Class Notes: Lecture 4 — 3 September 2009

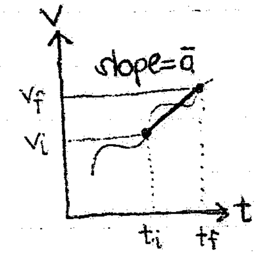
Average Acceleration

Changing velocity (non-uniform) means an acceleration is present

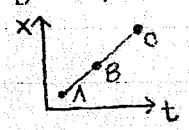
Acceleration: rate of change of the velocity

$\bar{a} = \Delta v / \Delta t = (v_f - v_i)/(t_f - t_i)$

Units are m/s^2 (SI), cm/s^2 (cgs), ft/sec^2 (US)



If $\bar{a}$ from A to C 2m/s, what is ...ue? ...s: A to B $\bar{a}$ = 2m/s ...$_A$ = 2m/s, and ...$_B$ = 2m/s



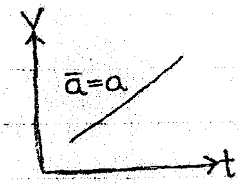
Instantaneous Acceleration

$a = \lim_{\Delta t \to 0} \Delta v / \Delta t$ slope of the line tangent to that specific pt.

Uniform/ Constant Acceleration

Velocity-vs.-time graph is a straight line

Most of our problems will have constant a, but multiple segments



Acceleration

...iving negative ...celeration does ...T always mean slowing down

Vector quantity: has direction and magnitude

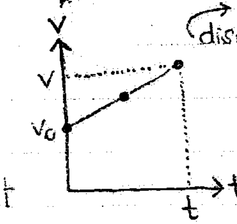
If the sign of the velocity & acceleration is the same, speed = increasing

If the sign of the velocity & acceleration is different, speed = decreasing

Kinematic Equations

Used in situations with uniform acceleration to find out unknown quantities using given values

$v_i = v_0$, $v_f = v$, $\Delta t = t$, $d = \Delta x$ displacement



$a = \frac{v_f - v_i}{\Delta t}$, $a = \frac{v - v_0}{t}$, $at = v - v_0$ →

$v = v_0 + at$

Shows velocity as a function of acceleration and time

Use when: don't know/ aren't asked to find displacement

$x = [(v_0 + v_0 + at)t]/2$, $x = \frac{2v_0t + at^2}{2}$ →

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

Gives displacement as a function of time, velocity, acceleration

Use when: don't know/ aren't asked to find final velocity

④ from ① and ②: $\Delta x = \frac{(v+v_0)}{2}\frac{(v-v_0)}{a}$, $2a\Delta x = v^2 - v_0^2$ →

$v^2 = v_0^2 + 2a\Delta x$

Gives velocity as a function of acceleration, displacement

Use when: don't know/ aren't asked for time

$v_{avg} = \frac{\Delta x}{t}$, $v_{avg} = \frac{v_0 + v}{2}$, $\Delta x = v_{avg}(t)$ →

$\Delta x = v_{average}\, t = [(v_0 + v)/2]\, t$

Gives displacement as a function of velocity, time

Use when: don't know/ aren't asked for acceleration

Free Fall

All objects moving under the influence of gravity only are said to be in free fall

All objects falling near the earth's surface fall w/ a constant acceleration

The acceleration is called "the acceleration due to gravity"; indicated by **g**

Acceleration Due to Gravity

- Symbolized by g
- $g = 9.8\ m/s^2$ (or $g \approx 10\ m/s^2$ for estimating)
- Always directed downward, towards the center of the earth
- Ignoring air resistance & assuming g doesn't vary w/ altitude over short distances (vertical), free fall is constantly accelerated motion

Example (#2.49):

initial speed = +50.0 m/s

acc = $2.00\ m/s^2$

engines stop @ alt. = 150 m

a) acc = ? when engines are on? $2.00\ m/s^2$

b) acc = ? when engines are off? $-9.8\ m/s^2$