Physics 101: Lecture 04

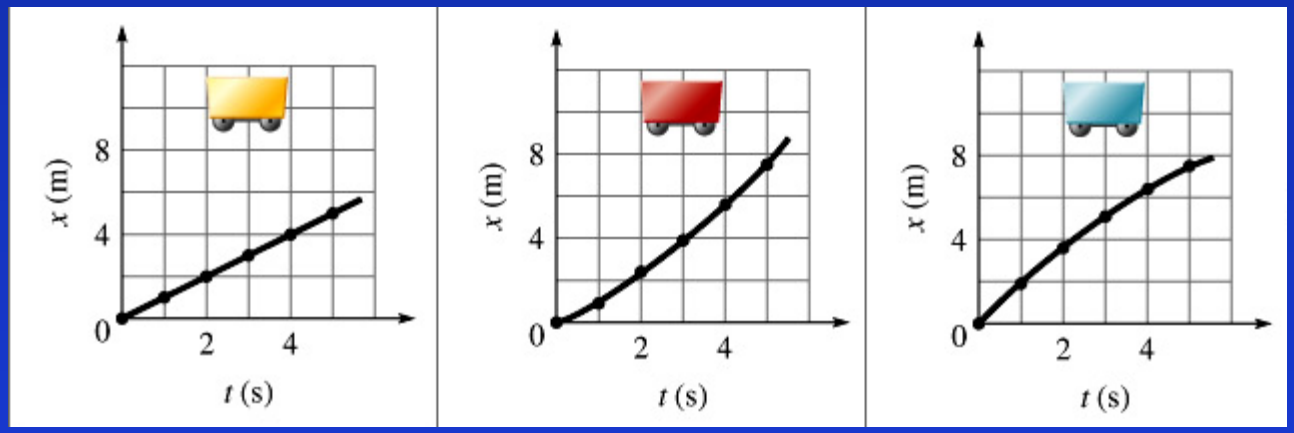
Kinematics + Dynamics

- Uniform acceleration
- Today's lecture will cover Textbook Chapter 4

Review

- Kinematics : Description of Motion
  - Position
  - Displacement
  - Velocity $v = \Delta x / \Delta t$
    - average
    - instantaneous
  - Acceleration $a = \Delta v / \Delta t$
    - average
    - instantaneous
  - Relative velocity: $v_{ac} = v_{ab} + v_{bc}$

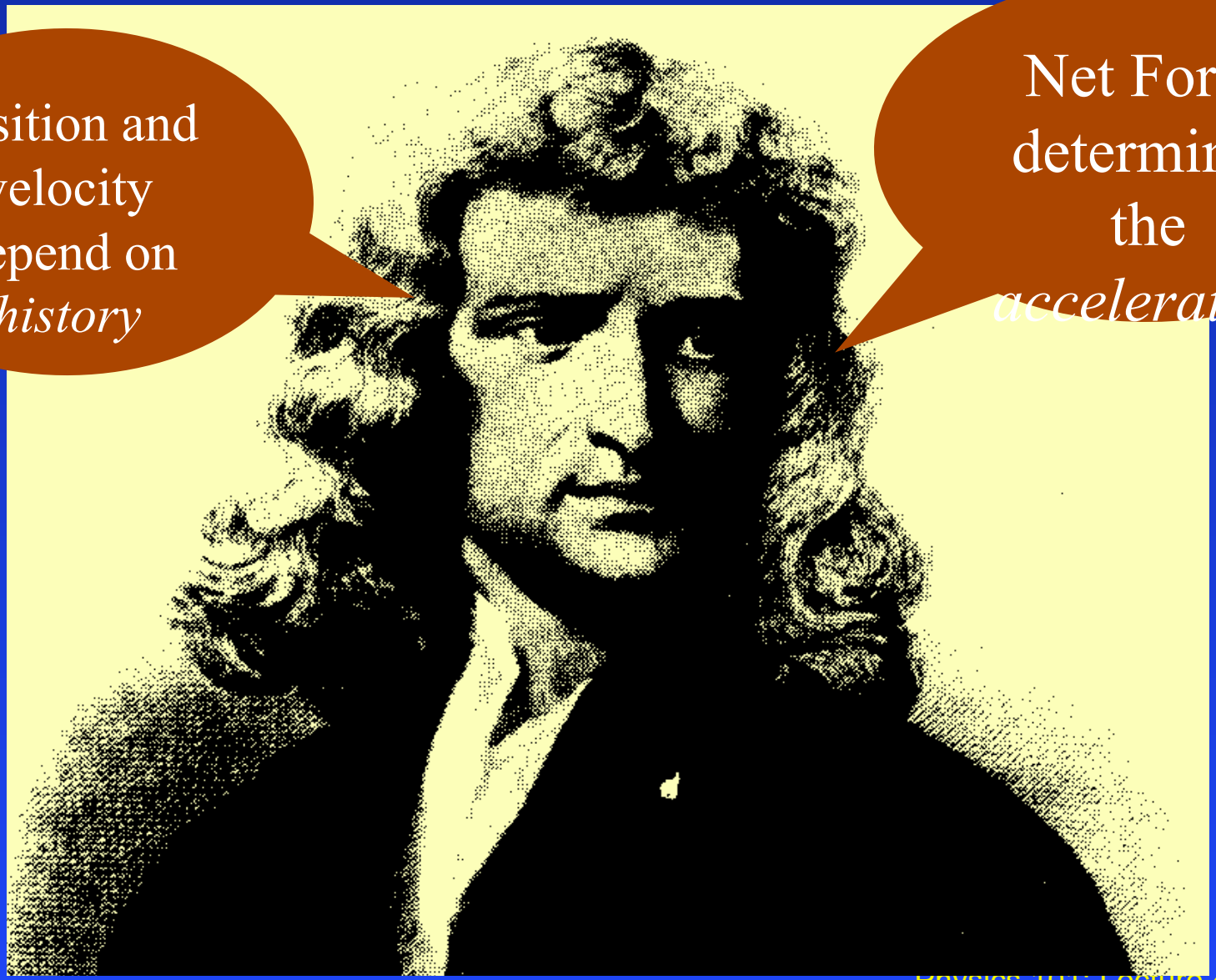
Preflight 4.1



(A) (B) (C)

- Which x vs t plot shows positive acceleration?

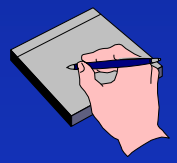
Newton's Second Law ΣF=ma



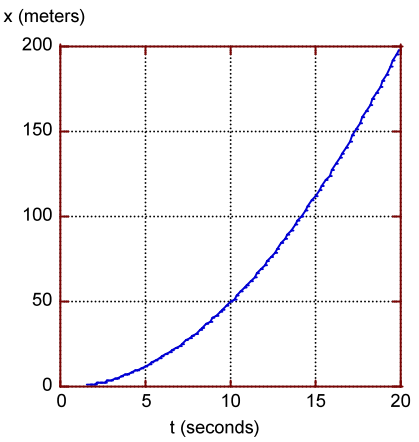
position and velocity depend on *history*

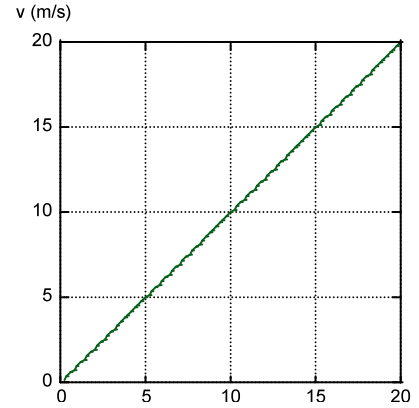
Net Force determines the *acceleration*

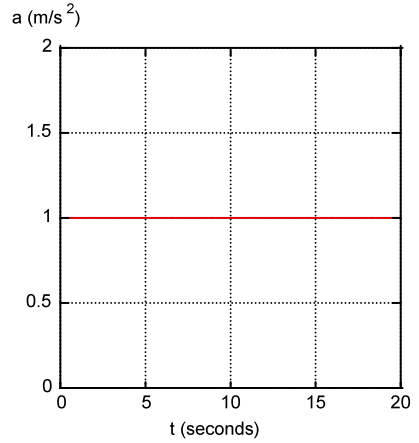
Equations for Constant Acceleration (text, page 108)



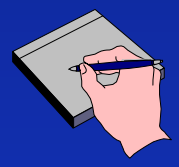
- $x = x_0 + v_0t + 1/2\ at^2$
- $v = v_0 + at$
- $v^2 = v_0^2 + 2a(x-x_0)$
- $\Delta x = v_0t + 1/2\ at^2$
- $\Delta v = at$
- $v^2 = v_0^2 + 2a\ \Delta x$







Kinematics Example



- A car traveling 30 m/s applies its breaks and stops after a distance of 150 m. How fast was the car going after it had traveled ½ the distance (75 meters) ?

A) v = 8 m/s B) v = 15 m/s C) v = 21 m/s

Acceleration ACT

A car accelerates uniformly from rest. If it travels a distance D in time t then how far will it travel in a time 2t ?

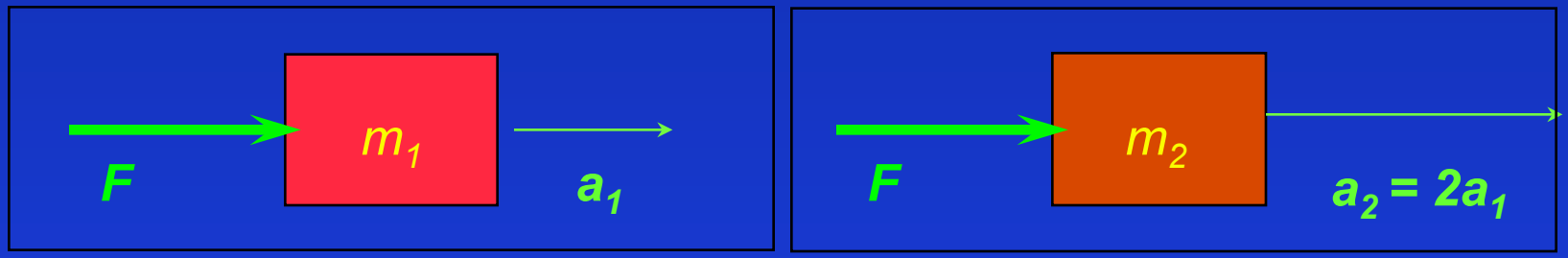
A. D/4
B. D/2
C. D
D. 2D
E. 4D

Follow up question: If the car has speed v at time t then what is the speed at time 2t ?

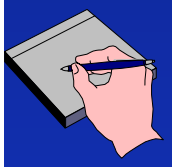
A. v/4
B. v/2
C. v
D. 2v
E. 4v

ACT

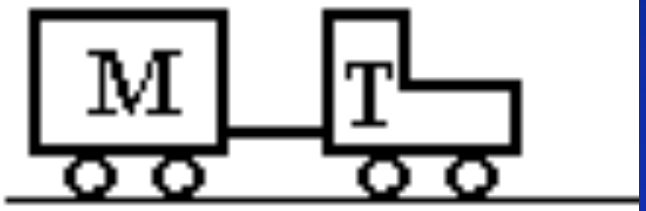
- A force F acting on a mass m_1 results in an acceleration a_1. The same force acting on a different mass m_2 results in an acceleration $a_2 = 2a_1$. What is the mass m_2?



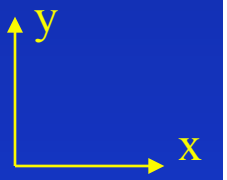
(A) $2m_1$ (B) m_1 (C) $1/2\ m_1$



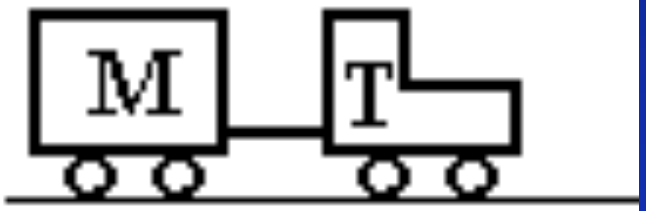
Example:



A tractor T (m=300Kg) is pulling a trailer M (m=400Kg). It starts from rest and pulls with constant force such that there is a positive acceleration of 1.5 m/s^2. Calculate the pulling force of the tractor.



Net Force ACT



Compare $F_{tractor}$ the NET force (ΣF) on the tractor, with $F_{trailer}$ the NET force (ΣF) on the trailer from the previous problem.

A) $F_{tractor} > F_{trailor}$

B) $F_{tractor} = F_{trailor}$

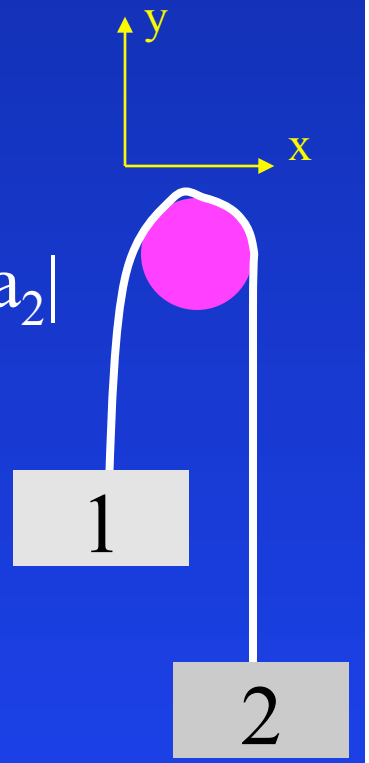
C) $F_{tractor} < F_{trailor}$

Pulley Example

- Two boxes are connected by a string over a frictionless pulley. Box 1 has mass 1.5 kg, box 2 has a mass of 2.5 kg. Box 2 starts from rest 0.8 meters above the table, how long does it take to hit the table.

•Compare the acceleration of boxes 1 and 2

A) $|a_1| > |a_2|$ B) $|a_1| = |a_2|$ C) $|a_1| < |a_2|$



Summary of Concepts

- Constant Acceleration
  - $x = x_0 + v_0 t + 1/2\ a t^2$
  - $v = v_0 + at$
  - $v^2 = v_0^2 + 2a(x-x_0)$
- F = m a
  - Draw Free Body Diagram
  - Write down equations
  - Solve