1 What is Classical Mechanics?

Classical Mechanics (CM) - A theory (framework) for predicting the future location (trajectory) of particles given their current positions and velocities

$$x_0,\, v_0 \to x(t),\, v(t) \quad \forall\, t > 0$$
$$\implies \text{deterministic "clockwork" universe}$$

Breaks down at:

1. High Speeds (Special Relativity)
2. Large Mass (General Relativity)
3. Small Scale (Quantum Mechanics)

2 Notation

2.1 Degrees of Freedom (dof)

Configuration - Set of numbers $\{q_1, \ldots, q_N\}$ required to specify the state of the mechanical system
Each q_i is a degree of freedom (dof)

1. 1 dof - $x(t)$
2. 2 dof - $\vec{r} = \begin{bmatrix} x \\ y \end{bmatrix}$
3. 3 dof - $\vec{r} = \begin{bmatrix} x \\ y \\ z \end{bmatrix}$
4. 6 dof (Spin) - $\{q_i\} = \{\vec{r}, \alpha, \beta, \delta\}$ Euler Angles
5. (Deformation) - Need field $R(\theta, \phi)$
6. Positions of every $10^{26}th$ atom

For 1-6, Newton predicts trajectory $q_i(t)$ from $q_i(t=0), v_i(t=0) = \frac{dq_i}{dt} = \dot{q}_i$

$\implies$ Physics is all about making "things as simple as possible, but no simpler" (Einstein)

3 Dimensional Analysis

$[\ldots]$ = Dimension of ...

If answer is $A = B$, check that $[A] = [B]$

Table 1: Base Quantities

Quantity	Length	Time	Mass
SI Unit	meter 'm'	second 's'	kilogram 'kg'
Measured	L	T	M