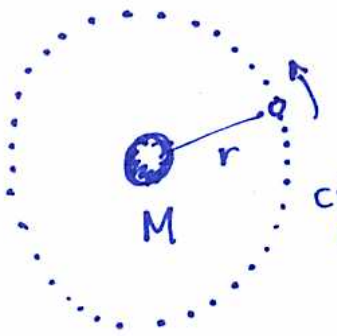
AY 212
THE TWO BODY PROBLEM

For the problem of two bodies, we have an astronomical case of one size fits all: at the AY2 level, we have:



$$F = ma \Rightarrow \frac{v^2}{r} = \frac{GM}{r^2} \; ; \; 2\pi r = vP \rightarrow P^2 = \frac{4\pi^2}{GM} r^3$$

KEY IDEA → An orbit is a state of continuous free fall.

The apocrophal(?) story of Newton and the apple:

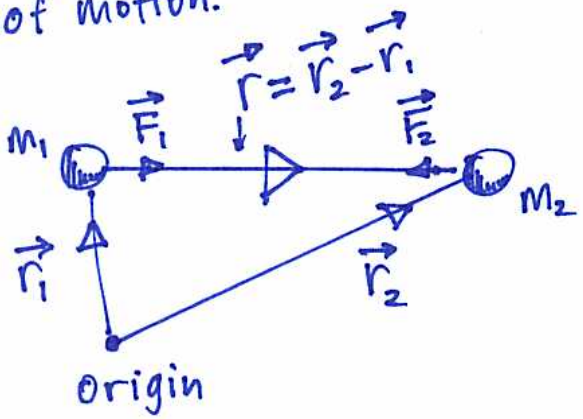
For the moon: $P^2 = \frac{4\pi^2}{GM} r^3_{\text{moon orbit}}$ (P: known; GM: determined; $r_{\text{moon orbit}}$: known)

determined → agreement in 1666 to 15% "pretty nearly"

For the apple: $g = \frac{GM}{r^2_{\oplus}}$ (g: known; $r_{\oplus}$: known)

Colwell, P. 1993 "Solving Kepler's equation over 3 centuries" (Willmann-Bell: Richmond)

- Scientific papers about the solution of the 2-body problem have been published in nearly every decade since 1650.
- n=1, n=2 are the only n-body systems for which an analytic solution describes the fully general possibilities of motion.



Newton II + Universal Gravitation

1. $\vec{F}_1 = +\frac{GM_1M_2}{r^3}\vec{r} = M_1\ddot{\vec{r}}_1$

2. $\vec{F}_2 = -\frac{GM_1M_2}{r^3}\vec{r} = M_2\ddot{\vec{r}}_2$