Mechanics

Lecture 1

Tasks for This week:
1) Chapters 1 – 5 in Tipler & Mosca
2) Core exercises 1.

How things are written

position	$\underline{r}$	or	$x\hat{i}$
disp	$\Delta\underline{r}$	or	$\Delta x\hat{i}$ or $(x_f - x_i)\hat{i}$ ← for motion in x direction, y is $\hat{j}$, z is $\hat{k}$
velocity	$\bar{\underline{v}}$	or	$\frac{\Delta x}{\Delta t}\hat{i}$ ← average
inst vel	$\underline{v}$	or	$\frac{dx}{dt}\hat{i}$

just like at school!

inst speed as above with a box $|\underline{v}|$

acceleration $\bar{\underline{a}}$ or $\frac{\Delta \underline{v}}{\Delta t}$ ← average

inst $\underline{a}$ or $\frac{d\underline{v}}{dt}$ or $\frac{d^2x}{dt^2}\hat{i}$

Lecture 2

Position Vector: $\underline{r} = x\hat{i} + y\hat{j}$ just like A-level

Thus:

$$\Delta\underline{r} = \underline{r}_f - \underline{r}_i = \Delta x\hat{i} + \Delta y\hat{j}$$

remember proving Hubble's Law?

This also produces the direction of the average velocity $\bar{\underline{v}}$.

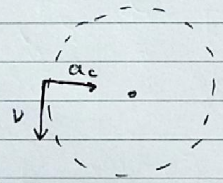
Little Recap:

$|\underline{r}| = \sqrt{x^2+y^2} \equiv r$ ← no underline

$\tan\theta = \frac{r_y}{r_x}$

Uniform Circular motion

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



Lecture 3

Newtons laws Recap

1st law: if $\Sigma F = 0$ then $a = 0$

whether you remain at rest / constant velocity depends on inertial reference frame.

Inertial reference frames – where Newton's laws are valid, Earth is an inertial reference frame for ease of in maths questions.

Force An external action, causes acceleration relative to an inertial frame. It is a VECTOR!

ΣForces $= F_1 + F_2 + F_3$ for resultant forces

To do this → $= (x_1 + x_2 + x_3)\hat{i} + (y_1 + y_2 + y_3)\hat{j} + (z_1 + z_2 + z_3)\hat{k}$

Inertial Mass — resistance to a change in velocity
↑ Inertia - resistance to motion.
Scalar — Mass - measure of inertia.

2nd Law $\Sigma F = ma$
↳ You MUST write this! ⚠
It only applies to a single object at a time.
Also, since $a \propto \frac{k}{m}$ a larger mass (more inertial mass) will accelerate slowly, it incorporates 1st Law!

3rd Law $F_{AB} = -F_{BA}$
(F_{AB} = Force of A on B btw)
Applies to 2 distinct objects, and always occurs in pairs!
It actually says nothing on motion!

Lecture 4

Friction

Caused by molecular adhesion (bonds forming & breaking), surface roughness, and deformation (one surface ploughs into another).
Static friction (opposes motion) $F_s \leq \mu_s F_N$
Kinetic friction (slows motion) $F_k = \mu_k F_N$

Circular Motion

$a_c = \frac{v^2}{r}$ $\Sigma F_r = m\frac{v^2}{r}$ Centripetal force exists, centrifugal force doesn't!