This unit will help you to describe and use graphs correctly.

An important part of physics is describing the patterns we see in our observations about the universe. Graphs help to show those patterns.

In the exam you will be asked to tackle questions such as the one below.

**Exam-style question**

1. A student is investigating the relationship between the force on a spring and its extension. The student’s data is shown plotted as a graph in Figure 1.

![Figure 1](image)

1.1 Describe the relationship shown by the graph.

1.2 Use Figure 1 to find the extension of the spring when the force is 12 N.

1.3 Use Figure 1 to find the spring constant in N/m.

You will already have done some work on graphs. Before starting the skills boosts, rate your confidence with these questions. Colour in the bars.
Look at the data in the table.

This data shows how the energy transferred by a resistor changes with time.

To plot this data on a graph you first need to label the axes.

The horizontal and vertical axes on this graph have been partly labelled.

<table>
<thead>
<tr>
<th>Time in s</th>
<th>Energy transferred in J</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>90</td>
</tr>
<tr>
<td>8</td>
<td>200</td>
</tr>
<tr>
<td>12</td>
<td>310</td>
</tr>
<tr>
<td>16</td>
<td>350</td>
</tr>
</tbody>
</table>

1. Complete the labels for the axes using information from the table.
2. Complete this sentence:
   Each label has the name of the quantity and its ________________________________
3. Complete the gaps along the x-axis to add the scale.
4. Now use the values from the table to plot the points on the graph.
5. Draw a line of best fit.

A line of best fit will pass through, or very near, all of the points, except any anomalous points (points which do not fit the pattern).
1 **How do I read correctly from a graph?**

In your exam you will need to use scientific information presented in the form of a graph. This page will help you to read values from graphs of different types and with different scales.

The **scale** on the axis shows how much each square is ‘worth’.

Here is part of a graph.

1. **How many small squares are there between the 0 and 10 marks?**

2. **How much is each small square worth on the scale?**

Here is part of another graph.

3. **How many small squares are there between the 0 and 20 marks?**

4. **How much is each small square worth on the scale?**

To read from a point on the graph, draw a line across and down until you meet each axis.

5. **Complete the sentence for the graph below.**

The point is where the length value = _______ cm and the force value = _______ N

Ten squares are worth 10 units.
How do I describe the shape of the graph?

Marks can be lost when describing graphs if not enough detail is given. This page will help you to work out what to say when asked to describe the shape of a graph.

Look at the example graphs below. They are called **sketch graphs** because they do not have points plotted: they only show the shape.

1. **Graph D** matches the statement: As force increases, speed also increases.

   Tick ✓ any other graphs that show this relationship.

To describe the shape fully, you have to say how these three graphs are different. Do this by describing how the steepness changes.

2. Look again at the three graphs you ticked in 1. Draw lines to link the description to the shape of each curve. Write the letter of the graph in the boxes on the right.

   ![Graphs A to F](image)

<table>
<thead>
<tr>
<th>Description</th>
<th>Shape</th>
<th>Graph</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decreasing rate</td>
<td>A curve that gets flatter</td>
<td></td>
</tr>
<tr>
<td>Constant rate</td>
<td>A straight line</td>
<td></td>
</tr>
<tr>
<td>Increasing rate</td>
<td>A curve that gets steeper</td>
<td></td>
</tr>
</tbody>
</table>

3. Which graph shows the relationship stated below? 📔

   As the force increases, the speed increases at a constant rate.

4. Now describe these graphs in the same way. The first description has been started for you.

   a. **Graph B:**

   b. **Graph C:**

   c. **Graph E:**

   d. **Graph F:**

---

**Physics Unit 6 Graph skills**
For many graphs in physics, the steepness or gradient of the line is an important quantity. This page will help you to find the gradient of a section of a graph.

On a distance–time graph, the gradient is important: it tells you the speed of the journey. The steeper the line, the higher the gradient so the faster the speed:

\[ \text{gradient} = \text{speed} \]

To calculate the speed / gradient at C on the graph we need to use the speed formula we already know.

\[ \text{speed} = \frac{\text{distance}}{\text{time}} = \frac{160 \text{ m}}{80 \text{ s}} = 2 \text{ m/s} \]

1. Now look at the first 100 seconds of the journey in the graph above. This is a straight line. Complete the calculation to find the gradient of the straight line.

\[ \text{Gradient} = \frac{\text{vertical distance between the start and end points}}{\text{horizontal distance between the same two points}} = \frac{80 \text{ m}}{80 \text{ s} - 0 \text{ s}} = \frac{80 \text{ m}}{80 \text{ s}} = \frac{1}{1} \text{ m/s} \]

Here is a speed–time graph. This time the gradient is the acceleration; a steeper line means a larger acceleration.

Two students have tried to calculate the acceleration between 40 s and 100 s.

A

\[ \text{Gradient} = \frac{\text{vertical distance between the start and end points}}{\text{horizontal distance between the same two points}} = \frac{60 \text{ m}}{100 \text{ s}} = 0.6 \text{ m/s}^2 \]

B

\[ \text{Gradient} = \frac{\text{vertical distance between the start and end points}}{\text{horizontal distance between the same two points}} = \frac{47 - 43 \text{ m/s}}{80 - 60 \text{ s}} = \frac{4 \text{ m/s}}{20 \text{ s}} = 0.2 \text{ m/s}^2 \]

2. The students have made different mistakes. Explain what each student has done wrong.

3. On paper, calculate the correct gradient.
Exam-style question

A student is investigating the relationship between the force on a spring and its extension. The student's data is shown plotted as a graph in Figure 1.

1.1 Describe the relationship shown by the graph.

(2 marks)

1.2 Use Figure 1 to find the extension of the spring when the force is 12 N.

(2 marks)

1.3 Use Figure 1 to find the spring constant in N/m.

(2 marks)

Look at this student’s answer to part 1.1.

Complete the student answer to describe the part of the graph between 15 N and 20 N.

Another student has read some data from the graph to answer part 1.2.

The extension is 4.4 cm when the force is 12 N.

Find 12 N on the vertical axis and draw a line across the graph.

a. How much is each small square on the vertical scale worth?

b. Explain how the student has read the scale incorrectly.
Exam-style question

A student is investigating the relationship between the force on a spring and its extension.

The student’s data is shown plotted as a graph in Figure 1.

1.1 Describe the relationship shown by the graph.

1.2 Use Figure 1 to find the extension of the spring when the force is 12 N.

1.3 Use Figure 1 to find the spring constant in N/m.

Your turn!

It is now time to use what you have learned to answer the exam-style question.

Read the exam-style question and answer it using the guided steps below.

1.1 Circle the words that could be used to describe the shape of the graph.

- straight line until 15 N
- extension increases
- force decreases
- decreasing gradient
- increasing gradient

1.2 i Draw a line across the graph where the force is 12 N.

ii Write the extension of the spring.

1.3 i What are the units of extension on the graph?

ii What are the units of the spring constant in the question?

iii What is 6 cm converted into metres?

iv Complete the gaps in this gradient calculation:

\[ \text{Gradient} = \frac{15 - 10 \text{ N}}{6 - 4 \text{ cm}} = \frac{5 \text{ N}}{2 \text{ cm}} = \frac{5 \text{ N}}{2 \text{ cm} / 100 \text{ m}} = 250 \text{ N/m} \]
In the exam, questions about graph skills could occur as:

- simple standalone questions
- part of a question on any physics topic, especially forces
- part of a question about a practical test.

Have a go at this exam-style question.

**Exam-style question**

1. The results of an investigation into refraction are shown in the graph below.

![Graph showing angle of incidence vs angle of refraction](image)

1.1 Describe the relationship between angle of refraction and angle of incidence.

1.2 Use the graph to find the angle of refraction when the angle of incidence is 40 degrees.

**Boost your grade**

Make sure you know how to read graphs to get the information you require as well as being able to draw graphs correctly yourself.

How confident do you feel about each of these skills? Colour in the bars.

1. How do I read correctly from a graph?
2. How do I describe the shape of a graph?
3. How do I find a gradient?