11-14 Acceleration

Prerequisites

Students should have already completed the **Distance Time Graphs** and the **Calculating Speed** sheets

The Main Points

- **Acceleration** is any change of **velocity** (speed or direction).
- Slowing down is a special kind of acceleration called **deceleration**.
- Something going at a steady speed in a straight line is not accelerating.
- We measure acceleration in metres per second squared (m/s^2)
- An acceleration of $3m/s^2$ means that its velocity goes up by 3m/s each second.
- An acceleration of $-4m/s^2$ means that its velocity goes down by 4m/s each second.
- Formula: acceleration = velocity change each second = velocity change / time taken
- Students will later find out that things accelerate if there are unbalanced forces on them.

Teacher Quarter Briefing

- Introduction: https://youtu.be/WQFCl4SMZ3w
- Practice: https://isaacphysics.org/gameboards#teach_quart_accel
- Review: https://youtu.be/-VTqfLGwC3I
- If you want to go further: https://isaacphysics.org/pages/covid19_gcse_archive#11

Class Question Notes

The worksheet can be printed either in full, or in cloze text form (where the red text is missing, and students can complete these blank spaces after class discussion). The online version of the notes requires the appropriate text to be dragged to the right place in the sentences.

1. The online questions are multiple choice, where students are guided with prompts. The question is 'Is it accelerating?' The options are 'Yes - the speed is changing', 'Yes - the direction is changing' and 'No'. This encourages them to correctly choose 'No' if neither are changing, and to recognise turning as accelerating even though there is no speed change.
2. These questions are also multiple choice with answers now just 'Yes' or 'No'. If students struggle to realise that the Earth is accelerating as it orbits the Sun, it may help to point out that there is a large force of attraction and that there is a link between unbalanced force and acceleration. It takes effort to turn something, as those who cycle or throw the hammer will know.
3. We introduce students to the numeric side of acceleration with number patterns. Here the speed goes up by 4m/s each second (that is the answer to part (d)), and in the earlier parts of the question, the students spot and use the pattern. Please encourage a problem solving approach here.
4. This is similar to the last question, the only difference being that the truck is moving at the beginning, and then gets faster. It is still a question which can be answered by spotting the pattern in the numbers. In part (d) watch out - the speed gets 3m/s faster each time, but the measurements are two seconds apart, so 3m/s is not the right answer.
5. Here the students should be encouraged to plot the graphs in different colours and fit good straight lines to them. We already know from q3 and q4 that the aeroplane accelerates faster than the truck - this comes out in it having a steeper line on the graph. The object slowing down (the bus) has a line sloping 'downwards'. Please note that the graph axis says 'velocity' rather than 'speed' - we want students to get used to that word. If something were going to go backwards, then we could show this on the graph using negative values of velocity.

6. The speed change each second is now the acceleration, with the m/s^2 as its unit. The reason for the ^{2} in the unit (in case anyone asks) is that it is a change in speed (m/s) divided by a time (s). When we divide the units we get $(m/s)/s = m/s^2$, however it does look odd as there isn't actually a 'square second' in the same way as you can have 'square metres'. You may find it helpful to call the m/s^2 the (m/s)/s or the m/s each second if that makes it clearer for your class.
7. While you can tell your students the formulae (and even get them to use their mathematical skills to do the rearranging), the aim is to work from the number patterns in q4 and q5.
    a. Acceleration = Velocity change each second = Velocity change / Time
    b. Velocity change = velocity change each second x time in seconds = acceleration x time taken
    c. Time taken = Velocity change / change each second = Velocity change / acceleration.
    d. When producing the rearrangements - it may help to use examples 'The aeroplane gained 20m/s in 5s, this is 4 each second, which is 20/5…'
8. Some students will prefer the saving in effort of writing symbols rather than words
9. Students can use the ideas of q4 and a5, or the formulae in q7 and q8
    a. Velocity change = 30-12 = 18m/s, so velocity gain each second = 18/6
    b. You gain 3m/s each second, so will take 4s to gain 12m/s, as there are four 3s in 12.

Homework Question Notes

These questions have a very similar form to the questions in the class task, so students can refer back to their earlier answers to help

1. This is just like q1,2 in the class work
    a. The cat has no change of speed or direction
    b. The aeroplane after landing is slowing down (its speed is changing)
    c. The cyclist is turning, so changing direction (velocity is changing)
    d. The cow has no speed at all, and this isn't changing
2. This question is very similar to q4 on the class work
3. This question is similar to q4 on the class work, but the bus is slowing down (students already plotted its graph in q5 in class, and can refer back to the graph).
    a. Slowing down is still acceleration (a special kind of acceleration called deceleration)
    b. The missing speed can be filled in by spotting that the speed goes down by 3m/s each second.
    c. The aim is for the students to find when the speed will be 0m/s. That is when the bus has stopped.
    d. The speed is getting less, so the speed change ought to be given as a negative number.
4. This is asking students to recap q7 of the class work.
5. This is the first of three questions putting the formulae (or principles) to use
    a. 1.5m/s gained each second, so after 6s we have 1.5x6 = …
    b. 1.5m/s gained each second, so to gain 15m/s we need 15/1.5 = …
6. Another calculation, here the cheetah does not start from rest
    a. Gains 26-6 = 20m/s in 4s, so gains 20/4 = … each second
    b. The acceleration is the speed gain each second in m/s^2. (same number as part (a), just a different unit.
7. Further practice, just like q5. 'Starting from rest' means speed = 0m/s at time 0s.
    a. 6m/s gained each second. So after 4s, we have 4x6 = …
    b. 6m/s gained each second. To gain 30m/s we need 30/6 = …
8. In this question, students work out who is beginning to win a race. Just because the blue car gets to a higher eventual speed does not mean it is 'first off the line' - we need to look at the times too. The accelerations can be calculated, and then compared.

Extension questions from Step Up to GCSE Physics:
https://isaacphysics.org/gameboards#step_up_phys_8_b1