AP Physics C: Mechanics Outline

June 2012

1 Motion in One Dimension

Name	Definition	Equations / Examples
Position	location of a particle with respect to a chosen reference point (origin)	
Displacement	change in position over time interval	$\Delta x = x_f - x_i$
Distance	length of particle followed by a particle	
Vector quantity	requiring both direction and magnitude	5m north
Scalar quantity	requiring only magnitude	5m
Average Velocity	displacement over time interval	$\overline{v}_x = \frac{\Delta x}{\Delta t}$
Average Speed	total distance over total time to travel	$\overline{speed} = \frac{totaldistance}{totaltime}$
Instantaneous Velocity	velocity at one time	$v_x = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt}$
Instantaneous Speed	speed at one time	
Average Acceleration	change in velocity over interval of time	$\overline{a}_x = \frac{\Delta v_x}{\Delta t} = \frac{V_f - V_i}{t_f - t_i}$
Instantaneous Acceleration	change in velocity at one time	$\overline{a}_x = \lim_{\Delta t \to 0} \frac{\Delta V_s}{\Delta t} = \frac{dv_s}{dt}$
Kinematics	1-dimensional motion with constant acceleration	$v = v_o + a \cdot t$ $\Delta x = \frac{v+v_o}{2} t$ $\Delta x = v_o t + .5at^2$ $v^2 = v_x^2 + 2\Delta x \cdot a$
Freely Falling Object	any object moving under influence of gravity alone a_x is always down (regardless of initial motion)	

2 Vectors

Name	Definition	Equations / Examples
Adding Vectors	draw from head → tail	
Subtracting Vectors	same as adding negatives of vectors	$\vec{A} - \vec{B} = \vec{A} + -\vec{B}$
Components	projects of vectors along coordinate axis	$A_x + A_y = A$
Unit Vector	dimensions vectors of magnitude 1	$\hat{\mathbf{i}}(i - hat) : x - axis$ $\hat{\mathbf{j}}(j - hat) : y - axis$ $\hat{\mathbf{k}}(k - hat) : z - axis$
Positional Vector ($\hat{r}$)	vector lying in plane	

3 Motion in Two Dimensions

Name	Definition	Equations / Examples
Uniform Circular Motion	object moving in circular path with constant speed v	
Centripetal Acceleration	where the acceleration vector is always perpendicular to the path and always points towards the center	a_c or $a_r = \frac{v^2}{r}$
Period	time required for one complete revolution	$T = \frac{2\pi r}{v}$
Tangential Acceleration	causes change in speed of particle	$a_t = \frac{d\lvert v\rvert}{dt}$ $a_r = -a_c = \frac{-v^2}{r}$ $a = a_t + a_r$
Relative Velocity	Velocity in reference to one perspective	
Relative Acceleration	Acceleration in reference to one perspective	

4 The Laws of Motion

Name	Definition	Equations / Examples
Net Force	Vector sum of all forces acting on an object	$\sum F$
Equlibrium		$\sum F = 0$
Netwon's Laws of Motion:		
First	When no force acts on an object, the acceleration is 0.	
Second	Acceleration of an object is directly proportional to the net force acting on it and inversely proportional to its mass.	$\sum F = ma$
Third	Every force has an equal but opposite force (action/reaction)	$F = -F$
Inertia	tendency of an object to resist any attempt to change its velocity	
Gravitational Force	attractive force exterted by earth	$F_g = mg$
Normal Force	the reaction force of F_g; perpendicular to F_g	$F_g = -F_N$
Free-Body Diagram	depicts an object with all of the forces acting on it	
Tension	a force of pull on an object (mainly found in strings and ropes)	T
Friction	resistance to motion either on surface or in air/water	
Force of Static Friction	resistance to motion that keeps an object in place	$f_s \leq \mu n$
Force of Kinetic Friction	friction force for an object in motion	$f_k = \mu n$
Coefficient of Static Friction	dimensionless constant	μ_s
Coefficient of Kinetic Friction	dimensionless constant (generally less than μ_s	μk

5 Circular Motion and Other Applications of Newton's Laws

Name	Definition	Equations / Examples
		$\sum F = ma_c = m\frac{v^2}{r}$

6 Energy and Energy Transfer

Name	Definition	Equations / Examples
Work	done on a system by an agent exerting a constant force an energy transfer between a system and agent	$W \equiv F\Delta rcos(\theta)$ $W \equiv F\Delta x$ Varying force: $W = \int_{x_i}^{x_f} F_x dx$
Power	time rate of energy transfer	$P \equiv \frac{W}{\Delta t} = \frac{dW}{dt} = F \cdot \frac{dr}{dt} = F \cdot v$

7 Potential Energy

Name	Definition	Equations / Examples
Potential Energy	energy possessed by virtue of position relative to others	U
Gravitational Potential Energy	potential to be pushed around by a force	$U_g \equiv mgy$ $W = \Delta U_g$
Conservation of Mechanical Energy (in an isolated system)	no energy transfer occurs sum of kinetic and potential energies remain constant	$E_{mech} = K + U$ $E_f = E_i$
Elastic Potential Energy	potential energy of springs	$U_s \equiv \frac{1}{2}kx^2$
Conservative Forces	force where only initial and final states matter (energy is conserved)	$W_c = U_f - U_i = \Delta U$