Formula Sheet for Exam 3 and Final – Page 1 of 2

1. $v = v_0 + a(t - t_0)$
2. $x = x_0 + v_0(t - t_0) + \frac{1}{2}a(t - t_0)^2$
3. $x = x_0 + \frac{1}{2}(v_0 + v)(t - t_0)$
4. $x = x_0 + v(t - t_0) - \frac{1}{2}a(t - t_0)^2$
5. $v^2 = v_0^2 + 2a(x - x_0)$
6. $\sum \vec{F} \equiv \vec{F}_{net} = m\vec{a}$
7. $T = \frac{2\pi r}{v}$
8. $a_{centripetal} = \frac{v^2}{r} = \omega^2 r$
9. $F_{centripetal} = m\frac{v^2}{r} = m\omega^2 r$
10. $\vec{p} \equiv m\vec{v}$
11. $\sum \vec{F} \equiv \vec{F}_{net} = \frac{d\vec{p}}{dt}$
12. $\vec{J} \equiv \int \vec{F}_{net}\, dt = \Delta\vec{p}$
13. $\vec{P} = \sum \vec{p}_i$
14. $\frac{d\vec{P}}{dt} = \sum \vec{F}_{ext}$
15. $M = \sum m_i$
16. $x_{cm} = \frac{1}{M}\sum m_i x_i \qquad y_{cm} = \frac{1}{M}\sum m_i y_i$
17. $\vec{P} = M\vec{v}_{cm}$
18. $\vec{a} \cdot \vec{b} = |\vec{a}||\vec{b}|\cos(\phi) = a_x b_x + a_y b_y$
19. $W = \vec{F} \cdot \vec{d}$
20. $W = \int \vec{F} \cdot d\vec{x}$
21. $K = \frac{1}{2}mv^2 = \frac{1}{2}m(v_x{}^2 + v_y{}^2)$
22. $K_f - K_i = W_{net}$
23. $U = -\int \vec{F}_{cons} \cdot d\vec{x}$
24. $U_g = mg(y - y_0)$
25. $U_s = \frac{1}{2}k(x - x_0)^2$
26. $\Delta K + \Delta U = W_{non-cons}$
27. $s = \theta r$
28. $v_{tangential} = \omega r$
29. $a_{tangential} = \alpha r$
30. $\omega = \omega_0 + \alpha(t - t_0)$
31. $\theta = \theta_0 + \omega_0(t - t_0) + \frac{1}{2}\alpha(t - t_0)^2$
32. $\theta = \theta_0 + \frac{1}{2}(\omega_0 + \omega)(t - t_0)$
33. $\theta = \theta_0 + \omega(t - t_0) - \frac{1}{2}\alpha(t - t_0)^2$
34. $\omega^2 = \omega_0^2 + 2\alpha(\theta - \theta_0)$
35. $|\vec{a} \times \vec{b}| = |\vec{a}||\vec{b}|\sin(\phi)$
36. $I = \sum m_i r_i{}^2$
37. $K_{rot} = \frac{1}{2}I\omega^2$
38. $W = \int \vec{\tau} \cdot d\vec{\theta}$
39. $\vec{\tau} = \vec{r} \times \vec{F}$
40. $\sum \vec{\tau} = I\vec{\alpha} = \frac{d\vec{L}}{dt}$
41. $\vec{l} = \vec{r} \times \vec{p}$
42. $\vec{L} = \sum \vec{l}_i$
43. $\vec{L} = I\vec{\omega}$

44x. $m_1 v_{1,x,before} + m_2 v_{2,x,before} = m_1 v_{1,x,after} + m_2 v_{2,x,after}$

44y. $m_1 v_{1,y,before} + m_2 v_{2,y,before} = m_1 v_{1,y,after} + m_2 v_{2,y,after}$

45a. $v_{1,f} = \frac{m_1 - m_2}{m_1 + m_2} v_{1,i} + \frac{2m_2}{m_1 + m_2} v_{2,i}$

45b. $v_{2,f} = \frac{2m_1}{m_1 + m_2} v_{1,i} + \frac{m_2 - m_1}{m_1 + m_2} v_{2,i}$

Formula Sheet for Exam 3 and Final – Page 2 of 2

46a. $|\vec{F}| = G\frac{m_1 m_2}{r^2}$

46b. $\vec{F} = G\frac{m_1 m_2}{r^2}\hat{r}$

47a. $|\vec{F}| = \frac{1}{4\pi\varepsilon_0}\frac{|q_1||q_2|}{r^2}$

47b. $\vec{F} = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}(-\hat{r})$

48a. $|\vec{E}_i| = \frac{1}{4\pi\varepsilon_0}\frac{|q_i|}{r_i^{\,2}}$

48b. $\vec{E} = \sum\frac{1}{4\pi\varepsilon_0}\frac{q_i}{r_i^{\,2}}(-\hat{r}_i)$

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

50. $V = \sum\frac{1}{4\pi\varepsilon_0}\frac{q_i}{r_i}$

51. $U = qV$

52. $V = -\int\vec{E}\cdot d\vec{x}$

53x. $E_x = -\frac{\partial V}{\partial x}$

53y. $E_y = -\frac{\partial V}{\partial y}$

54. $\vec{F} = q\vec{v}\times\vec{B}$

55. $r = \frac{mv}{qB}$

Useful Constants

(You can use the approximate values on tests.)

Universal Gravitation Constant	$G = 6.673\times10^{-11}\ \mathrm{N\,m^2\,kg^{-2}} \approx 6.67\times10^{-11}$
Electrostatic Force Constant	$\frac{1}{4\pi\varepsilon_0} = 8.987551788\times10^{+9}\ \mathrm{N\,m^2\,C^{-2}} \approx 9.0\times10^{+9}$
Magnetic Constant	$\mu_0 = 4\pi\times10^{-7}\ \mathrm{H\,m^{-1}} \approx 1.26\times10^{-6}$
Speed of Light in Vacuum	$c = 2.99792458\times10^{+8}\ \mathrm{m\,s^{-1}} \approx 3.0\times10^{+8}$
Charge of a Proton	$e = 1.602176462\times10^{-19}\ \mathrm{C} \approx 1.6\times10^{-19}$
Electron-Volt Conversion Constant	$1\mathrm{eV} = 1.602176462\times10^{-19}\ \mathrm{J} \approx 1.6\times10^{-19}$
Mass of a Proton	$m_p = 1.67262158\times10^{-27}\ \mathrm{kg} \approx 1.67\times10^{-27}$
Mass of an Electron	$m_e = 9.10938188\times10^{-31}\ \mathrm{kg} \approx 9.1\times10^{-31}$