11-14 Distance Time Graphs

The Main Points

- The graph shows how far something (or someone) has travelled (**distance**) as a function of time.
- A point (8s,12m) on the graph means that eight seconds after the start, the person has travelled 12m since starting.
- The shapes of curves on the graph give you an idea of the kind of motion
    - straight horizontal lines mean STATIONARY (regardless of the 'height' of the line) because the distance from the start isn't getting larger as the clock runs on
    - straight sloping lines mean motion at a steady speed
    - the steeper the line, the faster the motion
    - a curved line shows a changing speed
- If you want to work out the speed for the motion in a particular part of the graph, you measure the gradient of the line = distance moved in that part of the motion / time taken for that part of the motion.
- You can also plot **displacement** time graphs. Displacement measures the position of someone or something - usually as a distance in a particular direction from an agreed reference point.
    - In a displacement-time graph, the lines sometimes have negative gradient (sloping downwards) telling you that the object is moving back towards the starting point.

Teacher Quarter Briefing

- Introduction: https://youtu.be/lqKsi8_X5Jg
- Practice: https://isaacphysics.org/gameboards#teach_quart_distancetime
- Review: https://youtu.be/E0BNwptljKg
- If you want to go further: https://isaacphysics.org/pages/covid19_gcse_archive#10

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. Here the student puts labels A, B, C, D on the graph at the appropriate point. In the online version, the student matches labels P, Q, R, S on the graph to the descriptions. Note that the first 'flat' section (from 5 to 10 min) is the teenager waiting at the bus stop.
2. In this section, students read information from the graph of the teenager going to the sports centre. In part (d) the bus takes them from 0.6km from home to 3km from home, which is a distance of 2.4km.
3. See if students work this out for themselves - the 'bus' line is steeper than the 'walking' line - the bus moves further each minute than a walking person would.
4. This question asks the student to look at the first five minutes of the graph (where the walker travels 0.6km = 600m). As this is 1/12 of an hour, in a whole hour they would walk 0.6km x 12 = 7.2km. Equally, five minutes is 5x60s = 300s. So in one second they walk 600m/300 = 2m
5. Here, the student uses their answers to q4 to write down the speed as 7.2km/h and 2m/s.
6. Here, the student uses the methodology from q4 and q5 independently in one go to work out the speed of the bus in km/h and m/s. The bus travels 2.4km in 5 minutes, so in one hour it would go 12 x 2.4km = 28.8km. This means that the bus speed is 28.8km/h. Given that the bus goes 2400m in 5min = 300s, in one second the bus goes 2400m/300 = 8m, so its speed is 8m/s.

7. Students who know the speed = distance/time formula can use it. However we prefer them to work more intuitively. We already know that it takes the teenager 5 minutes to walk 0.6km. The full distance of 3km is 5x as far, so walking the whole way will take 5 x 5min = 25min.
8. This is the same as q7, but now looking at the bus. Here it is easier to say that the bus travels 2.4km in 5 minutes, so travels 2.4km/5 = 0.48km each minute. The whole journey is 3km, so the number of minutes taken = total distance / distance travelled each minute = 3/0.48 = 6.25 minutes.
9. In this question, the student has a displacement time graph. This means that the line can go up (when the lift is going up) or down (when the lift is going down). Horizontal lines still represent times when the lift is stationary (e.g. between 60s and 100s). In part (c) they are asked for the slowest moving part of the motion (ie not stationary) - they are looking for the least steep part of the graph (the last bit). For part (d) they need to add up all of the up and down motions (9m up, then 6m down [from 9 to 3 is a distance of 6m], then 9m up then 12m down makes a total of 36m).

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. Here students match graphs to descriptions. This includes a sloping curve which they have not seen before, but can work it out by elimination or by realising that if steepness gives the speed, then a line which is getting steeper represents something getting faster.
2. This is similar to q2 of the class work, but now is about a train. There are four horizontal parts of the graph representing stopping at four stations (we call them first, second, third, fourth on the sheet). The first sloping line goes up by 6km, so the first two stations are 6km apart.
3. This question also asks students to read the graph of the train. Students do have to work out speeds from the data. Example calculations are given here:
    a. first sloping line goes from 2min to 7min, so journey takes 5min
    b. in those 5 minutes, the train goes 6km, so distance each minute = 6km/5 = 1.2km
    c. if the train goes 1.2km each minute it will go 1.2km x 60 = 72km in one hour
    d. for the last two stations, the train travels 30-20 = 10km in 28-20 = 8 min. So the train travels 10km/8 =1.25km in one minute and 1.25km x 60 in one hour = 75 km/h
4. Here the student has to work out the speed in 3(c) in m/s. The train goes 1.2km = 1200m in one minute, so it goes 1200m/60 = 20m each second, so the speed is 20m/s
5. This is similar to q7 and q8 in the class work. The first and last stations are 30km apart. In 3(d) we had a train which went 1.25km each minute. So it would take 30 / 1.25 = 24 min.
6. This is a displacement time graph, with the upward slopes representing the jogging and the steeper downward slopes representing the running.
    a. there are no horizontal lines, so the athlete takes no breaks
    b. the athlete jogs 20m, then runs, then jogs 40, then runs, then jogs 60m. Total distance jogged = 20+40+60 = 120m
    c. to work out the speed of running, we choose one of the steep lines. If we use the first one, it drops from (15s,20m) to (20s,0m) so they go 20m in 5s, which means they go 4m each second, so the speed is 4m/s. If this were a graph from an experiment, we would prefer to take our measurement from the last downwards line as it is longest and therefore we can measure the times and distances more accurately.

Extension questions from ‘Step Up to GCSE Physics’
https://isaacphysics.org/gameboards?#step_up_phys_3_b1