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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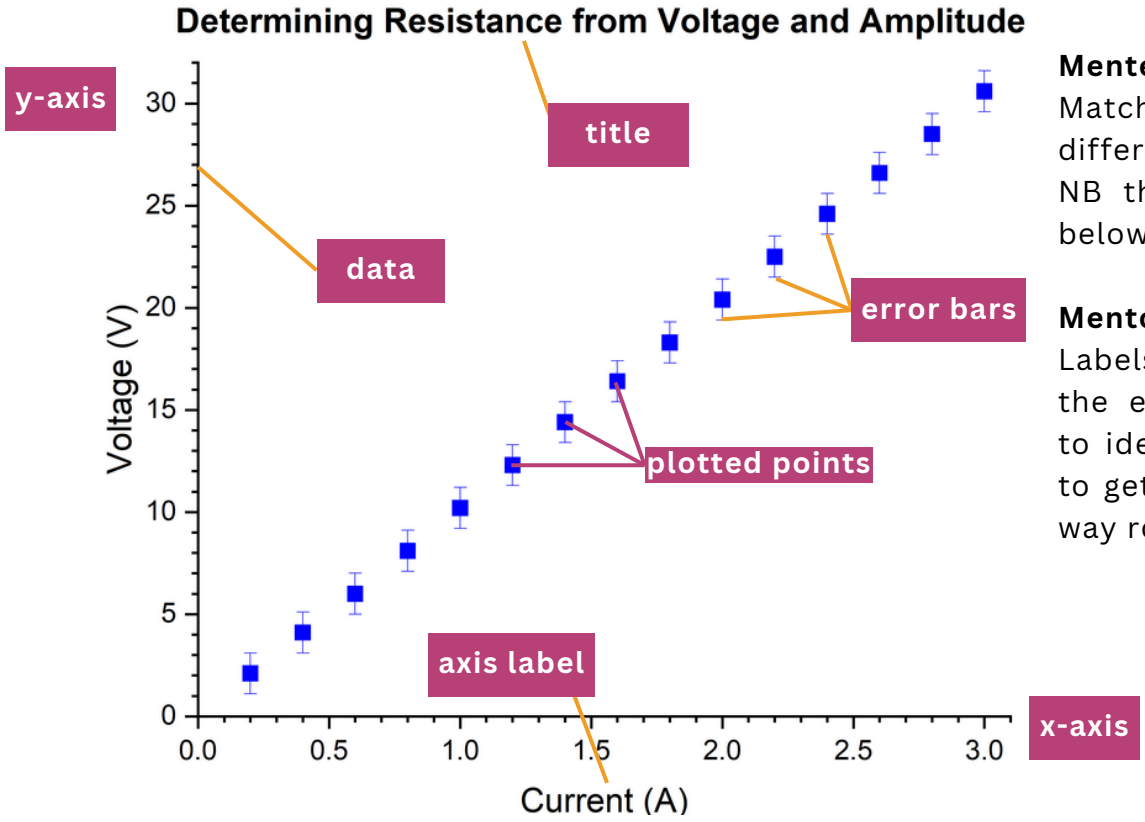
MENTOR GUIDANCE

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.

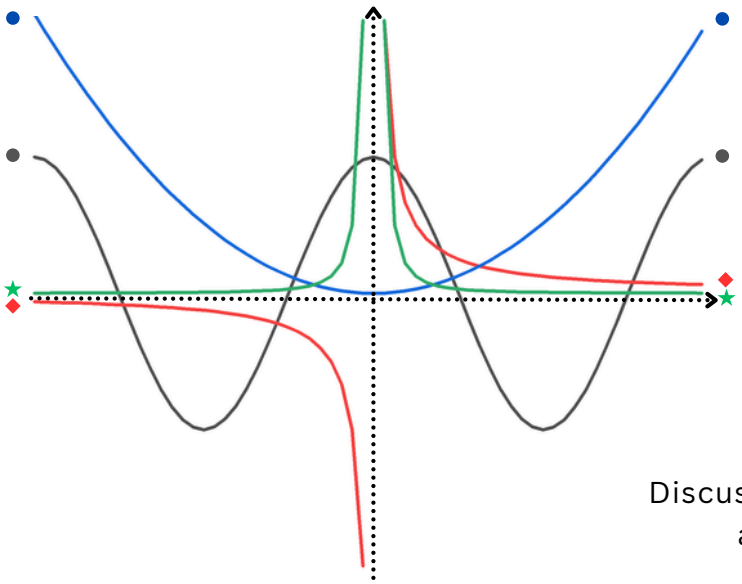
TASK 1: THE BASICS



Mentee task:
Match the labels to the different graph elements. NB there are more labels below than on the graph.

Mentor guidance:
Labels with yellow lines are the elements for mentees to identify, they also need to get the axes the correct way round.

TASK 2: RECOGNISING GRAPHS



- $y = k\cos(x)$
- $y = kx^2$
- $y = kx^{-2}$
- $y = kx^{-1}$

Discuss what the graphs of y = ksin(x) and y = kx would look like.

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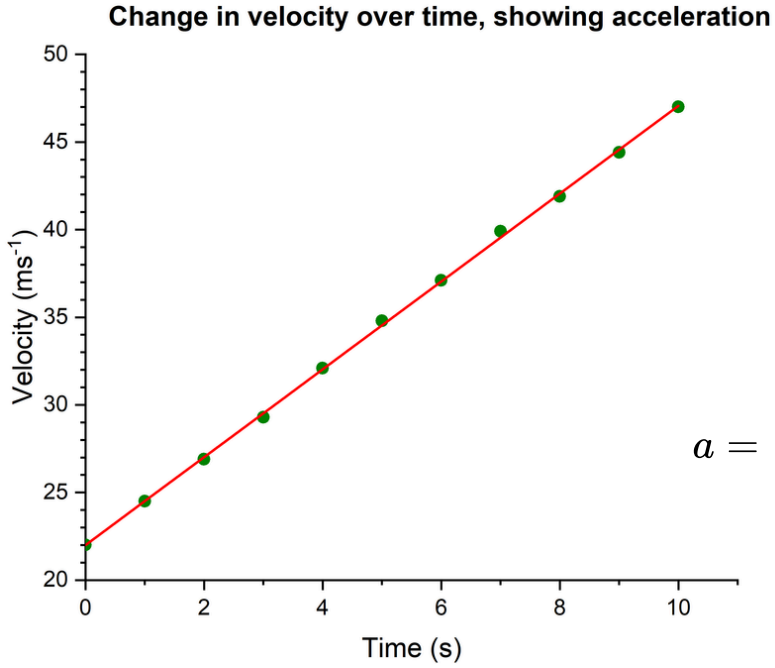
TASK 3: FINDING THE CONSTANTS



Mentees should use this equation to find a value for the acceleration

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

For example:

$$a = \frac{42 - 32}{8 - 4} = \frac{10}{4} = \frac{5}{2} = 2.5ms^{-2}, u = 22ms^{-1}$$

TASK 4: PLOTTING GRAPHS

1. ELEMENTS OF THE GRAPH THAT COULD BE IMPROVED (MENTEES SUGGEST AT LEAST 3):

- Title - ‘S vs T’ doesn’t definitively describe what’s being measured in the graph
- Axis labels with units - ‘Time’ doesn’t tell you what unit it’s been measured in, e.g. seconds, minutes, hours, and the y-axis doesn’t tell you what’s being measured
- Data measurements - intervals between data measurements should be equal on a linear graph, i.e. after 50 on the x-axis it should be 55, 60, 65 etc...
- Error bars - Error bars should be added to data where applicable as all measurements will have some error in the value

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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.

1. Use Task 3 as an example; the line is the plot of the equation **v=u+at,** how the y-intercept provides the value of u and the gradient provides the acceleration, a.
2. Discuss how graphing shows important trends in science.

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

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.

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, whereas it will when it is moving. Mathematically, kinetic energy is defined by the equation:

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

where **m** is the mass of the object and **v** is the velocity

Mentees will use the data on the powerpoint to draw a graph of the energy vs velocity for an object of fixed mass, and use it to calculate the mass of the object.

TOP TIPS

- If they're unsure about the shape of the graph, encourage them to look at their Task 2 answers and see if they can find any similarities between their equation and one of the answers
- If they are stuck on finding m, discuss how the KE equation represents the equation 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.

Idea 3

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.

Idea 4

ABC