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TX PACT: PHYSICAL SCIENCE: GRADES 6–12 CONSTANTS

Description	Value
Ideal gas constant (R)	0.0821 L•atm/mol•K = 8.31 J/mol•K
Faraday constant (F)	9.65×10^{4} C/mol e^{-} = 9.65×10^{4} J/V•mol e^{-}
Rydberg constant (R)	1.097×10^{7} m^{-1}
Planck's constant (h)	6.63×10^{-34} J•s = 4.14×10^{-15} eV•s
Boltzmann constant (k_b)	1.38×10^{-23} J/K
Rydberg constant × Planck's constant × speed of light in a vacuum (Rhc)	2.18×10^{-18} J
Molal freezing point depression constant for water (K_f)	1.86°C/m
Molal boiling point elevation constant for water (K_b)	0.51°C/m
Heat of fusion of water (ΔH_{fus})	334 J/g = 80 cal/g = 6.01 kJ/mol
Heat of vaporization of water (ΔH_{vap})	2260 J/g = 540 cal/g = 40.7 kJ/mol
Specific heat (s) of water (liquid)	4.184 J/g•K = 4.184 J/g•°C = 1.0 cal/g•°C
Dissociation constant of water (K_w)	1.0×10^{-14} at 25°C
Standard atmospheric pressure	1 atm = 760 mm Hg = 760 torr = 101.325 kPa
Speed of light in a vacuum (c)	3.00×10^{8} m/s
1 calorie (cal)	4.184 J
1 watt (W)	1 J/s

TX PACT: PHYSICAL SCIENCE: GRADES 6–12 CONSTANTS (continued)

Description	Value
Acceleration of gravity on Earth (g)	$9.80\ m/s^2$
Electron rest mass (m_e)	9.11×10^{-31} kg
Proton rest mass (m_p)	1.67×10^{-27} kg
Elementary charge (e)	1.60×10^{-19} C
Coulomb's constant (k_e)	$8.99 \times 10^9\ N \cdot m^2/C^2$
Gravitational constant (G)	$6.67 \times 10^{-11}\ N \cdot m^2/kg^2$
Permeability of free space (μ_0)	$4\pi \times 10^{-7}$ T•m/A
Avogadro's number (N_A)	6.02×10^{23} particles/mole
Density of water (ρ_w)	$1.00 \times 10^3\ kg/m^3$

TX PACT: PHYSICAL SCIENCE: GRADES 6–12 FORMULAS

Description	Formula
Gibbs free energy equation	$\Delta G = \Delta H - T\Delta S$
Nernst equation	$E = E° - \frac{RT}{n\mathrm{F}} \ln Q$ $E = E° - \left(\frac{0.0257\,\mathrm{V}}{n}\right) \ln Q$ at 298 K $E = E° - \left(\frac{0.0592\,\mathrm{V}}{n}\right) \log Q$ at 298 K
Relationship between emf and free energy change for reactants and products in their standard states	$\Delta G° = -nFE°$
Energy change as an electron transitions between energy states	$\Delta E = Rhc\left(\frac{1}{n_\mathrm{i}^2} - \frac{1}{n_\mathrm{f}^2}\right)$
Henderson-Hasselbalch equation	$\mathrm{pH} = \mathrm{p}Ka + \log\left(\frac{[\text{conjugate base}]}{[\text{acid}]}\right)$
Coulombs (C)	C = amperes × seconds
Photon energy	$E = h\nu$
Speed of light	$c = \lambda\nu$
Nuclear binding energy	$\Delta E = c^2 \Delta m$
Amount of heat (q)	$q = ms\Delta T$
Root-mean-square speed	$u_\mathrm{rms} = \sqrt{\frac{3RT}{M}}$
Graham's law of diffusion	$\frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}}$
Pressure-volume work (at constant pressure)	$w = -P\Delta V$

Mathematics

$C = 2\pi r$

$A = \pi r^2$

$SA = 4\pi r^2$

$V = \frac{4}{3}\pi r^3$

(a, b) denotes a vector with an x-component of a and a y-component of b.

Force and Motion

$v_f = v_i + at$

$x_f = x_i + v_i t + \frac{1}{2}at^2$

$v_f^2 - v_i^2 = 2a(x_f - x_i)$

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

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

$F = -kx$

$F \leq \mu N$

$F = \frac{Gm_1 m_2}{r^2}$

$\theta_f = \theta_i + \omega_i t + \frac{1}{2}\alpha t^2$

$\omega_f = \omega_i + \alpha t$

$v = r\omega$

$a = r\alpha$

$\mathbf{r}_{cm} = \frac{\Sigma m\mathbf{r}}{\Sigma m}$

$I = \Sigma\, mr^2$

$\boldsymbol{\tau} = \mathbf{r} \times \mathbf{F}$

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

$P = \rho gh$

$F = \rho Vg$

$A_1 v_1 = A_2 v_2$

$P + \frac{1}{2}\rho v^2 + \rho g y = \text{constant}$

Energy, Momentum, and Heat Transfer

$W = Fd \cos \theta$

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

$KE = \frac{1}{2}mv^2$

$PE = mgh$

$PE = \frac{1}{2}kx^2$

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

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

$\Delta \ell = \alpha \ell_0 \Delta T$

$Q = mc\Delta T$

$Q = mL$

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

$PV = nRT$

$\frac{1}{2}m\overline{v^2} = \frac{3}{2}k_b T$

$\Delta E = Q - W$

$W = P\Delta V$

$e = \frac{T_h - T_c}{T_h}$

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

$\mathbf{L} = \mathbf{r} \times \mathbf{p}$

$L = I\omega$

$T_k = 273 + T_c$

Electricity and Magnetism

$F = \frac{k_e q_1 q_2}{r^2}$

$\mathbf{E} = \frac{\mathbf{F}}{q_0}$

$PE = qV$

$V = -Ed$

$V = \frac{k_e q}{r}$

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

$V = IR$

$R = \Sigma R_i$

$\frac{1}{R} = \sum \frac{1}{R_i}$

$P = IV$

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

$C = \Sigma C_i$

$\frac{1}{C} = \sum \frac{1}{C_i}$

$\mathbf{F} = q\mathbf{v} \times \mathbf{B}$

$\mathbf{F} = I\boldsymbol{\ell} \times \mathbf{B}$

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

$B = \frac{\mu_0 N I}{\ell}$

$\varepsilon_{ave} = -\frac{\Delta \phi}{\Delta t}$

$\phi = B_\perp A$

In questions on electricity and magnetism, the term *current* refers to "conventional current" and the use of the right-hand rule is assumed.

Waves, Sound, and Light

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

$a = -\omega^2 x$

$x = A \sin \omega t$

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

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

$v = f\lambda$

$v = \sqrt{\frac{T}{\mu}}$

$v = \sqrt{\frac{\gamma RT}{M}}$

$2L = n\lambda$, n is an integer

$4L = n\lambda$, n is odd

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

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

$\frac{1}{f} = \frac{1}{s_i} + \frac{1}{s_0}$

$M = \frac{h_i}{h_0} = -\frac{s_i}{s_0}$

$d \sin \theta = m\lambda$

$I = I_0 \cos^2 \theta$

Modern Physics

$E = hf$

$E = \gamma mc^2$

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

$hf = \phi + eV$

$\Delta x \Delta p \geq h$

$\Delta E \Delta t \geq h$

$p = \frac{h}{\lambda}$

NOTES

Not all constants and formulas necessary are listed, nor are all constants and formulas listed used on this exam.

While attention has been paid to significant figures, no answer should be considered incorrect solely because of the number of significant figures.

In questions on electricity and magnetism, the term *current* refers to "conventional current" and the use of the right-hand rule is assumed.