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FREE LEARNING NOTES FOR ZAMBIA

FORM 2

Mathematics

Travel graphs: distance-time graphs

Lesson notes for learners · Competence-Based Curriculum

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Every day people and objects move from one place to another. A learner walks to school, a bus travels between towns, a cyclist changes speed on a journey. A distance-time graph is a picture of such a journey, and it lets you see at a glance who is moving fastest.

AFTER THESE NOTES YOU SHOULD BE ABLE TO

- Describe a journey using distance, time and speed
- Read a distance-time graph and say who is moving fastest
- Calculate speed, distance and time, and average speed
- Compare a predicted result with a measured one using absolute and percentage error

KEY WORDS

distance	how far an object has travelled
time	how long the journey takes
speed	how fast an object is moving
average speed	total distance travelled divided by total time taken
distance-time graph	a graph showing the distance an object has travelled against the time taken
constant speed	moving so that equal distances are covered in equal times
stationary	not moving
absolute error	the size of the difference between the measured result and the predicted result

1 Reading a distance-time graph

When an object moves, the distance it has travelled usually changes as time passes. A distance-time graph shows the relationship between the distance travelled and the time taken. Distance goes on the vertical axis and time on the horizontal axis.

The shape and the steepness of the graph tell you how the object is moving: quickly or slowly, or whether it has stopped. A steeper line means more distance in the same time.

Three learners, Mwansa, Chipo and Tembo, leave school at the same time and walk towards a sports ground. Their distances from the school are recorded every 2 minutes. Mwansa covers 100 m, 200 m, 300 m, 400 m and 500 m. Chipo covers 150 m, 300 m, 450 m, 600 m and 750 m. Tembo covers 80 m, 160 m, 240 m, 320 m and 400 m. In the first 10 minutes Chipo travels the greatest distance, so Chipo is moving fastest.

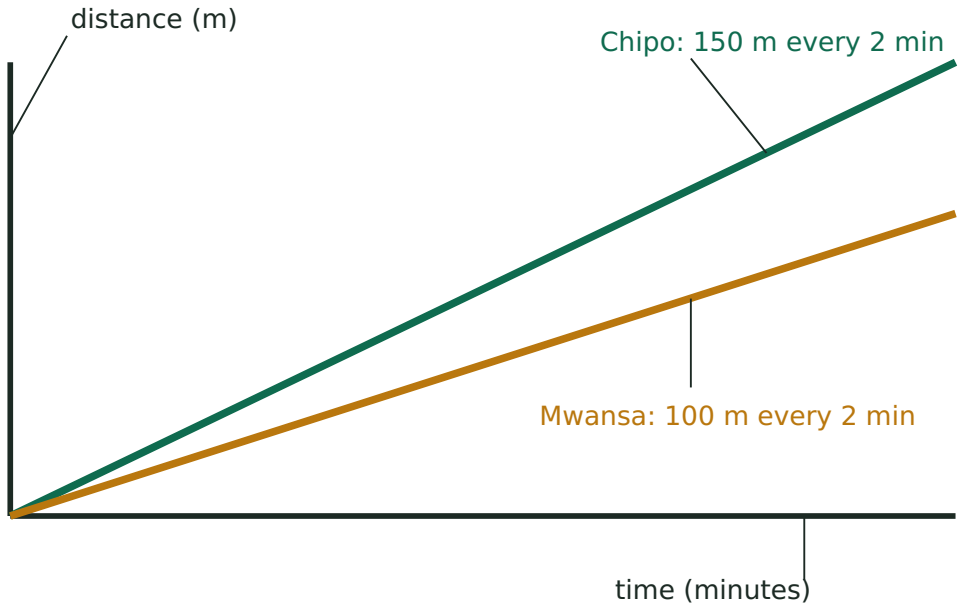

Figure 1. Distance-time lines for Mwansa and Chipo over 10 minutes

2 Speed, distance and time

Distance describes how far an object has travelled. Time describes how long the journey takes. Speed describes how fast an object is moving. For an object moving at constant speed, equal distances are covered in equal intervals of time. A faster object covers more distance in the same time.

The three quantities are linked by speed = distance ÷ time, distance = speed × time and time = distance ÷ speed. Keep the units compatible: metres with seconds give metres per second (m/s).

Time (minutes)	Mwansa (m)	Chipo (m)	Tembo (m)
0	0	0	0
2	100	150	80
4	200	300	160
6	300	450	240
8	400	600	320
10	500	750	400

Figure 2. Distance every 2 minutes for three learners

WORKED EXAMPLE

Mwansa covers 100 m every 2 minutes and Tembo covers 80 m every 2 minutes. Find how far each walks in 10 minutes and say who is faster.

Mwansa: 100 m every 2 minutes, so in 10 minutes (5 intervals) 5 × 100 = 500 m

Tembo: 80 m every 2 minutes, so in 10 minutes 5 × 80 = 400 m

Mwansa covers more distance in the same time, so Mwansa is faster

3 Average speed

Human movement is not perfectly constant, so we use average speed: average speed = total distance travelled ÷ total time taken, or v = d ÷ t.

In the school-ground speed trial, groups of four or five mark a straight route of 20 m or 30 m. One learner walks it at a normal pace and then at a brisk pace, while others time, measure and record. The average speed is calculated for each trial. Repeat a measurement before drawing a conclusion, because timing with a stopwatch has some error.

WORKED EXAMPLE

A learner walks 30 m in 24 s. Find the average speed.

v = d ÷ t

v = 30 ÷ 24

v = 1.25 m/s

4 Predicting, testing and error

You can use the formulas to predict a result and then test it. Challenge A: move at 1.5 m/s for 20 seconds, predict the distance, then test it. Challenge B: cover 40 m at an intended average speed of 1.25 m/s, predict the time, then test it.

The measured result may differ from the prediction. Compare them with two quantities. Absolute error = |measured result − predicted result|. Percentage error = (absolute error ÷ predicted result) × 100%.

The difference combines variation in the learner's movement with error in measurement. Use it to plan an adjustment and try again.

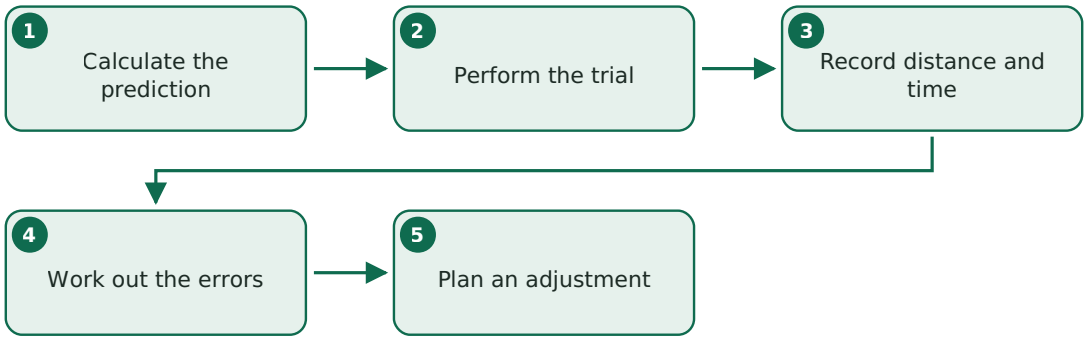

Figure 3. Predict, test and improve

WORKED EXAMPLE

For Challenge A the predicted distance is 30 m. The measured distance is 28.5 m. Find the absolute error and the percentage error.

Absolute error = $|28.5 - 30| = 1.5$ m

Percentage error = $(1.5 \div 30) \times 100\% = 5\%$

TRY THIS

In groups of four or five, mark a straight 20 m route on the school ground. Choose who will walk, who times with a stopwatch, who measures, who records and who checks. Predict the time for a normal walk, test it, calculate the average speed and the percentage error, then repeat at a brisk pace and compare.

REMEMBER

- A distance-time graph has distance on the vertical axis and time on the horizontal axis.
- The steepness of the graph shows how fast the object moves.
- Speed = distance ÷ time, distance = speed × time, time = distance ÷ speed.
- Average speed = total distance ÷ total time.
- Absolute error = |measured − predicted|; percentage error = absolute error ÷ predicted × 100%.
- Repeat measurements before drawing a conclusion.

? Check yourself

1. Which axis of a distance-time graph shows distance?
2. A learner walks 45 m in 30 s. Find the average speed.
3. How far does a cyclist go at 4 m/s in 15 seconds?
4. How long does it take to walk 60 m at 1.5 m/s?
5. Why is it useful to repeat a measurement before drawing a conclusion?
6. You are a learner in a group testing a 20 m route at school. You predict a time of 16 s but your group measures 18 s. (a) Find the average speed from the measured time. (b) Find the absolute error. (c) Find the percentage error and say what it tells you.
7. Three learners, Tendai, Grace and Banda, leave the school gate at the same time. After 4 minutes Tendai has covered 200 m, Grace 320 m and Banda 240 m. (a) Who is moving fastest? (b) Find each learner's distance every minute. (c) On a distance-time graph, whose line would be the steepest and why?

ANSWERS

1. The vertical axis. Time is on the horizontal axis.
2. v = 45 ÷ 30 = 1.5 m/s.
3. Distance = speed × time = 4 × 15 = 60 m.
4. Time = distance ÷ speed = 60 ÷ 1.5 = 40 s.
5. Human movement is not perfectly constant and timing has measurement error, so repeating shows whether the results agree.
6. (a) v = 20 ÷ 18 = 1.11 m/s (to 2 decimal places). (b) Absolute error = |18 − 16| = 2 s. (c) Percentage error = (2 ÷ 16) × 100% = 12.5%. The measured time differs from the prediction by 12.5% of the predicted time.
7. (a) Grace, who covered the most distance in the same time. (b) Tendai 200 ÷ 4 = 50 m, Grace 320 ÷ 4 = 80 m, Banda 240 ÷ 4 = 60 m. (c) Grace's line, because a steeper line means more distance in the same time.

Written by 25Schools to follow the Form 2 Mathematics syllabus of the Zambian competence-based curriculum. Free for learners to read, download and share. More notes and quizzes at 25schools.com.