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/uyGKgHBOkn4
- Practice: https://isaacphysics.org/gameboards#itsp_teach_disttime
- Review: https://youtu.be/8ItJ_66qf0c
- 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.

Shallow learning gradient online assignment - q1,2,3,4,5,6,7,8
Steeper learning gradient online assignment - q1,2,3,9,10,11

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. In this question, the student is given a description of a journey and plots a distance-time graph using the information. Possible points for the line through on the graph are labelled with letters A-H (the line only goes through some of the labelled points). For example, the first stage involves cycling 5km in 15 minutes. This takes the artists from A to E.
5. Here students identify the points on the graph in q4 corresponding to particular parts of the motion.

6. Students use the graph in q4 to work out how far the artists move each minute while walking. In the question it says they take 10 minutes to walk 1km. Encourage the students to use common sense and arithmetic (1000m in 10min, so 100m in 1min) rather than use a special formula.
7. In this question, students use similar reasoning to work out how far the artists cycled each second. This is to build on q6 and get them ready for later work on speed calculations.
    a. 5km = 5000m (the question reminds them that 1km = 1000m)
    b. 15min = 15x60s = 900s
    c. Cycling 5000m in 900s means they would cycle 5000/900 metres each second
8. In this question, the students work out how far cyclists would go in an hour if they could go 5km in 15min. Encourage the students to think that 15min is a quarter of an hour, so in one hour they will go four times as far (4x5km = 20km). The question points out that this means their speed is 20km/h.
9. Here a distance-time graph of a student travelling home from their lab is given. They journey is partly by cycle, and partly on foot. The question guides them through the process of working out the cycling and walking speeds from the data in the graph.
    a. Total distance = 3.6km
    b. Student cycles 3km in 5min. One hour is made of 12 lots of 5 minutes, so in an hour the cyclist could go 3km x 12 = 36km.
    c. Student walks 0.6km in 5 minutes. So in an hour they would go 12 x 0.6km = 7.2km.
    d. Cycling speed in km/h: they go 36km in an hour, so the speed is 36km/h.
    e. Cycling speed in m/s: they go 3000m in 5min (300s) so they go 3000/300 = 10m each second, so the cycling speed is 10m/s.
10. This question relies on the cycling speed from q9e, and students work out how much time the journey from q9 would take if the student could cycle the whole way. This is 3.6km when they can cycle 3km in 5min (which is 10m each second), so it will take 360s (6 minutes) to travel 3600m.
11. 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

Shallow learning gradient online assignment - q1,2,3,4
Steeper learning gradient online assignment - q1,3,4,5,6,7,8

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. Here students are given a distance-time graph of a wolf running a race against a sheep.
    a. If the sheep goes at a steady speed and starts and finishes at the same time as the wolf, the sheep's line on the graph will be a straight line from the origin to the final point (30km, 90min).
    b. By seeing where the two lines cross, we know the sheep passes the wolf 20km from the start (reading off the vertical axis).

    c. By seeing where the two lines cross, we know the sheep passes the wolf 60min from the start (reading off the horizontal axis).
3. 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.
4. 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
5. Here the student has to work out the speed in 4(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
6. This is similar to q7 and q8 in the class work. The first and last stations are 30km apart. In 4(d) we had a train which went 1.25km each minute. So it would take 30 / 1.25 = 24 min.
7. This is similar to q4 of the class work.
    a. An ant runs 50cm, and we are told it goes 10cm each second, so it takes 50/10 = 5s
    b. The snail goes 2.5cm each second. To go 50cm, it will take 50/2.5 = 20s.
    c. Using this information, students put the information about the motion of the leaf on a distance-time graph. Some points are labelled for ease of reference - the line does not go through all of these labelled points, though. To start, the ant carries the leaf 50cm, and this takes 5s (as in q7a), so the first part of the line goes from A to C.
8. 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