2025 PhysicsBowl Exam Constants

Use the following values in determining the answers on this exam. If you use other values in calculating answers, you may obtain values that do not exactly match answer selections found on this exam. You will then need to choose the answer on the test closest to your value.

acceleration due to gravity	g	$= 10\ m/s^2$
gravitational constant	G	$= 6.7\times10^{-11}\ N\cdot m^2/kg^2$
mass of the Earth	M_E	$= 6.0\times10^{24}\ kg$
radius of the Earth	R_E	$= 6.4\times10^{6}\ m$
atomic mass unit	$1\ u$	$= 1.7\ x\ 10^{-27}\ kg$
electron volt	$1\ eV$	$= 1.6\times10^{-19}\ J$
rest mass of electron	m_e	$= 9.1\times10^{-31} kg$
rest mass of proton	m_p	$= 1.7\times10^{-27} kg$
elementary charge	e	$= 1.6\times10^{-19} C$
Coulomb's constant	k	$= 9.0\times10^{9}\ \ N\cdot m^2/C^2$
permittivity constant	ε_0	$= 8.9\times10^{-12}\ \ C^2/N\cdot m^2$
permeability constant	μ_0	$= 4\pi\times10^{-7}\ T\cdot m/A$
speed of sound in air ($20^\circ C$)	v_s	$= 340\ m/s$
speed of light in vacuum	c	$= 3.0\times10^{8}\ \ m/s$
Planck's constant	h	$= 6.6\times10^{-34}\ \ J\cdot s = 4.14\times10^{-15}\ eV\cdot s$
Boltzmann constant	k_B	$= 1.38\times10^{-23}\ \ J/K$
Universal Gas Constant	R	$= 8.21\times10^{-2}\ \frac{L\cdot atm}{mol\cdot K} = 8.31\frac{J}{mol\cdot K}$
Avogadro's Number	N_A	$= 6.02\times10^{23}\ \ mol^{-1}$
Atmospheric Pressure	P_{atm}	$= 1.013\times10^{5}\ \ Pa$

Water Properties:

Latent Heat of Vaporization	L_v	$= 540\ \ kcal/kg\ = 2.3\times10^{6}\ \ J/kg$
Latent Heat of Fusion	L_f	$= 80\ \ kcal/kg\ = 3.3\times10^{5}\ \ J/kg$
Density	ρ_w	$= 1.0\times10^{3}\ \ kg/m^3$
Specific heat	c_w	$= 1.0\ \ kcal/kg\cdot K = 4.2\times10^{3}\ J/kg\cdot K$
Specific heat (ice)	c_i	$= 0.50\ \ kcal/kg\cdot K = 2.1\times10^{3}\ J/kg\cdot K$
Specific heat (vapor)	c_v	$= 0.48\ \ kcal/kg\cdot K = 2.0\times10^{3}\ J/kg\cdot K$

2025 PhysicsBowl Exam Equations

$$\Delta x = v_0 t + \frac{1}{2} a t^2 \qquad v = v_0 + at \qquad v^2 = v_0^2 + 2a\Delta x$$

$$\sum \vec{F} = m\vec{a} \qquad F_{fric} \le \mu F_N \qquad F_g = G\frac{m_1 m_2}{r^2}$$

$$F_g = mg \qquad \vec{p} = m\vec{v} \qquad a = \frac{\boldsymbol{v^2}}{\boldsymbol{r}}$$

$$v_t = r\omega \qquad a_t = r\alpha \qquad \tau = RF\sin\theta = R_\perp F = RF_\perp$$

$$\sum \vec{\tau} = I\vec{\alpha} \qquad KE = \frac{1}{2} m v^2 \qquad \Delta PE_g = mg\Delta y$$

$$W = Fd\cos\theta = F_\parallel d = Fd_\parallel \qquad PE_s = \frac{1}{2} k x^2 \qquad P = \frac{W}{\Delta t}$$

$$\vec{F} = -k\vec{x} \qquad T = 2\pi\sqrt{\frac{m}{k}} \qquad T = 2\pi\sqrt{\frac{L}{g}}$$

$$\rho = \frac{m}{V} \qquad F_{buoy} = \rho g V \qquad P_1 + \frac{1}{2}\rho v_1^2 + \rho g y_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g y_2$$

$$P = \frac{F}{A} \qquad PV = nRT = Nk_B T \qquad \Delta U = Q + W_{on\ system}$$

$$Q = mc\Delta T \qquad Q = \pm mL \qquad \Delta S = \frac{Q}{T}$$

$$v = f\lambda \qquad f_o = f_s\left(\frac{v_{snd} \pm v_{obs}}{v_{snd} \mp v_{src}}\right) \qquad n = \frac{c}{v}$$

$$n_1 \sin\theta_1 = n_2 \sin\theta_2 \qquad m\lambda = d\sin\theta \qquad \frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

$$m = -\frac{d_i}{d_o} \qquad F_e = k\frac{q_1 q_2}{r^2} \qquad \vec{E} = \frac{\vec{F}}{q}$$

$$V = \frac{kq}{r} \qquad V = \frac{W}{q} \qquad \Delta V = -Ed\cos\theta = -E_\parallel d = -Ed_\parallel$$

$$PE_e = \frac{kq_1 q_2}{r} \qquad Q = CV \qquad PE = \frac{1}{2} C V^2$$

$$V = RI \qquad P = IV \qquad F = qvB\sin\theta = qvB_\perp$$

$$B = \frac{\mu_0 I}{2\pi r} \qquad B = \mu_0 nI \qquad F = ILB\sin\theta = ILB_\perp$$

$$\varepsilon = vBL = \left(\frac{B\Delta A}{t}\right)$$

Continued on next page…

$E = \gamma m_0 c^2 = mc^2$ $E = hf$ $p = \frac{h}{\lambda}$

$hf = KE_e + W_0$ $Q = e\sigma T^4 At$

$p = \frac{mv}{\sqrt{1-\frac{v^2}{c^2}}}$ $E = \frac{mc^2}{\sqrt{1-\frac{v^2}{c^2}}}$

Moments of Inertia:

Hoop with a perpendicular axis through its center: $I = MR^2$

Solid disk or cylinder with a perpendicular axis through its center: $I = \frac{1}{2}MR^2$

Solid sphere about a diameter: $I = \frac{2}{5}MR^2$

Thin rod about the center, perpendicular to rod: $I = \frac{1}{12}ML^2$

Thin rod about the end: $I = \frac{1}{3}ML^2$