Dynamics 2 (MECE08009)

Particles in Linear Motion
(Dynamics of Single Particles)

d'Alembert Approach

- Newton's 2nd Law (N2) in vector form:

$$\Sigma \mathbf{P} = M\mathbf{a}$$

- re-write as

$$\Sigma \mathbf{P} - M\mathbf{a} = \mathbf{0} \quad \text{or} \quad \Sigma \mathbf{P} + M(-\mathbf{a}) = \mathbf{0}$$

- $M(-\mathbf{a})$ is the particle "inertia force".
- include as a "double-headed arrow" on the FBD, acting in *opposite* direction to acceleration

D'Alembert Approach

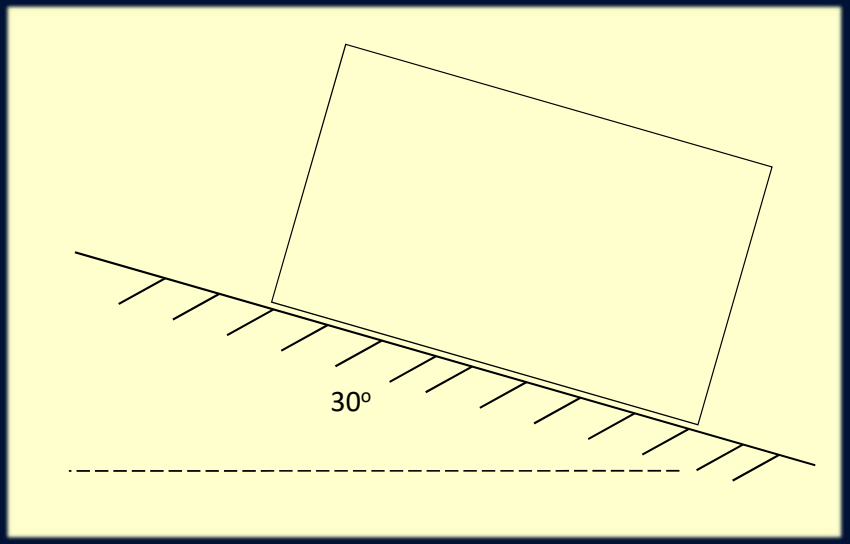
- D'Alembert form of N2

$$\Sigma \mathbf{P} + M(-\mathbf{a}) = \mathbf{0}$$

- "the sum of the forces, including the particle inertia force, must be zero"
  - FBD including the inertia force must satisfy vector equilibrium
  - i.e. drawn in opposite direction to acceleration
- true for vector components
- looks trivial, but very powerful – use it!

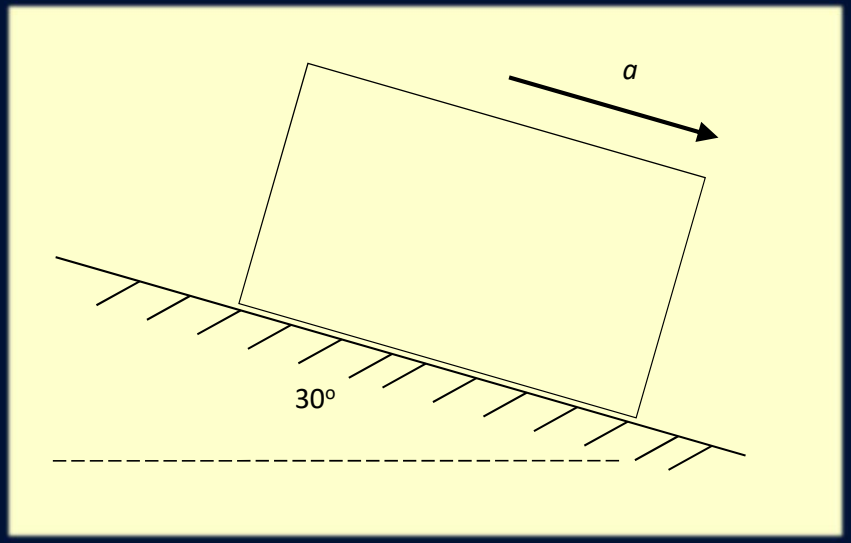
Example 1.1

- block of mass 2 kg on 30° slope
- coefficient of friction $\mu = 0.4$ for both static and kinetic friction
- using D'Alembert, determine if the block slides, and if it slides, what is its acceleration?



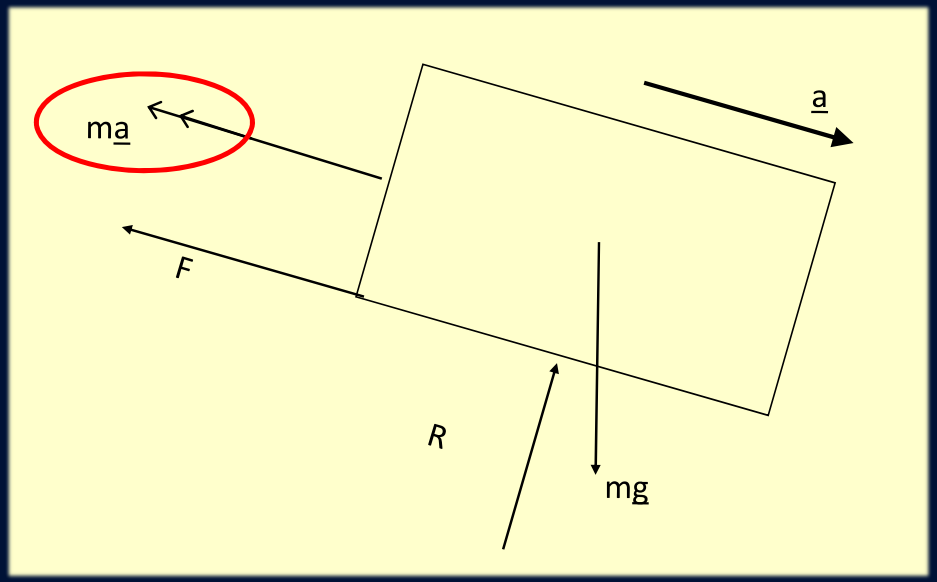
Example 1.1 (D'Alembert solution)

- (a) & (b): assume block sliding *down* the slope and accelerating at *a*



Example 1.1 (D'Alembert solution)

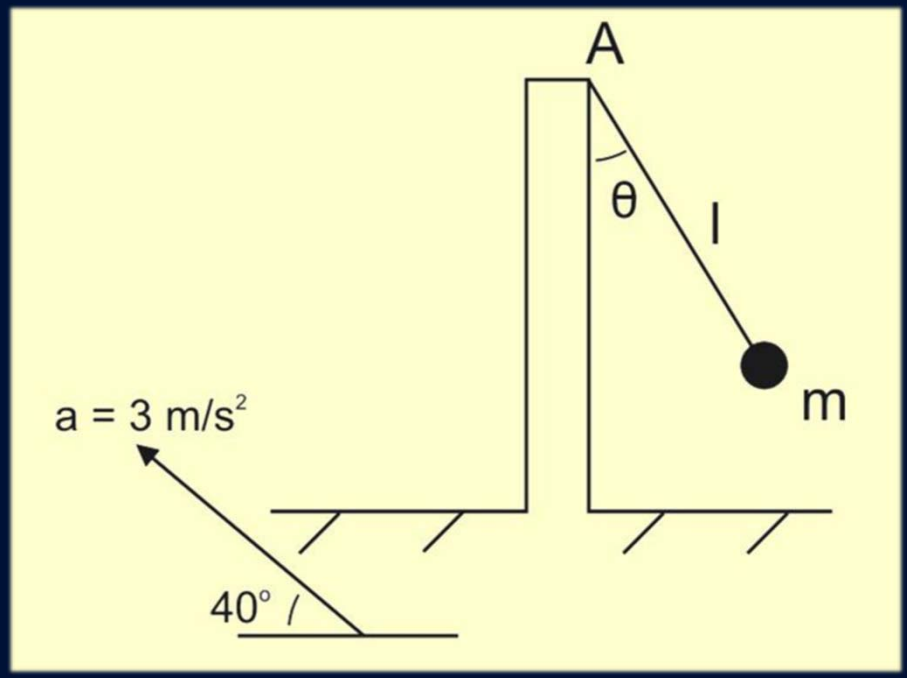
- Draw FBD including Inertia Force
  - acts in *opposite* direction to a
  - i.e. *up* the slope
  - double headed arrow



- resolve force components....

Example 1.3

- 0.5 kg mass m
- 0.2 m wire
- platform accelerates at 3 m/s^2 at 40°
- what is steady state angle θ?
- what is the force on the bar at A?
- what would the results be if m = 0.95 kg ?



Example 1.4

- A 1.4 kg mass m on a wedge-shaped block
- a) if the block is accelerated to the right at 16 m/s² does the mass slip? (μ = 0.6)
- b) if it slips what is the acceleration up/down the slope?