ADVANCED CONNECTIONS | CYSYLLTIADAU PELLACH

SESSION PLAN

Physics Tutorial 4: Illustrating Like a Physicist

Aim

To recognise different graph functions and understand how to analyse graph trends.

Learning Objectives

By the end of this session, the mentees will be able to...

- Identify the different graph elements
- Calculate the gradient and intercept of linear graphs
- Know how to apply y=mx+c to equations and plot them in a graph

Prepare in Advance

- There shouldn't be anything to prepare in advance, just have a read through the answers and make sure you understand and can explain them!

Scaffolding

If a mentee finishes early:

- Get them to try the optional extras (if they haven't already)
- Suggest watching this YouTube video about quadratic graphs and their transformations:

https://youtu.be/qveAZLu2xFA?si=lOcetqzqt38Ddm57

If a mentee is struggling:

- Suggest using https://www.desmos.com/calculator so the mentees can see how the graphs are formed and transformed
- Go through the self-study questions with them and go over where they may have gone wrong.

Session Flow

Time	Activity
5 min	**Introduction** • Run through the aim and LOs • Recap the ground rules if needed
20 min	**Self-study Recap** • Go through the self-study materials and any solutions (on next page) • Answer any questions the mentees may have about the materials
10 min	**Why Graphs Are Useful** • Discuss the gradient and y-intercept of line graphs with mentees to make sure they understand • Ask what information can be gathered from the gradient and intercept
20 min	**Kinetic Energy** • Mentees will draw out an energy graph for a constant mass and changing velocity • Discuss how the graph can be used to find the mass of the object
5 min	**Plenary** • Allow some time for mentees to ask questions and discuss today's topic

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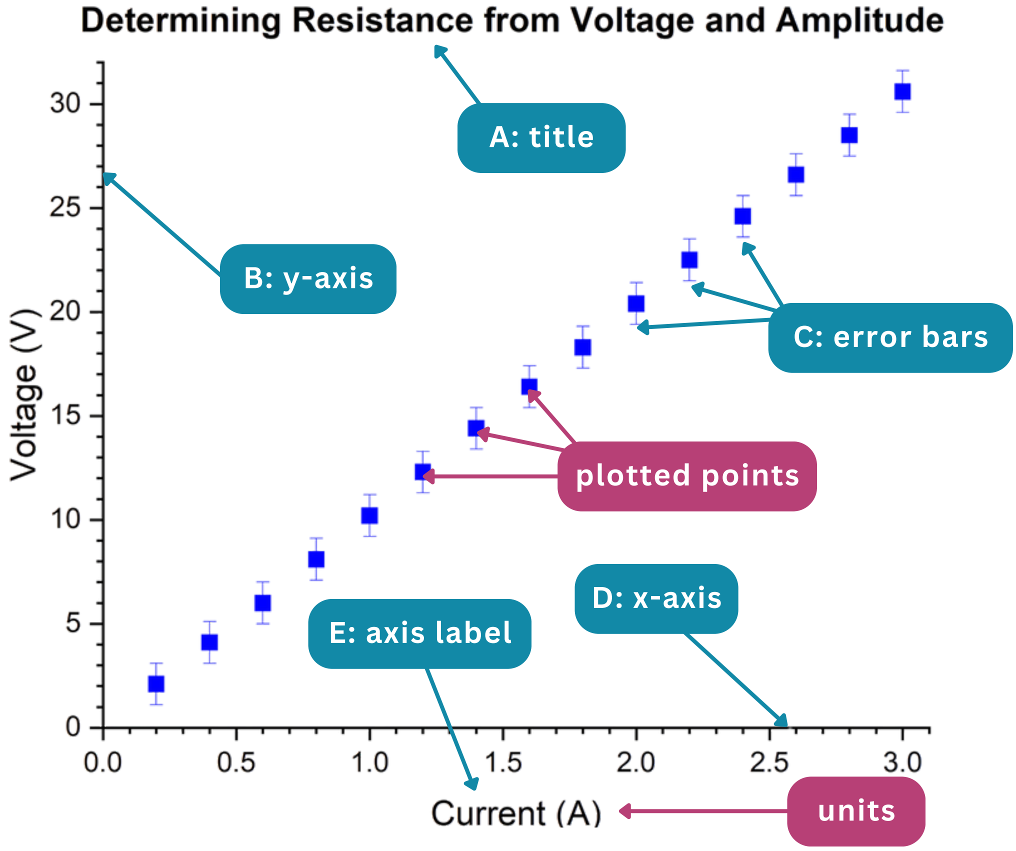
MENTOR GUIDANCE

SESSION 4: ILLUSTRATING LIKE A PHYSICIST

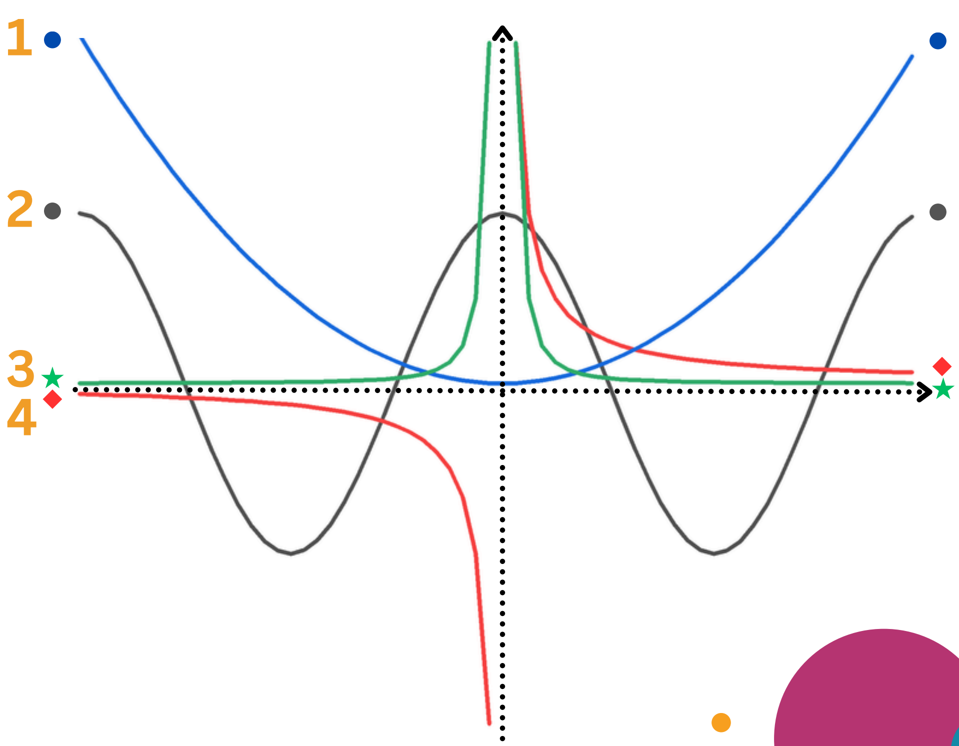
PART 1: SELF-STUDY RECAP

This first half of this tutorial is going through the self-study materials to ensure that mentees understand what uncertainty is, why we use it, and how to calculate it.

TASK 1: THE BASICS



TASK 2: RECOGNISING GRAPHS



1. F $y = kx^2$

2. A $y = k\cos(x)$

3. C $y = kx^{-2}$

4. D $y = kx^{-1}$

Discuss what the other two graphs would look like:

B $y = k\sin(x)$

E $y = kx$

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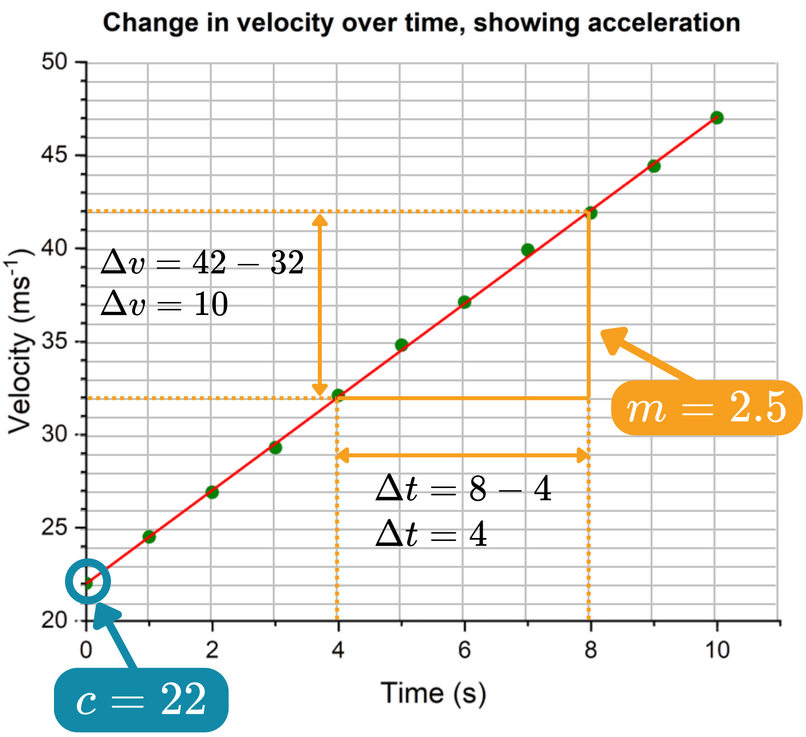
TASK 3: FINDING THE CONSTANTS



Mentees should recognise that the equation is the same as the generic straight line equation:

$$v = u + at$$

$$y = mx + c$$

So, the gradient is a and the y-intercept is u:

$$c = 22 \text{ ms}^{-1}$$

$$a = 2.5 \text{ ms}^{-2}$$

TASK 4: PLOTTING GRAPHS

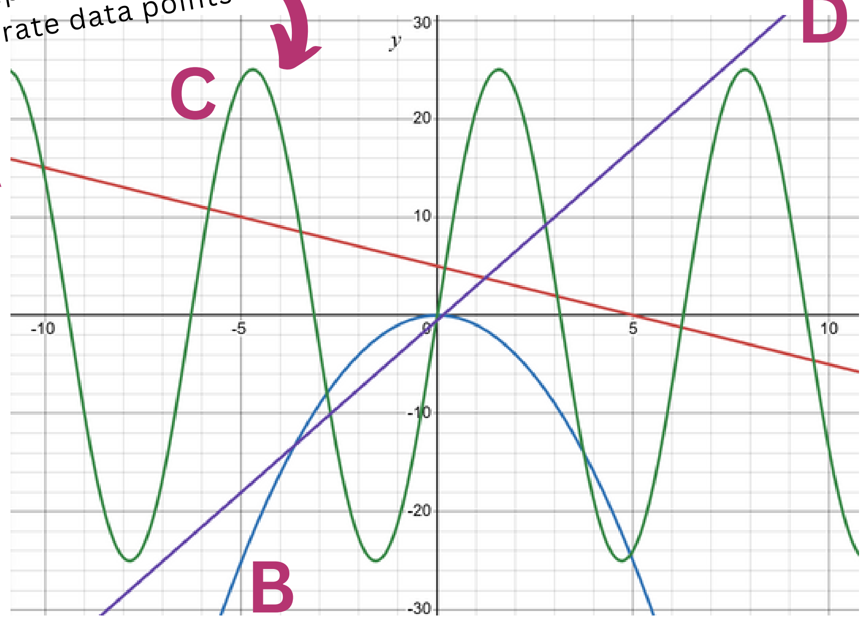
IMPROVING GRAPHS

Some things mentees could suggest:

- **TITLE:** we don't know what 'S' and 'T' represent
- **AXIS LABELS:**
  - **X-AXIS:** no units for time
  - **Y-AXIS:** no axis label at all
- **AXES:** the data intervals on the x-axis aren't evenly spaced
- **ERROR BARS:** there are none!
- **GRIDLINES:** again, there are none

SKETCHING GRAPHS

The shape is more important than accurate data points



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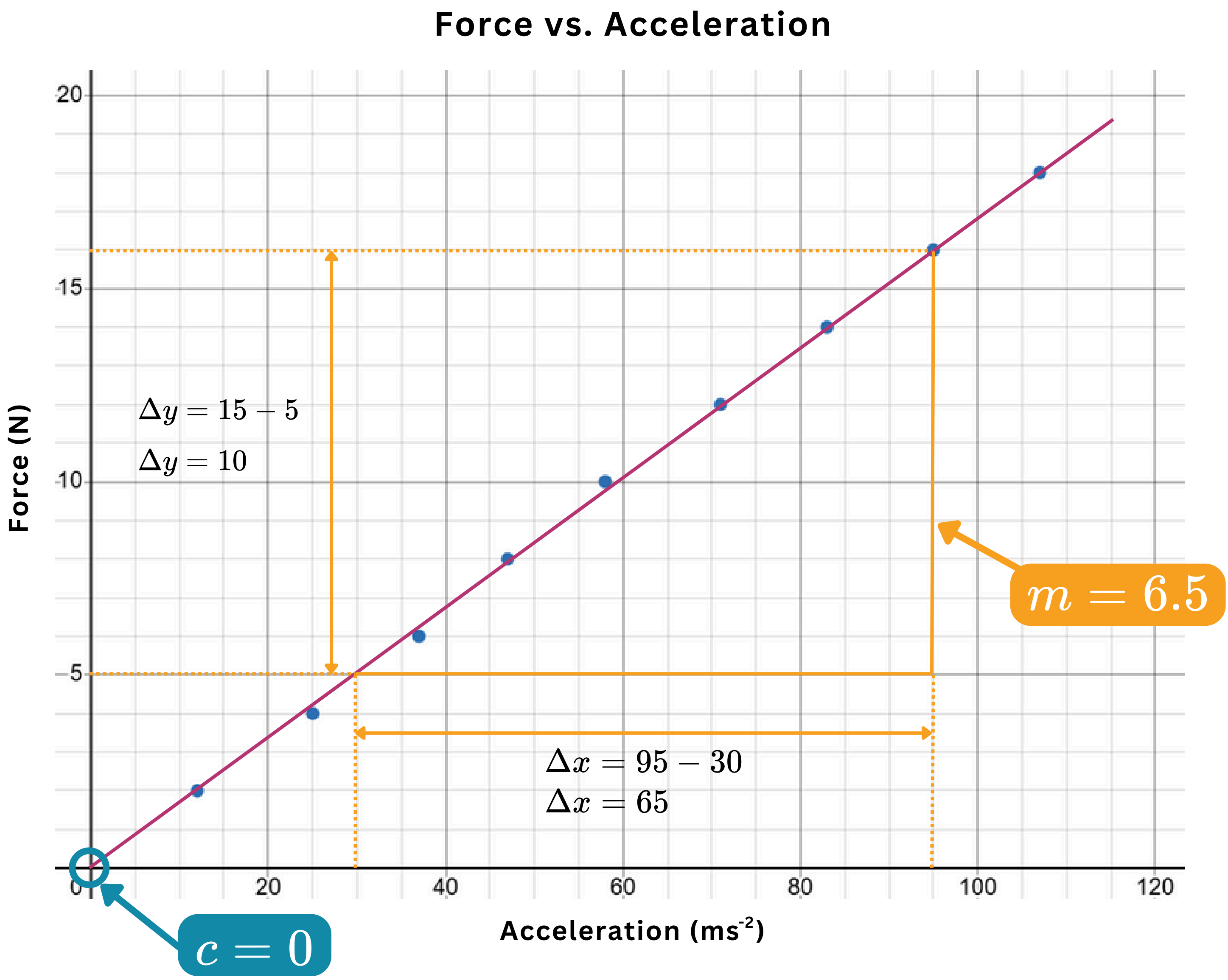
TASK 4: PLOTTING GRAPHS

TRY IT YOURSELF!

The below ideal example graph is on the PPT for you to show the mentees, along with the gradient and intercept calculations.



When discussing what the graph shows, you could prompt the mentees to think about:

- What does the gradient represent? *The gradient is the mass of the object!*
- Why is c always zero on a F/a graph? *No force = no acceleration*
- Is there a physics equation that represents this graph? *F = ma*

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SESSION 4: ILLUSTRATING LIKE A PHYSICIST

PART 1: SELF-STUDY RECAP

OPTIONAL

EXAM PRACTICE

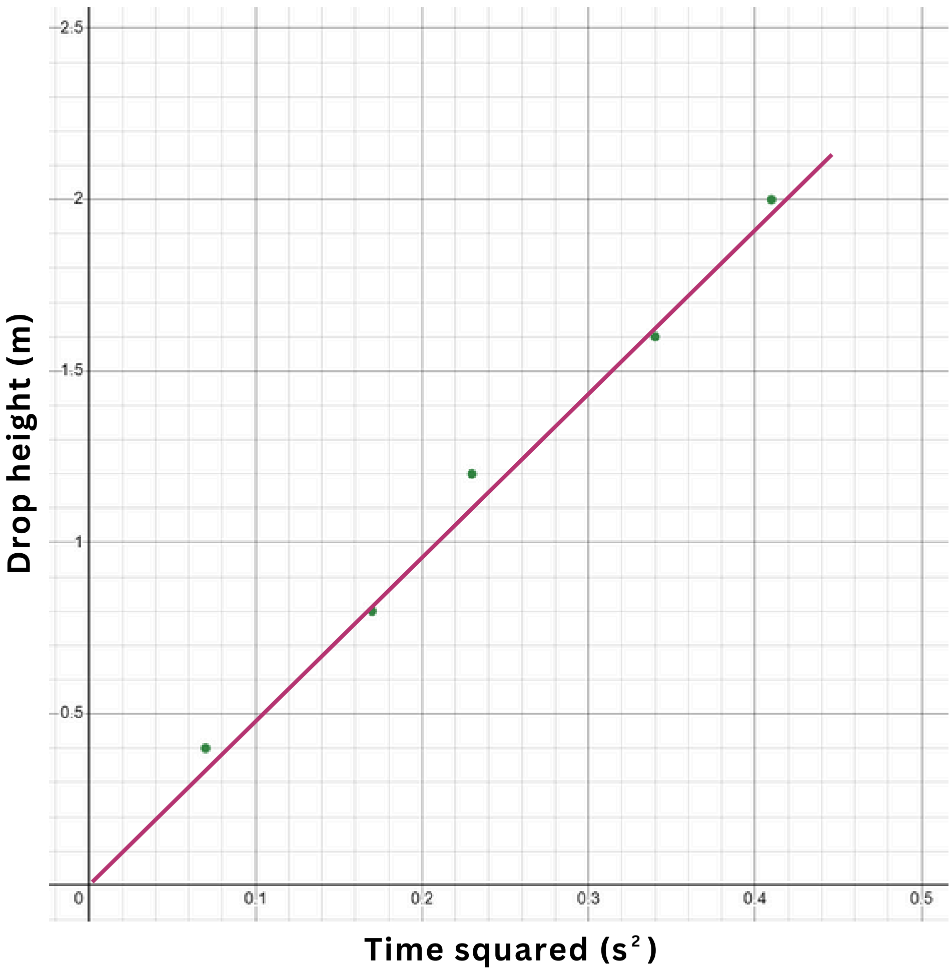
1. (a) (i)

Drop height, h/m	0.40	0.80	1.20	1.60	2.00
Corrected time, t/s	0.27	0.41	0.48	0.58	0.64
Corrected time squared, t^2/s^2	0.07	0.17	0.23	0.34	0.41

All values calculated correctly **1 mark**

To 2 sig. fig. **1 mark**

1. (a) (ii)



Suitable scale and axes labelled **1 mark**

If: *All 5 points plotted correctly* **2 marks**

4 points plotted correctly **1 mark**

3 or less points plotted correctly **0 marks**

Appropriate line of best fit that goes through origin **1 mark**

1. (a) (iii)

- It's a straight line/linear graph
- Goes through the origin

1 mark for each

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PART 1: SELF-STUDY RECAP

OPTIONAL

EXAM PRACTICE

2. (a) (i)

Distance, d / mm	Force, F / N		
	Trial 1	Trial 2	Mean
100	2.8	2.6	2.7 OR 2.70
250	5.2	5.7	5.5 OR 5.45
400	8.8	8.5	8.7 OR 8.65
550	11.2	11.6	11.4 OR 11.40
700	14.6	14.5	14.6 OR 14.55
850	17.2	17.6	17.4 OR 17.40

All values calculated correctly **1 mark**

2. (a) (ii)

Titles and units on axes correct **1 mark**

Suitable scale chosen **1 mark**

All points plotted correctly **1 mark**

Appropriate line of best fit that goes through origin **1 mark**

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SESSION 4: ILLUSTRATING LIKE A PHYSICIST

PART 2: SKILLS PRACTICE

The second half of this tutorial gives students an opportunity to practice their skills and ask any questions.

WHY GRAPHS ARE USEFUL

10 MINS

Discuss the definitions of the **gradient and intercept** and why they are important in science.

- Use Task 3 as an example
- Discuss how graphing shows important trends in science
    - Can the mentees think of any graphs that visualise physics formulae?

Hertzsprung-Russell Diagram:
The H-R diagram is a graph which shows the relationship between a star's surface temperature and its luminosity. Using this, scientists have been able to put stars into a classification system, determine the size and colours of stars and predict what stage of its lifecycle the star is in and how it will evolve.

Use the Hertzsprung-Russell diagram on the PPT to show mentees how putting star data onto graphs has allowed astronomers to understand more about the lifecycle of stars and make predications about how the different star types will evolve.

KINETIC ENERGY

20 MINS

Kinetic energy is defined as the **amount of energy** an object has due to its **motion.** If an object is stationary it won't have any kinetic energy. Kinetic energy is defined by the equation:

$m =$ mass
$v =$ velocity

$$E = \frac{1}{2}mv^2$$

Get the mentees to **draw a graph** of energy versus velocity using the data on the PPT

Can they calculate the **mass** using their graph?

TOP TIPS

- Mentees unsure what the shape of the graph will be?
    - Encourage them to look at the graphs in Task 2 and see if any equations are similar to the one above
- Mentees unsure how to find the mass?
    - Can they try rewriting the equation so it fits "on top of" y=mx+c?

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PHYSICS TUTORIAL 4: ILLUSTRATING LIKE A PHYSICIST

BRIGHT IDEAS!

This page contains ideas for alternative sessions, changes/additions, extra activities, etc.
Feel free to use as you wish!

Graphs Everywhere

You could challenge mentees to think of various careers and situations where graphs are used. Some examples:

- Engineering and construction: used to predict how materials break down over time
- Biology and chemistry: can be used to find trends in ecosystems or chemical reactions
- Physics (of course!): modelling systems (e.g. mass on a spring) to predict how the system will behave and determine factors which may affect the system (e.g. damping on a mass-spring system)

Physics Skills

If you think the mentees are struggling to link the topic to wider skill applications, you can run an activity where they list the skills they use to solve the problems, and then discuss where they use those skills in physics.

Graph Transformations

Use desmos.com to discuss graph transformations and consider what the graphs from Task 2 would look like if they were given negative constants. Discuss how powers in one of the variables affects the shape of the graph, i.e. produces straight lines or parabolas.