O2 • Exploring equations of motion

Mathematical goals

To encourage learners to:

- use past paper examination questions creatively.

To give learners practice in:

- using the equations of motion for constant acceleration.

To develop learners' ability to:

- generalise from specific situations of motion.

Starting points

Learners should have some knowledge and understanding of the equations of motion for constant acceleration.

Materials required

For each learner you will need:

- Sheet 1 – *Examination question*.

Time needed

At least 45 minutes.

Suggested approach

Beginning the session

Give each learner a copy of Sheet 1 – *Examination question*. Allow a maximum of five minutes for them to have a go at the question. Quickly go over the answers and ask learners to mark their own work.

Working in groups (1)

Ask learners to work in pairs to come up with a possible part (c) for the question.

Whole group discussion (1)

Write a range of questions that learners have come up with on the board and discuss how some of them could be tackled.

Alternatively, exchange part (c) questions between pairs of learners and ask them to solve them. Move round the room listening to their discussions and then, in whole group discussion, share any difficulties they have had in understanding or solving the question.

Working in groups (2)

Ask each pair of learners to come up with a possible 'What might happen to the boat next?' scenario.

Whole group discussion (2)

Ask each pair of learners to describe their scenario. Write a key phrase or a diagram on the board as a reminder of that scenario. Possible suggestions may include:

- boat goes over a waterfall;
- passenger jumps overboard;
- boat collides with another boat, or similar.

If the mechanics of a scenario are beyond what some of the learners have studied before, just have some general discussion about the effects of the scenario on the velocity and acceleration of the boat.

If the topic is due to be learned shortly, the scenario could be saved for that time or the topic could be introduced through the scenario.

Working in groups (3)

Choose a scenario that learners can investigate using the laws of motion, e.g. going over a waterfall. Ask learners, working in pairs, to come up with some relevant mechanics for the scenario.

Whole group discussion (3)

Share the mechanics of the scenario that learners have suggested and explore it further if appropriate.

Working in groups (4)

Ask pairs of learners to write a part (d) for the examination question, using this scenario and the mechanics that they have explored. Exchange part (d) questions between pairs of learners and ask each pair to complete the question that they have been given and return it to the authors for checking.

Other suggested scenarios can be used in a similar way.

Reviewing and extending learning

If not many learners completed the original examination question correctly, go back to it and ask learners to have another go. Then ask learners to generalise the original problem and solve it using variables rather than numerical values.

Ask each pair of learners to write an examination question together with its marking scheme. Give them as many constraints as you want, e.g. the question must involve a train or a ball and/or the equation $s = ut + \frac{1}{2}at^2$, and so on.

What learners might do next

Learners could develop the mechanics of the scenarios whose solution required more than just the laws of motion.

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O2 Sheet 1 – *Examination question*

A boat is travelling in a straight line down a river. On one particular stretch of the river the boat is moving with constant acceleration; its velocity increases from 10 m s^{-1} to 16 m s^{-1} in 4 seconds.

(a) Find how far the boat travels during this time.

(b) Find the acceleration of the boat.