# Exemplar activity 3 (age 16-18):

# Unearthing SUVAT equations (Specific Teachers’ Notes)

## About this activity:

This is one of three exemplar activities that make up the Empowering Maths Learners collection.

This activity is aimed at learners aged 16-18.

These Specific Teachers’ Notes are designed to supplement the Generic Teachers Notes that apply to all three activities and explain the rationale for the six learning phases.   
***You should refer to the Generic Teachers Notes alongside these Specific Teachers’ Notes.  
Note the diagrams/prompts below are included in a separate PowerPoint file accompanying these notes.***

## Additional mathematics aims specific to this activity:

This activity aims to:

* Reinforce understanding of the properties of distance-time and speed-time graphs.
* Develop understanding of time, displacement/distance, speed/velocity, acceleration and the relationship between them.
* Consolidate understanding of rearranging equations and algebraic manipulation of variables.

## The six learning phases (refer also to Generic Teachers Notes):

### Phase 1: Reviewing prior knowledge

#### Resources:

Students have a go at these questions, on their own to begin with, before sharing responses with others:

1. A cyclist rides in a straight line for 20 minutes. She waits for half an hour, then returns in a straight line to her starting point in 15 minutes. Here is a displacement-time graph for her journey:
2. Work out the average velocity for each stage of the journey in km h-1.
3. Write down the average velocity for the whole journey.
4. Work out average speed for the whole journey.
5. A particle moves along a straight line. The particle accelerates uniformly from rest to a velocity of 8 ms-1 in T seconds. The particle then travels at a constant velocity of 8 ms-1 for 5T seconds. The particle then decelerates uniformly to rest in a further 40 s.
   1. Sketch a velocity-time graph to illustrate the motion of the particle.
   2. Given that the total displacement of the particle is 600m, find the value of T.

#### Additional guidance specific to this activity:

* None

### Phase 2: Generating ideas

#### Resources:

Provide students with this prompt:

Diagram

Description automatically generated

Find as many equations as possible that connect some of the variables: *s, u, v, a, t*.

#### Additional guidance specific to this activity:

* Questions to prompt discussions around prompt:
  + *What does the gradient of the line represent?*
  + *How would you work out the acceleration?*
  + *What does the area under the line represent?*
  + *How would you work out the displacement?*
* Prompts to generate questions to enable students to develop their ideas further:
  + *How would you write down a connection between some of the variables?*
  + *Which variables have we connected so far? How can we write this?*
  + *How many variables are there in each equation?*
  + *Which combinations of variables are possible? How do you know?*
  + *Can you find an equation with each of the variables (s, u, v, a, t) as the subject?*
  + *How could you go about finding all possible equations?*

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| ***Common Issues*** | ***Suggested questions/prompts/actions*** |
| Students struggle to recognise acceleration as gradient. | *If you had a distance-time graph, what would the gradient represent?* |

### Phase 3: Developing ideas

#### Resources:

Display the questions generated from Phase 2 so that students can work on these collaboratively in groups.

#### Additional guidance specific to this activity:

* Questions/prompts to facilitate group discussions/learning:
  + *How do you know if you have found all possible equations?*
  + *Can you write the equations in different ways?*

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| ***Common Issues*** | ***Suggested questions/prompts/actions*** |
| Students struggle to recognise acceleration as gradient. | *If you had a distance-time graph, what would the gradient represent?* |

### Phase 4: Formalising ideas

#### Resources:

You could get groups to present their ideas as posters (sugar paper, flip chart pens needed).

#### Additional guidance specific to this activity:

* If you are collating group’s ideas without using posters, it is important you write down each equation exactly as the group has written them (include initials of all group members).
* Questions/prompts to facilitate a whole group discussion:
  + *Are any of your equations similar to those of other groups?*
  + *Are they equivalent? What is different about them?*
  + *How might a mathematician write them? Why?*

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| ***Common Issues*** | ***Suggested questions/prompts/actions*** |
| Equations may only differ in the choice of variable as the subject. | Emphasise that these are rearrangements of the same equations. *Which arrangement would be easiest to use for calculating [variable]?* |
| Students assume ‘v = u + at’ is correct and ‘v = ta + u’ is incorrect. | *Is ‘v = ta + u’ mathematically incorrect? Why? Why do you think it is ‘commonly’ written as ‘v = u + at’ in textbooks?* (avoid using ‘normally’ as this implies the textbook is always correct, i.e. it is the ultimate authority) |

### Phase 5: Reinforcing ideas

#### Resources:

Students have a go at a range of textbook/exam-style questions that require the application of SUVAT equations. Here are some examples:

1. A cyclist travels along a straight road. She accelerates at a constant rate from a velocity of 4 ms-1  
   to a velocity of 7.5 ms-1 in 40 seconds.
   1. Find the distance she travels in these 40 seconds.
   2. Find her acceleration in the same time period.
2. A particle is moving in a straight horizontal line with constant deceleration 4 ms-2.   
   At time t=0 the particle passes through a point O with speed 13 ms-1 travelling towards a point A, where OA=20 m. Find:
   1. the times when the particle passes through A.
   2. the value of t when the particle returns to O.
3. A cheetah has the ability to accelerate from rest to 108 kmh-1 in 25 metres.  
   Find the acceleration. What assumption have you made?
4. The Highway Code states that a car travelling at 20 ms^(-1) requires a minimum braking distance of 30 m. What deceleration is this and how long will it take for the car to come to rest?

#### Additional guidance specific to this activity:

* Questions/prompts to encourage students to reflect on their learning:
  + *How do you know which equation to use to solve the problem?*
  + *How can you use the equation to solve the problems?*
  + *Generate some hints and tips to help others solve similar problems.*

### Phase 6: Deepening understanding

#### Resources:

Pieces of card (A5 or A6 – different colours?) for students to devise and share questions with each other (see Generic Teachers Notes).

#### Additional guidance specific to this activity:

* None