Welcome!

Physics 1 Prep
(for PHYS 1310)

Presented by:
Arturo Sanchez

With support from:
Kushal Kadel

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Outline

• Units
• Graphs
• Motion
• Geometry/Trigonometry in physics
• How to approach word problems
Units
A standard of measurement of physical quantities
What are physical quantities?
What are NON-physical quantities?
What are SI units?
<table>
<thead>
<tr>
<th>Base Quantity</th>
<th>Name</th>
<th>Symbol</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>Meter</td>
<td>m</td>
<td></td>
</tr>
<tr>
<td>Mass</td>
<td>Kilogram</td>
<td>kg</td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>Second</td>
<td>s</td>
<td></td>
</tr>
<tr>
<td>Electric Current</td>
<td>Ampere</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>Kelvin</td>
<td>K</td>
<td></td>
</tr>
<tr>
<td>Amount of Substance</td>
<td>Mole</td>
<td>mol</td>
<td></td>
</tr>
<tr>
<td>Luminous Intensity</td>
<td>candela</td>
<td>cd</td>
<td></td>
</tr>
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Helpful Website: National Institute of Standards and Technology
[https://physics.nist.gov/cuu/Units/units.html](https://physics.nist.gov/cuu/Units/units.html)
Velocity = +25 m/s

Density = kg/m³

Derived Quantities
Scalar and Vector quantities

Scalar
- Volume
- Temperature
- Speed

Vector
- Time
- Weight
- Magnetic field
- Thrust
- Velocity
What does 2500 m equal to in km?
What is $10 \, g/cm^3$ equal to in $kg/m^3$?
Is density scalar or vector?
Is Time (seconds) fundamental or derived?

Problem 4: Fundamental vs derived
Is Area \( (m^2) \) "fundamental or derived?"
(Independent variable) causes a change in (Dependent Variable) and it isn't possible that (Dependent Variable) could cause a change in (Independent Variable)
How to read a graph

Slope = \frac{Y_2 - Y_1}{X_2 - X_1}
On a Velocity vs. Time graph, any time the line crosses the "x" axis, the object is changing direction.
Variable Speed
Average and instantaneous speed
Geometry & Trig in Physics
Basic Trigonometric Functions

- **SOH**  \( \sin \theta = \frac{\text{Opposite}}{\text{Hypotenuse}} \)
- **CAH**  \( \cos \theta = \frac{\text{Adjacent}}{\text{Hypotenuse}} \)
- **TOA**  \( \tan \theta = \frac{\text{Opposite}}{\text{Adjacent}} \)
\[ \sin(\theta) = \frac{\text{Opposite}}{\text{Hypotenuse}} \]
\[ \cos(\theta) = \frac{\text{Adjacent}}{\text{Hypotenuse}} \]
\[ \tan(\theta) = \frac{\text{Opposite}}{\text{Adjacent}} \]

**SOH CAH TOA Rule**
Pythagorean Theorem

\[ a^2 + b^2 = c^2 \]
\[ \sin(\theta) = \cos(90^\circ - \theta) \]


The Unit Circle
Pythagoras Theorem for physical quantities

https://youtu.be/LE6dmczMc68
Special Triangles

45-45-90 Triangle

30-60-90 Triangle

3-4-5 Triangle

5-12-13 Triangle

Special Triangles
Determine the Magnitude and direction
Pythagoras Theorem for physical quantities

Determine the Magnitude and direction

Road starts

3 km north

5 km journey

4 km east

Road ends
Determine the Magnitude and direction

Road starts

3 km north

4 km east

Road ends
Trigonometry of inclined planes

Forces
A **Force** is a push or a pull that causes an object with mass to move faster (accelerate), or slower (decelerate), change direction, or deform.
Forces are vector quantities because they have a magnitude and direction.
Types of Forces:

- Applied Force
- Pull (Tension)
- Push (Compression)
- Normal Force (Perpendicular to the Surface)
- Drag Force (Resistance to motion in Air or Water)
- Friction (Always moves opposite to motion)
- Spring Force
- Weight (mass * acceleration)
Force = Mass * Acceleration

\[ [N] = [kg] \times \left[ \frac{m}{s^2} \right] \]

\[ \sum \vec{F} = m\vec{a} \]
A uniform ladder 5 m long weighing 200 N is leaning against a smooth vertical wall with its base 3 m from the wall. The coefficient of static friction between the bottom of the ladder and the ground is 0.4. How far, measured along the ladder, can a 600 N man climb before the ladder starts to slip?
As you go along...Formula Sheet

Geometric Formulas
- Circle: circumference = $2\pi R$, area = $\pi R^2$
- Sphere: surface area = $4\pi R^2$, volume = $\frac{4}{3}\pi R^3$

Trigonometry
- $\sin \alpha = \frac{A}{C}$, $\cos \alpha = \frac{B}{C}$
- $\tan \alpha = \frac{A}{B}$
- $\sin \alpha = \sin \beta = \sin \gamma$
- $A^2 + B^2 - 2AB \cos \gamma = C^2$

Rotational Motion & Gravity
- $v = \omega r = \frac{2\pi r}{T}$, $\omega = 2\pi f = \frac{2\pi}{T}, f = 1/T$
- $\alpha = \frac{\omega_f - \omega_0}{t} = \frac{a}{r}$
- $L = I\omega = mvr \sin \theta$, ($\theta$ = angle between $v$ and $r$)
- $KE = \frac{L^2}{2I} = \frac{1}{2} I\omega^2$
- $\tau = rF \sin \theta$, $I\alpha = \tau$, $I_{point} = mR^2$
- $I_{cyl.\ shell} = mR^2$, $I_{sphere} = \frac{2}{5} mR^2$, $I_{solid\ cyl.} = \frac{1}{2} mR^2$
A bus traveled on a level road for 6 hours at an average speed 20 miles per hour faster than it traveled on a winding road. The time spent on the winding road was 3 hours. Find the average speed on the level road if the entire trip was 462 miles.

<table>
<thead>
<tr>
<th>categories</th>
<th>rate</th>
<th>time</th>
</tr>
</thead>
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<tr>
<td>level road</td>
<td>$x + 20$</td>
<td>6 hr</td>
</tr>
<tr>
<td>winding rd.</td>
<td>$x$</td>
<td>3 hr</td>
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Step 2: Draw a picture
A rectangular field is to be fenced off next to a straight wall, with fencing on three sides, with the wall making the fourth side. Exactly 150 feet of fencing is to be used. Express the area of the field as a function of its width.

**Given:**

\[ p = 150 \text{ ft} \]  (3 sides)

\[ x = \text{width} \]

\[ y = \text{length} \]
Three coffees and two muffins cost a total of 7 dollars. Two coffees and four muffins cost 8 dollars. What is the individual price for a single coffee and a single muffin?

Let $x =$ cost of a single coffee
Let $y =$ cost of a single muffin
Step 5: Begin strategizing for the answer based on the given information
What is the average velocity of the car if it travels 60 km in 1.5 hours?
Displacement: \( = x_2 - x_1 = 60 \text{ km} \)
Time = 1.5 hours

Average Velocity = Displacement / Time
A plane lands at a speed of 68 m/s and slows down at a rate of 4m/s². How much runway is needed to stop the plane?
Word Problem 2: Write all the given quantities

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Initial Value</th>
<th>Final Value</th>
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<tbody>
<tr>
<td>$x_{\text{initial}}$</td>
<td>0 m</td>
<td>$x_{\text{final}}$</td>
</tr>
<tr>
<td>$t_{\text{initial}}$</td>
<td>0 s</td>
<td>$t_{\text{final}}$</td>
</tr>
<tr>
<td>$v_{\text{initial}}$</td>
<td>68 m/s</td>
<td>$v_{\text{final}}$</td>
</tr>
<tr>
<td>$a_{\text{initial}}$</td>
<td>4 m/s$^2$</td>
<td>$a_{\text{final}}$</td>
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Word Problem 1

\[ x_1 \quad \rightarrow \quad x_2 \]
A plane lands at a speed of 68 m/s and slows down at a rate of 4m/s$^2$. How much runway is needed to stop the plane?

\[ x_{\text{initial}} = 0 \text{ m} \quad x_{\text{final}} \]
\[ t_{\text{initial}} = 0 \text{ s} \quad t_{\text{final}} \]
\[ v_{\text{initial}} = 68 \frac{m}{s} \quad v_{\text{final}} = 0 \frac{m}{s} \]
\[ a_{\text{initial}} = 4 \frac{m}{s^2} \quad a_{\text{final}} = 4 \frac{m}{s^2} \]

**Word Problem 2:** Write all the given quantities

\[ x_1 = 0 \text{ m} \quad x_2 \]
A plane lands at a speed of 68 m/s and slows down at a rate of 4m/s$^2$. How much runway is needed to stop the plane?

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<tr>
<th></th>
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<th>0 m</th>
<th>$x_{\text{final}}$</th>
<th>578 m</th>
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<tbody>
<tr>
<td>$t_{\text{initial}}$</td>
<td>0 s</td>
<td>$t_{\text{final}}$</td>
<td>17 s</td>
<td></td>
</tr>
<tr>
<td>$v_{\text{initial}}$</td>
<td>68 m/s</td>
<td>$v_{\text{final}}$</td>
<td>0 m/s</td>
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$x_1 = 0 \text{m}$

Word Problem 2: Write all the given quantities.
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