

# Physics Midterm Review

## ① Scalars and Vectors:

- When Converting Units, Use the Reference table
- Begin With What's given to you, go through Step by Step  
Ex: Convert 34 Km/hr to m/s

$$\frac{34 \text{ Km}}{\text{hr}} \times \frac{10^3 \text{ m}}{1 \text{ Km}} \times \frac{1 \text{ hr}}{60 \text{ min}} \times \frac{1 \text{ min}}{60 \text{ s}} = 9.44 \text{ m/s}$$

Scalars - Scalars are quantities (numbers) that have a magnitude (size) only.

- Mass (kg)
- Distance (m)
- Speed (m/s)
- Time (seconds)
- Energy (Joules)
- Power (Watts)
- Temperature

Vectors - Vectors are quantities (numbers) that have a magnitude and a direction

- Displacement
- Velocity
- Acceleration
- Force
- Impulse
- Momentum

## Similar Quantities

### Scalars

- Distance

- Speed →

### Vectors

- Displacement

- Velocity

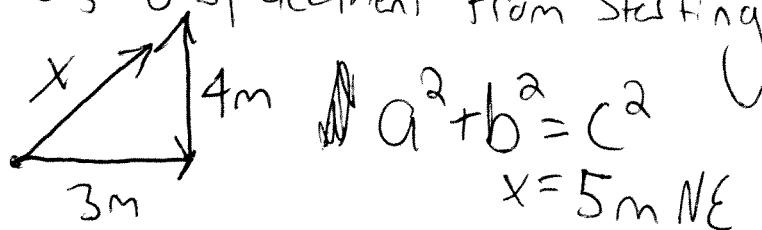
- Acceleration

## Distance Vs. Displacement

Chuck the Squirt travels 3m East and then 4m North  
What distance did Chuck travel?

$$3\text{m} + 4\text{m} = 7\text{m} \text{ distance traveled}$$

What is Chuck's displacement from starting point?



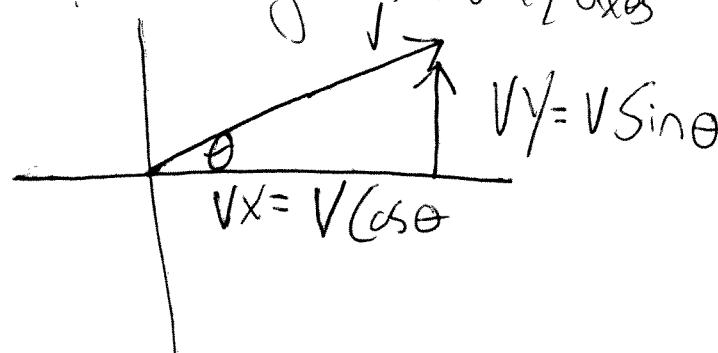
## Adding Vectors Graphically

- Line Vectors up tip to tail

## Vector Components

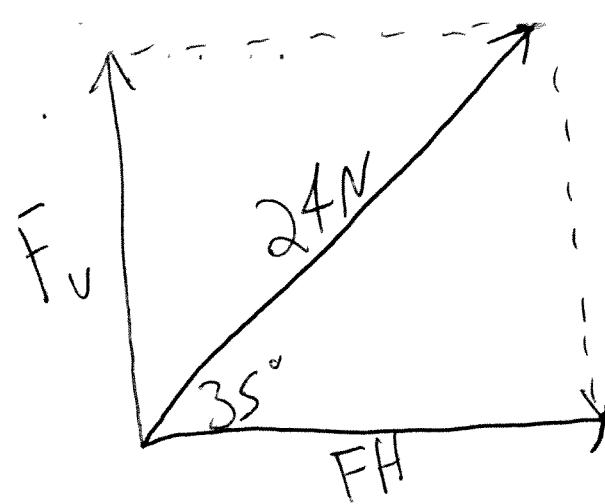
- Sometimes it's helpful to break up a vector into components along the x and y axes (Projectile/Force Problems)

into components along the x and y axes



$$X = \cos$$

$$Y = \sin$$



$$F_H = 24 \text{ N} \cos 35^\circ \quad F_v = 24 \text{ N} \sin 35^\circ$$

## ② Motion Graphs:

- Distance is how far you have traveled (scales)
- Displacement is the straight line distance from where you start to where you finish (a vector)

### Speed - Velocity

- Speed is the rate at which your distance changes (a scalar)
- Velocity is the rate at which your displacement changes (a vector)
- Both Speed and Velocity Use the same formula

$$V = \frac{D}{t}$$

$$a = \frac{\Delta V}{t}$$

### Acceleration

- Acceleration is the rate at which your Velocity Change
- Acceleration is a Vector

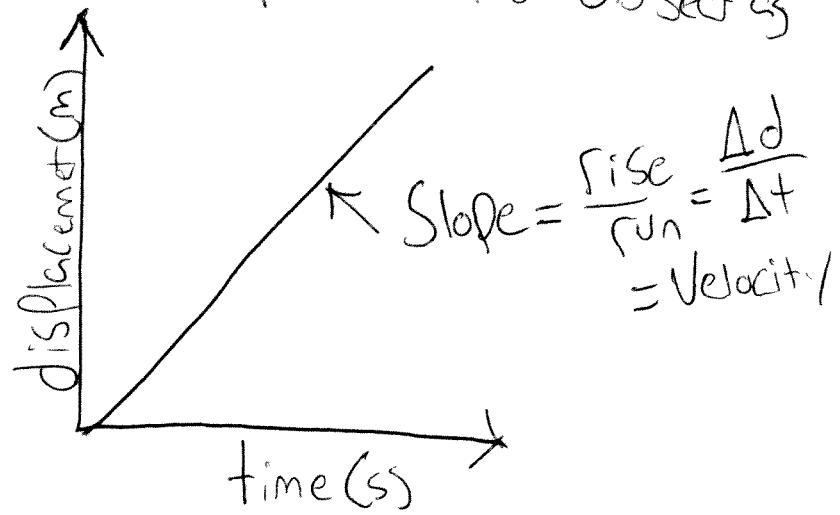
# Motion diagrams

- Motion diagrams are often used to show the position of an object at regular time intervals

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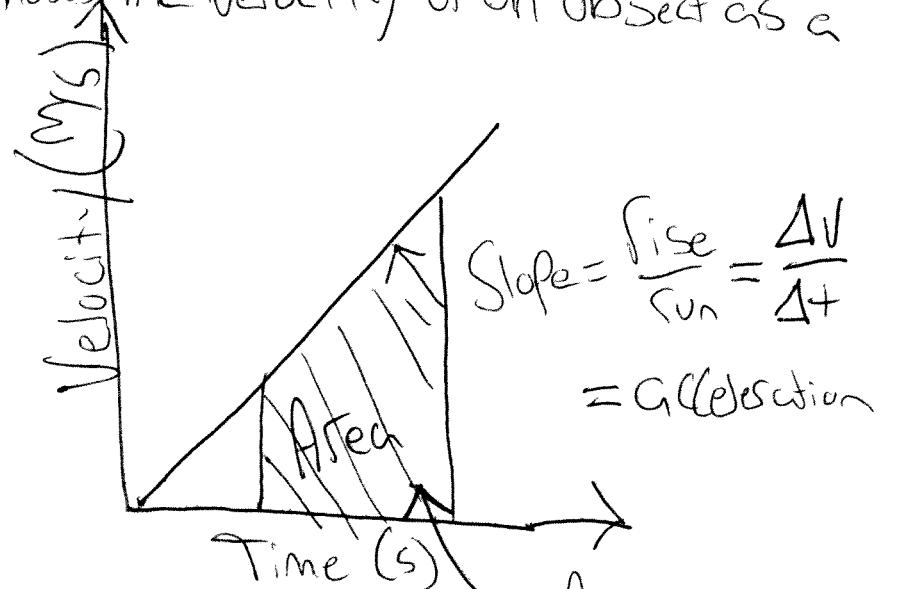
## Displacement - Time Graphs

- A d-t graph shows the displacement of an object as a function of time



## Velocity - Time graphs

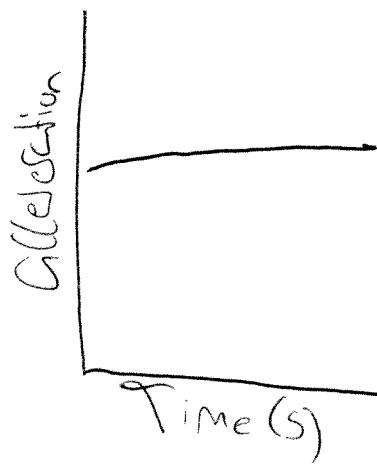
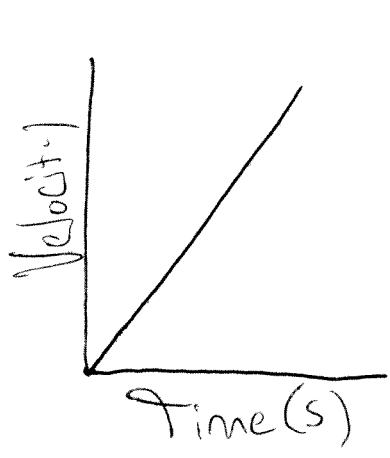
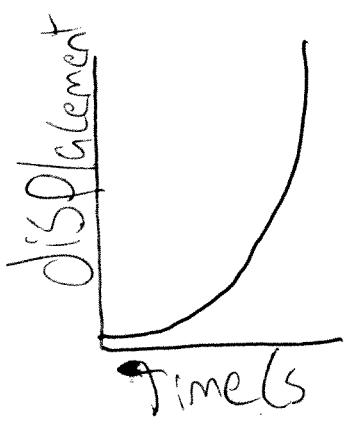
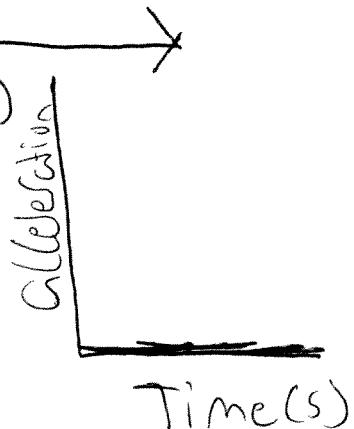
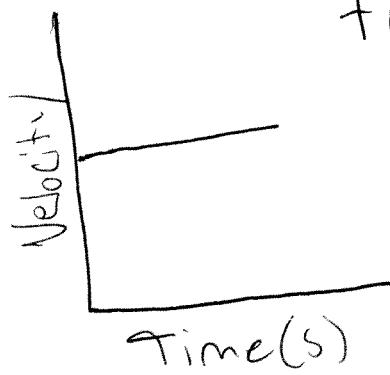
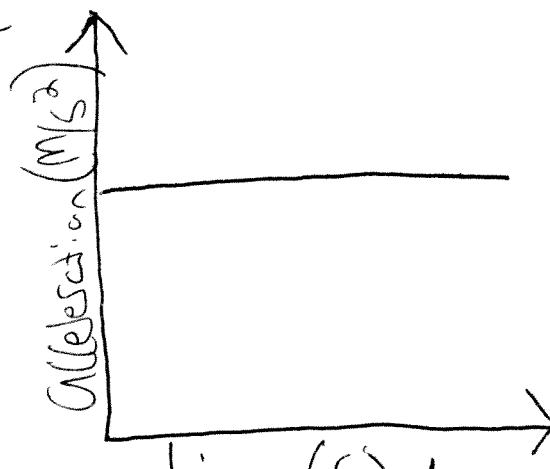
- A V-t graph shows the velocity of an object as a function of time



Area Under a  
V-t graph Shows  
distance traveled

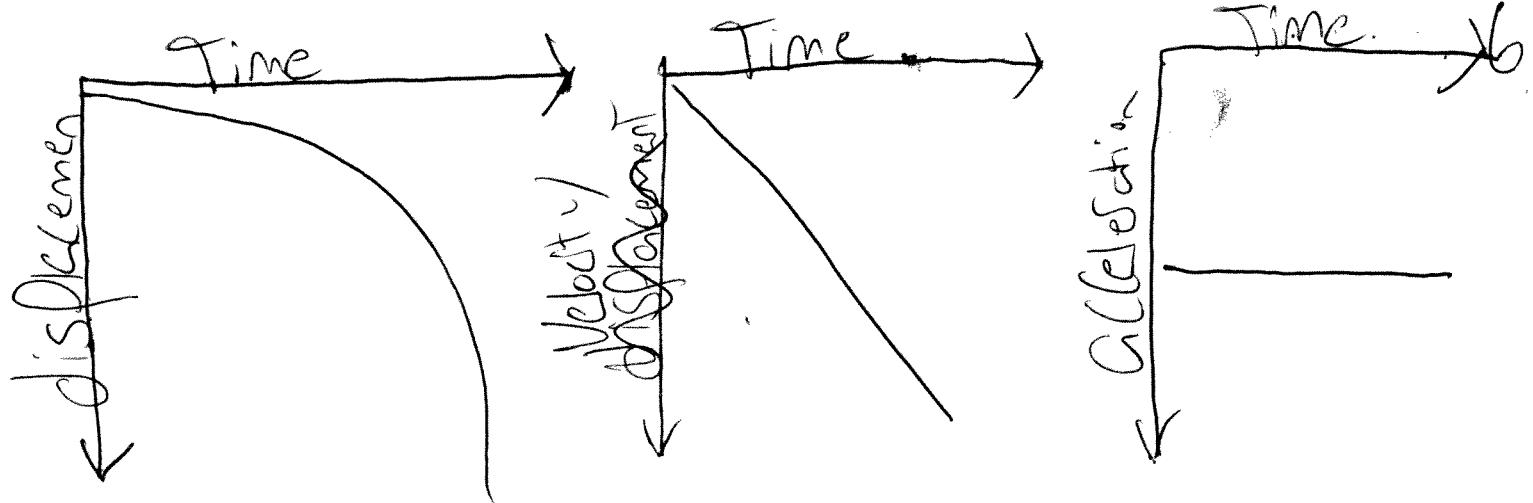
## Acceleration-time graphs

- A-t. graph Shows the acceleration of an object as a function of time



## Free Fall

- Objects at the surface of the earth fall with an acceleration equal to  $9.81 \text{ m/s}^2$ , which is also constant
- If an object is dropped, initial velocity is 0



### ③ Kinematics Equations

- Kinematics is a physical description of Motion

$v_i$   
 $v_f$   
 $d$   
 $a$   
 $t$

Kinematic equations:

$$\bar{v} = \frac{v_f - v_i}{t}$$

$$a = \frac{v_f^2 - v_i^2}{2d}$$

$$d = v_i t + \frac{1}{2} a t^2$$

### 2-D motion (Projectiles)

- The key to projectile problems is breaking them into two separate 1-D problems:
  - X direction (horizontal)
  - Y direction (vertical)
- Once broken up you can treat each direction independently
- You may have to break up an initial velocity vector into its components

# Projectile hints

- Maximum range launch angles is  $45^\circ$
- The entire time an object is in the air, its acceleration is  $9.81 \text{ m/s}^2$  down
- There is no acceleration in the X direction  
Gravity (only) pulls you down

## ④ Dynamics:

- A force is a push or a pull on an object
- Force is a vector  $\rightarrow$  it has a direction
- The Unit of force is the Newton

### Net Force ( $F_{\text{net}}$ )

- Net force is the vector sum of all forces on an object
- If the net force on an object is zero, it is said to be in static equilibrium
- Objects in static equilibrium do not accelerate
  - They move at a constant speed and in a straight line
- This is Newton's 1st law (law of inertia)

# Free body/ Diagrams

- free body/ diagrams show all ~~of~~ the forces acting upon a single object
- The object is represented by a dot, and the force vectors are represented by arrows.
- Label all forces



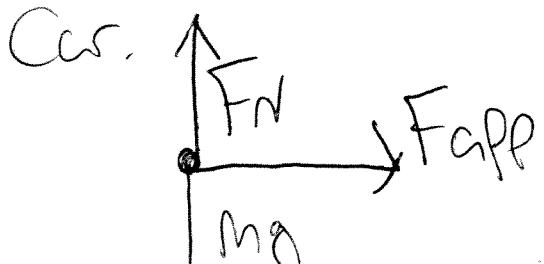
## Newton's Laws of Motion

1. An object at rest tends to stay at rest, (inertia) unless acted upon

$$2. \sum F_{\text{net}} = Ma$$

$$3. F_{1,2} = -F_{2,1} \text{ (Action Reaction)}$$

Doug pushes his non-functional 2,000 kg car horizontally with a force of 400 N. What is the acceleration of the car?



$$\sum F_{\text{net},x} = Ma_x \Rightarrow a_x = \frac{F_{\text{app}}}{m}$$

$$F_{\text{app}} = Ma_x \Rightarrow \frac{400 \text{ N}}{2000 \text{ kg}} = 0.2 \text{ m/s}^2$$

- Inertia is equivalent to Mass

- Mass doesn't change therefore inertia  
doesn't change

## ⑤ Friction: Push or Pull

- Friction is a force that opposes Motion

- Static Friction - "Still" Friction

- Kinetic Friction - Sliding (Moving) friction

### Calculate Friction

$$F_f = \mu F_n \quad \text{Normal force}$$

Coefficient  
of friction

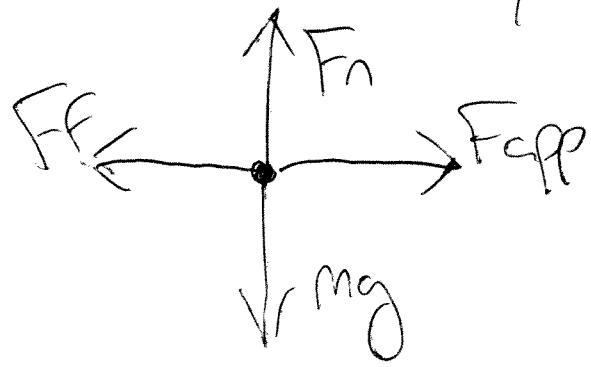
$\mu$  is located on reference table

80 kg skier on waxed skis slides along snow at constant velocity. What is horizontal component of force pushing him?

$$F_{net\ x} = Ma_{x\ avg} = 0$$

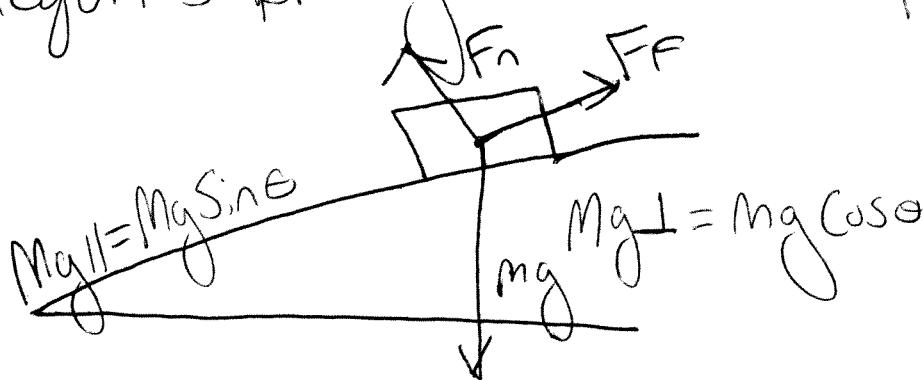
$$F_{app} - f_f = 0$$

$$F_{app} = f_f$$



# Objects on ramps

- Requires breaking Vectors into Components



## ⑥ Uniform Circular Motion and Gravity

- Uniform Circular is Motion in a Circular Path at a Constant Speed
- If Something is Moving in a Circle, Although its Speed May Be Constant, its Velocity is Changing
  - Velocity is a Vector, it has a direction

### Centrifugal Acceleration

- because the objects Velocity is changing, it must be accelerating
- The direction of the objects acceleration is always toward the Center of the circle
- A Centrifugal acceleration ( $a_c$ ) is an acceleration toward the Center of a Circle

Magnitude of  $a_c$  is given by  $a_c = \frac{V^2}{r}$  ||

Newton's 2nd law for Uniform Circular Motion

$$F_{\text{Net}} = Ma$$
$$F_{\text{Netc}} = Ma_c = F_{\text{Net}} = \frac{Mv^2}{r}$$

- Acceleration Vector always points toward Center of Circle for Uniform Circular Motion

Newton's Law of Universal gravitation

- There is a force attracting any two objects that have Mass. (Gravity)

$$F_g = \frac{Gm_1 m_2}{r^2}$$

- On the Surface of the earth, the force is also called an Object's Weight, and can be calculated by Weight =  $mg$

- Weight and Mass are not the same

$$F_g = Mg \quad F_g = \frac{Gm_1 m_2}{r^2}$$

on front  
of reference  
table

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## 7 Momentum and Impulse

### Momentum

- Momentum is a vector

$$P = mv$$

- Units for momentum are  $\frac{kg\ m}{s}$  or  $N\ s$

### Impulse

- ~~All~~ A change in Momentum is an impulse
- Impulse ( $J$ ) is also a Vector quantity

$$J = \Delta p = F\Delta t \quad F = \frac{\Delta p}{\Delta t} \quad F = \frac{m\Delta v}{\Delta t}$$

### Collisions

- When objects interact with each other Momentum can be transferred from object to object

One object hits another object

- One object splits into two or more objects
- Several objects combine into fewer objects
  - = When this happens, the momentum of the system is conserved (law of conservation of momentum)

## Types of Collisions

- Elastic
  - "Bouncy" collisions
    - Kinetic Energy is conserved
- Inelastic
  - "Sticky" collisions
    - Kinetic Energy is not conserved
- Use Momentum tables to solve collision problems

Object	P before (Kg m/s)	P after (Kg m/s)
Mass1	1100 ✓	0 0
Mass2	$2500 \times 8 = 20000$	0
total	$1100 + 20000$	0

(Conservation of Energy)

## ⑧ Work and Power/Energy

- WORK is a force causing a displacement
- The process of moving an object

$$W = Fd \cos\theta$$

### Force - Displacement graphs

- The work done is the area under a force N displacement graph



# Power

- Power is the rate at which work is done

- Units are Watts (W)  $P = \frac{W}{t}$

$$P = \frac{W}{t} = \frac{Fd}{t} = Fv$$

# Energy

- Kinetic  $KE = \frac{1}{2}mv^2$

- Potential

- Gravitational  $P_{\text{grav}} = Mgh$

- Spring

$$P_{\text{spring}} = \frac{1}{2}Kx^2$$

# Conservation of Energy

- Energy cannot be created or destroyed

- Energy can be transformed 16

Example : Roller Coaster



## Springs

- to Compress or Stretch a string from its equilibrium position, you must apply a force

This force can be determined from Hooke's law

$$F = kx \quad k = \text{Spring Constant (N/m)}$$

Energy stored in compressed spring is  $P_{es} = \frac{1}{2} kx^2$