Exam I

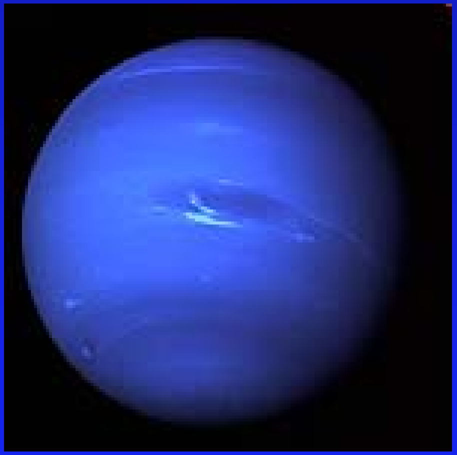
Physics 101: Lecture 04

Kinematics + Dynamics

- Today's lecture will cover Textbook Chapter 4

iclicker scores have been imported again – please check!

If you are new to the course, please read the course description on the course web page (and email policy from Lecture 1 note)!



neptune

What’s Most Difficult

I am finding vectors as the most difficult problems in class right now.

The concept with the kinetic and static forces.

Trying to remember the formulas and im rusty with trig so all the sin, cos, and tan is tricky for me.

Tension / setting up problem / vectors / free body diagrams.

pulley problems

remembering to do the prefilghts / Staying awake.

You can review vectors using the textbook!!!

Pages 28-35 of Textbook

This also includes trigonometry

Also see course web site.

Discussion book answers are posted online before the session!

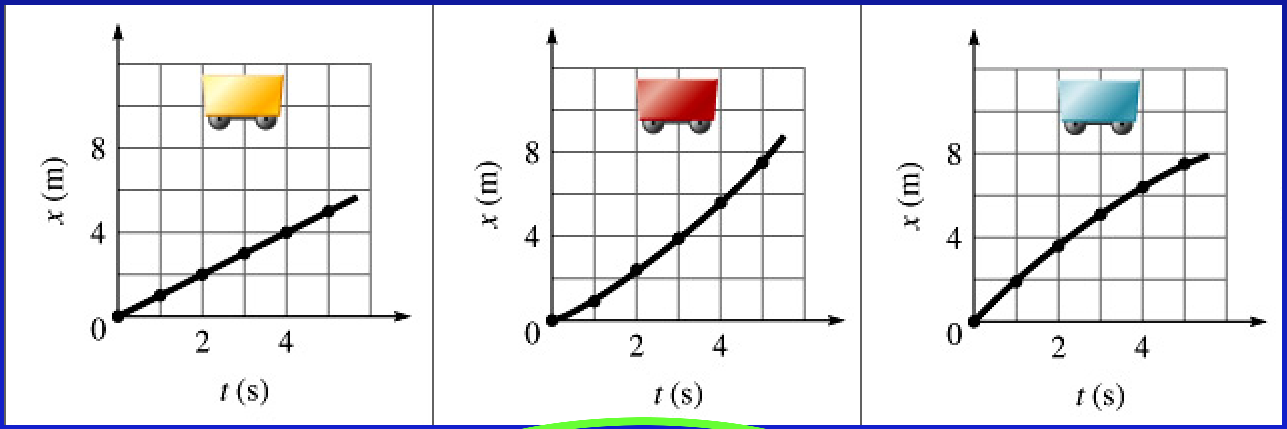
Quiz answers posted too but after the session.

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

...interpreting graphs...



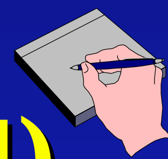
(A) (B) (C)

- Which x vs t plot shows positive acceleration?

89% got this correct!!!!

"This shows that more distance is being covered per second as the graph proceeds. This means that the speed of the car is increasing which means a positive acceleration.
"

Equations for Constant Acceleration (text, page 113-114)



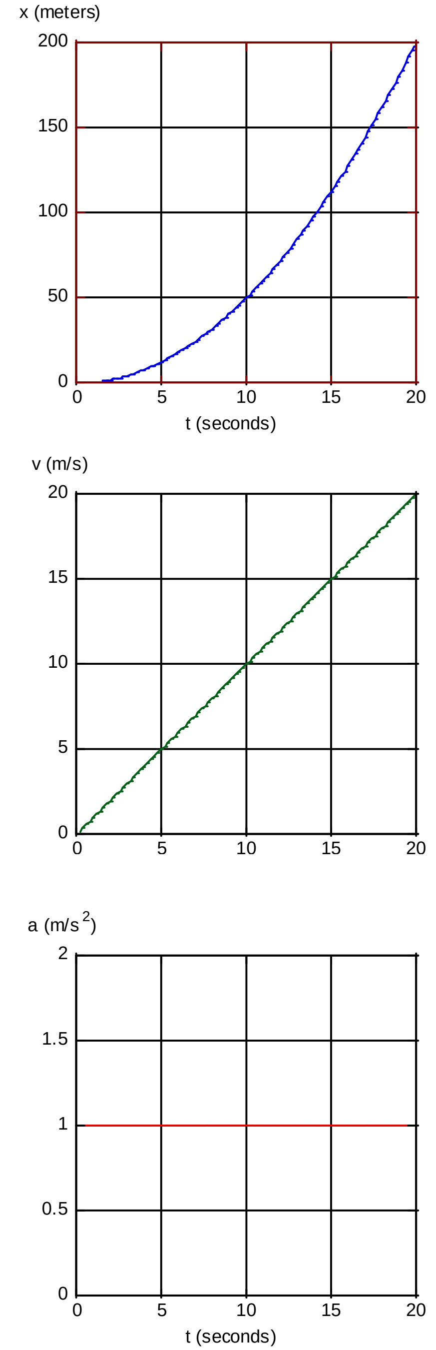
- $x = x_0 + v_0 t + 1/2\ at^2$
- $v = v_0 + at$
- $v^2 = v_0^2 + 2a(x-x_0)$
- $\Delta x = v_0 t + 1/2\ at^2$
- $\Delta v = at$
- $v^2 = v_0^2 + 2a\ \Delta x$

$$x = x_0 + \bar{v}\, t$$

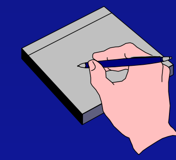
$$x = x_0 + v_0 t + \frac{1}{2} a t^2$$

$$\bar{v} = \frac{v_0 + v_f}{2} = \frac{v_0 + (v_0 + \Delta v)}{2}$$

$$= \frac{2v_0 + at}{2} = v_0 + \frac{1}{2} at$$



Kinematics Example



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

A) v < 15 m/s B) v = 15 m/s C) v > 15 m/s

$$v^2 = v_o^2 + 2a\Delta x$$

$$a = \frac{v_f^2 - v_o^2}{2(150)} = \frac{-30^2}{2(150)}$$

$$v_{75}^2 = 30^2 + 2a(75)$$

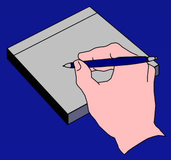
$$v_{75}^2 = 30^2 + 2\frac{(-30^2)}{2(150)}(75)$$

$$v_{75}^2 = 30^2 + \frac{1}{2}(-30^2)$$

$$v_{75}^2 = \frac{1}{2}30^2$$

$$v_{75} = \sqrt{\frac{1}{2}}30 = 21 m/s$$

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 ?

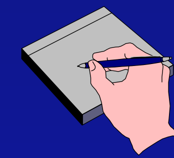
A. D/4
B. D/2
C. D
D. 2D   Demo…
E. 4D ← Correct $x=1/2\ at^2$

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

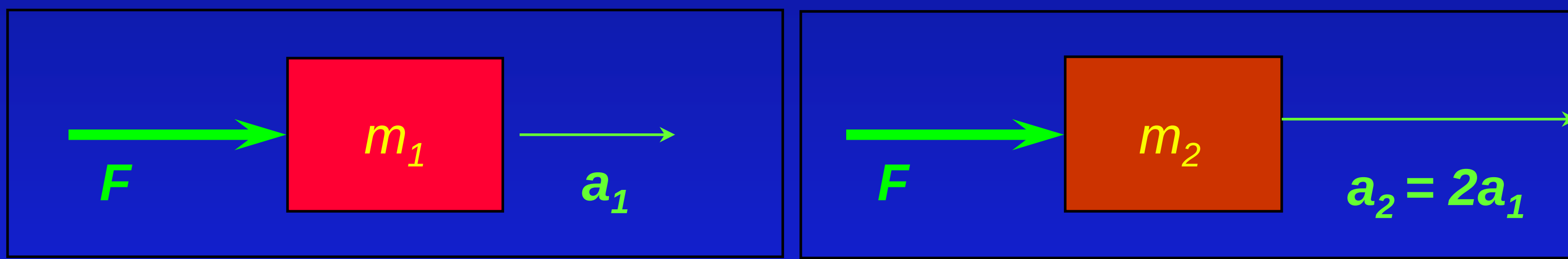
A. v/4
B. v/2
C. v
D. 2v ← Correct $v=at$
E. 4v

Newton's Second Law ΣF=ma

ACT



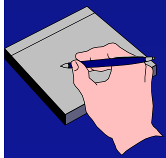
- A force F acting on a mass m_1 results in an acceleration a_1.The same force acting on a different mass m_2 results in an acceleration $a_2 = 2a_1$. What is the mass m_2?



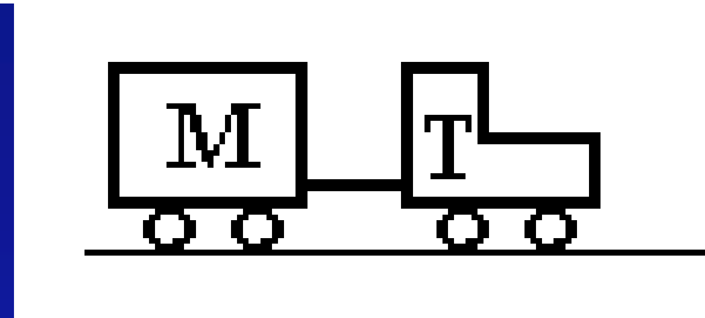
(A) $2m_1$ (B) m_1 (C) $1/2\ m_1$

- F=ma
- $F = m_1 a_1 = m_2 a_2 = m_2(2a_1)$
- Therefore, $m_2 = m_1/2$

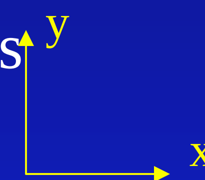
- Or in words…twice the acceleration means half the mass



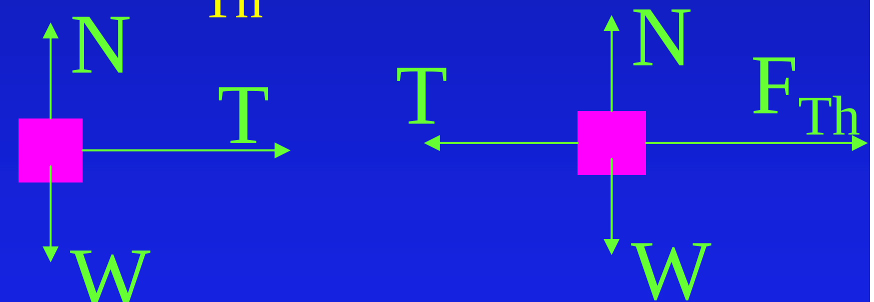
Example:



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 horizontal thrust force on the tractor due to the ground.



$F_{Th} = 1050$ N



X direction: Tractor

$\Sigma F = ma$

$F_{Th} - T = m_{tractor} a$

$F_{Th} = T + m_{tractor} a$

X direction: Trailer

$\Sigma F = ma$

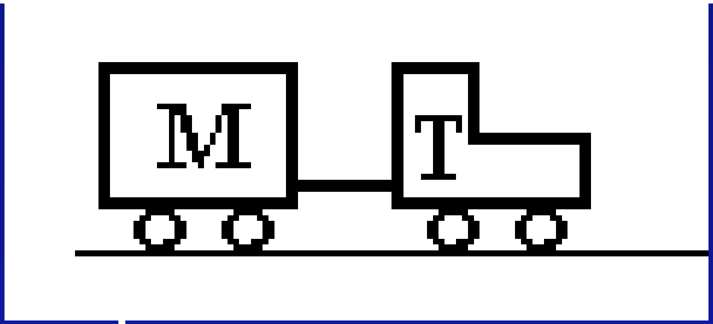
$T = m_{trailer} a$

Combine:

$F_{Th} = m_{trailer} a + m_{tractor} a$

$F_{Th} = (m_{trailer} + m_{tractor}) a$

Net Force ACT



Compare $F_{tractor}$ the net force on the tractor, with $F_{trailer}$ the net force on the trailer from the previous problem.

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

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

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

$\Sigma F = m\ a$

$F_{tractor} = m_{tractor}\ a$

$= (300\ kg)\ (1.5\ m/s^2)$

$= 450\ N$

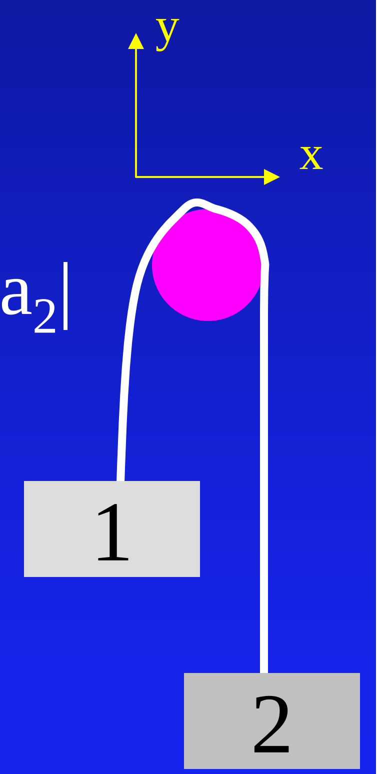
$F_{trailer} = m_{trailer}\ a$

$= (400\ kg)\ (1.5\ m/s2)$

$= 600\ N$

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) $|a_1| < |a_2|$

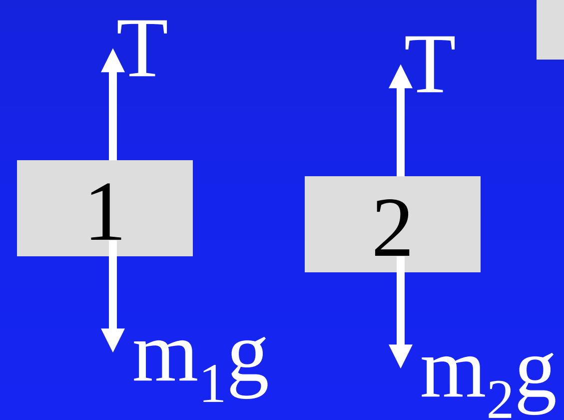
1) $T - m_1 g = m_1 a_1$

2) $T - m_2 g = -m_2 a_1$

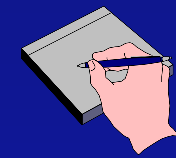
2) $T = m_2 g - m_2 a_1$

1) $m_2 g - m_2 a_1 - m_1 g = m_1 a_1$

$a_1 = (m_2 - m_1)g / (m_1 + m_2)$



Pulley Example



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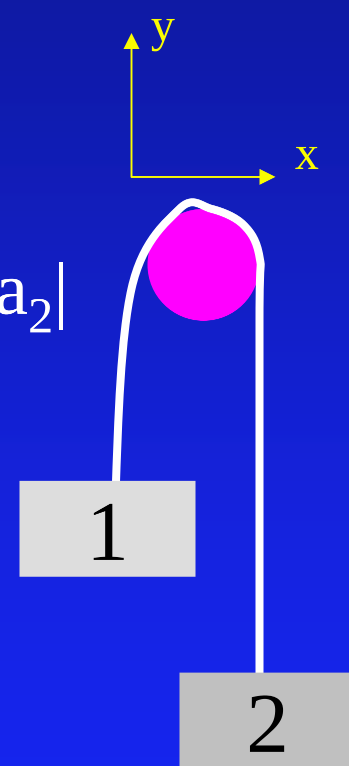


- Compare the acceleration of boxes 1 and 2

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

$a_1 = (m_2 - m_1)g \,/\, (m_1+m_2)$

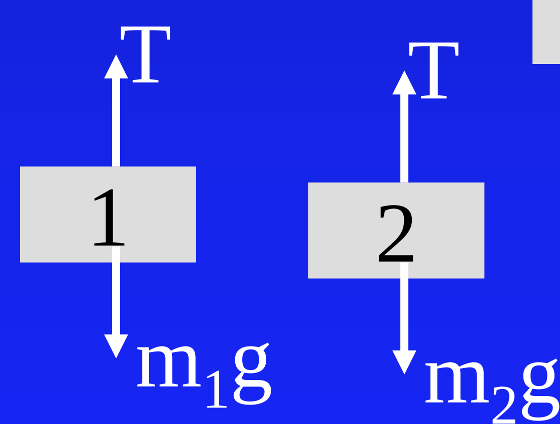
$a = 2.45\ \text{m/s}^2$

$\Delta x = v_0 t + \frac{1}{2} a t^2$

$\Delta x = \frac{1}{2} a t^2$

$t = \text{sqrt}(2\ \Delta x/a)$

$t = 0.81$ seconds



Summary of Concepts

- Constant Acceleration
    - $x = x_0 + v_0 t + 1/2\ at^2$
    - $v = v_0 + at$
    - $v^2 = v_0^2 + 2a(x-x_0)$
- $F = m\ a$
    - – Draw Free Body Diagram
    - – Write down equations
    - – Solve
- Next time: textbook section 4.3, 4.5