Llywodraeth Cymru
Welsh Government

Narrative – Heartbeat

<table>
<tr><td>Year group and curriculum area</td><td>Year 9 or Year 10.
Science/biology/mathematics.</td></tr>
<tr><td>Activity</td><td>Evaluating an established relationship between variables and investigating the impact of a change in the relationship.</td></tr>
<tr><td>Topic</td><td>Heart rate/exercise/healthy living/exploring mathematical relationships (either as a context in mathematics or as an application of the topic).</td></tr>
<tr><td>Possible strategy</td><td>
Requirements
• Use the activity sheet setting out the issue – ‘Heartbeat’.

Possible strategy

Learners are introduced to the problem and are set to mindmap and investigate it, in small groups, e.g. three or four. The learners should be encouraged to devise their own strategy to investigating the changes. Typically this could be done in the following way.

• Investigating the first equation, e.g. by substituting various ages into the equation and solving, in order to establish the range of possible heart rates and the pattern of change.

Recommended maximum heart rate = 220 – age

<table>
<tr><th>Age</th><th>Substitution</th><th>Max heart rate</th></tr>
<tr><td>20</td><td>220 – 20</td><td>= 200</td></tr>
<tr><td>30</td><td>220 – 30</td><td>= 190</td></tr>
<tr><td>40</td><td>220 – 40</td><td>= 180</td></tr>
<tr><td>50</td><td>220 – 50</td><td>= 170</td></tr>
<tr><td>60</td><td>220 – 60</td><td>= 160</td></tr>
<tr><td>70</td><td>220 – 70</td><td>= 150</td></tr>
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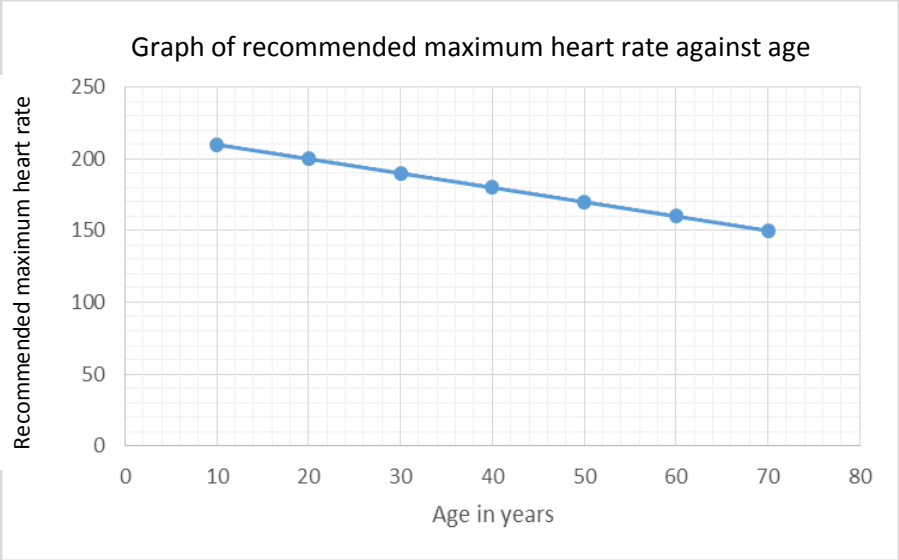
Graphically this would look like this.

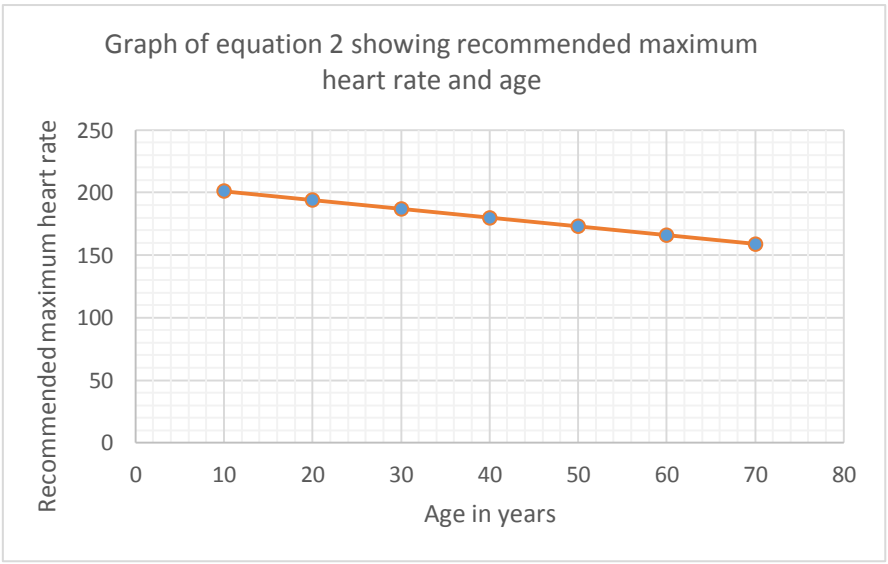


The first equation gives a linear relationship between the recommended maximum heart rate and age, with a negative gradient showing that as age increases the maximum recommended heart rate decreases.

- Similarly this could be done for the second equation.

Recommended maximum heart rate = 208 – (0.7 x age)

Age	Substitution	Max heart rate
20	208 – (0.7x20)	= 194
30	208 – (0.7x30)	= 187
40	208 – (0.7x40)	= 180
50	208 – (0.7x50)	= 173
60	208 – (0.7x60)	= 166
70	208 – (0.7x70)	= 159



The second equation leads to a differing outcome above and below the age of 40. The slope/gradient of the graph is different. One possibility is to draw both graphs on the same axis to compare them more directly.

- Learners then compare differences and arrive at a conclusion in terms of how the heart rate changes with age in both equations and what the differences represent.
- Learners can use either a numerical analysis or graphical analysis to evaluate the equations (as shown above).
- Each group shares their strategy with the class as a whole. This could include a discussion on merits of each strategy.

A more formal strategy could involve a staged approach, with more teacher-led input while still allowing for both individual and group work.

1. Investigate the first equation and the simple relationship between age and recommended maximum heart rate. Learners could investigate the problem using graphs, e.g. predicting the shape of the graph, drawing a graph of the variables, deciding on a suitable range for the x and y axis, making the link with the relationship $y = mx + c$, identifying that the gradient is negative from the shape of the graph and confirming by substitution (as shown above).

2. Investigate the second equation and the more complex relationship between age and recommended maximum heart rate. Learners could investigate these using graphs. Predict the difference between the graph produced by the second equation compared with the first, making the link with the relationship $y = mx + c$ and a negative gradient, comparing gradients and identifying the common age where the recommended heart rate is the same.

	3. Using the information obtained, compare the two relationships, either by equating both equations to each other (see below) and arriving at one point where the age in both equations gives the same recommended maximum heart rate. This involves solving a simultaneous equation. Equating both given equations and calculating the common age: 220 – age = 208 – 0.7 x age 12 = 0.3age Age = 12/0.3 = 40 results in a common age of 40. Learners will then arriving at a conclusion, e.g. that people above 40 will have a higher recommended maximum heart rate under the new formula, while those less than 40 will have a lower recommended heart rate. Learners might then draw inferences as to why this is sensible. N.B. This is not a prescriptive solution only an example of the kind of thinking strategy that will arrive at a solution. **Explanations** Finally learners need to link these ideas with their knowledge of science and write a response to both questions given in the task. The presentations need to explain their reasoning very clearly.
Links with the LNF	**Skills** • Generating and using a strategy to solve problems. • Working collaboratively to solve a problem. **Numeracy component** **Strand: Developing numerical reasoning (Year 10)** **Element: Identify processes and connections (Year 10)** Learners are able to: • transfer mathematical skills across the curriculum in a variety of contexts and everyday situations • select, trial and evaluate a variety of possible approaches and break complex problems into a series of tasks • prioritise and organise the relevant steps needed to complete the task or reach a solution • choose an appropriate mental or written strategy and know when it is appropriate to use a calculator

	• identify what further information might be required and select what information is most appropriate • select appropriate mathematics and techniques to use. **Element: Represent and communicate (Year 10)** Learners are able to: • explain results and procedures precisely using appropriate mathematical language • refine methods of recording calculations • select and construct appropriate charts, diagrams and graphs with suitable scales • interpret graphs that describe real-life situations, including those used in the media, recognising that some graphs may be misleading. **Element: Review (Year 10)** Learners are able to: • interpret answers within the context of the problem and consider whether answers, including calculator, analogue and digital displays, are sensible • interpret mathematical information; draw inferences from graphs, diagrams and data, including discussion on limitations of data • draw conclusions from data and recognise that some conclusions may be misleading or uncertain. **Strand: Using number skills (Year 9)** **Element: Calculate using mental and written methods (Year 9)** Learners are able to: • use efficient written methods to add and subtract numbers and decimals of any size, including a mixture of large and small numbers with differing numbers of decimal places • multiply and divide whole numbers and decimals • use the order of operations including brackets and powers. **Strand: Using data skills (Year 9)** **Element: Collect and record data, Present and analyse data, Interpret results (Year 9)** Learners are able to: • construct and interpret graphs and diagrams (including pie charts) to represent discrete or continuous data, with the learner choosing an appropriate scale • examine results critically, select and justify choice of statistics recognising the limitations of any assumptions and their effect on the conclusions drawn • use appropriate mathematical instruments and methods

	to construct accurate drawings. **Literacy component** **Strand: Writing across the curriculum (Year 10)** **Element: Organising ideas and information (Year 10)** **Aspect: Meaning, purposes, readers (Year 10)** Learners are able to: • write both extended pieces, which include detailed evidence and information, and shorter pieces which summarise concisely, showing clear awareness of the reader or intended audience • construct responses that connect and develop ideas to fully cover the topic • plan appropriately to develop writing for a range of different purposes and audiences • use the tools and conventions of ICT creatively and appropriately to communicate effectively in a range of contexts. **Aspect: Structure and organisation (Year 10)** Learners are able to: • improve the content, structure and accuracy of their writing through independent review and editing • write independently in an appropriate form with increasing confidence, ensuring content is organised, detailed and relevant, *e.g. how best to present opinions, information and explanations* • show clear awareness of different readers by selecting from a range of styles and structures, and adapting their use of language • organise writing in an appropriate form, ensuring content is detailed within and between paragraphs or sections. **Element: Writing accurately (Year 10)** **Aspect: Grammar, Punctuation, Spelling, Handwriting (Year 10)** Learners are able to: • vary sentence structures to engage and sustain the reader's interest and write with grammatical accuracy • use the full range of punctuation in order to vary pace, clarify meaning, avoid ambiguity and create deliberate effects • use a variety of strategies and resources to accurately spell an increasing range of familiar, unfamiliar and subject-specific words • present their handwritten or on-screen work effectively, choosing form, images and graphics to enhance meaning

	• Welsh-medium statement: write grammatically accurate sentences ensuring that the verb tense and person is correct in context • Welsh-medium statement: use a range of mutations correctly (soft, nasal and aspirate mutations) in context.