Physics 12—Equation Sheet

Motion

$$v = \frac{\Delta d}{\Delta t} \tag{1}$$
$$v_f = v_i + at \tag{2}$$
$$d = \frac{(v_f + v_i)t}{2} \tag{3}$$
$$d = v_i t + \tfrac{1}{2}at^2 \tag{4}$$
$$v_f^2 = v_i^2 + 2ad \tag{5}$$

Forces

$$F_{net} = ma \tag{6}$$
$$F_f = \mu F_N \tag{7}$$
$$F_g = mg \tag{8}$$
$$g = -9.80\,\mathrm{m/s^2} \tag{9}$$
$$F = kx \tag{10}$$

Energy

$$\mathrm{KE} = \tfrac{1}{2}mv^2 \tag{11}$$
$$\mathrm{PE} = mgh \tag{12}$$
$$\mathrm{KE}_1 + \mathrm{PE}_1 = \mathrm{KE}_2 + \mathrm{PE}_2 \tag{13}$$
$$\mathrm{EE} = \frac{1}{2}kx^2 \tag{14}$$

Work

$$W = Fd\cos\theta \tag{15}$$
$$W_{net} = \Delta\mathrm{KE} + \Delta\mathrm{PE} \tag{16}$$
$$P = \frac{W}{t} \tag{17}$$

Momentum

$$\Delta p = m\Delta v \tag{18}$$
$$J = F\Delta t = m\Delta v \tag{19}$$

Machines

$$\mathrm{MA} = \frac{F_R}{F_e} \tag{20}$$
$$\mathrm{IMA} = \frac{d_e}{d_R} \tag{21}$$
$$\mathrm{eff} = \frac{\mathrm{MA}}{\mathrm{IMA}} \times 100\% \tag{22}$$
$$\mathrm{eff} = \frac{W_o}{W_i} \times 100\% \tag{23}$$
$$W_o = F_R\, d_R \tag{24}$$
$$W_i = F_e\, d_e \tag{25}$$

Waves

$$v = \lambda f \tag{26}$$
$$v = \frac{\lambda}{T} \tag{27}$$
$$f = \frac{1}{T} \tag{28}$$
$$f' = f\left(\frac{v + v_o}{v - v_s}\right) \tag{29}$$
$$v = 331 + 0.6T \tag{30}$$

Light

$$n = \frac{c}{v} \tag{31}$$
$$n_i \sin\theta_i = n_r \sin\theta_r \tag{32}$$
$$c = 3.00 \times 10^8\,\mathrm{m/s} \tag{33}$$

Mirrors/Lenses

$$\frac{1}{f} = \frac{1}{d_i} + \frac{1}{d_o} \tag{34}$$
$$m = \frac{h_i}{h_o} = -\frac{d_i}{d_o} \tag{35}$$
$$d_i = \frac{f d_o}{d_o - f} \tag{36}$$
$$d_o = \frac{f d_i}{d_i - f} \tag{37}$$
$$f = \frac{d_i d_o}{d_i + d_o} \tag{38}$$

Object	Mass (kg)	Radius of object (m)	Period of rotation on axis (s)	Mean radius of orbit (m)	Period of revolution of orbit (s)	Kepler constant R^3/T^2 ($\mathrm{m^3/s^2}$)
sun	1.98×10^{30}	6.95×10^8	2.14×10^6	—	—	3.35×10^{18}
Mercury	3.28×10^{23}	2.57×10^6	5.05×10^6	5.79×10^{10}	7.60×10^6	3.35×10^{18}
Venus	4.83×10^{24}	6.31×10^6	2.1×10^7	1.08×10^{11}	1.94×10^7	3.35×10^{18}
Earth	5.98×10^{24}	6.38×10^6	8.61×10^4	1.49×10^{11}	3.16×10^7	3.35×10^{18}
Mars	6.37×10^{23}	3.43×10^6	8.85×10^4	2.28×10^{11}	5.94×10^7	3.35×10^{18}
Jupiter	1.90×10^{27}	7.18×10^7	3.54×10^4	7.78×10^{11}	3.74×10^8	3.35×10^{18}
Saturn	5.67×10^{26}	6.03×10^7	3.60×10^4	1.43×10^{12}	9.30×10^8	3.35×10^{18}
Uranus	8.80×10^{25}	2.67×10^7	3.88×10^4	2.87×10^{12}	2.66×10^9	3.34×10^{18}
Neptune	1.03×10^{26}	2.48×10^7	5.69×10^6	4.50×10^{12}	5.20×10^9	3.37×10^{18}
Pluto	6×10^{23}	3×10^7	5.51×10^5	5.9×10^{12}	7.82×10^9	3.36×10^{18}
moon	7.34×10^{22}	1.74×10^6	2.36×10^6	3.8×10^8	2.36×10^6	—

Torque

$$\tau = F_{\perp}\text{leverarm} \tag{39}$$

Centripetal

$$v_c = \frac{2\Pi r}{\mathrm{T}} \tag{40}$$
$$a_c = \frac{{v_c}^2}{r} \tag{41}$$
$$F_c = \frac{mv^2}{r} \tag{42}$$
$$F_c = \frac{4\Pi^2 mr}{T^2} = 4\Pi^2 mrf^2 \tag{43}$$
$$\tan\theta = \frac{v^2}{rg} \tag{44}$$

Gravitational

$$F_g = \frac{Gm_1m_2}{d^2} \tag{45}$$
$$g = \frac{Gm_1}{d^2} \tag{46}$$
$$k = \frac{r^3}{T^2} \tag{47}$$
$$v = \sqrt{\frac{Gm}{r}} \tag{48}$$
$$T = 2\Pi\sqrt{\frac{R^3}{Gm}} \tag{49}$$

Electricity and Magnetism

$$F_e = k\frac{q_1q_2}{r^2} \tag{50}$$
$$\varepsilon = k\frac{q_1}{r^2} \tag{51}$$
$$\varepsilon = \frac{F_e}{q} \tag{52}$$
$$I = \frac{q}{t} \tag{53}$$
$$V = \frac{\Delta E}{q} \tag{54}$$
$$V = lvB \tag{55}$$
$$V = IR \tag{56}$$
$$P = IV = I^2R \tag{57}$$
$$F_m = B_{\perp}Il\sin\theta \tag{58}$$
$$F_m = Bqv\sin\theta \tag{59}$$
$$\frac{N_p}{N_s} = \frac{V_p}{V_s} = \frac{I_s}{I_p} \tag{60}$$

Simple Harmonic Motion

$$T = 2\Pi\sqrt{\frac{1}{g}} \tag{61}$$
$$T = 2\Pi\sqrt{\frac{m}{k}} \tag{62}$$
$$F_s = -kx \tag{63}$$
$$\mathrm{EE} = \tfrac{1}{2}kx^2 \tag{64}$$

Quantum and Nuclear

$$E_n = \frac{-13.6}{n^2}\mathrm{eV} \tag{65}$$
$$\lambda = \frac{h}{mv} \tag{66}$$
$$p = \frac{h}{\lambda} = \frac{hf}{c} \tag{67}$$
$$c = f\lambda \tag{68}$$
$$E_{\text{photon}} = hf = \frac{hc}{\lambda} \tag{69}$$
$$E_{\text{photon}} = pc \tag{70}$$
$$E_{\text{photon}} = |E_f - E_i| \tag{71}$$
$$E = mc^2 \tag{72}$$
$$E_k = hf - hf_0 \tag{73}$$
$$E_k = QV_0 \tag{74}$$
$$N = N_0\left(\frac{1}{2}\right)^{\frac{\Delta t}{T_{1/2}}} \tag{75}$$

Constants

$G = 6.67 \times 10^{-11}\ \mathrm{Nm^2/kg^2}$
$k = 9.0 \times 10^{9}\ \mathrm{Nm^2/C^2}$
$e = 1.6 \times 10^{-19}\ \mathrm{C}$
$m_e = 9.11 \times 10^{-31}\ \mathrm{kg} = 0.000549\ \mathrm{u}$
$m_p = 1.672 \times 10^{-27}\ \mathrm{kg} = 1.007276\ \mathrm{u}$
$m_n = 1.675 \times 10^{-27}\ \mathrm{kg} = 1.008665\ \mathrm{u}$
$1\ \mathrm{u} = 1.6605 \times 10^{-27}\ \mathrm{kg}$
$h = 6.63 \times 10^{-34}\ \mathrm{J/Hz}$ or Js
$c = 3.00 \times 10^{8}\ \mathrm{m/s}$
$1\ \mathrm{eV} = 1.6 \times 10^{-19}\ \mathrm{J}$