | Coulomb's law constant, $k = 1/4\pi\varepsilon_0 = 9.0 \times 10^9$ $N{\bullet}m^2/C^2$ |
| Electron mass, $m_e = 9.11 \times 10^{-31}$ kg | Universal gravitational constant, $G = 6.67 \times 10^{-11}$ $m^3/kg{\bullet}s^2$ |
| Speed of light, $c = 3.00 \times 10^8$ m/s | Acceleration due to gravity at Earth's surface, $g = 9.8$ $m/s^2$ |

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|---|---|---|---|---|
| UNIT SYMBOLS | meter, m | kelvin, K | watt, W | degree Celsius, ˚C |
| | kilogram, kg | hertz, Hz | coulomb, C | |
| | second, s | newton, N | volt, V | |
| | ampere, A | joule, J | ohm, Ω | |

| 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 | $\mu$ |
| $10^{-9}$ | nano | n |
| $10^{-12}$ | pico | p |

**VALUES OF TRIGONOMETRIC FUNCTIONS FOR COMMON ANGLES**

| $\theta$ | 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 | $\sqrt{3/3}$ | ¾ | 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. Assume air resistance is negligible unless otherwise stated.
III. In all situations, positive work is defined as work done on a system.
IV. The direction of current is conventional current: the direction in which positive charge would drift.
V. Assume all batteries and meters are ideal unless otherwise stated.

## ADVANCED PLACEMENT PHYSICS 1 EQUATIONS, EFFECTIVE 2015

| MECHANICS | | |
|---|---|---|
| **Equation** | **Usage** | |
| $\overrightarrow{v_{avg}} = \frac{\Delta\vec{x}}{\Delta t}$ | Calculate average velocity | $a$ = acceleration<br>$A$ =amplitude<br>$d$ = distance<br>$E$ = energy<br>$f$ = frequency<br>$F$ = force<br>$I$ = rotational inertia<br>$K$ =kinetic energy<br>$k$ = spring constant<br>$L$ = angular momentum<br>$\ell$ = length<br>$m$ = mass<br>$P$ =power<br>$p$ = momentum<br>$r$ = radius or separation<br>$T$ = period<br>$t$ = time<br>$U$ = potential energy<br>$V$ = volume<br>$v$ = speed<br>$W$ = work done on a system<br>$x$ = position<br>$y$ = height<br>$\alpha$ = angular acceleration<br>$\mu$ = coefficient of friction<br>$\theta$ = angle<br>$\rho$ = density<br>$\tau$ = torque<br>$\omega$ = angular speed |
| $\overrightarrow{a_{avg}} = \frac{\Delta\vec{v}}{\Delta t}$<br>$\vec{a} = \frac{\Sigma\vec{t}}{I} = \frac{\overrightarrow{t_{net}}}{I}$ | Calculate average acceleration<br>Calculate acceleration | |
| $v_x = v_{x0} + a_x t$<br>$x = x_0 + v_{x0}t + \frac{1}{2}a_x t^2$<br>$v_x^2 = v_{x0}^2 + 2a_x(x - x_0)$<br>$x = Acos(2\pi ft)$ | Kinematic equations for describing linear motion with constant acceleration in one and two dimensions. | |
| $\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$<br>$\omega = \omega_0 + \alpha t$<br>$\omega^2 = \omega_0^2 + 2\alpha_x(\theta - \theta_0)$ | Kinematic equations for describing angular motion with constant angular acceleration. | |
| $\vec{g} = \frac{\vec{F_g}}{m}$ | Calculate gravitational force on an object with mass *m* in a gravitational field of strength *g* in the context of the effects of a net force on objects and systems. | |
| $\left\lvert\vec{F_f}\right\rvert \leq \mu \left\lvert\vec{F_n}\right\rvert$<br>$\left\lvert\vec{F_s}\right\rvert = k\lvert\vec{x}\rvert$ | Make claims about various contact forces between objects based on the microscopic cause of these forces.<br>Explain contact forces (tension, friction, normal, spring) as arising from interatomic electric forces and that they therefore have certain directions. | |
| $\vec{a} = \frac{\Sigma\vec{F}}{m} = \frac{\vec{F}_{net}}{m}$ | If an object of interest interacts with several other objects, the net force is the vector sum of the individual forces. | |
| $\lvert F_g\rvert = G\frac{m_1 m_2}{r^2}$ | Use Newton's law of gravitation to calculate the gravitational force that two objects exert on each other and use that force in contexts other than orbital motion.<br>Calculate gravitational force between | |

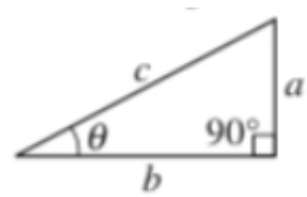
| | | |
|---|---|---|
| | two objects and use that force in contexts involving orbital motion. | |
| $a_c = \frac{v^2}{r}$ | Calculate acceleration for situations where there is both a radial and tangential acceleration for an object moving in a circular path. | |
| $K = \frac{1}{2}mv^2$<br><br>$\Delta E = W = F_{\parallel}d = Fdcos\theta$ | Determine the change in kinetic energy of an object given the forces on the object and the displacement of the object. | |
| $K = \frac{1}{2}\mathrm{I}\omega^2$<br><br>$\Delta U_g = mg\Delta y$<br><br>$U_s = \frac{1}{2}kx^2$<br><br>$U_g = -\frac{Gm_1m_2}{r}$ | Calculate the total energy of a system.<br>Predict changes in the total energy of a system due to changes in position and speed of objects or frictional interactions within the system. | |
| $T = \frac{2\pi}{\omega} = \frac{1}{f}$<br><br>$T_p = 2\pi\sqrt{\frac{l}{g}}$<br><br>$T_s = 2\pi\sqrt{\frac{m}{k}}$<br><br>$P = \frac{\Delta E}{\Delta t}$ | Calculate and/or describe potential energy, the internal energy of systems, and changes in kinetic energy and potential energy of a system.<br><br>Calculate power, defined as the rate of energy transfer into, out of, or within a system. | |
| $p = \frac{m}{V}$<br><br>$\vec{p} = m\vec{v}$<br><br>$\Delta\vec{p} = \vec{F}\Delta t$ | Calculate momentum. | |
| $\tau = r_{\perp}F = rFsin\theta$ | Calculate torque | |
| $L = \mathrm{I}\omega$<br><br>$\Delta L = \tau\Delta t$<br>$L = mvr$ | Use the torque exerted on an object to calculate angular momentum, the magnitude of angular momentum, and change in angular momentum. | |

## ADVANCED PLACEMENT PHYSICS 1 EQUATIONS

| ELECTRICITY | | |
|---|---|---|
| **Equation** | **Usage** | |
| $\left\|\vec{F}_E\right\| = k\left\|\frac{q_1 q_2}{r^2}\right\|$ | Calculate the magnitude of an electric field (Coulumb's Law) | $A$ = area<br>$F$ = force<br>$I$ = current<br>$\ell$ = length<br>$P$ = power<br>$q$ = charge<br>$R$ = resistance<br>$r$ = separation<br>$t$ = time<br>$V$ = electric potential<br>$\rho$ = resistivity |
| $I = \frac{\Delta q}{\Delta t}$ | Calculate conservation of electric charge | |
| $R = \frac{\rho \ell}{A}$ | Calculate resistivity of matter | |
| $I = \frac{\Delta V}{R}$<br>$R_s = \sum_i R_i$<br>$\frac{1}{R_p} = \sum_i \frac{1}{R_i}$ | Describes the conservation of electric charge in electrical circuits (Kirchhoff's junction rule) | |
| $P = I\Delta V$ | Describe conservation of energy in electrical circuits (Kirchoff's loop rule) | |

| WAVES | | |
|---|---|---|
| **Equation** | **Usage** | $f$ = frequency<br>$v$ = speed<br>$\lambda$ = wavelength |
| $\lambda = \frac{v}{f}$ | Calculate the wavelength of a periodic wave | |

| GEOMETRY AND TRIGONOMETRY | | |
|---|---|---|
| **Equation** | **Usage** | |
| $A = bh$ | Area of a rectangle | $A$ = area<br>$C$ = circumference<br>$V$ = volume<br>$S$ = surface area<br>$b$ = base<br>$h$ = height<br>$\ell$ = length<br>$w$ = width<br>r = radius |
| $A = \frac{1}{2}bh$ | Area of a triangle | |
| $A = \pi r^2$<br>$C = 2\pi r$ | Area of a circle<br>Circumference of a circle | |
| $V = \ell wh$ | Volume of a rectangular solid | |
| $V = \pi r^2 \ell$<br>$S = 2\pi r\ell + 2\pi r^2$ | Volume of a cylinder<br>Surface area of a cylinder | |
| $V = \frac{4}{3}\pi r^3$<br>$S = 4\pi r^2$ | Volume of a sphere<br>Surface area of a sphere | |

| | | |
|---|---|---|
| Pythagorean theorem<br>Calculate the value of the angles of a right triangle | $c^2 = a^2 + b^2$<br>$\sin\theta = \frac{a}{c}$<br>$\cos\theta = \frac{b}{c}$<br>$\tan\theta = \frac{a}{b}$ |  |