

Topic Physics Numerical Questions

Learning Objectives:

At the end of this topic you will understand;

- how calculation questions are presented and marked on Foundation and Higher tier questions;
- how to present your answers to obtain your best mark.

Introduction

Every physics unit has ideas in it which are expressed in mathematical language. Because of this, every question paper has questions which require you to write down equations and use them to work out answers. Page 2 of every question paper has a list of equations which you might need:

This is the equation list from the January 2009, Physics 1 Foundation tier paper.

EQUATIONS

$$\text{power} = \text{voltage} \times \text{current}$$

$$\text{energy transfer} = \text{power} \times \text{time}$$

$$\text{units used (kWh)} = \text{power (kW)} \times \text{time (h)}$$

$$\text{cost} = \text{units used(kWh)} \times \text{cost per unit}$$

$$\text{efficiency} = \frac{\text{useful energy transfer}}{\text{total energy input}} \times 100\%$$

$$\text{wave speed} = \text{wavelength} \times \text{frequency}$$

$$\text{speed} = \frac{\text{distance}}{\text{time}}$$

There are several different ways in which questions involving equations appear in questions on Physics papers. In the work that follows, the equation $\text{speed} = \frac{\text{distance}}{\text{time}}$ will be used, as that is a familiar equation from Key Stage 3.

Low demand questions

These are questions which appear in the first part of Foundation tier papers. In these questions, the equation will always be given in the question in the form which is most useful to you.

Example of a Low Demand question:

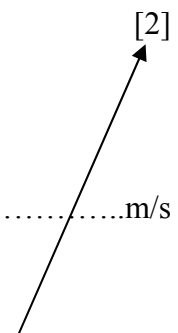
An Olympic athlete runs the 100 m final in a time of 9.65 seconds.
Use the equation

$$\text{speed} = \frac{\text{distance}}{\text{time}}$$

to calculate the athlete's average speed.

Average speed =m/s

[2]



This kind of question usually has 2 marks. This is shown here.

1st step: In the space provided, write the equation with the numbers in:

speed = $\frac{100}{9.65}$ ✓ - this gets you your 1st mark - **even if you make a mistake in working out the answer.**

2nd step: use your calculator to finish the calculation and write your answer in

speed = $\frac{100}{9.65} = 10.4$ [you can write 10.3626943 but it is a bit silly!]

3rd step: write your answer in the space provided:

Average speed = ...**10.4**.....m/s✓

-this gets your 2nd mark [if the answer is correct!]

Try the next example for yourself:

Sound travels at 330 m/s. A worried hill walker, on the top of a ridge, notices that the thunder came 6 seconds after a lightning stroke.

Use the equation

$$\text{distance} = \text{speed} \times \text{time}$$

to calculate how far away the lightning stroke was. [2]

Distance =m

Standard demand questions

These are questions in the latter part of the Foundation paper and about half of the questions on the Higher paper.

In these questions you'll have to decide for yourself which equation to use, from the equations on page 2 of the question paper. You will not need to swap the equation around.

Example:

An Olympic athlete runs the 100 m final in a time of 9.65 seconds.

Write down an equation as it appears on page 2 and use it to calculate the athlete's average speed.

Equation:
 [1]

Calculation: [2]

Average speed =m/s

[On page 2 of the question paper, the equation $\text{speed} = \frac{\text{distance}}{\text{time}}$ will appear]

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Your answer should look as follows:

An Olympic athlete runs the 100 m final in a time of 9.65 seconds.

Write down an equation as it appears on page 2 and use it to calculate the athlete's average speed.

Equation: $\text{speed} = \frac{\text{distance}}{\text{time}}$ ✓ - 1st mark [1]

Calculation: [2]

$\text{speed} = \frac{100}{9.65}$ ✓ - 2nd mark

$\text{speed} = \frac{100}{9.65} = 10.4$

Average speed = 10.4.....m/s ✓
3rd mark

The equation:

What if I write the "equation" just as $\frac{\text{distance}}{\text{time}}$? - 1st mark ×

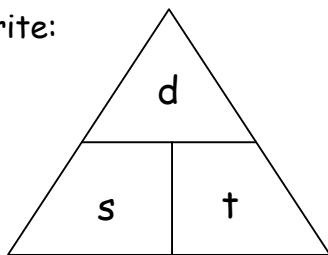
What if I write the "equation" just as = $\frac{\text{distance}}{\text{time}}$? - 1st mark ×

What if I write more than one equation, e.g.

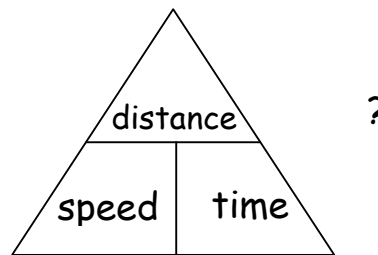
$\text{speed} = \frac{\text{distance}}{\text{time}}$ and $\text{distance} = \text{speed} \times \text{time}$? - 1st mark ✓ - but only if both equations are correct.

What if I write $s = \frac{d}{t}$? - 1st mark × What do s, d and t stand for?

What if I write:



or



1st mark × - these are not equations.

The calculation:

What if I write $\text{speed} = \frac{9.65}{100} = \dots\dots\dots?$ × 0 marks even if you write = 10.4 as your answer [in this case you have made 2 mistakes!]

What if I write $\text{speed} = 9.65 \times 100 = \dots\dots\dots?$ × 0 marks

Rule: You cannot gain marks for substitution into an incorrect equation or incorrect substitution into a perfectly good equation, even though the arithmetic is right.

High demand questions

25 of the marks on Higher tier papers are for “high demand” questions, which are more difficult. In these questions, you will probably have to manipulate the equation. For example, the question asks you to calculate the time but the equation is given as:

$$\text{speed} = \frac{\text{distance}}{\text{time}}$$

These questions are marked in the same way as the low and standard demand questions.

1st mark - selecting and writing the equation which you will use - remember to write the full equation.

2nd mark - putting the numbers correctly into the equation.

3rd mark - correct answer.

Sometimes there will be a mark for swapping the equation around as well - sometimes not. If there is a mark for manipulating the equation you will see that there are [3] marks for the calculation.

Example:

[This was at the end of a question on optical fibres. In the previous part of the question. candidates had worked out that the speed of infra red radiation in a glass fibre was 2.0×10^8 m/s]

Write down an equation from page 2 and use it to calculate the time taken by an infra red signal to travel along a glass fibre 10 km long.

Equation: [1]

Calculation: [3]

Time =s

[On page 2 of the question paper, the equation appeared as $\text{speed} = \frac{\text{distance}}{\text{time}}$]

Your answer should look as follows:

Write down an equation from page 2 and use it to calculate the time taken by an infra red signal to travel along a glass fibre 10 km long.

Equation: $\text{speed} = \frac{\text{distance}}{\text{time}}$ - ✓ 1st mark [1]

Calculation: $2 \times 10^8 = \frac{10 \text{ km}}{\text{time}}$ or $2 \times 10^8 = \frac{10\,000 \text{ m}}{\text{time}}$ - ✓ 2nd mark [3]

So time = $\frac{10\,000}{2 \times 10^8}$ - ✓ 3rd mark
 $= 5 \times 10^{-5} \text{ s}$

Time = $5 \times 10^{-5} \text{ s}$
 - ✓ 4th mark

Hints to get good marks:

1. The calculation:

- always show your working
- write the equation with the correct numbers in
- if it's a fraction, make sure it's the right way up
- if you have to manipulate the equation, write it with the numbers in first - that way you get the 1st mark even if you miss out on the next ones.

2. The equation (standard and higher questions only)

- always write the full equation including the left hand side and the "=" sign.
- don't use symbols unless they are given on page 2 of the question paper.