# A level Physics Transition Tasks 2024

## Instructions

**You are required to complete two compulsory tasks before your first Physics lesson in September**. Ensure you bring all of your written work to your lesson where it will be collected by your teacher. Your written work should be on A4 paper, clearly structured and labelled. Your calculations must be logically presented. It is expected you will work independently, finding out any necessary information in order to carry out the tasks. The compulsory tasks are provided in this document (part 1) as well as in part 2.

In addition, there are some **optional extension tasks** that you **may** wish to carry out. These are a selection of physics related interesting books, films and movie clips. You may wish to choose a particular book to read, for example, from the selection provided. The optional extension tasks are listed below in this document (part 1).

## The 2 Compulsory tasks (Please note that you must do both of these compulsory tasks and you will be required to hand the written work in)

1. **Foundations of Physics Calculation sheet: determining uncertainty**
   This provides information and worked examples on uncertainties for you to read as well as questions for you to complete.
2. **17 exam style questions** involving uncertainties *(see Task 2)*

1. **Foundations of Physics Calculation sheet: determining uncertainty**

# Determining uncertainty

## Specification references

- *2.2.1 c)*
- *M0.3 Use ratios, fractions, and percentages*
- *M1.5 Identify uncertainties in measurements and use simple techniques to determine uncertainty when data are combined by addition, subtraction, multiplication, division, and raising to powers*

## Learning outcomes

After completing the worksheet you should be able to:

- demonstrate knowledge and understanding of percentage errors and uncertainties
- evaluate absolute and percentage uncertainties
- determine uncertainty when data are combined by addition, subtraction, multiplication, division, and raising to powers.

## Percentage uncertainties

### Introduction

When something is measured there will always be a small difference between the measured value and the true value. There are several possible reasons for uncertainty in measurements, including the difficulty of taking the measurement, the precision of the measuring instrument (for example, due to the size of the scale divisions), and the natural variation of the quantity being measured. The word ‘uncertainty’ is generally used in preference to ‘error’, because ‘error’ implies something that is wrong – mistakes in making measurements should be avoided, and are not included in the uncertainty.

A measurement of 2.8 g on a scale with divisions of 0.1 g means the value is closer to 2.8 g than 2.7 g or 2.9 g. If the measurement were exactly half-way between 2.8 g and 2.9 g you would round up and record 2.9 g, so 2.8 g is anything from 2.75 g up to, but not including, 2.85 g, and the measurement is written 2.8 (± 0.05) g. The ‘(± 0.05) g’ is called the absolute uncertainty.

The percentage uncertainty in a measured value is calculated as shown below.

$$\text{percentage uncertainty} = \frac{\text{uncertainty}}{\text{measured value}} \times 100\%$$

## Worked example

### Question

**a** The distance from **A** to **B** is carefully measured as 7.500 m, using a 10 m tape measure marked in millimetre increments.

**i** Deduce the absolute uncertainty in the measurement.

**ii** Determine the percentage uncertainty in the measurement.

**b** The distance from **B** to **C** is measured as 6.500 m using a stick 1 m in length with no scale divisions, in difficult conditions.

**i** Deduce the absolute uncertainty in the measurement.

**ii** Determine the percentage uncertainty in the measurement.

**c** Calculate the absolute uncertainty in the total distance from **A** to **B** to **C**.

**d** Calculate the percentage uncertainty in the total distance from **A** to **B** to **C**.

### Answer

**a i** *Step 1*

Consider the start point (**A**) and end point (**B**) of the measurement, the scale division size, and the difficulty of measuring. There will be an uncertainty in the measurement both at the start point (**A**) and the end point (**B**).

The uncertainty in the measurement $= 2$ mm
(If you measure a shorter length with a 30 cm ruler, there would be an uncertainty of 0.5 mm at each end, resulting in a 1 mm uncertainty overall.)

*Step 2*

Write out the measurement with its absolute uncertainty. The uncertainty has the same unit as the measurement.

The distance **AB** is $7.500\ (\pm 0.002)$ m.

**ii** *Step 3*

Calculate the percentage uncertainty using the equation:

$$\text{percentage uncertainty} = \frac{\text{uncertainty}}{\text{measured value}} \times 100\%$$

$$\text{percentage uncertainty} = \frac{0.002}{7.500} \times 100\% = 0.03\%$$

**b i** *Step 4*

Consider the start point (**B**) and end point (**C**) of the measurement, the scale division size, and the difficulty of measuring. There will be an uncertainty in the measurement at the start point (**B**) and at the end point (**C**). Because the metre stick has no scale divisions, you can only estimate to the nearest half a metre.

The uncertainty in the measurement $= 0.5$ m

*Step 5*

Write out the measurement with its absolute uncertainty.

The distance **BC** is $6.5\ (\pm 0.5)$ m.

*Step 6*

$$\text{The percentage uncertainty} = \frac{0.5}{6.5} \times 100\%$$

$$= 7.69\%$$

$$= 8\% \text{ (to nearest \%)}$$

Unless the percentage uncertainty is less than 1%, it is acceptable to quote percentage uncertainties to the nearest whole number.

**c** *Step 7*

For the distance **ABC** the two measurements are added. The overall absolute uncertainty will be the sum of the individual absolute uncertainties.

uncertainty in **ABC** = uncertainty in **AB** + uncertainty in **BC**

$$= 0.002\text{ m} + 0.5\text{ m}$$

$$= 0.5\text{ m (since 0.002 is insignificant compared to 0.5)}$$

**d** *Step 8*

To find the percentage uncertainty, first calculate the measured value of **ABC**.

**ABC** $= 7.5 + 6.5 = 14.0$ m

*Step 9*

Calculate the percentage uncertainty using the equation:

$$\text{percentage uncertainty} = \frac{\text{uncertainty}}{\text{calculated value}} \times 100\%$$

$$\text{percentage uncertainty} = \frac{0.5}{14.0} \times 100\%$$

$$= 3.57\%$$

$$= 4\% \text{ (to nearest \%)}$$

## Questions

**1** Write down these measurements with their absolute uncertainty.

**a** 6.0 cm length measured with a ruler marked in mm (*1 mark*)

**b** 0.642 mm diameter measured with a digital micrometer (*1 mark*)

**c** 36.9 °C temperature measured with a thermometer which has a quoted accuracy of: '± 0.1 °C (34 to 42 °C), rest of range ± 0.2 °C'. (*1 mark*)

**2** Calculate the percentage uncertainty in these measurements.

**a** 5.7 ± 0.1 cm (*1 mark*)

**b** 2.0 ± 0.1 A (*1 mark*)

**c** 450 ± 2 kg (*1 mark*)

**d** 10.60 ± 0.05 s (*1 mark*)

**e** 47.5 ± 0.5 mV (*1 mark*)

**f** 366 000 ± 1000 J (*1 mark*)

**3** Calculate the absolute uncertainty in these measurements.

**a** 1200 W ± 10% (*1 mark*)

**b** 34.1 m ± 1% (*1 mark*)

**c** 330 000 Ω ± 0.5% (*1 mark*)

**d** 0.008 00 m ± 1% (*1 mark*)

**4** Calculate the absolute and percentage uncertainty in the total mass of suitcases of masses $x$, $y$, and $z$.

$x = 23.3\ (\pm\ 0.1)$ kg, $y = 18\ (\pm\ 1)$ kg, $z = 14.7\ (\pm\ 0.5)$ kg (*2 marks*)

# Combining uncertainties

## Introduction

In a calculation, if several of the quantities have uncertainties then these will all contribute to the uncertainty in the answer. The following rules will help you calculate the uncertainty in your final answers.

- When quantities are added, the uncertainty is the sum of the *absolute* uncertainties.
- When quantities are subtracted, the uncertainty is also the sum of the *absolute* uncertainties.
- When quantities are multiplied, the *total percentage* uncertainty is the sum of the *percentage* uncertainties.
- When quantities are divided, the *total percentage* uncertainty is also the sum of the *percentage* uncertainties.
- When a quantity is raised to the power $n$, the *total percentage* uncertainty is
  $n$ multiplied by the *percentage* uncertainty – for example, for a quantity $x^2$, total percentage uncertainty $= 2 \times$ percentage uncertainty in $x$.

## Worked example

### Question

A current of 2.8 ($\pm$ 0.1) A passes through a kettle element. The mains power supply is 230 ($\pm$ 12) V.

Calculate the power transferred, including its uncertainty.

### Answer

*Step 1*

Calculate the power.

$P = IV$

$P = (2.8\ \text{A}) \times (230\ \text{V}) = 644\ \text{W}$

*Step 2*

Calculate the percentage uncertainties.

The percentage uncertainty in current $= \frac{0.1}{2.8} \times 100\% = 3.57\%$

The percentage uncertainty in voltage $= \frac{12}{230} \times 100\% = 5.22\%$

The percentage uncertainty in power $= 3.57\% + 5.22\% = 8.79\% = 9\%$ (to nearest %)

*Step 3*

Calculate the absolute uncertainty in the power.

The absolute uncertainty $= \frac{9}{100} \times 644\ \text{W} = 58.0\ \text{W}$

*Step 4*

State the answer with units.

Power = 644 ($\pm$ 58) W

## Questions

**5** A piece of string 1.000 ($\pm$ 0.002) m is cut from a ball of string of length 100.000 ($\pm$ 0.002) m. Calculate the length of the remaining string and the uncertainty in this length. (*2 marks*)

**6** A runner completes 100 ($\pm$ 0.02) m in 18.6 ($\pm$ 0.2) s. Calculate his average speed and the uncertainty in this value. (*2 marks*)

**7** A car accelerates, with constant acceleration, from 24 ($\pm$ 1) m s$^{-1}$ to 31($\pm$ 2) m s$^{-1}$ in 9.5 ($\pm$ 0.1) s. Calculate the acceleration. State your answer with its absolute uncertainty. (*3 marks*)

**8** A cube has a mass of 7.870 ($\pm$ 0.001) kg and sides of length 10.0 ($\pm$ 0.1) cm. Give the value of the density of the cube. (*2 marks*)

**9** In a Young's slits experiment, two slits that are very close together are illuminated, and on a distant screen an interference pattern of light and dark fringes is seen. The separation of the fringes can be

used to calculate the wavelength of the light. In a demonstration of this experiment:

- the double slit separation, $a = 0.20\ (\pm 0.01)$ mm
- the distance from the slits to the screen, $D = 4.07\ (\pm 0.01)$ m
- the distance between two adjacent bright fringes $x = 12.0\ (\pm 0.05)$ mm.

The equation for calculating wavelength is $\lambda = \frac{ax}{D}$.

**a** Calculate:

**i** the wavelength, $\lambda$, of the light (*1 mark*)

**ii** the absolute uncertainty in the wavelength. (*2 marks*)

**b** The distance between 11 fringes (10 spaces) = 120.0 ($\pm$ 0.05) mm. Using this value, calculate the new absolute uncertainty in the wavelength. (*2 marks*)

**c** Comment on whether the uncertainty in the wavelength could be significantly reduced by increasing the number of fringes measured to, for example, 20 or more. (*1 mark*)

## Maths skills links to other areas

You may also need to calculate uncertainties when considering precision and accuracy of measurements and data, including margins of error, percentage
errors, and uncertainties in apparatus.

**No complete task 2 17 multiple choice questions (found in the other document)**

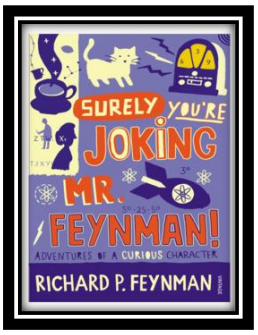
## Optional Extension tasks (these are purely for your interest and are not compulsory)

**A selection of interesting books, films and movie clips that you may wish to read/see are given below.**

# Book Recommendations

Below is a selection of books that should appeal to a physicist – someone with an enquiring mind who wants to understand the universe around us. None of the selections are textbooks full of equation work (there will be plenty of time for that!) instead each provides insight to either an application of physics or a new area of study that you will be meeting at A Level for the first time.

1. **Surely You're Joking Mr Feynman: Adventures of a Curious Character**

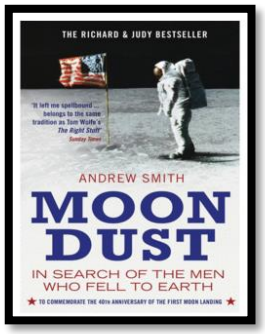



**ISBN - 009917331X -** Richard Feynman was a Nobel Prize winning Physicist. In my opinion he epitomises what a Physicist is. By reading this books you will get insight into his life's work including the creation of the first atomic bomb and his bongo playing adventures and his work in the field of particle physics.

(Also available on Audio book).

https://www.waterstones.com/books/search/term/surely+youre+joking+mr+feynman++adventures+of+a+curious+character

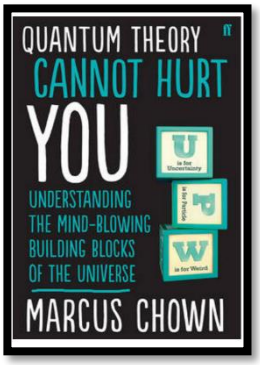
2. **Moondust: In Search of the Men Who Fell to Earth**




**ISBN – 1408802384 -** One of the greatest scientific achievements of all time was putting mankind on the surface of the moon. Only 12 men made the trip to the surface, at the time of writing the book only 9 are still with us. The book does an excellent job of using the personal accounts of the 9 remaining astronauts and many others involved in the space program at looking at the whole space-race era, with hopefully a new era of space flight about to begin as we push on to put mankind on Mars in the next couple of decades.

https://www.waterstones.com/books/search/term/moondust++in+search+of+the+men+who+fell+to+earth

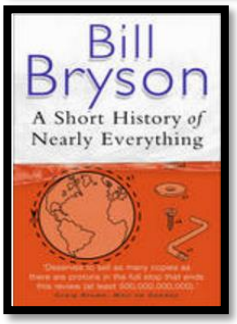
3. **Quantum Theory Cannot Hurt You: Understanding the Mind-Blowing Building Blocks of the Universe**




**ISBN - 057131502X -** Any Physics book by Marcus Chown is an excellent insight into some of the more exotic areas of Physics that require no prior knowledge. In your first year of A-Level study you will meet the quantum world for the first time. This book will fill you with interesting facts and handy analogies to whip out to impress your peers!

https://www.waterstones.com/book/quantum-theory-cannot-hurt-you/marcus-chown/9780571315024

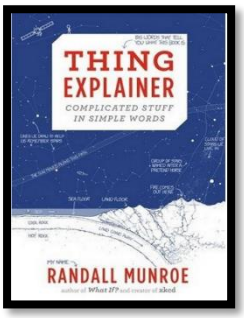
4. **A Short History of Nearly Everything**




**ISBN – 0552997048 -** A modern classic. Popular science writing at its best. A Short History of Nearly Everything Bill Bryson's quest to find out everything that has happened from the Big Bang to the rise of civilization - how we got from there, being nothing at all, to here, being us. Hopefully by reading it you will gain an awe-inspiring feeling of how everything in the universe is connected by some fundamental laws.

https://www.waterstones.com/books/search/term/a+short+history+of+nearly+everything

5. **Thing Explainer: Complicated Stuff in Simple Words**




**ISBN – 1408802384 -** This final recommendation is a bit of a wild-card – a book of illustrated cartoon diagrams that should appeal to the scientific side of everyone. Written by the creator of online comic XTCD (a great source of science humour) is a book of blueprints from everyday objects such as a biro to the Saturn V rocket and an atom bomb, each one meticulously explained BUT only with the most common 1000 words in the English Language. This would be an excellent coffee table book in the home of every scientist.

https://www.waterstones.com/book/thing-explainer/randall-munroe/9781473620919

# Movie / Video Clip Recommendations

Hopefully you'll get the opportunity to soak up some of the Sun's rays over the summer – synthesising some important Vitamin-D – but if you do get a few rainy days where you're stuck indoors here are some ideas for films to watch or clips to find online.

**Science Fictions Films**

1. **Moon (2009)**
2. **Gravity (2013)**
3. **Interstellar (2014)**
4. **The Martian (2015)**
5. **The Prestige (2006)**

**Online Clips / Series**

1. **Minute Physics –** Variety of Physics questions explained simply (in felt tip) in a couple of minutes. Addictive viewing that will have you watching clip after clip – a particular favourite of mine is "Why is the Sky Dark at Night?"

   **https://www.youtube.com/user/minutephysics**

2. **Wonders of the Universe / Wonders of the Solar System –** Both available of Netflix as of 17/4/16 – Brian Cox explains the Cosmos using some excellent analogies and wonderful imagery.

3. **Shock and Awe, The Story of Electricity –** A 3 part BBC documentary that is essential viewing if you want to see how our lives have been transformed by the ideas of a few great scientists a little over 100 years ago. The link below takes you to a stream of all three parts joined together but it is best watched in hourly instalments. Don't forget to boo when you see Edison. (alternatively watch any Horizon documentary – loads of choice on Netflix and the I-Player)

   **https://www.youtube.com/watch?v=Gtp51eZkwoI**

4. **NASA TV –** Online coverage of launches, missions, testing and the ISS. Plenty of clips and links to explore to find out more about applications of Physics in Space technology.

   **http://www.nasa.gov/multimedia/nasatv/**

5. **The Fantastic Mr. Feynman –** I recommended the book earlier, I also cannot recommend this 1 hour documentary highly enough. See the life's work of the "great explainer", a fantastic mind that created mischief in all areas of modern Physics.

   **https://www.youtube.com/watch?v=LyqleIxXTpw**