Designing Mobile Games

A module on linear functions

Teacher guide

CORNERSTONE MATHS

On the cover
Once upon a time, there was a company founded by an artist and a computer programmer, both graduates of University College London. In an old office building in the Silicon Roundabout area of London, they launched SandCircle Mobile Games, a company dedicated to delivering the most exciting mobile phone games in the world. The name, SandCircle, is a play on silicon, which is made from sand, and roundabout, also known as a circle. SandCircle's logo evokes the road configuration of the Old Street Roundabout while the logo colour scheme calls to mind the London Tube's station signs.

Designing Mobile Games

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This unit is inspired by and based on the work and ideas of Jim Kaput.

For more information about Cornerstone Mathematics, please visit www.ucl.ac.uk/cornerstone-maths

Teacher Notes

Controlling Characters with Graphs

Key Ideas

- → Graphs are mathematical representations of relationships such as motion.
- → Graphs of motion show characters' start position, speed (relative) and places and times where characters meet.
- → For graphs of motion (that is, time versus distance), the steeper the line, the faster the motion.
- → Speed can be determined from different parts of a graph and simulation.

Main Activity — 45 minutes total

Discussion — Whole Class | 5 minutes

- In the "Texas Road Rally" game, cars move across a map of Texas, city to city, as in a real road rally. Explain that we are making the graphs to control the motion of the cars and setting up the mathematics that will make the game work. You may wish to reiterate that we are modelling cars' trips. While the actual races may be hundreds of miles long and take hours, we are using mathematics and software to model the races by showing the cars moving a few hundred pixels across a computer screen in a matter of seconds.

Questions 1 and 2 — Whole Class | 20 minutes

- Help pupils connect distance/time and "slant of line" as two ways to represent the speed of a car. Elicit the concept of unit rate.
- **Discuss** after pupils complete the question.

Discussion — Group | 20 minutes

- "Predict, check, explain" enables pupils to come to understand that, on the same axes, steeper lines represent faster trips.
- Some pupils may believe that shorter lines represent faster trips (which is true when the distance travelled is the same). Encourage pupils to create a counterexample in which a faster trip is represented with a graph line that is longer than the graph line representing a slower trip.
- **Discuss** with pupils after they complete the question.

Plenary — Whole Class | 5 minutes

- Ask pupils to summarise what information they can derive from having only a graph of motion.
- Ask what kind of information is not included in a graph of motion.
- Restate the key ideas of this activity: Graphs of motion tell us starting positions, speeds and ending positions; the steeper the line, the faster the motion.
- If there are any pupils still holding on to the misconception that shorter lines represent faster trips, show a counterexample in which a faster trip is represented with a graph line that is

longer than a graph line representing slower trip.

Pupil Difficulties

Pupils may have difficulty

- Accepting that predictions can be wrong and that there is value in reflecting on and analysing the predictions that were incorrect.
- Understanding why "on the same graph" is in the "Steeper is faster" callout box.
- Interpreting the intersection of two lines in a graph.

Pupils may have misconceptions

- Incorrectly associating the "shorter time" with simply "shorter line" to indicate faster motion.
- Thinking that parallel lines in a graph represent parallel tracks or paths.

Controlling Characters with Graphs

In America, there is a car race called the Texas Road Rally. SandCircle is building a game for sale in America based on the race. We need to set up the mathematics for a new game. In our simulation, we will use graphs to control motion. Remember, we'll make the game cool later!

In road rally races, professional drivers compete as they travel from town to town.

Same motion, different representations

Graphs, tables, and equations are mathematical representations. Each can show the same motion in a different way.

1. Your computer shows a graph of a race between the Green Grass team car and the Blue Waters team car.

   A. Using the graph, predict which car will win.

   Predict which car is faster.

   This is a prediction.
   Any answer is acceptable.

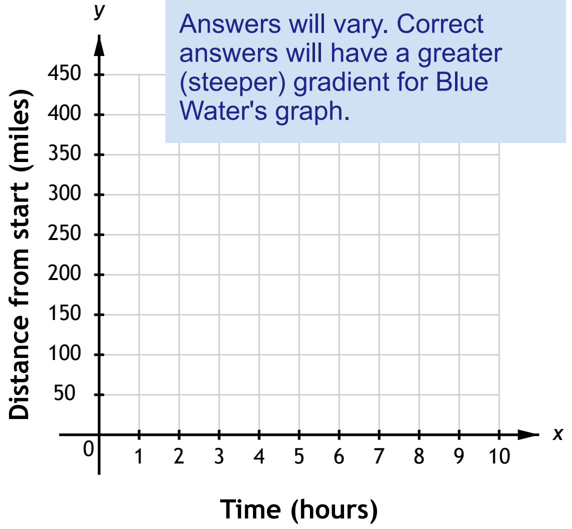
   Check your prediction by calculating the cars' speeds.

   Orange Rose: 50 mph

   Longhorn:
   35 mph

   Now run the simulation and check your answers.

B. Now edit the graph to change the speed of each car so that the other car is faster this time. Then fill in the boxes below. Don't forget to label your lines (the ones representing each car's motion) in the graph.



Answers will vary. Correct answers will have a greater (steeper) gradient for Blue Water's graph.

Faster Car

Blue Waters.

Speed of Each Car

Answers will vary

Now play the simulation and check your answers.

C. By looking at the distance/time graphs of two cars in a rally, how can you predict which one will win?

The car with the steeper line wins. (Potential misconception: Pupils may think that the car with the shorter line wins. You can make a shorter line where this is not the case as a counterargument to help them arrive at the conclusion that it's not the length of a line, but its steepness that matters, when graphed in the same coordinate system).

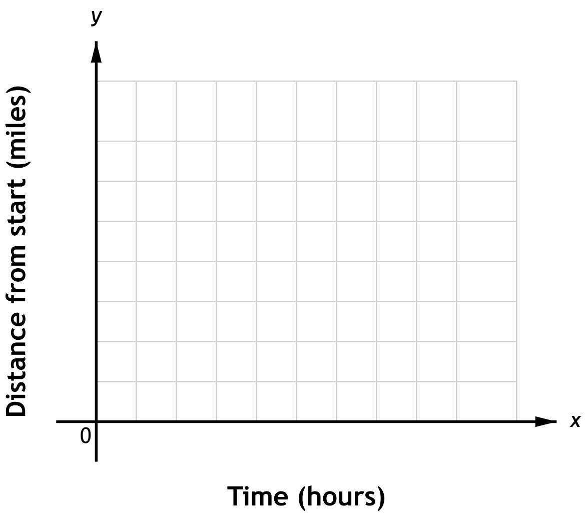
D. Explain how a car's speed and its graph line are related to each other.

The steeper the line, the faster the car (when it is graphed in the same coordinate system.)

2. Below are ideas to use in other games. *Note: There is more than one way to draw the graph for most of these situations.*

   A. **Predict**: Sketch a graph of a race in which the Green Grass and Blue Waters team cars start at the same position and travel the same distance but at different speeds.

      Don't forget to label your graph lines.



This is a prediction, so any answers are acceptable.

   B. **Check**: Now create the graphs to match your drawing. Then run the simulation. Do not alter your prediction in the graph above.

   C. **Explain**: Explain any changes you would have needed to make to the graph in order to correctly represent the race described in instruction A.

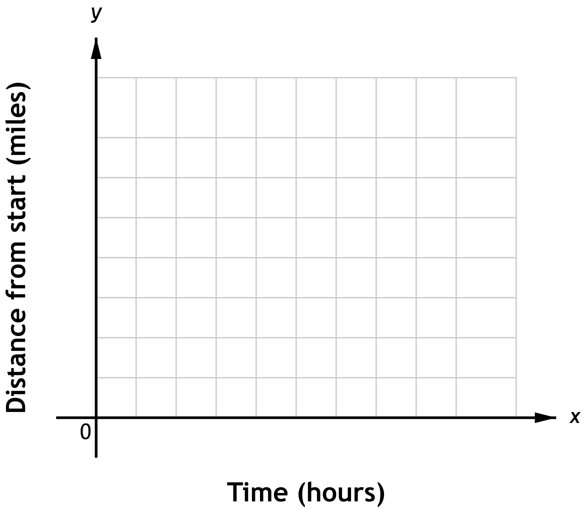
Pupils should identify the critical features of correct graphs:
- Start and ending positions are the same (same *y*-intercept and ending position).
- Graphs have different gradients.

D. Now edit the equation for each car so that:

- The two team cars start at different positions,
- the two team cars travel the same speed, but
- Green Grass finishes before Blue Waters.

Run the simulation and check that your model matches the situation. Edit the equations if necessary to match the situation correctly.

Now sketch the graph below.



Critical features:

- Graphs have different y -intercepts or starting positions with Green Grass' y-intercept being greater than that of Blue Waters.
- Graphs for Green Grass and Blue Waters have the same gradient.

E. Explain how the table provides evidence that you correctly modeled the situation above.