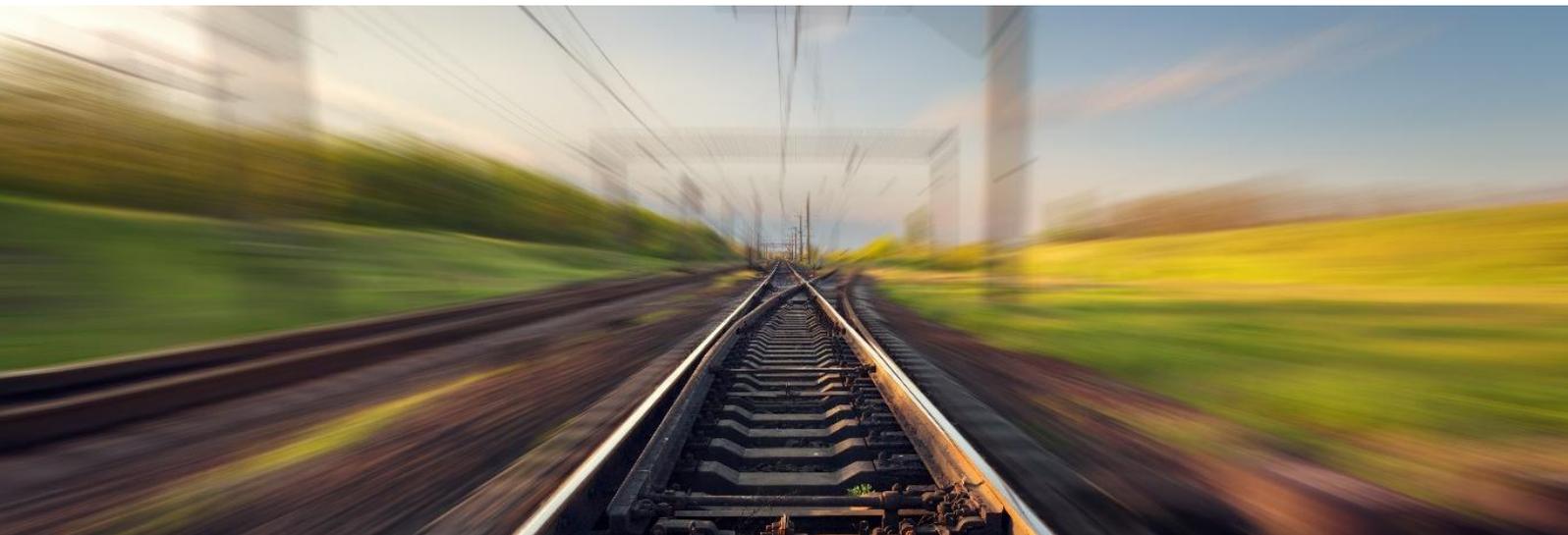


## Rail Activity For Education

### Real-life Maths: Carrying More by Freight



### Ambassador/ Teacher Session Guide



## Introduction

This activity is designed with the idea to promote critical thinking, basics of design, engineering and innovation. This will in turn encourage teamwork and leadership from all those involved. A hands-on and fun activity to do, providing some introduction and insights to some areas of the railway industry.

## Activity Overview

Carrying more freight by rail could help reduce road congestion and lower the carbon emissions caused by road freight transport, but rail freight services must be integrated into existing passenger timetables. In this challenge students complete a passenger timetable for a short section of railway network before calculating the travel time for a freight service to travel through each station on the network. Students then analyse possible starting times for freight services to identify which freight journeys might be possible.

## Learning outcomes

Use these to generate appropriate success criteria for your students.

- Interpret a train timetable and complete missing information.
- Represent a timetable visually using a form of graph and identify when trains may pass each other.
- Demonstrate how maths is used in a practical situation.

## Curriculum links

KS3 Maths:

- use mass, length, time, money and other measures, including with decimal qualities.
- solve kinematic problems involving constant speed.

Other subject links: Physics – motion; Biology/Chemistry - climate change.

## Activity Timings

This challenge is best delivered in a double lesson. More able students may be able to complete all tasks in a single lesson

## Materials/ Equipment

- Each student or pair will need a copy of activity sheets 1 and 2.
- You may want to provide additional graph paper for plotting stringline graphs.
- Less able students may benefit from using graph paper and scissors to help with task 3.

## Step by Step Instructions

### Preparation (Optional):

Before you begin the main challenge you may want to:

- Review time notation.
- Set students some simple addition and subtraction tasks using times, including ones that pass through the hour.
- Use a sample timetable (your local bus and or train operator will provide downloadable PDFs) to discuss how to read a timetable and spot patterns such as regular departure and journey times.

### Main challenge:

Introduce the challenge: explain that students need to help a rail company introduce a freight service to its early morning timetable.

Ask students how they think the food and products we use each day get from where they are made to where we can buy them and help students consider the number of freight journeys required to sustain our daily eating and consumption of goods. Link this to the number of lorries on our roads. Briefly discuss some advantages to transporting freight by rail, and then ask students to identify some problems that may occur when adding slow freight trains to a busy existing passenger timetable.

### Task 1

1. Review the network map on activity sheet 1 and identify that trains may pass one another only between stations B and D.
2. Review the timetable, which is incomplete. Make sure students understand that all passenger trains take the same time to travel between A and B, and between D and E.
3. Students complete the remaining missing times.

Less able:	More able:
<ul style="list-style-type: none"> <li>• Show/model how you can use the information from the 10:00 express to calculate when the 08:00 express will reach station E.</li> <li>• Students work in pairs to complete the other missing times.</li> </ul>	<ul style="list-style-type: none"> <li>• Students complete the timetable unaided.</li> </ul>

4. Review the missing times.
5. Introduce stringline graphs as a way to visually represent timetables:
  - Time is on the x-axis.
  - Stations are equally spaced on the y-axis.
6. Explain that the stringline graph represents how trains move from station to station.
7. Explore how the first express train has been drawn on the graph. (Note that for simplicity this activity ignores stopping times at stations.)

Less able:	More able:
<ul style="list-style-type: none"> <li>Students can trace their finger from bottom (station A) to top (station E) noting when the train passes through each station, stopping at B and E.</li> </ul> <p>Or</p> <ul style="list-style-type: none"> <li>Ensure students mark spots like co-ordinates (time, station), and then join with lines. The stopping service won't be a straight line from A to E.</li> <li>Ask students to draw a stringline graph for the other two services.</li> </ul>	<ul style="list-style-type: none"> <li>Discuss how the gradient of a train's stringline indicates its speed, with faster trains at a steeper gradient.</li> <li>Ask what students would need to know and change about the y-axis so they could answer questions about the speed of the train (they would need to know the distance between each station and mark these to scale on the y-axis).</li> </ul>

8. Review students' completed stringline graphs for the three passenger services.

## Task 2

- Establish that the freight service will pass through the stations but not stop. Students need to calculate the freight train's travel time between each station, so they can create a freight timetable and transfer this to their stringline graph.

Less able:
<ul style="list-style-type: none"> <li>First ask students to use their timetable to calculate how long the stopping service takes to get from A to E.</li> </ul>

- Ask students to explain how they could calculate the travel times for the proposed freight service. The network map does not include distances, so how can they do this? (Multiply the timetable times by 1.5).
- Students calculate the time for each stage of the freight journey.

Less able:	More able:
<ul style="list-style-type: none"> <li>Students can work as a team and calculate one section each.</li> </ul>	<ul style="list-style-type: none"> <li>Students work individually and complete all missing times.</li> </ul>

## Task 3

- Ask students to convert their times for the freight journey between each station into a timetable for the two freight services.

Less able:
<ul style="list-style-type: none"> <li>Ask students to explain how they will draw a table and populate it with the information from task 2.</li> </ul>

- Explain that students need to identify whether either of these two freight services can fit into the passenger timetable.

3. Ask students to explain what you mean by 'fit in' – it means that the freight trains can travel along the tracks without disrupting the passenger services, for example causing a fast passenger service to get stuck behind a slow freight train on a single track section of line where it can't pass by.

Less able:	More able:
<ul style="list-style-type: none"> <li>• Ask students to carefully add stringlines for their two freight services to their graph, using a different colour.</li> <li>• Ask students to share ideas on how they might know that one train must pass another, guiding them to look at what happens to the lines between two stations. (The lines on the graph will cross if the trains need to pass.) You could model this by moving your fingers along a sketched stringline diagram for two stations, with two services crossing in between, moving along the stringline of a faster train quicker than along that of a slower one until you meet the point where they cross.</li> <li>• As a class, identify the four 'crossing points' where trains will pass. Ask students to recall where trains can pass one another (on the double tracks between B and D) and mark each point with a tick (if it's between B and D) or a cross (if it's outside of this, between A and B, or D and E).</li> </ul>	<ul style="list-style-type: none"> <li>• Ask students to add the two freight stringlines to their graph and use their understanding of the gradients to identify where a faster train will need to pass a slower one between stations.</li> <li>• Ask students to identify which overtaking instances would be possible, and which not, and use this to assess whether either freight service would be possible.</li> </ul>

4. Discuss the results and establish that the 08:30 freight service would be possible.

More able:
<ul style="list-style-type: none"> <li>• See if students can infer that a 09:30 service would also be possible due to the uniform nature of the timetable.</li> <li>• Ask students to cut out a silhouette of the freight stringline (cut away the paper to the left of/above of it, and leave the paper to the right/below it). See if they can move this along the x-axis to identify time 'zones' between passenger services when a freight service would be possible (e.g. the freight stringline only crosses a passenger service's stringline between B and D).</li> </ul>

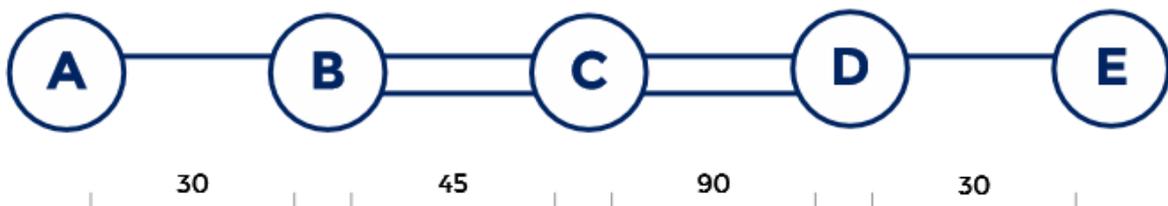
## Answers

1

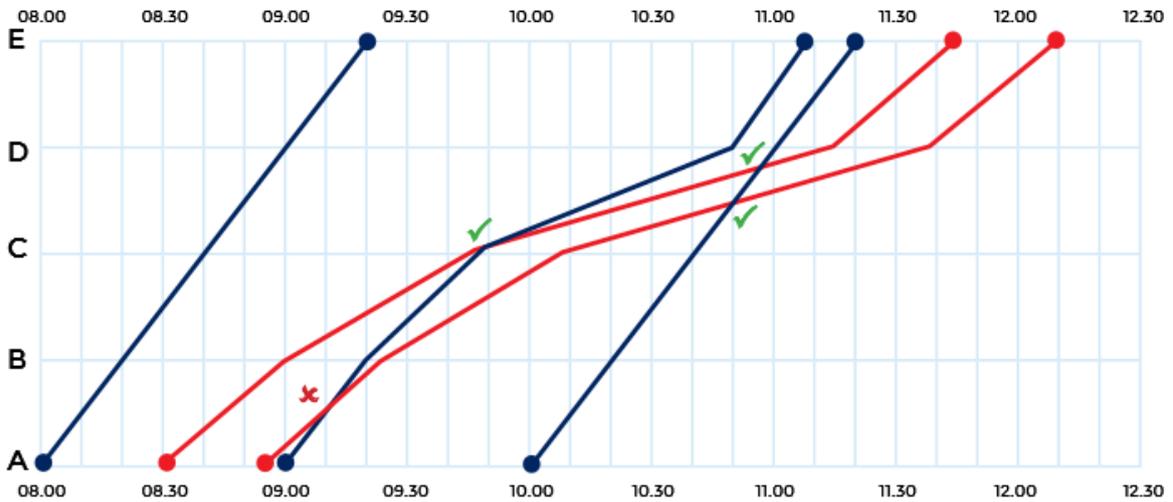
Service	Express	Stopping	Express
A	08:00	09:00	10:00
B	08:20	09:20	10:20
C	-	09:50	-
D	-	10:50	-
E	09:20	11:10	11:20

2

The freight train will take 3 hours and 15 minutes (195 minutes) to get from A to E. The times to pass between each station are, in minutes:



3



Freight train departure from station A	Is this journey possible?	Reason
08:30	Yes	The 9:00 stopping and 10:00 express can overtake the slow freight train between stations B and D.
08:55	No	The 09:00 stopping service would need to overtake the slow freight train before station B, but this is not possible because of the single track between those stations.