Physical Science
Chapter 1

Motion

Are You Moving?

• You are sitting down, reading a book....
• Are you moving?
• Object is in motion when its distance from another object is changing.
• All depends on the “Point of Reference”
• Therefore object is in motion if it changes position relative to a reference point.
International System of Units

• “SI”
  – Based on the number 10
  – Distance (length) uses meter (about 39 inches)
  – Mass (how much matter) uses gram (a nickel is about 5 grams)
  – Volume (how much space)
    • Liquid volume – uses liter (a little more than a quart)
    • Solid volume – uses cm³ (about the size of a sugar cube)
    • $1 \text{ ml} = 1 \text{ cm}^3$
  – Weight (affect gravity has on object) uses newton (an apple weighs about 1 newton) (1 pound is about 4.4 newtons)
  – $\text{Density} = \frac{\text{Mass}}{\text{Volume}} = \frac{\text{grms}}{\text{ml}}$

To Amplify the Point

• Distances can be short or very long.
  – Basic metric unit of length is the meter.
  – Metric prefixes are based on the number 10.
  – 10 meters = 1 dekameter
  – 10 dekameters = 1 hectoliter
  – 10 hectoliters = 1 kilometer
  – Therefore: 1 kilometer = 1000 meters
  – And...
  – There are 10 decimeters in a meter
  – There are 10 centimeters in a decimeter
  – There are 10 millimeter in a centimeter
  – Therefore: 1000 millimeters = 1 meter
Metric Stairs

- You should be comfortable with converting from [cm] to [m], [mm] to [km], and so on.

Convert: 1527 centigrams into hectograms: going four steps up means you move the decimal 4 places to the left. Therefore:

**1527 centigrams = .1527 hectograms**

&

**9.8712345 kg = (steps to the right) 9871234.5 mg**

Graphing (x,y) coordinates

- A graph w/ points (2,3), (-2,1) & (1.5, -1) plotted:

Remember:

a. the x axis is the horizontal axis

b. The y axis is vertical axis

c. The origin is (0,0)
More Graphing!

• Graph the following points:
  a) (3, 3)
  b) (-2, 3)
  c) (-1, -2)
  d) (3, 0)
  e) (0, 0)
  f) (0, -4)

& Still More Graphing....

• What are the coordinates of these points?

Click for the answers...

a. (2, 0)

b) (0, 2)

c) (4, 3)

d) (-1, 3)

e) (-3, 3)

f) (-1, 3)

g) (-3, -1)

h) (2, -4)
Graphing line slopes (rise/run)

• 1. Graph the line which passes through (2, 3) and has a slope of 2/3.
• 2. Graph the line which passes through (1, 1) and has a slope of -4. (remember - 4 = -4/1)

Graphing points & slope (rise/run)

• 1. Graph the line which passes through (0, 2) and has a slope of 3. (remember 3 can be written as 3/1)
• 2. Graph the line which passes through (-1, 1) and has a slope of – 2/3.
Working w/ Units

• Determining the correct units in a problem is just as important as getting the number correct.
• Remember we can “cancel” numerators & denominators to make the math easier:

\[
\frac{24 \times 6 \times 2 \times 9 \times 18}{12 \times 18 \times 3 \times 3 \times 24} = \frac{24 \times 6^2 \times 2 \times 3 \times 9}{12 \times 18 \times 3 \times 3 \times 24} = 4
\]

We can do the same w/ units....

Multiplying & Dividing Units

• Do this problem:
  5 minutes x 3 feet = 15 minute feet
• Do this problem:
  \[
  \frac{12 \text{ miles}}{3 \text{ hours}} \equiv \frac{4 \text{ miles}}{\text{hour}}
  \]
• Do this problem:
  \[
  \text{mile} \times \text{week} \times \text{dollar} \times \text{bananas} \times \text{week} \times \text{newton} \times \text{week} \equiv \text{dollar} \times \text{newton} \times \text{mile} \times \text{bananas} \times \text{week} \times \text{kiagram} \times \text{week}
  \]

  \[
  \text{mile} \times \text{week} \times \text{dollar} \times \text{bananas} \times \text{week} \times \text{newton} \times \text{week} \equiv \text{dollar} \times \text{newton} \times \text{mile} \times \text{bananas} \times \text{week} \times \text{kiagram} \times \text{week}
  \]

  \[
  \text{Week} \equiv \text{kiagram}
  \]
Speed = distance / time

• Formula: \[ S = \frac{D}{T} \]
• What is the speed of a car that traveled 75 km in 1.5 hr?
  \[ S = \frac{D}{T} = \frac{75\text{ km}}{1.5\text{ hr}} = 50\text{ km/hr} \]
• Tells only a magnitude (how much)
  – Distance units include: inches (in), feet (ft), miles (mi), meters (m), kilometers (km), centimeters (cm), light year, etc.
  – Time units include minutes (min), seconds (sec), hours (hr), years (yr), etc.
  – Speed can be any distance unit divided by any time unit!!
  – Mi/hr, ft/sec, km/min

Velocity is speed with a direction

- Written like: 125 miles/hour east or 83 m/sec towards the house
- What is the velocity of a jet that traveled 1623 mi North in 83 min?
  \[ V = \frac{D}{T} = \frac{1623\text{ mi}}{83\text{ min}} = 19.5\text{ mi/min North} \]

Average Speed or Average Velocity

• Average speed = total distance / total time

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>Distance (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>50</td>
</tr>
<tr>
<td>2</td>
<td>75</td>
</tr>
<tr>
<td>3</td>
<td>90</td>
</tr>
<tr>
<td>4</td>
<td>110</td>
</tr>
<tr>
<td>5</td>
<td>125</td>
</tr>
</tbody>
</table>

What is the average speed after 2 minutes?
  total distance is 75m, total time is 2 minutes.
  \[ S = \frac{D}{T} \]
  \[ S = \frac{75\text{ m}}{2\text{ min}} \]
  \[ S = 37.5\text{ m/min} \]

What is the average speed between 2 & 4 minutes?
  total distance: 110m – 75m = 35m
  total time: 4min – 2min = 2minutes total time
  \[ S = \frac{D}{T} \]
  \[ S = \frac{35\text{ m}}{2\text{ min}} \]
  \[ S = 17.5\text{ m/min} \]
Acceleration

• The change in speed or velocity over time
  – In scientific community, the symbol for “change” is the triangle: ▲
  – Change in velocity is found by subtracting the final speed from the initial speed
    \[ V_f - V_i = ▲V \]

The formula for acceleration is:
\[ A = \frac{V_f - V_i}{\text{time}} = \frac{▲V}{\text{time}} \]

Therefore the units for acceleration are going to be a distance/time/time

distance/time/time

Example

ft/min/sec

Acceleration

• For an object to accelerated it
  – Speed up (positive acceleration)
  – Slow down (negative acceleration a.k.a deceleration)
  – Change direction of travel

Each of these pictures depicts a type of acceleration:

1: the shuttle is speeding up every sec of the flight into orbit
2. the horse has come to a screeching halt (slowing down)
3. the baseball thrown to the batter is hit into the outfield (changed direction)
What’s it mean?

- **What does \( a = 5 \text{ [m/sec}^2 \text{]} \)** mean?
- If an object starts at rest, its *velocity increases by 5 [m/sec] every second.*

<table>
<thead>
<tr>
<th>Time (sec)</th>
<th>Acceleration</th>
<th>Velocity</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>5 m/sec(^2)</td>
<td>0 m/sec</td>
</tr>
<tr>
<td>1</td>
<td>5 m/sec(^2)</td>
<td>5 m/sec</td>
</tr>
<tr>
<td>2</td>
<td>5 m/sec(^2)</td>
<td>10 m/sec</td>
</tr>
<tr>
<td>3</td>
<td>5 m/sec(^2)</td>
<td>15 m/sec</td>
</tr>
<tr>
<td>4</td>
<td>5 m/sec(^2)</td>
<td>20 m/sec</td>
</tr>
</tbody>
</table>

Therefore, an object accelerating at 5m/sec\(^2\) will be travelling at 20 m/sec after 4 seconds.

Accelerate Problems:

- Calculate acceleration for the following data:

\[
A = \frac{V_f - V_i}{\text{time}} = \frac{\Delta V}{\text{time}}
\]

<table>
<thead>
<tr>
<th>Initial Velocity</th>
<th>Final Velocity</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 km/hr</td>
<td>60 km/hr</td>
<td>10 s</td>
</tr>
<tr>
<td>60 m/s</td>
<td>150 m/s</td>
<td>5 s</td>
</tr>
<tr>
<td>25 km/hr</td>
<td>1200 km/hr</td>
<td>2 min</td>
</tr>
</tbody>
</table>

\[
A = \frac{60 \text{ km/hr} - 20 \text{ km/hr}}{10 \text{ sec}} = \frac{4 \text{ km/hr}}{\text{sec}}
\]

\[
A = \frac{150 \text{ km/sec} - 50 \text{ km/sec}}{5 \text{ sec}} = \frac{20 \text{ km}}{\text{sec}^2}
\]

\[
A = \frac{1200 \text{ km/hr} - 25 \text{ km/hr}}{2 \text{ min}} = \frac{587.5 \text{ km/hr}}{\text{min}}
\]
Well, I checked for boo boos...
They should be fixed now...
Hopefully this works correctly...

cuz we’re done w/ 1