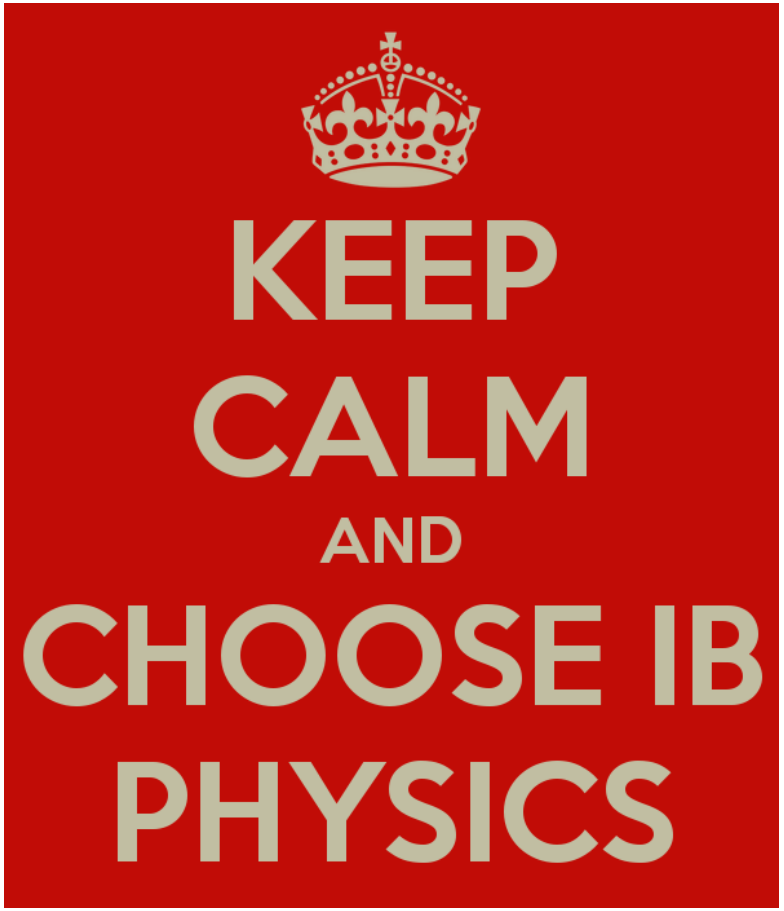
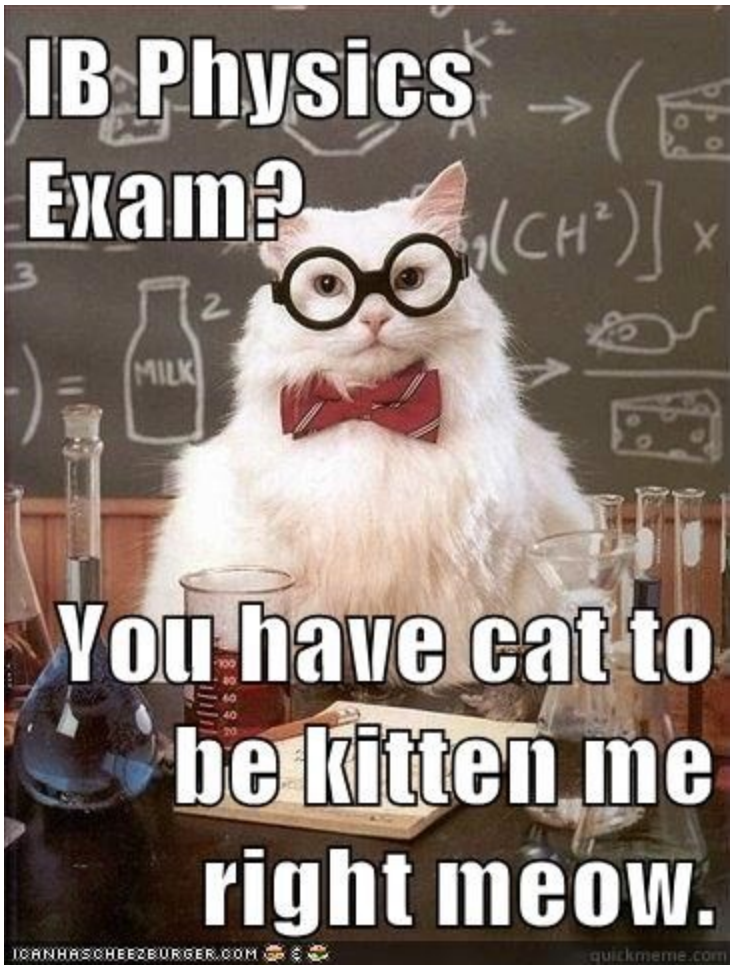
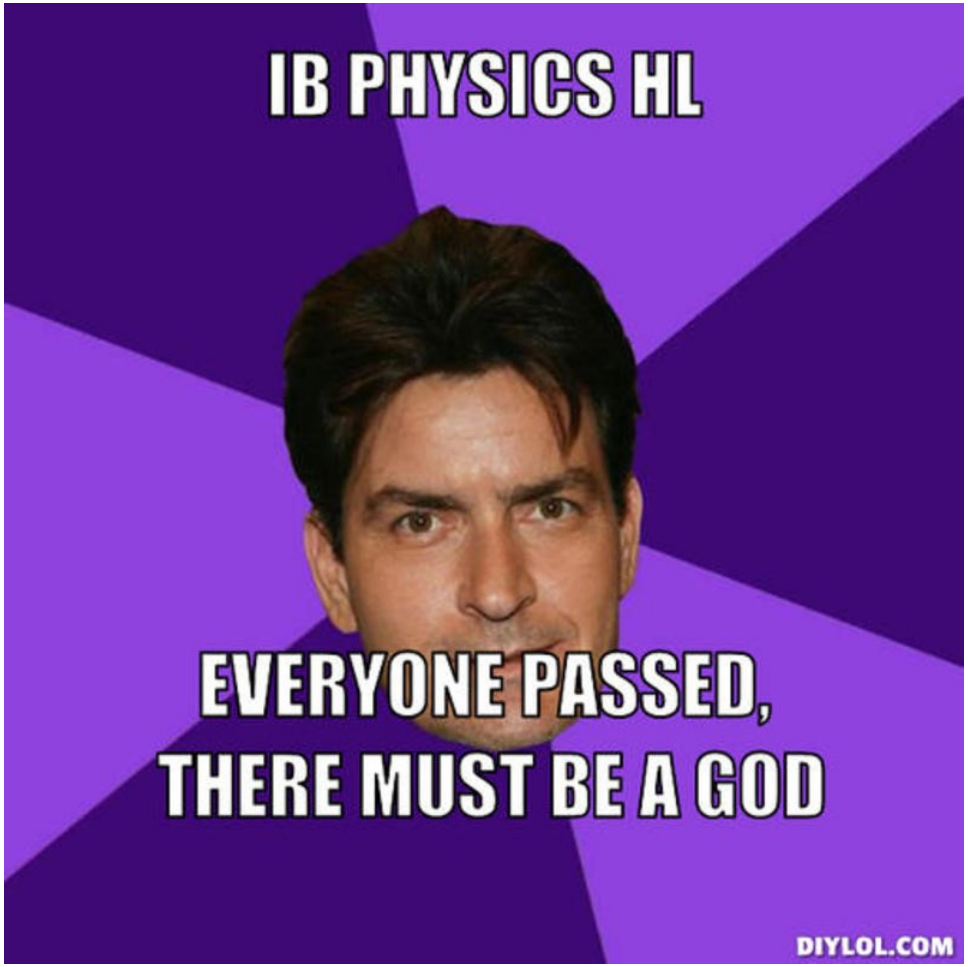

COLEGIO DEL MUNDO • WORLD SCHOOL • ECOLE DU MONDE •
ib
®


KEEP
CALM
AND
CHOOSE IB
PHYSICS

IB Scale 1 through 7

Physics Exam?





How has IB Physics changed?

IA no longer comprised of several lab reports, just one 10 hour paper

New topic: Nature of Science

Only one option instead of two

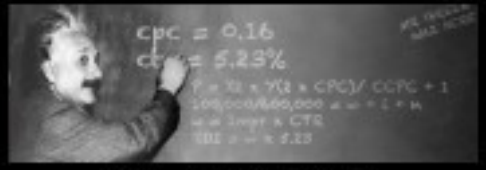
IB Students

What my friends think I do

What my Mom thinks I do

What IB thinks I do

What my IB teachers think I do



What I think I do

What I actually do

Assessment

Component	Overall weighting (%)	Approximate weighting of objectives (%)		Duration (hours)
		1+2	3	
Paper 1	20	10	10	1
Paper 2	36	18	18	2¼
Paper 3	24	12	12	1¼
Internal assessment	20	Covers objectives 1, 2, 3 and 4		10

Personal engagement	Exploration	Analysis	Evaluation	Communication	Total
2 (8%)	6 (25%)	6 (25%)	6 (25%)	4 (17%)	24 (100%)

IA Time

- It is recommended that a total of approximately 10 hours of teaching time should be allocated to the work. This should include:
- time for the teacher to explain to students the requirements of the internal assessment
- class time for students to work on the internal assessment component and ask questions
- time for consultation between the teacher and each student
- time to review and monitor progress, and to check authenticity.

Guidelines

- Should be 6 to 12 pages long
- Demonstrates personal significance
- Relevant and focused research question

- Addresses safety concerns

TRU Credits?

- “TRU is pleased to recognize enriched secondary school programs. Students who have successfully completed IB courses can apply to have the courses equated to specific courses offered at TRU. Students receive introductory credit for Higher Level subjects passed with a grade of at least 5.

  The student can receive the specific TRU credit for the courses. This credit will count towards the total TRU credits in their program, and the student can take fewer courses at TRU to complete their program”

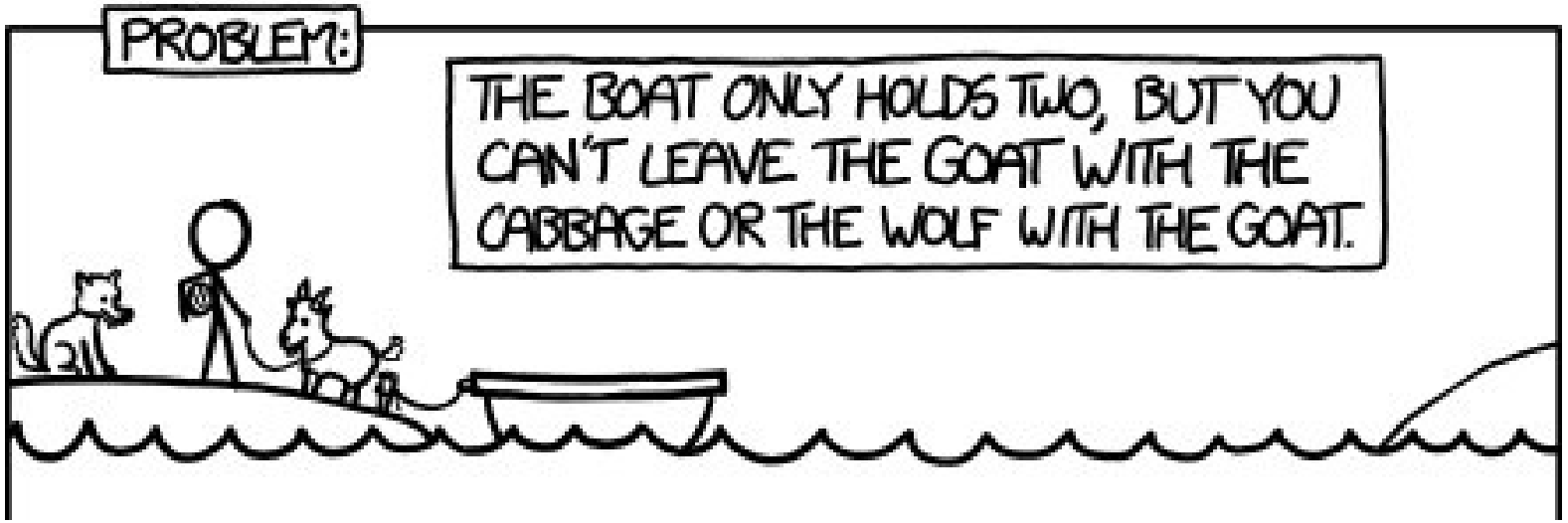
IB Learner Profile

- Inquirers
- Knowledgeable
- Thinkers
- Communicators
- Principled
- Open-minded
- Caring
- Risk-takers
- Balanced
- Reflective

Physics HL

Topic 1:
Measurement

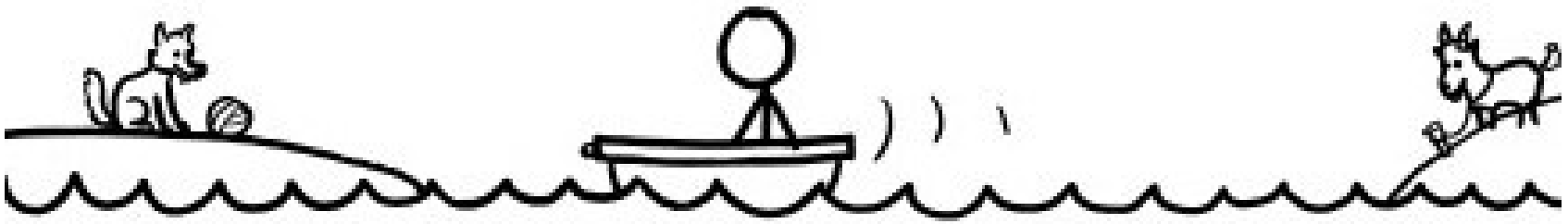
Problem solving

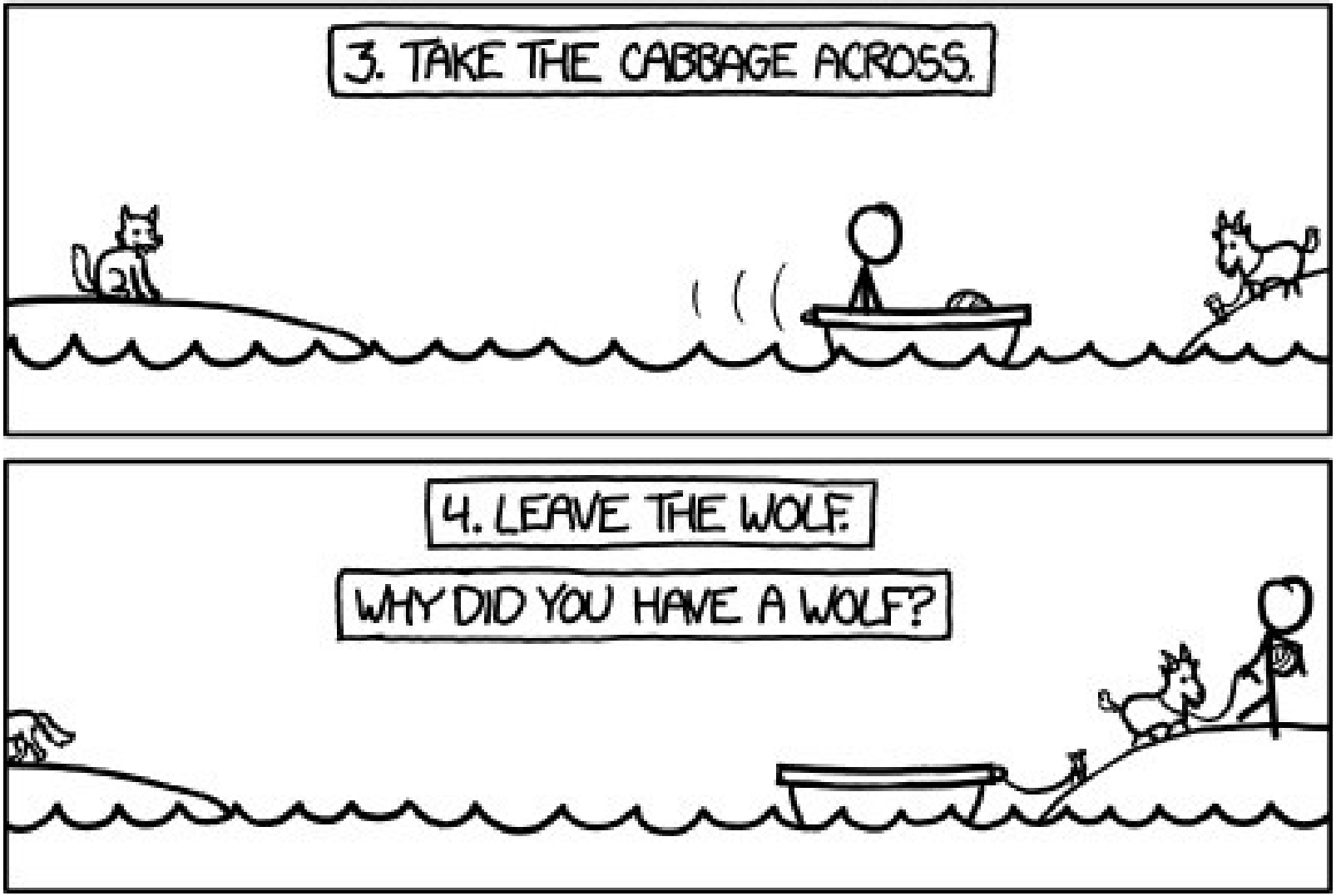


SOLUTION:

1. TAKE THE GOAT ACROSS.

2. RETURN ALONE.




3. TAKE THE CABBAGE ACROSS.
4. LEAVE THE WOLF.
WHY DID YOU HAVE A WOLF?

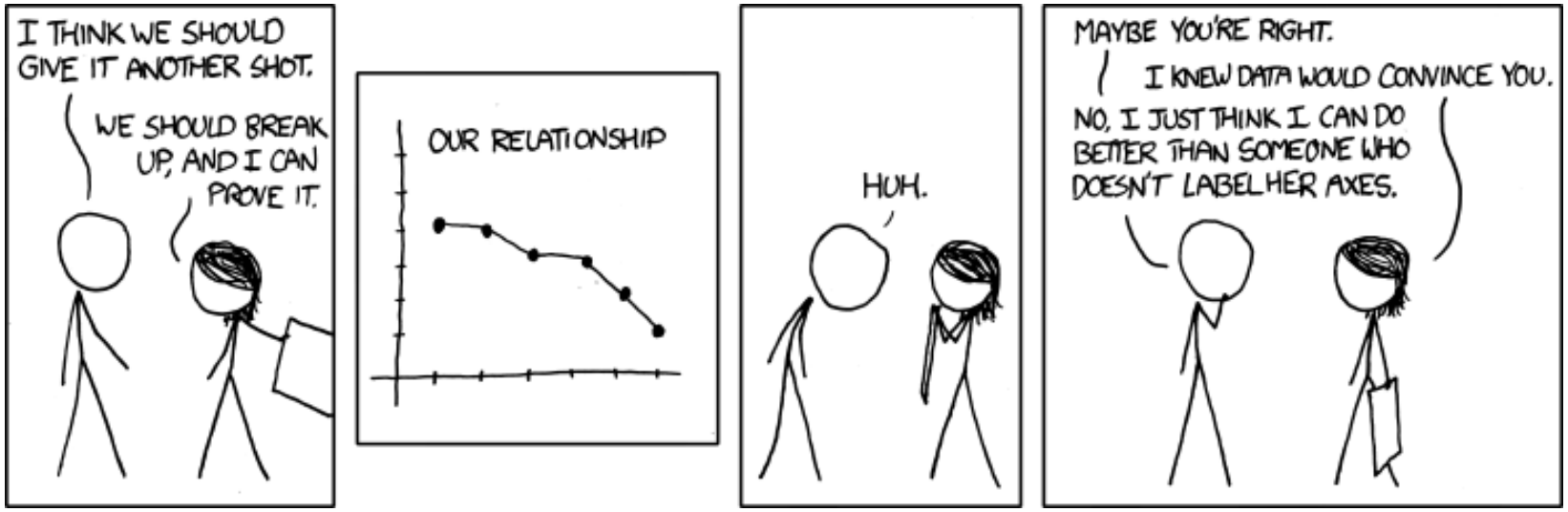
Paper Bridge

Goal: build the strongest bridge spanning 20 cm out of one sheet of paper & 30cm tape

Not a lab, just an “activity”

Own practice sheet

Wait for competition sheet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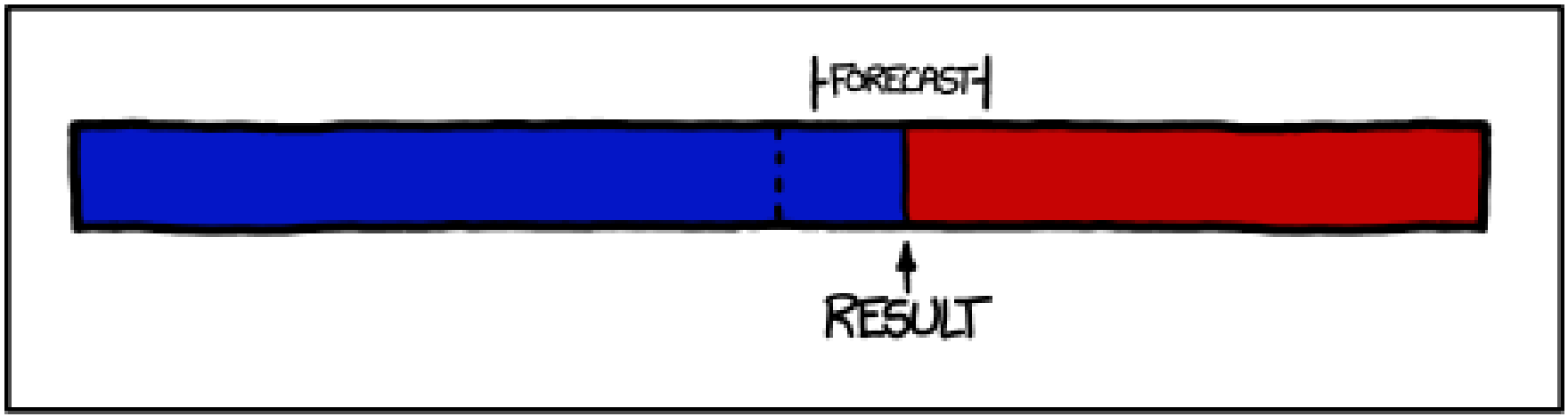


BREAKING: TO SURPRISE OF PUNDITS, NUMBERS CONTINUE TO BE BEST SYSTEM FOR DETERMINING WHICH OF TWO THINGS IS LARGER.

Paper Tower

Goal: build the tallest free standing tower out of one sheet of paper & 30cm tape

Not a lab, just an “activity”

White practice sheet

Yellow competition sheet

Measurement

Physicists (and physicists in training) need to excel at taking measurements

Ex 1: what is the width of your table?

Who can get closest to the accepted value?

Measurement

Physicists (and physicists in training) need to excel at taking measurements

Ex 1: what is the width of your table?

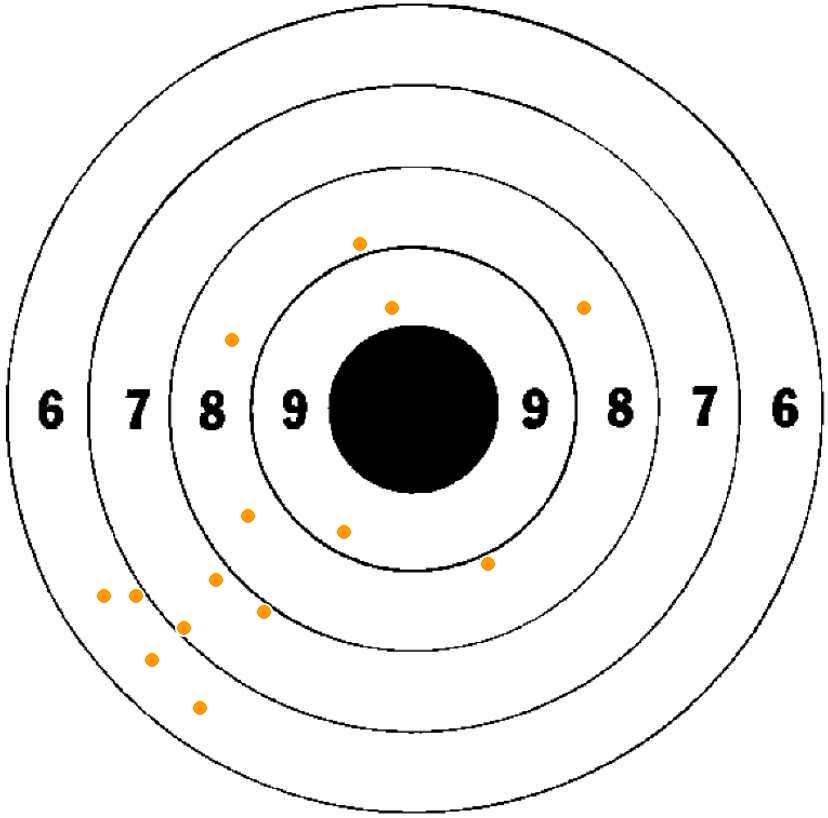
Who can get closest to the accepted value?

$1.524m$

Precision & Accuracy

Accuracy refers to the correctness of a measurement

Precision is how well you define the value, ex: 3.14159 is more precise than 3.14



Error

There is no such thing as a perfect measurement

Random error: unpredictable fluctuations in measurements, e.g. parallax

Systematic error: bias caused by poor calibration or technique, e.g. meniscus

Metric System

Units

We have fundamental units:

- meters
- kilograms
- seconds

Other units are derived from these:

- Velocity: $m \cdot s^{-1}$
- Force: $1N \equiv 1kg \cdot m \cdot s^{-2}$

When doing calculations, we always carry the units through to help check our answer

Unit Conversions

We often want to convert to “mks” units:

- sometimes we multiply by a scale factor
  - this is a fraction equivalent to 1
  - you must choose one that will cancel out the unwanted units!
- Ex 2: convert to m/s

$$100\frac{km}{h} \qquad \frac{1000m}{1km} \qquad \frac{1h}{3600s}$$

$$28\frac{m}{s} \qquad 28m\cdot s^{-1}$$

Prefixes

These are another way to simplify large or small values:

- **deca**
- **hecto**
- **kilo**
- **Mega**
- **Giga**
- Tera

deci

centi

milli

micro (μ)

nano

pico

To convert we fill in the appropriate factor of 10 for the prefix: e.g. 23 ms = 23×10^{-3} s

XKCD PRESENTS:

SOME NEW SCIENCE MNEMONICS

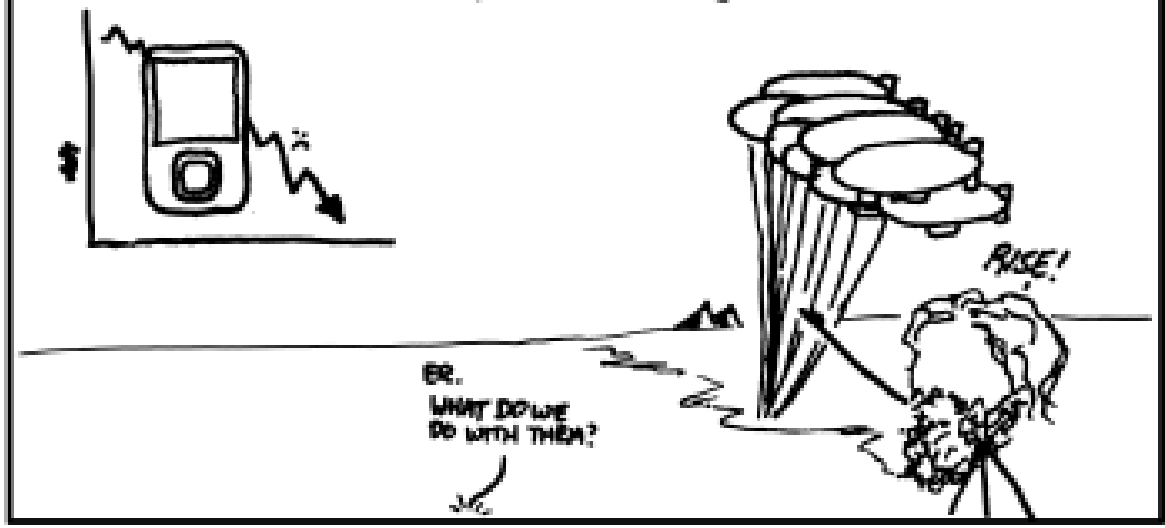
DER OF OPERATIONS

IESES, EXPONENTS, DIVISION &
ATION, ADDITION & SUBTRACTION
: PLEASE EXCUSE MY DEAR AUNT SALLY

E EMAIL MY DAD A SHARK
LE EXPECT MORE DRUGS AND SEX

SI PREFIXES

KILO, MEGA, GIGA, TERA, PETA, EXA, ZETTA, YOTTA
MILLI, MICRO, NANO, PICO, FEMTO, ATTO, ZEPTO, YOCTO
TRADITIONAL: [I NEVER LEARNED ONE]



BIG:
KARL MARX GAVE THE PROLETARIAT ELEVEN ZEPPELINS, YO.
SMALL:
MICROSOFT MADE NO PROFIT FROM ANYONE'S ZUNES, YO.

TAXONOMY

GEOLOGIC PERIODS

Operations with Prefixes

We often want to convert to similar units first:

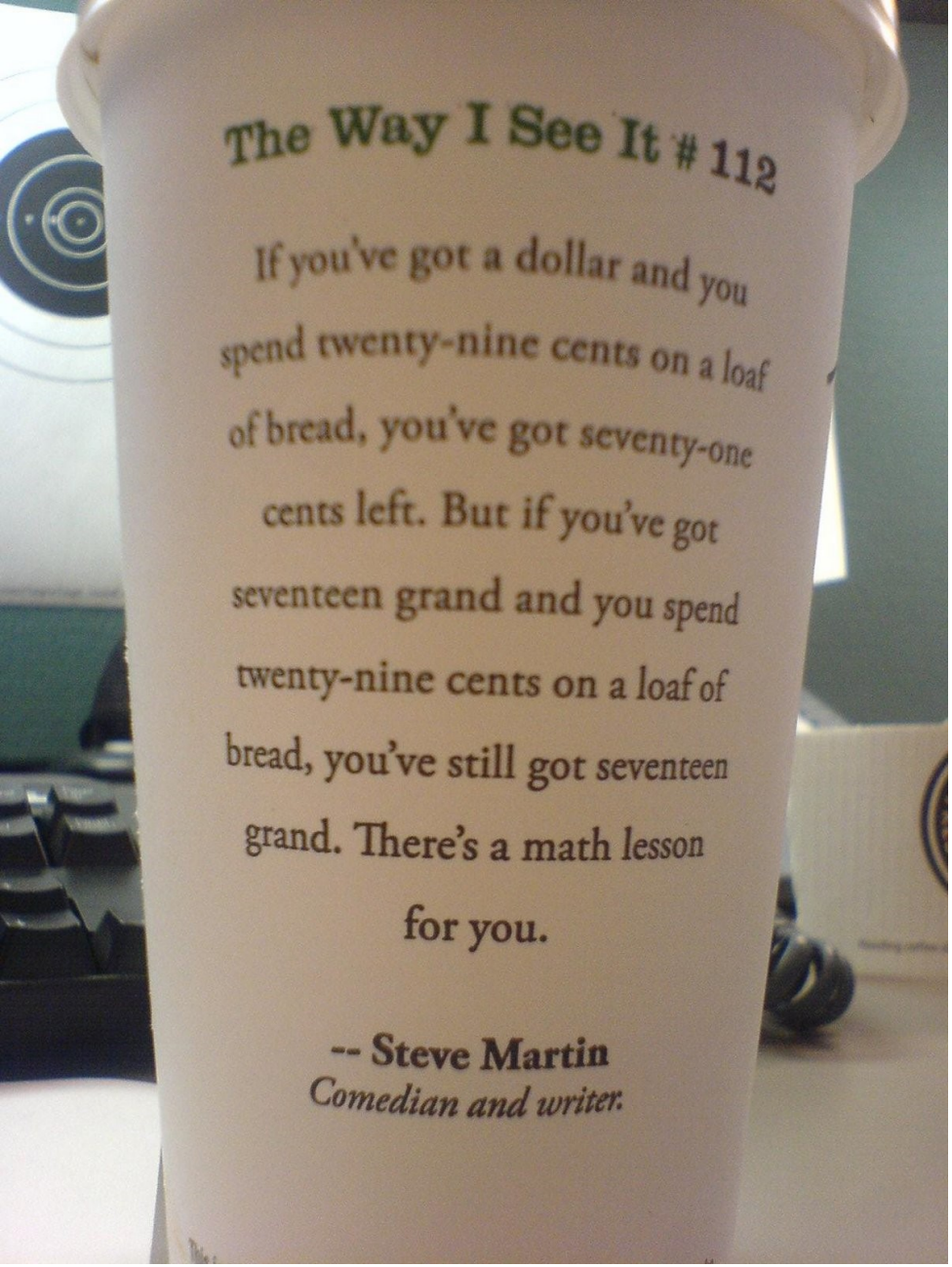
ex 1: 230 mg + 0.000 42 kg

230×10^{-3} g + $0.000\,42 \times 10^{3}$ g

0.23 g + 0.42 g

0.65 g

650 mg?



If you've got a dollar and you spend twenty-nine cents on a loaf of bread, you've got seventy-one cents left. But if you've got seventeen grand and you spend twenty-nine cents on a loaf of bread, you've still got seventeen grand. There's a math lesson for you.

Operations using Place Value

The least precise measurement dominates calculations

When adding or subtracting, we use place value

ex 1:

$$\begin{array}{r} 32\ .25 \\ +\ 2\ .2 \\ \hline 34\ .45 \end{array}$$

34.4

Significant Figures

A number should indicate the precision of the measurement

e.g. t=5.2 s implies the time is known to the nearest tenth of a second: 2 sig figs.

5.21 s =>3 sf

A number such as 550 kg causes uncertainty *WS*

To clarify, we follow these rules:

Any non-zero digits are significant: 223.4 m

Place holding zeroes are not: 0.003 m

Sandwiched zeroes are: 900 023 s

Trailing zeroes after the decimal are: 2.30 m

Operations using Sig Figs

The least precise measurement dominates calculations

When multiplying or dividing, we can use sig figs

ex 1:

$$3.2 \times 22 = 70.4$$

$$71$$

Scientific Notation

We can express very small numbers and very large numbers in more compact form:

The mass of a proton m_p=

0.000 000 000 000 000 000 000 000 001 67 kg

or 1.67×10^{-27} kg

The mass of the Sun m_s=

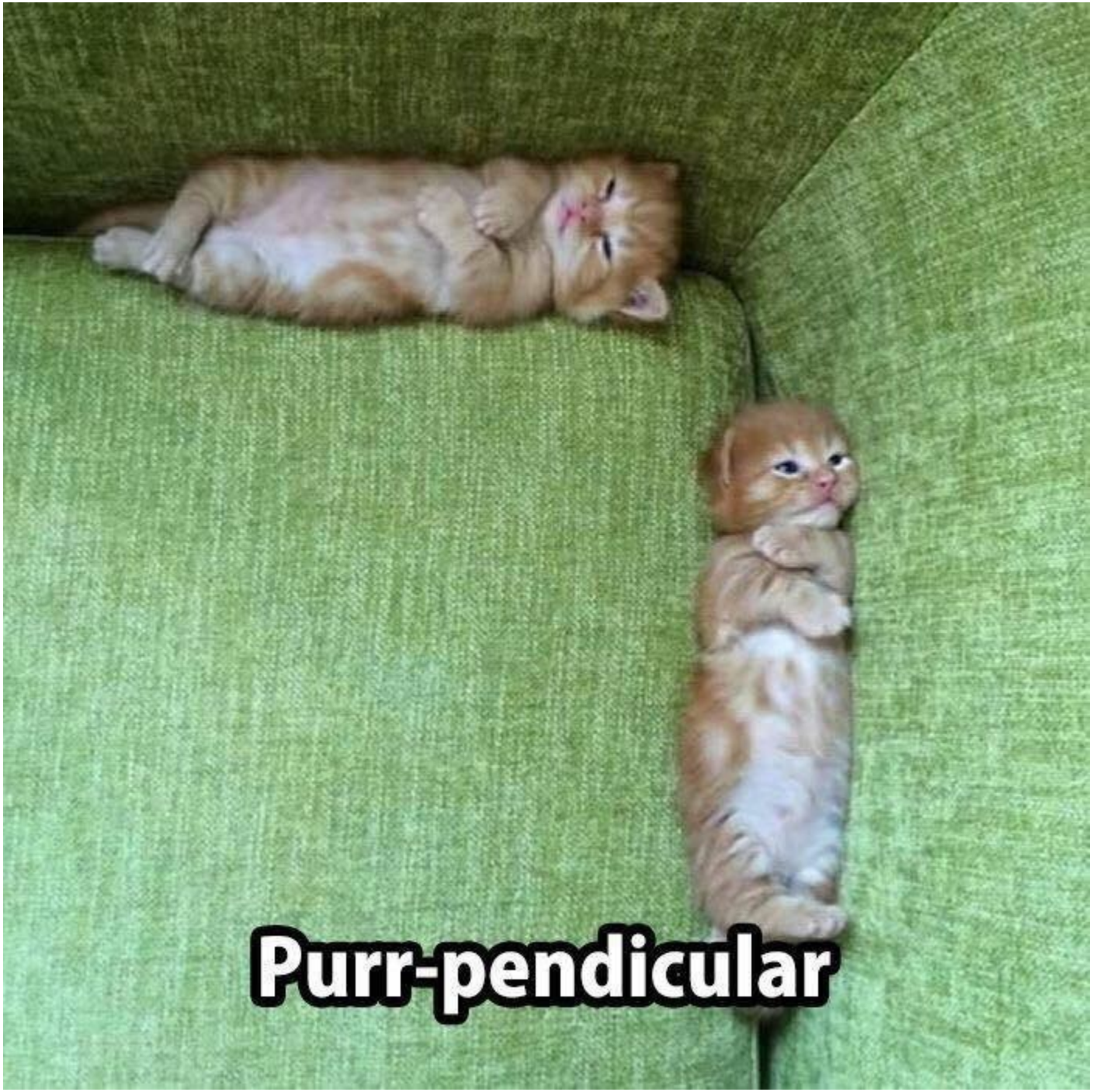
1 980 000 000 000 000 000 000 000 000 000 kg

or 1.98×10^{30} kg

The value is written as a decimal number x (where $1 \leq x < 10$) multiplied by a factor of 10

Test Yourself

#1-10 p. 6


Purr-pendicular

Absolute Uncertainty

- When adding or subtracting we can add each absolute uncertainty

- If $y = a \pm b$

- then $\Delta y = \Delta a + \Delta b$

- Ex:

$$0.55 \pm 0.02m + 1.22 \pm 0.01m$$

$$1.77 \pm 0.03m$$

Percent Uncertainty

- When multiplying or dividing we can add each percent uncertainty

- If: $y = \frac{ab}{c}$

- then $\frac{\Delta y}{y} = \frac{\Delta a}{a} + \frac{\Delta b}{b} + \frac{\Delta c}{c}$

Percent Uncertainty

- When using powers, we multiply the exponent by the percent uncertainty

- If: $y = a^n$

- then $\frac{\Delta y}{y} = \left| n \frac{\Delta a}{a} \right|$

- Ex: Find the area of a rectangle with a length of 0.55 m +/- 3% and a width of 1.22 m +/- 2%

$$0.55m \pm 3\% \times 1.22m \pm 2\%$$

$$0.671m^2 \pm 5\%$$

$$0.67m^2 \pm 5\%$$

- Ex: Find the area of a circle with a radius of 18 m +/- 2%

$$A = \pi r^2$$

$$\pi(18m)^2 \pm 4\%$$

$$1018m^2 \pm 4\%$$

$$1.02 \times 10^3 m^2 \pm 4\%$$

- Ex: Find the radius of a sphere with a volume of 1.00 m^3 +/- 6%

$$V = \frac{4}{3}\pi r^3$$

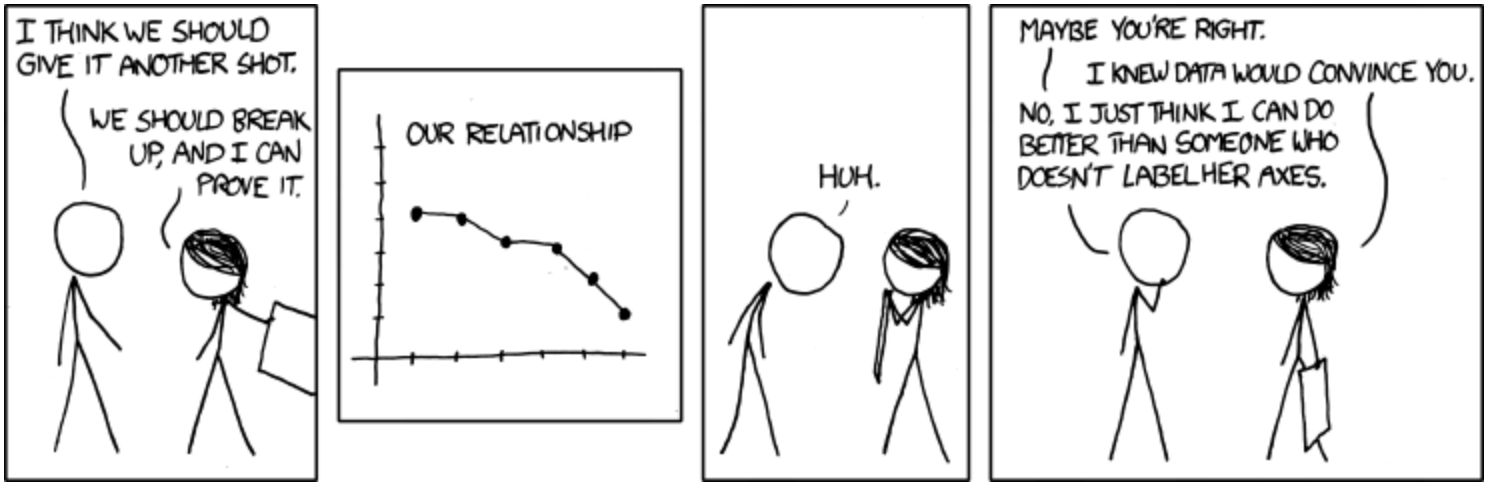
$$r = \left(\frac{3V}{4\pi}\right)^{1/3}$$

$$r = \left(\frac{3 \cdot 1.00 m^3}{4\pi}\right)^{1/3} \pm 2\%$$

$$r = 0.62m \pm 2\%$$

Hamper Text

- Read p. 1-14, try q's 2-7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The Best Graph*

Title

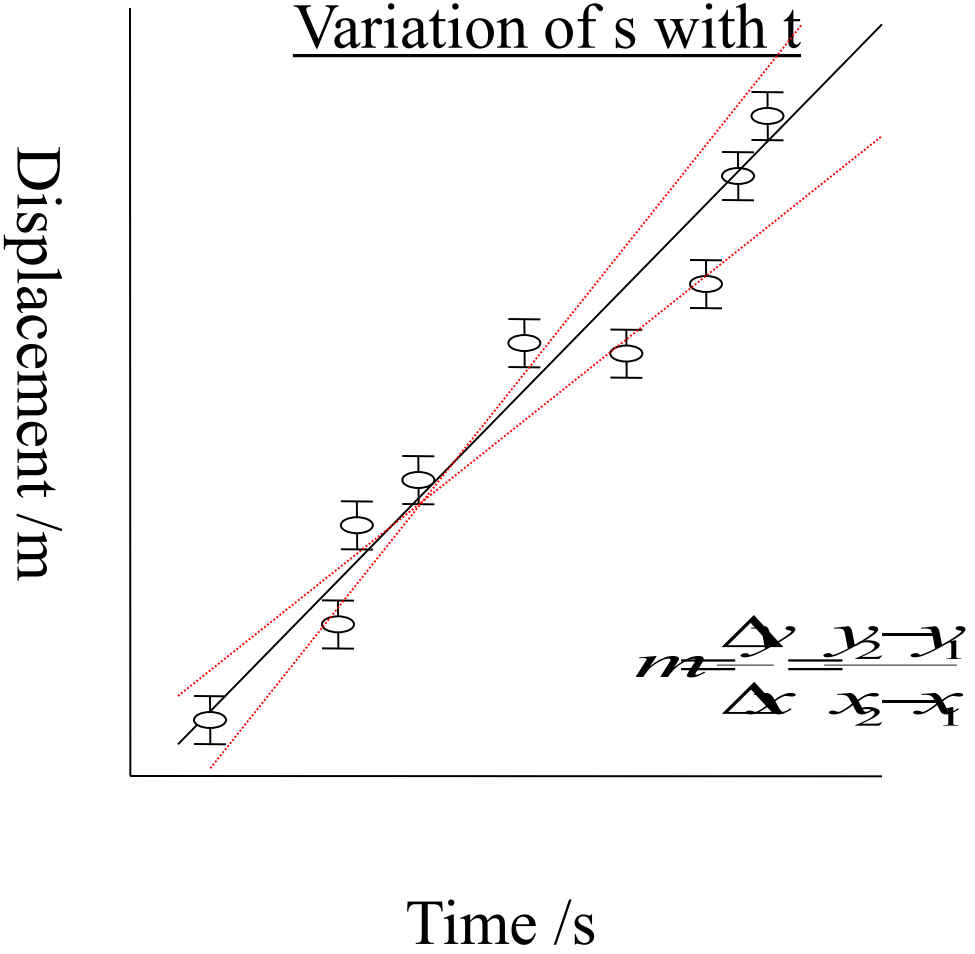
Labelled axes

Appropriate scale

Best fit, max/min gradients

Slope calculations

Correctly chosen dependent/ independent variables

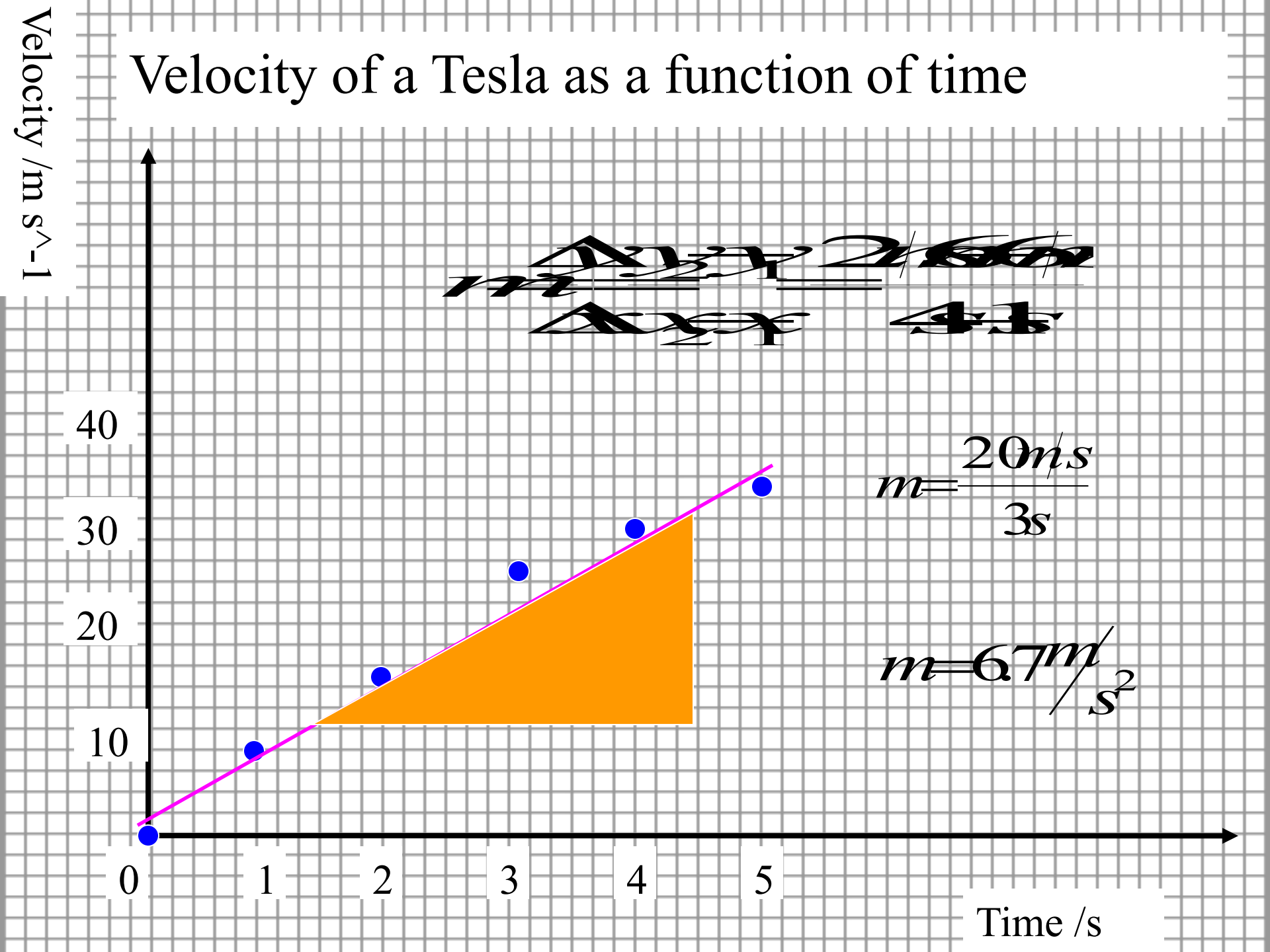


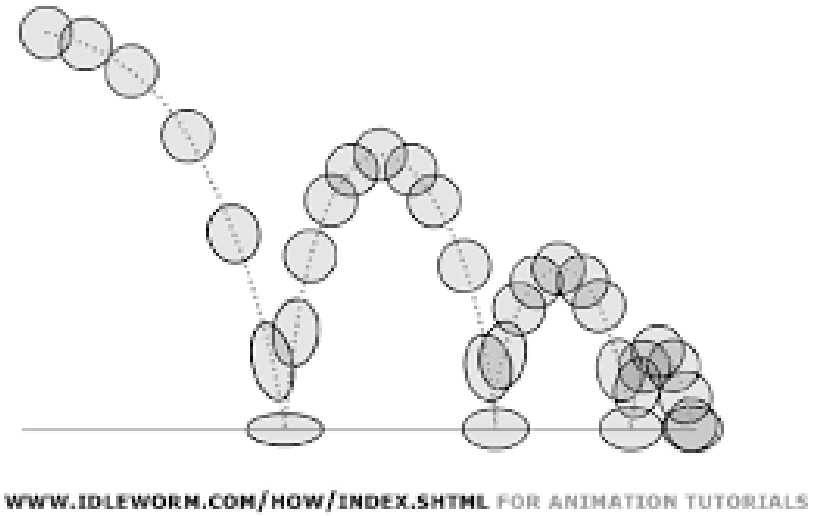
Ex 1: Graph v vs t

Graph the velocity of a Tesla S90D as a function of time given:

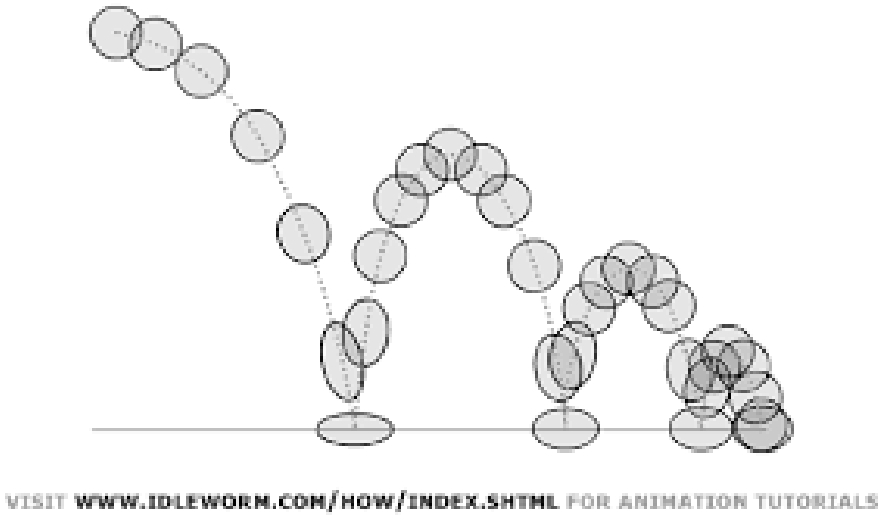
time (s)	velocity (m/s)
0	0
1	9
2	15
3	24
4	30
5	36

Velocity of a Tesla as a function of time





Activity: measure and graph the relationship between the height and number of bounces for a golf ball. Include error bars!



Test yourself

Start p. 20 #23-34

“According to astronomy, when you wish upon a star you’re actually a few million years late.

That star is dead.

Just like your dreams. “

Rearranging

$$a\,l\,m\,o\,F_{r}\quad u\qquad\qquad e$$

Rearranging Formulae

Basic rules for rearranging equations:

- We can do ***anything*** as long as we do the same to the other side of the equation
- To move a variable or term to the other side, perform the **opposite** operation
- To isolate a buried variable, work from the outside in: SAMDEB!!!

Ex 1: solve for a

$$v = v_0 + at$$

$$v - v_0 = at$$

$$\frac{at}{t} = \frac{v - v_0}{t}$$

$$a = \frac{v - v_0}{t}$$

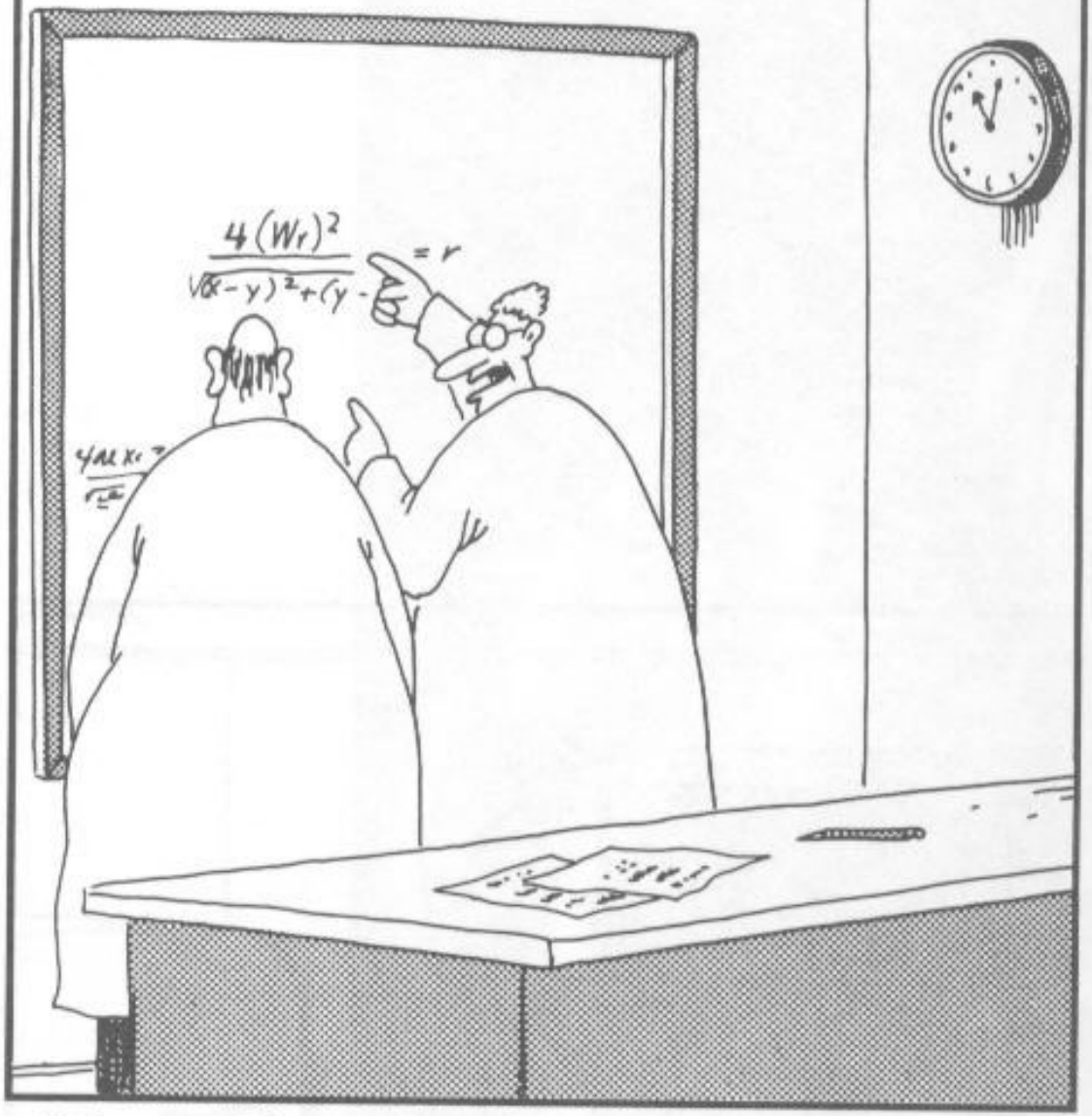
$$d = v_0 t + \frac{1}{2} a t^2$$

$$d - v_0 t = \frac{1}{2} a t^2$$

$$2(d - v_0 t) = a t^2$$

$$\frac{2(d - v_0 t)}{t^2} = a$$

$$a = \frac{2(d - v_0 t)}{t^2}$$



"Yes, yes, I *know* that, Sidney … *every*body knows *that!* … But look: Four wrongs *squared*, minus two wrongs to the fourth power, divided by this formula, *do* make a right."

Ex 3: rearrange to find v

$$\gamma = \frac{1}{\sqrt{1 - v^2/c^2}}$$

Practice problems up to #22

Ex 3: rearrange to find v

$$\gamma = \frac{1}{\sqrt{1 - v^2/c^2}}$$

$$\gamma^2 = \frac{1}{1 - v^2/c^2}$$

$$\left(1 - v^2/c^2\right)\gamma^2 = 1$$

$$1 - v^2/c^2 = \frac{1}{\gamma^2}$$

$$-v^2/c^2 = \frac{1}{\gamma^2} - 1$$

$$v^2/c^2 = 1 - \frac{1}{\gamma^2}$$

$$\sqrt{v^2/c^2} = \sqrt{1 - \frac{1}{\gamma^2}}$$

$$\frac{v}{c} = \sqrt{1 - \frac{1}{\gamma^2}}$$

$$v = c\sqrt{1 - \frac{1}{\gamma^2}}$$

$$\frac{v}{\sqrt{1 - \frac{1}{\gamma^2}}} = c$$

Dimensional Analysis

We always carry units through to check our work

We can even use units to check if a formula is correct

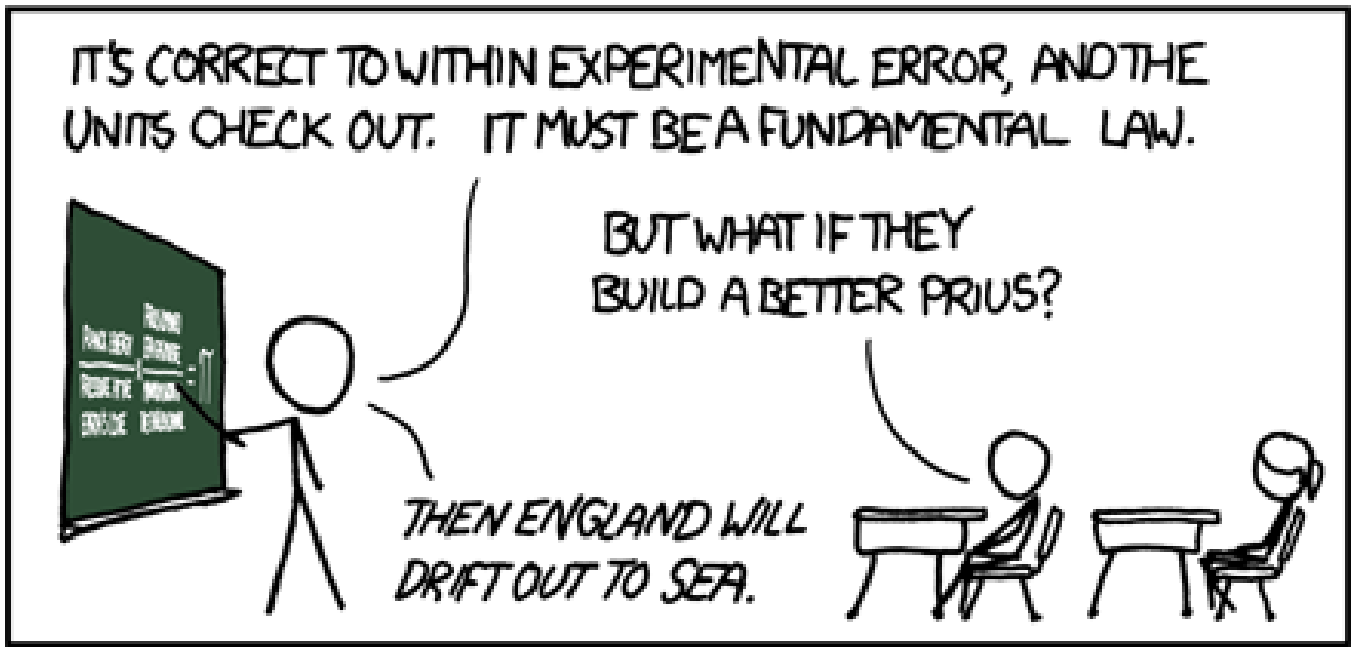
Ex 1: which is the correct formula for time?

$t = dv$ $\quad$ $t = dv^2$ $\quad$ $t = d/v$ $\quad$ $t = v/d$

$m \cdot \left(m \cdot s^{-1}\right)$ $\quad$ $m \cdot \left(m \cdot s^{-1}\right)^2$ $\quad$ $\dfrac{m}{m \cdot s^{-1}}$ $\quad$ $\dfrac{m \cdot s^{-1}}{m}$

My Hobby:
Abusing dimensional analysis

$$\frac{\text{Planck energy}}{\text{Pressure at the Earth's core}} \times \frac{\text{Prius combined EPA gas mileage}}{\text{Minimum width of the English Channel}} = \pi$$



Words and Phrases to Math Symbols

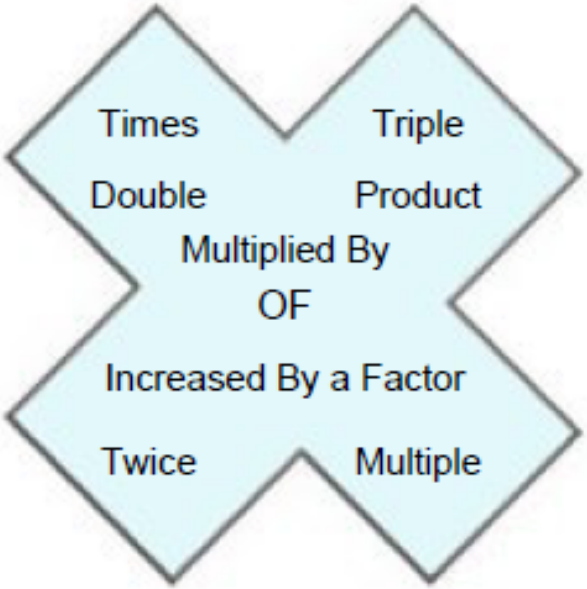
Addition

Plus
And
Total of
Altogether Increased By
Combined Add Sum
Together More Than
Added To
In All
Make

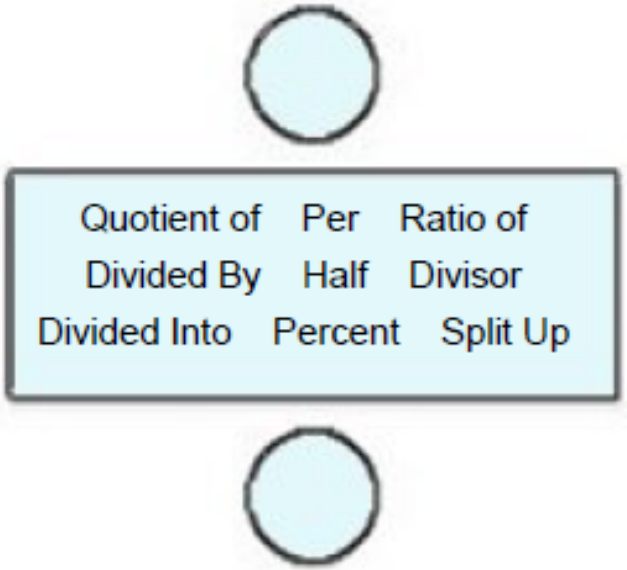
Subtraction

Subtract Gave Take Away
Decrease By Fewer Minus
Shared Fewer Than Less Than
Difference Less

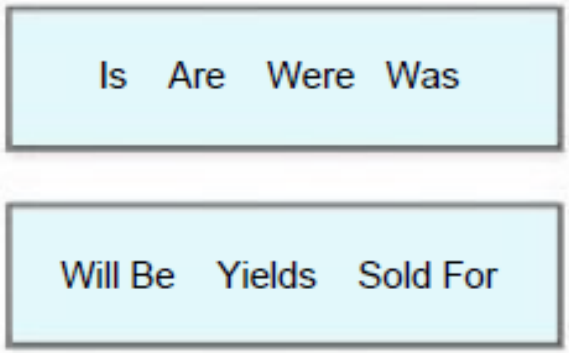
Multiplication



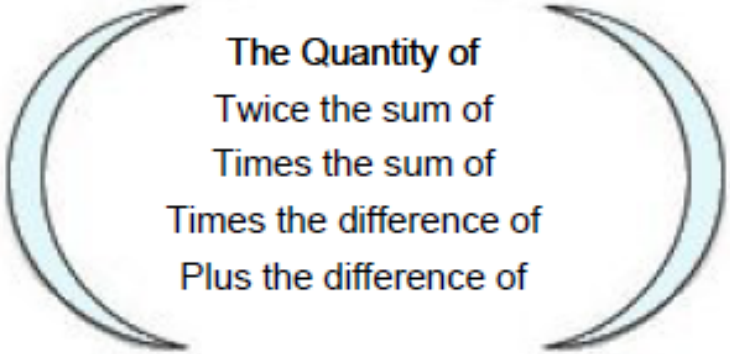
Division



Equals



Parenthesis Words

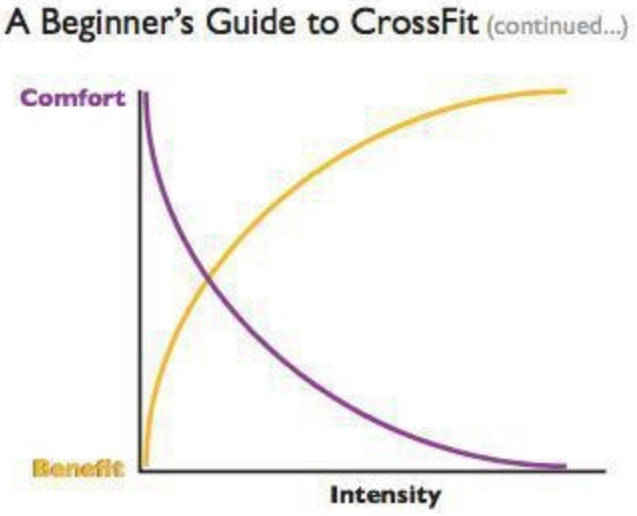


Proportionality

- If two variables are proportional to each other, this means:
- They result in a straight line graph
- The formula is of the form y=kx
- If we double one, this doubles the other
- Ex: C=2∏r, A=lw, d=vt, etc.

Inverse Proportionality

- If two variables are inversely proportional to each other, this means:
- They result in a curved graph
- The formula is of the form $y=k/x$
- If we double one, this halves the other
- Ex: $V=kQ/r$, $I=I_0/\gamma$, $d=vt$, etc.



Example: write five proportionality relationships & sketch graphs for:

$$pV = nRT$$

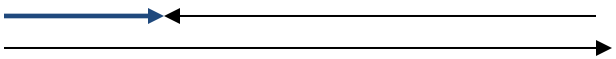
1. Pressure is directly proportional to Temperature
2. The number of moles n is proportional to Volume
3. Pressure is proportional to number of moles
4. The number of moles is inversely proportional to Temperature
5. Volume is proportional to Temperature
6. Volume is inversely proportional to pressure

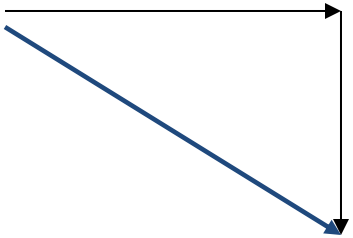
Scalars vs. Vectors

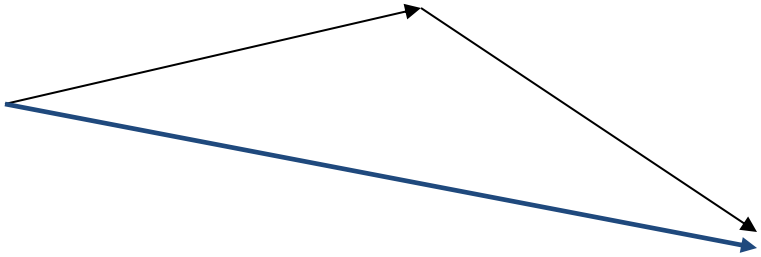
-
  -
  -
  -
  -
- Vectors: have magnitude and direction
  - force
  - momentum
  - displacement
  - velocity

Adding Vectors

- We always rearrange vectors to add them tip-to-tail.
- The resultant is the vector that reaches from the tail of the 1st to the tip of the 2nd

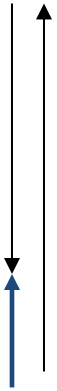


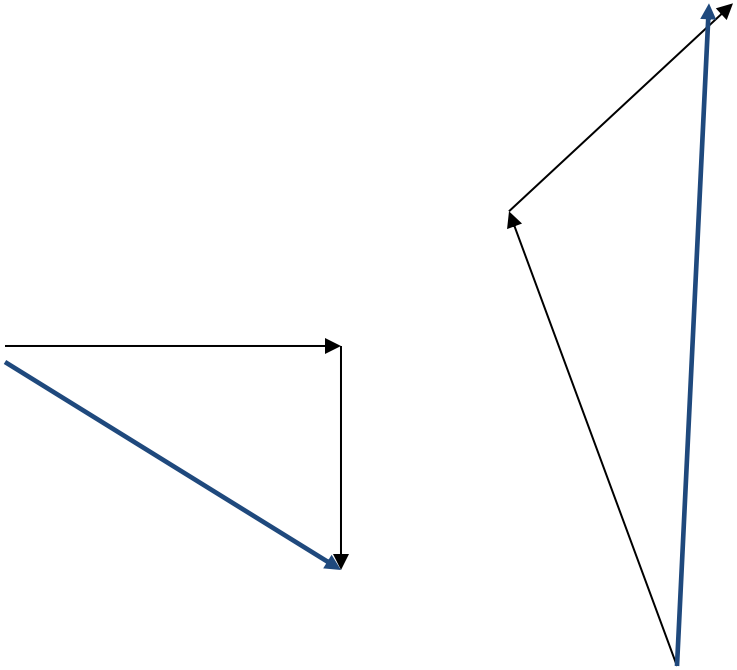




Adding Vectors

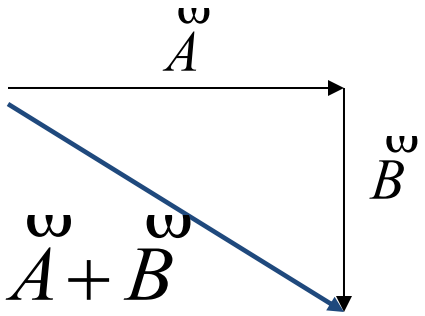
- Ex: Draw a scale diagram for:
- 5 m North + 3 m South
- 4 N East + 3 N South
- 10 m North + 5 m Northeast

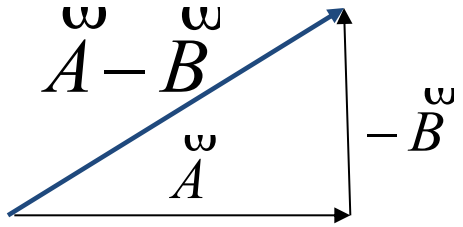




Subtracting Vectors

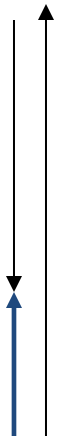
- We can think of vector A – B as being equivalent to A + (-B)





- Ex 1. Harminder walks 15 blocks North then 10 blocks South. Find his:
  - distance:

    d=15 blocks + 10 blocks=25 blocks
  - displacement



$$d = 15blocks + (-10blocks)N$$

$$d = 5blocks \uparrow North$$

- Ex 2. Brody walks 7 m East then 10 m North. Find his displacement :

- Ex 2. Brody walks 7 m East then 10 m North. Find his displacement :

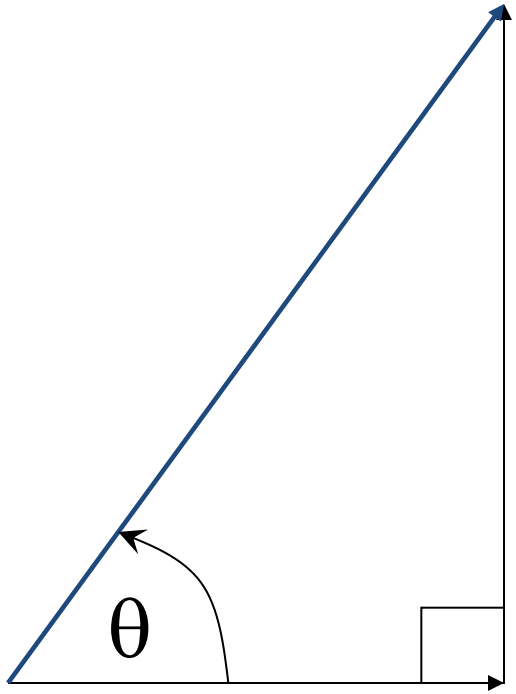
$$a^2 + b^2 = c^2$$

$$d^2 = 7^2 + 10^2$$

$$d = 12m$$

$$\theta = \tan^{-1}\left(\frac{y}{x}\right) = \tan^{-1}\left(\frac{10}{7}\right)$$

$$d = 12m, 55° \, NofE$$

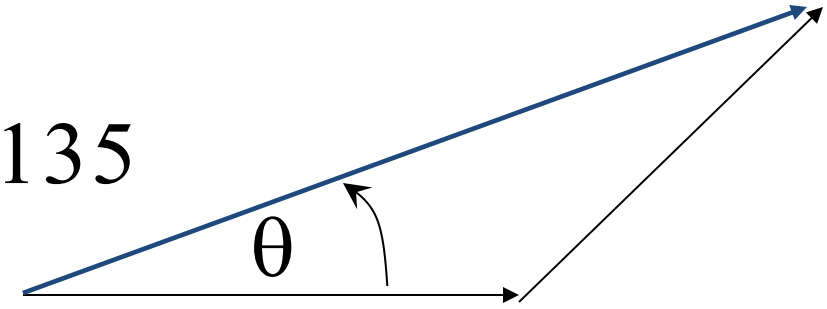


- Ex 3. Brittny carries the ball 7.0 m East then 10 m Northeast. Find her displacement :
  - cosine law!

$$c^2 = a^2 + b^2 - 2ab\cos C$$

$$d^2 = 7^2 + 10^2 - 2 \cdot 7 \cdot 10 \cdot \cos 135$$

$$d = 16m$$



$$\sin law$$

$$\frac{\sin A}{a} = \frac{\sin B}{b}$$

$$\theta = \sin^{-1}\left(\frac{10 \cdot \sin 135}{15.75}\right)$$

$$\frac{\sin\theta}{10} = \frac{\sin 135}{15.75}$$

$$d = 16m, 27° NofE$$

Work on:

Start p. 30 #35-46

Work on:

Start Exam style questions p. 32 #1-11