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Students preparing for SAT2 Physics immediately realize no formula sheet is given on the exam. SAT2 Physics is a standardized test that covers a large variety of topics in fundamental Physics. The test is particularly challenging without a preparation formula sheet. In assisting students preparing for this test, I have not found a concise and complete sheet available on the Internet.

In an effort to make the formula sheet more accessible, I have put together a collection of formula suitable for SAT 2 Physics Subject Test. This formula sheet will also do reasonably well for students taking college board AP1 and AP2 exams, and preparing for the US high school physics bowl competition.

If you find any error or any formula that you feel useful to be added to the formula sheet for SAT2 and AP1/2 exams, please do not hesitate to write me at Fei.Liu@njsci.org. I'll be happy to update the formula sheet for future revisions.

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Physics Formula (Fei.Liu@njsci.org) version 1.6

Kinematics

$$v = v_0 + at$$

$$\Delta x = v_0 t + 1/2 a t^2$$

$$v^2 = v_0^2 + 2a\Delta x$$

$$\Delta x = \frac{v_0 + v}{2} t$$

Dynamics

$$\Sigma \vec{F} = m\vec{a}$$

$$f_k = \mu_k N$$

$$f_s \leq \mu_s N$$

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

$$F_g = G\frac{Mm}{r^2}$$

$$g = \frac{GM}{r^2}$$

$$T = \frac{2\pi r}{v}$$

$$T^2/R^3 = constant$$

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

$$\vec{j} = \vec{F}\ t$$

$$\vec{j} = \Delta\vec{p}$$

$$m_1 v_1 + m_2 v_2 = m_1 v_1' + m_2 v_2'$$

$$KE = 1/2\ mv^2$$

$$GPE = mgh$$

$$EPE = 1/2\ k\Delta x^2$$

$$\vec{F}_T = -k\Delta\vec{x}$$

$$W = F\ d\ cos\theta = F_\parallel\ d = F\ d_\parallel$$

$$W_{net} = \Delta KE$$

$$W_{net,non-conservative} = \Delta E$$
$$= \Delta(KE + GPE + EPE)$$

$$P = \frac{W}{\Delta t} = \frac{\Delta E}{\Delta t} = Fvcos\theta$$

$$f = \frac{1}{T}$$

$$\omega = \frac{2\pi}{T} = 2\pi f$$

$$v_t = r\omega$$

$$a_t = r\alpha$$

$$\tau = rFsin\theta = r_\perp F = rF_\perp$$

$$\Sigma\vec{\tau} = I\vec{\alpha}$$

$$L = r\ mv\ sin\theta$$

$$L = I\ \omega$$

$$T = 2\pi\sqrt{\frac{m}{k}}$$

$$T = 2\pi\sqrt{\frac{L}{g}}$$

$$\rho = \frac{m}{V}$$

$$p = \frac{F}{A}$$

$$p = \rho gh$$

$$F_{buoy} = \rho_{fluid} V_{submerged} g$$

$$\rho_1 v_1 A_1 = \rho_2 v_2 A_2$$

$$p_1 + \frac{1}{2}\rho v_1^2 + \rho g h_1 = p_2 + \frac{1}{2}\rho v_2^2 + \rho g h_2$$

Thermaldynamics

$$\Delta l = l_0(1 + \alpha\Delta T)$$

$$\Delta V = V_0(1 + \beta\Delta T)$$

$$pV = nRT = Nk_B T$$

$$\overline{KE} = 3/2\ k_B\ T$$

$$\Delta E = Q + W_{on\ system}$$

$$W = -p\Delta V$$

$$Q = mc\Delta T$$

$$Q = mL$$

$$\Delta S = \frac{Q}{T}$$

$$Q = \frac{kA\Delta T\ t}{\Delta x}$$

$$Q = \epsilon\sigma T^4 A\ t$$

$$\Delta S_{isolated} \geq 0$$

$$e = \frac{W}{Q_H} \leq \frac{T_H - T_L}{T_H}$$

$$cop = \frac{Q_L}{W} \leq \frac{T_L}{T_H - T_L}$$

Wave, Sound, Optics

$$v = f\lambda$$

$$\lambda_n = \frac{2L}{n}$$

$$I \propto \frac{1}{r^2}$$

$$dB = 10\ log_{10}\frac{I}{I_0}$$

$$f_{obs} = f_{src}\frac{v_{snd} \pm v_{obs}}{v_{snd} \mp v_{src}}$$

$$n = \frac{c}{v}$$

$$n_1 sin\theta_1 = n_2 sin\theta_2$$

$$\frac{1}{f} = \frac{1}{d_{obj}} + \frac{1}{d_{img}}$$

$$m = -\frac{d_i}{d_o} = \frac{h_i}{h_o}$$

$$m\lambda = dsin\theta$$

$$\theta \approx \frac{\lambda}{D}$$

$$I = I_0 cos^2(\theta)$$

Electromagnetism

$$F_e = \frac{kQq}{r^2}$$

$$E = \frac{kQ}{r^2}$$

$$V = \frac{kQ}{r}$$

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

$$\Delta V = \frac{W}{q}$$

$$\Delta V = -Edcos\theta = -E_\parallel d = -Ed_\parallel$$

$$PE_e = \frac{kQq}{r}$$

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

$$R_{eq} = R_1 + R_2 + R_3...$$

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}...$$

$$\Delta V = IR$$

$$P = I\Delta V = I^2 R = \frac{\Delta V^2}{R}$$

$$C = \frac{\epsilon A}{d}$$

$$Q = CV$$

$$PE_e = \frac{1}{2}CV^2 = \frac{1}{2}QV = \frac{1}{2}\frac{Q^2}{C}$$

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}...$$

$$C_{eq} = C_1 + C_2 + C_3...$$

$$\tau = R\ C$$

$$F = qvBsin\theta = qvB_\perp$$

$$F = ILBsin\theta = ILB_\perp$$

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

$$B = \mu_0 nI$$

$$\varepsilon = N\frac{BA}{\Delta t}$$

$$\varepsilon = vlB$$

$$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$

$$\frac{I_s}{I_p} = \frac{N_p}{N_s}$$

Modern Physics

$$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$$

$$t = \gamma\ t_0$$

$$l = \frac{l_0}{\gamma}$$

$$p = \gamma m_0 v$$

$$E = \gamma m_0 c^2 = mc^2$$

$$E = hf$$

$$hf = KE_e + W_0$$

$$\lambda = \frac{h}{m\ v}$$

$$f = \frac{E}{h} = \frac{\sqrt{p^2c^2 + m_0^2 c^4}}{h}$$

$$\Delta E \cdot \Delta t \geq \frac{h}{4\pi}$$

$$\Delta m v_x \cdot \Delta x \geq \frac{h}{4\pi}$$

$$\Delta m v_y \cdot \Delta y \geq \frac{h}{4\pi}$$

$$\Delta m v_z \cdot \Delta z \geq \frac{h}{4\pi}$$

$$N = N_0 e^{-kt}$$

$$t_{\frac{1}{2}} = \frac{ln2}{k}$$

$$E_n = \frac{-13.6eV}{n^2}$$

$$E_n - E_m = hf_{m->n}$$

University of Sussex
Physics and Astronomy Examinations Sub-Board

Table of Physical Constants

Revised January 2008

Electron rest mass	m_e	9.109×10^{-31} kg
Proton rest mass	M_p	1.6726×10^{-27} kg
Electronic charge	e	1.6022×10^{-19} C
Speed of light in free space	c	2.9979×10^{8} m s^{-1}
Permeability of free space	μ_0	$4\pi \times 10^{-7}$ H m^{-1}
Permittivity of free space	ϵ_0	8.854×10^{-12} F m^{-1}
Planck's constant	h	6.626×10^{-34} J s
Reduced Planck's constant	$\hbar = h/2\pi$	1.0546×10^{-34} J s
	$\hbar c$	197.33 MeV fm
Boltzmann's constant	k_B	1.3807×10^{-23} J K^{-1}
Gas constant	$\mathcal{R} = k_B/m_H$	8.250×10^{3} J kg^{-1} K^{-1}
Molar gas constant	R	8.315 J mol^{-1} K^{-1}
Avogadro's number	N_A	6.022×10^{23} mol^{-1}
Standard molar volume		22.414×10^{-3} m^3 mol^{-1}
Unified atomic mass unit (^{12}C scale)	u	931.5 MeV/c^2 = 1.660538×10^{-27} kg
Mass of hydrogen atom	m_H	$1.0078u = 1.6735 \times 10^{-27}$ kg
Bohr magneton	μ_B	9.274×10^{-24} A m^2 or J T^{-1}
Nuclear magneton	μ_N	5.051×10^{-27} A m^2 or J T^{-1}
Proton magnetic moment	μ_p	$2.7928\mu_N$
Neutron magnetic moment	μ_n	$-1.9130\mu_N$
Bohr radius	a_0	5.292×10^{-11} m
Fine structure constant	$\alpha = e^2/(4\pi\epsilon_0\hbar c)$	$(137.04)^{-1}$
Compton wavelength of electron	$\lambda_C = h/(m_e c)$	2.4263×10^{-12} m
Rydberg's constant	R_∞	1.0974×10^{7} m^{-1}
	$R_\infty hc$	13.606 eV
Stefan-Boltzmann constant	σ	5.671×10^{-8} W m^{-2} K^{-4}
Radiation density constant	$a = 4\sigma/c$	7.561×10^{-16} J m^{-3} K^{-4}
Gravitational constant	G	6.673×10^{-11} N m^2 kg^{-2}

Rest masses of some leptons and hadrons in MeV/c^2:

$e^{\pm}$ 0.5110, $\mu^{\pm}$ 105.66, $\tau^{\pm}$ 1777, π^0 134.98, $\pi^{\pm}$ 139.57, $K^{\pm}$ 493.7, K^0 497.7, η 547, D^0 1865, $D^{\pm}$ 1869, p 938.3, n 939.6, Λ^0 1115.7, Σ^+ 1189, Σ^0 1193, Σ^- 1197, Ξ^0 1315, Ξ^- 1321, Ω^- 1672, Z^0 91.187×10^3, $W^{\pm}$ 80.41×10^3.

Quark	Charge	I_3	S	C	B	T	Mass (GeV/c^2)
u	$+\frac{2}{3}$	$\frac{1}{2}$	0	0	0	0	∼0.003
d	$-\frac{1}{3}$	$-\frac{1}{2}$	0	0	0	0	∼0.006
c	$+\frac{2}{3}$	0	0	+1	0	0	∼1.25
s	$-\frac{1}{3}$	0	-1	0	0	0	∼0.11
t	$+\frac{2}{3}$	0	0	0	0	+1	174.3
b	$-\frac{1}{3}$	0	0	0	-1	0	4.2

Astrophysical Data

1 astronomical unit	AU	1.496×10^{11} m
1 parsec	pc	3.086×10^{16} m
Luminosity of Sun	$L_\odot$	3.85×10^{26} W
Mass of Sun	$M_\odot$	1.989×10^{30} kg
Radius of Sun	$R_\odot$	6.96×10^{8} m
Mass of Earth	M_E	5.9742×10^{24} kg
Radius of Earth	R_E	6.3781×10^{6} m

Other data and conversion factors

1 ångstrom	Å	10^{-10} m
1 fermi	fm	10^{-15} m
1 barn	b	10^{-28} m^2
1 pascal	Pa	1 Nm^{-2}
1 standard atmosphere		1.0132×10^{5} Pa
Standard acceleration due to gravity	g	9.807 m s^{-2}
1 electron volt	eV	1.6022×10^{-19} J
	eV/hc	8.065×10^{5} m^{-1}
	eV/k_B	1.1604×10^{4} K
Wavelength of 1 eV photon		1.2399×10^{-6} m

Trigonometrical identities

$$\sin(\theta + \phi) = \sin(\theta)\cos(\phi) + \cos(\theta)\sin(\phi)$$
$$\cos(\theta + \phi) = \cos(\theta)\cos(\phi) - \sin(\theta)\sin(\phi)$$
$$\sin\alpha + \sin\beta = 2\sin\tfrac{1}{2}(\alpha+\beta)\cos\tfrac{1}{2}(\alpha-\beta)$$
$$\cos\alpha + \cos\beta = 2\cos\tfrac{1}{2}(\alpha+\beta)\cos\tfrac{1}{2}(\alpha-\beta)$$
$$\cos\alpha - \cos\beta = 2\sin\tfrac{1}{2}(\alpha+\beta)\sin\tfrac{1}{2}(\beta-\alpha)$$

In a triangle ABC, $a/\sin A = b/\sin B = c/\sin C$

and $a^2 = b^2 + c^2 - 2bc\cos A$

Prefixes

T = tera = 10^{12}
G = giga = 10^{9}
M = mega = 10^{6}
k = kilo = 10^{3}

c = centi = 10^{-2}
m = milli = 10^{-3}
μ = micro = 10^{-6}
n = nano = 10^{-9}
p = pico = 10^{-12}
f = femto = 10^{-15}