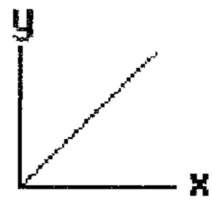
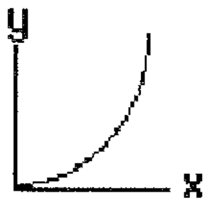
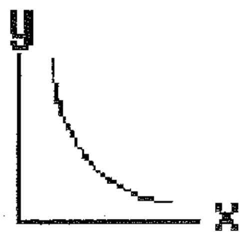
Topic 2D: Skill 19 - Graphical Relationships (Direct, Direct Square, Direct Square Root)

Every experiment, and resulting equation, summarizes the relationship between an independent variable (x-axis), a dependent variable (y-axis) and one or more things held constant (represented by m).

For "x" and "y" in the same direction with varying relationships

<table>
<tr><td colspan="4">Notice that if "x" is in the numerator (for y in simplest terms), it means that "x" and "y" will go in the same direction according to the function of "x"
If "x–the independent variable" increases, "y-the dependent variable" increases by... x, x^2, $\sqrt{x}$</td></tr>
<tr><td>TYPE OF RELATIONSHIP</td><td>Direct Relationship</td><td>Direct Square Relationship</td><td>Direct Square Root Relationship</td></tr>
<tr><td>EQUATION FORMAT</td><td>y=mx</td><td>$y=mx^2$</td><td>$y=m\sqrt{x}$</td></tr>
<tr><td>IN OTHER WORDS</td><td>Whatever happens to "x" happens to "y"</td><td>For any change in "x", a square of that change happens to "y"</td><td>For any change in "x", a square root of that change happens to "y"</td></tr>
<tr><td>GRAPHICAL PATTERN</td><td></td><td></td><td></td></tr>
<tr><td>Example from projectiles with sample data</td>
<td>d=vt
d is the dependent
t is the independent
v is the constant slope
<table>
<tr><th>v</th><th>t</th><th>d</th></tr>
<tr><td>2m/s</td><td>1s</td><td>2m</td></tr>
<tr><td>2m/s</td><td>2s</td><td>4m</td></tr>
<tr><td>2m/s</td><td>3s</td><td>6m</td></tr>
<tr><td>2m/s</td><td>4s</td><td>8m</td></tr>
</table>
Whatever change occurs to time also happens to distance</td>
<td>$d=1/2at^2$
d is the dependent
t is the independent
a is constant (but it is not slope)
<table>
<tr><th>a</th><th>t</th><th>d</th></tr>
<tr><td>$10m/s^2$</td><td>1s</td><td>5m</td></tr>
<tr><td>$10m/s^2$</td><td>2s</td><td>20m</td></tr>
<tr><td>$10m/s^2$</td><td>3s</td><td>45m</td></tr>
<tr><td>$10m/s^2$</td><td>4s</td><td>80m</td></tr>
</table>
Whatever change occurs to time the square of that change happens to distance.
Ie. When the time of fall doubles 2s to 4s, the distance of the fall quadruples from 20 to 80m</td>
<td>$t=\sqrt{\frac{2d}{g}}$
We don't see this graph often but we did investigate this.
If you change the height of the fall the time increases but not directly or by the square. Instead it increases by the square root.
<table>
<tr><th>a</th><th>d</th><th>t</th></tr>
<tr><td>$10m/s^2$</td><td>5m</td><td>1s</td></tr>
<tr><td>$10m/s^2$</td><td>10m</td><td>1.4s</td></tr>
<tr><td>$10m/s^2$</td><td>15m</td><td>1.73s</td></tr>
<tr><td>$10m/s^2$</td><td>20m</td><td>2s</td></tr>
<tr><td>$10m/s^2$</td><td>25m</td><td>2.23s</td></tr>
<tr><td>$10m/s^2$</td><td>30m</td><td>2.45s</td></tr>
<tr><td>$10m/s^2$</td><td>35m</td><td>2.67s</td></tr>
<tr><td>$10m/s^2$</td><td>40m</td><td>2.86s</td></tr>
<tr><td>$10m/s^2$</td><td>45m</td><td>3s</td></tr>
</table>
When the height doubles, the time of fall increases by $\sqrt{2}$, When the height quadruples, the time of fall increases by $\sqrt{4}$; When the height of the fall is multiplied by 9, the time of fall increases by $\sqrt{9}$</td></tr>
</table>

For "x" and "y" in the opposite direction (Inverse)

<table>
<tr><td colspan="4">Notice that if "x" is in the denominator (for y in simplest terms), it means that "x" and "y" will go in opposite directions according to the function of "x"
If "x–the independent variable" increases, "y-the dependent variable" decrease by... x, x^2</td></tr>
<tr><td>TYPE OF RELATIONSHIP</td><td>Inverse Relationship</td><td>Inverse Square Relationship</td><td>Direct Square Root Relationship</td></tr>
<tr><td>EQUATION FORMAT</td><td>$y=\frac{m}{x}$</td><td>$y=\frac{m}{x^2}$</td><td>$y=\frac{m}{\sqrt{x}}$</td></tr>
<tr><td>IN OTHER WORDS</td><td>Whatever happens to "x" the opposite happens "y"</td><td>For any change in "x", the opposite squared of that change happens to "y"</td><td>For any change in "x", the opposite square root of that change happens to "y"</td></tr>
<tr><td>GRAPHICAL PATTERN</td><td colspan="3">
The graph shape is the same for all inverse relationships the bend increases as the "power" of the denominator increases.</td></tr>
<tr><td colspan="4">Notice all forms of this graph have a curve which will approach but not cross "x" since the independent variable is in the denominator. This is different than negative and direct such as an object travelling towards something at a constant speed (d=-vt)</td></tr>
<tr><td colspan="4">We will see more of this graph in UNIT3 so you will not be quizzed on this until we see some examples in action.</td></tr>
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