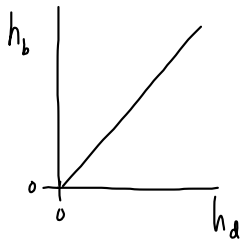
Working with Proportionalities in Physics

Recall Bounce that Ball:



Since the graph is linear with a y-intercept of zero we can say that the "bounce height is directly proportional to the drop height"

or

"the bounce height varies directly with the drop height"

Consider your data:

drop height	bounce height	
80cm	32cm	x2
40cm	15cm	x2 (roughly)

When these two factors match, this indicates that there is a direct proportionality.

mathematically

$$h_b \propto h_d$$

$$h_b = k\, h_d$$

$(y = mx + b)$

where k is the proportionality constant.

A graph of h_b vs h_d will be linear with a slope of k and a y-intercept of zero.

Types of proportionalities:

direct => $y \propto x$

inverse => $y \propto \frac{1}{x}$

squared => $y \propto x^2$

combined => $y \propto \frac{x^3}{z}$ $\left(y \propto x^3 \text{ and } y \propto \frac{1}{z}\right)$

Practice: (on sheet)

1. a) $z \propto t^3$

b) $p \propto w^2$

c) $A \propto m$

d) $V \propto r^3$

e) $S \propto r$

Example

The force of air resistance F varies directly with the square of an object's velocity v. If the force is 57 N for an object travelling at 11 m/s, what will the force be if the object travels at 15 m/s?

$F \propto v^2$ (proportionality statement)

$F = kv^2$ (general equation)

rearrange for k

$k = \frac{F}{v^2}$ (find k)

$k = \frac{57\,N}{(11\,m/s)^2}$

$k = 0.47\ \frac{N}{m^2/s^2}$

$F = \left(0.47\ \frac{N}{m^2/s^2}\right)v^2$ (specific equation)

$F = \left(0.47\ \frac{N}{m^2/s^2}\right)(15\,m/s)^2$ (find new value)

$F = 1.1 \times 10^2\ N$