# *PLANNING SUPPORT BOOKLET*

**J259**

**For first teaching in 2016**

This support material booklet is designed to accompany the OCR GCSE (9–1) specification in Physics B and Combined Science B (Twenty First Century Science).

***DISCLAIMER***

This resource was designed using the most up to date information from the specification at the time it was published. Specifications are updated over time, which means there may be contradictions between the resource and the specification, therefore please use the information on the latest specification at all times.If you do notice a discrepancy please contact us on the following email address: [resources.feedback@ocr.org.uk](mailto:resources.feedback@ocr.org.uk)

# Introduction

This support material is designed to accompany the OCR GCSE (9-1) specification in Physics B (Twenty First Century) for teaching from September 2016.

The Planning Guidance table on the following pages sets out *suggested* teaching times for the topics within the specification. Note that we always recommend that individual centres plan their schemes of work according to their individual needs. Actual teaching times for topics will depend on the amount of practical work done within each topic and the emphasis placed on development of practical skills in various areas, as well as use of contexts, case studies and other work to support depth of understanding and application of knowledge and understanding. It will also depend on the level of prior knowledge and understanding that learners bring to the course.

The table follows the order of the topics in the specification. It is not implied that centres teach the specification topics in the order shown, centres are free to teach the specification in the order that suites them.

## Delivery guides

The column ‘Delivery guides’ refers to individual teacher guides available from the GCSE Physics B qualification page.

These Delivery guides provide further guidance and suggestions for teaching of individual topics, including links to a range of activities that may be used and guidance on resolving common misconceptions.

## Ideas about Science (P7) and Practical Work (P8)

Ideas about Science (P7) and Practical Skills (P8) are not explicitly reference in the high level planning table below, as these ideas and skills are expected to be developed in the context of Topics P1–P6. Links to P7 learning outcomes and suggested practical activities are included in the outline scheme of work. Indications of where PAG activities can be carried out should not be seen as an exhaustive list.

| **Topic** | **Teaching hours** separate / combined | **Delivery Guides** | **PAG opportunities** | |
| --- | --- | --- | --- | --- |
| **Chapter 1: Radiation and waves** | | | | |
| 1.1 What are the risks and benefits of using radiation | 5 / 5 hours | Radiation and waves – delivery guide |  |
| 1.2 What is climate change and what is the evidence for it? | 3 / 3 hours | Radiation and waves – delivery guide |  |
| 1.3 How do waves behave? | 7 / 7 hours | Radiation and waves – delivery guide | PAG4: measure the speed, frequency and wavelength of a wave  PAG8: Investigate the reflection of light off a plane mirror and the refraction of light through prisms |
| 1.4 What happens when light and sound meet different materials? | 7 / 0 hours | Radiation and waves – delivery guide |  |
| **Total for chapter 1 = 22 / 15 hours** | | | |
| **Chapter 2: Sustainable energy** | | | |
| 2.1 How much energy do we use? | 4 / 4 hours | Sustainable energy – delivery guide |  |
| 2.2 How can electricity be generated? | 5 / 5 hours | Sustainable energy – delivery guide |  |
| **Total for chapter 2 = 9 / 9 hours** | | | |
| **Chapter 3 Electric circuits** | | | |
| 3.1 What is electric charge | 2 / 0 hours | Electric circuits – delivery guide |  |
| 3.2 What determines the current in an electric circuit? | 4 / 4 hours | Electric circuits – delivery guide | PAG6: Investigate the I-V characteristics of circuit elements |
| 3.3 How do series and parallel circuits work? | 5 / 5 hours | Electric circuits – delivery guide | PAG7: Investigate the brightness of bulbs in series and parallel |
| 3.4 What determines the rate of energy transfer in a circuit? | 4 / 4 hours | Electric circuits – delivery guide |  |
| 3.5 What are magnetic fields? | 4 / 3 hours | Electric circuits – delivery guide |  |
| 3.6 How do electric motors work? | 3 / 3 hours | Electric circuits – delivery guide |  |
| 3.7 What is the process inside an electric generator? | 4 / 0 hours | Electric circuits – delivery guide |  |
| **Total for chapter 3 = 26 / 19 hours** | | | |
| **Chapter 4 Explaining motion** | | | |
| 4.1 What are forces? | 4 / 4 hours | Explaining motion – delivery guide |  |
| 4.2 How can we describe motion? | 7 / 7 hours | Explaining motion – delivery guide | PAG3: Investigate acceleration of a trolley down a ramp |
| 4.3 What is the connection between force and motion? | 12 / 9 hours | Explaining motion – delivery guide |  |
| 4.4 How can we describe motion in terms of energy transfer? | 5 / 5 hours | Explaining motion – delivery guide |  |
| **Total for chapter 4 = 28 / 25 hours** | | | |
| **Chapter 5 Radioactive materials** | | | |
| 5.1 What is radioactivity? | 6 / 6 hours | Radioactive materials – delivery guide |  |
| 5.2 How can radioactive materials be used safely? | 3 / 3 hours | Radioactive materials – delivery guide |  |
| 5.3 How can radioactive materials be used to provide energy? | 4 / 0 hours | Radioactive materials – delivery guide |  |
| **Total for chapter 5 = 13 / 9 hours** | | | |
| **Chapter 6 Matter – models and explanations** | | | |
| 6.1 How does energy transform matter? | 5 / 5 hours | Matter – delivery guide | PAG1: Determine the densities of a variety of objects both solid and liquid  PAG5: Determine the specific heat capacity of a metal |
| 6.2 How does the particle model explain the effects of heating? | 2 / 2 hours | Matter – delivery guide |  |
| 6.3 How does the particle model relate to material under stress? | 4 / 4 hours | Matter – delivery guide | PAG2: Investigate the effect of forces on springs |
| 6.4 How does the particle model relate to pressure in fluids? | 5 / 0 hours | Matter – delivery guide |  |
| 6.5 How can scientific models help us understand the Big Bang? | 6 / 0 hours | Matter – delivery guide |  |
| **Total for chapter 6 = 22 / 11 hours** | | | |
| **Total teaching hours = 120 hours / 88 hours** | | | |

# Outline Scheme of Work: P4 – Explaining motion

## Total suggested teaching time – 28 hours

|  |  |
| --- | --- |
| **Additional online learning opportunities**  As a response to the Covid-19 outbreak, additional online learning opportunities were identified for each topic in June 2020. | |
| **Statement** | **Teaching activities** |
| P4.2.1 | Homework - Worksheets of speed calculations for [Higher](https://www.tes.com/teaching-resource/calculating-speed-distance-and-time-11235104) and [Foundation](https://www.tes.com/teaching-resource/speed-distance-and-time-calculations-6143770) Tier. |
| P4.2.2 | Pages 1 and 2 of the [BBC Bitesize](https://www.bbc.co.uk/bitesize/guides/zq4mfcw/revision/1) section can be used as flipped learning to introduce typical speeds and how to estimate accelerations. |
| P4.2.4 | Page 1 of this [Bitesize section](https://www.bbc.co.uk/bitesize/guides/zq4mfcw/revision/1) and this [video](https://www.youtube.com/watch?v=8HjpgJBMMNo) can be used as flipped learning to explain how to convert units when calculating speeds. |
| P4.2.8, P4.2.9, P4.2.10 | [Video](https://www.youtube.com/watch?v=RM02SnuJ0MY) describing distance-time graphs to use as flipped learning. |
| P4.2.8 | Cambridge International [Video](https://ocr.org.uk/rpgphys4) on experiment used to plot a speed-time graph which can be used as flipped learning. |
| P4.2.10 | [Worked examples](https://mathsmadeeasy.co.uk/gcse-maths-revision/velocity-time-graphs-gcse-revision-and-worksheets/) including area under the graph. Worksheet also available. Can be used as homework. |
| P4.3.4 | Short [video](https://www.youtube.com/watch?v=ZtQhlwPxE28) to use as flip learning on momentum and using the equation. |
| P4.3.15, P4.3.17, P4.3.18 | A great [animation](https://www.scootle.edu.au/ec/viewing/L51/L51/index.html) where students compare braking distances in different conditions. They need to write the results down and then choose different conditions to compare. Can be used as flipped learning. |
| P4.3.14 | Quick and fun [activity](https://www.justpark.com/creative/reaction-time-test/) to measure your reaction time! |
| P4.3.16 | Students could use this Which? [article](https://www.which.co.uk/reviews/new-and-used-cars/article/car-safety-features-explained) to research safety features before doing the main activity in lesson 5. It also includes videos links and a quiz. |
| P4.3.16 | Top gear short [video](https://www.youtube.com/watch?v=L_OLeeNsnF0) showing crumple zones. |

### P4.1 What are forces? (4 /4 hours)

|  |  |
| --- | --- |
| Links to KS3 Subject content  * forces as pushes or pulls, arising from the interaction between two objects * force measured in Newtons * non-contact forces: gravity forces acting at a distance on Earth and in space | |
| Links to Mathematical Skills  * M1c * M3b * M3c | Links to Practical Activity Groups (PAGs)  * N/A |

# Overview of P4.1 What are forces?

| Lesson | Statements | Teaching activities | Notes |
| --- | --- | --- | --- |
| 1 (1hr for separate and combined) | P4.1.1 recall and apply Newton’s Third Law | **Engage:** A short clip from the film *Interstellar* in which a rocket attempts to avoid falling into a black hole by ejecting some mass towards it and thus accelerating the ship away from it.  [View full activity in P4.1 What are forces? – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/delivery-guide-gpbdg014-p41-what-are-forces?activity=290815#290815)  **Explore:** Newton’s third law of motion: Action-reaction law. A short interactive demonstrating [View full activity in P4.1 What are forces? – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/delivery-guide-gpbdg014-p41-what-are-forces?activity=290806#290806)  **Explain:** practical demonstrations  <https://spark.iop.org/skateboard-forces>  <https://spark.iop.org/action-and-reaction-metre-rule>  <https://spark.iop.org/action-and-reaction-trolleys>  **Extend:** Newton’s laws of motion and forces  A video containing a précis of Newton’s Laws of Motion, with CGI objects demonstrating the result of the application of forces under various conditions. [View full activity in P4.1 What are forces? – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/delivery-guide-gpbdg014-p41-what-are-forces?activity=290802#290802)  **Evaluate:** Get pupils to start a Newton’s laws fact sheet. What have they learnt today? What is Newton’s third law? Pupils to write relevant information and start their fact sheet. | Link to delivery guide  <http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/> |
| 2 (1hr for separate and combined) | P4.1.2 recall examples of ways in which objects interact: by gravity, electrostatics, magnetism and by contact (including normal contact force and friction)  P4.1.3 describe how examples of gravitational, electrostatic, magnetic and contact forces involve interactions between pairs of objects which produce a force on each object | **Engage:** Fundamental forces  A cartoon in which a stick figure explains the four fundamental forces of physics.  [View full activity in P4.1 What are forces? – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/delivery-guide-gpbdg014-p41-what-are-forces?activity=290810#290810)  **Explore**: Forces and motion: Basics 1.1.0  A set of interactives exploring forces and motion. The first, featuring a simple tug of war between participants exerting opposing forces, is directly relevant to this subtopic, while the others are relevant to topics explored later in the chapter.  [View full activity in P4.1 What are forces? – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/delivery-guide-gpbdg014-p41-what-are-forces?activity=290798#290798)  **Explain:** Give pupils images or do a circus activity when pupils go around the room observing an object moving, stationary, falling etc. Pupils identify the forces acting on the objects  **Extend:** Gravitation: The four fundamental forces of physics  A video following on from the two about electromagnetism featured in the delivery guide for chapter 3.  [View full activity in P4.1 What are forces? – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/delivery-guide-gpbdg014-p41-what-are-forces?activity=290808#290808)  **Evaluate:** Get pupils to add to their Newton’s laws fact sheet. What have they learnt today? In what ways do objects interact? Pupils to write relevant information and start their fact sheet. | Link to delivery guide [explaining motion](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/) |
| 3 (1hr for separate and combined) | P4.1.4 represent interaction forces as vectors | **Engage:** Give pupils the scenario of two forces acting on an object where the forces are not in a straight line. How would you work out the resultant force here? Illicit ideas from pupils, the brighter may think about Pythagoras.  **Explore:** how to draw [vector diagrams](https://www.youtube.com/watch?v=Hjc8WwqqF6s)  **Explain:** Pupils should be shown how to draw vector diagrams to illustrate resolution of forces and given plenty of opportunity to practice drawing them.  **Extend:** Vector diagram [worksheet](https://www.tes.com/teaching-resource/vectors-practice-questions-on-using-scale-diagrams-to-find-the-resultant-force-11360752)  **Evaluate: Forces dance mat**  This could be used as a plenary activity to summarise resultant forces [View full activity in 2.2 Newton’s Laws – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat002-p2-forces/delivery-guide-gpadg005-p22-newtons-laws?activity=294710#294710) | Link to delivery guide [explaining motion](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/) |
| 4 (1hr for separate and combined) | P4.1.5 define weight  P4.1.6 describe how weight is measured  P4.1.7 recall and apply the relationship between the weight of an object, its mass and the gravitational field strength:  weight (N) = mass (kg) × gravitational field strength (N/kg)  M1c, M3b, M3c | **Engage:** Feather in vacuum  A video featuring an experiment in which a feather and a large ball bearing are dropped in a vacuum.  [View full activity in P4.1 What are forces? – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/delivery-guide-gpbdg014-p41-what-are-forces?activity=290813#290813)  **Explore:** Practical- Use Newton meters to get pupils to see the relationship between mass and weight. Pupils can plot graphs and calculate the gravitational field strength from the gradient.  **Explain:** Introduce the required equations to the pupils. Pupils should work through example calculations with the teacher first before being given the opportunity to practice using these. Make sure pupils are comfortable rearranging equations and converting between units.  **Extend:** Conceptual physics: Mass vs. weight  A short video of a demonstration of the difference between inertial mass and weight.  [View full activity in P4.1 What are forces? – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/delivery-guide-gpbdg014-p41-what-are-forces?activity=290800#290800)  **Evaluate:** Get pupils to calculate their own weight on different planets | Link to delivery guide [explaining motion](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/) |

# Outline Scheme of Work: P4 – Explaining motion

## Total suggested teaching time – 28 hours

### P4.2 How do we describe motion? (7 / 7 hours)

|  |  |
| --- | --- |
| Links to KS3 Subject content  * speed and the quantitative relationship between average speed, distance and time (speed = distance ÷ time) * the representation of a journey on a distance-time graph * relative motion: trains and cars passing one another | |
| Links to Mathematical Skills  * M1a * M1c * M2b * M2f * M3b * M3c * M3d * M4a * M4b * M4c * M4d * M4f | Links to Practical Activity Groups (PAGs)  * PAG 3: Investigate acceleration of a trolley down a ramp |

# Overview of P4.2 How do we describe motion?

| Lesson | Statements | Teaching activities | Notes |
| --- | --- | --- | --- |
| 1 (1hr for separate and combined) | P4.2.1 recall and apply the relationship:  average speed (m/s) = distance (m) ÷ time (s)  M1a, M1c, M3b, M3c, M3d  P4.2.2 recall typical speeds encountered in everyday experience for wind, and sound, and for walking, running, cycling and other transportation systems | **Engage:** [Usain Bolts](https://www.youtube.com/watch?v=By1JQFxfLMM) world record beating 100m  **Explore:** Speed  Here is a [Speed Distance Time Calculator](https://www.calculatorsoup.com/calculators/math/speed-distance-time-calculator.php) for students to investigate speed in different units.  **Explain:** Practical pupil speed  Get pupils outside timing each other running or walking over a set distance and calculating their speeds  **Extend:** The moving man: Motion, velocity, acceleration  An interactive Java applet in which the relationship between motion and the terms distance, velocity and time is explored.  [View full activity in P4.2 How can we describe motion? – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/delivery-guide-gpbdg015-p42-how-can-we-describe-motion?activity=291036#291036)  **Evaluate:** Applying the speed distance time triangle  This page includes worked examples and opportunities for learners to practice applying the formulae with worked answers for them to self-assess.  [View full activity in 2.1 Motion – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat002-p2-forces/delivery-guide-gpadg004-p21-motion?activity=294654#294654) | Link to delivery guide [explaining motion](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/) |
| 2 (1hr for separate and combined) | P4.2.3 a) make measurements of distances and times, and calculate speeds  b) describe how to use appropriate apparatus and techniques to investigate the speed of a trolley down a ramp  M2b, M2f  *PAG 3*  P4.2.4 make calculations using ratios and proportional reasoning to convert units, to include between m/s and km/h  M1c, M3c | **Engage:** Dirk tackles 80 MPH question  One of the many examples of “The 80mph question”, in which a staggering number of people turn out not to understand the meaning of the term “miles per hour”.  [View full activity in P4.2 How can we describe motion? – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/delivery-guide-gpbdg015-p42-how-can-we-describe-motion?activity=291038#291038)  **Explore:** Mini white board – quick calculations. Hand out white boards, ask a question using the speed equation and pupils race to answer on white boards.  **Explain:** velocity of a trolley  <https://spark.iop.org/timing-trolley-slope>  **Extend:** Introduce the required equations to the pupils. Pupils should work through example calculations with the teacher first before being given the opportunity to practice using these. Make sure pupils are comfortable rearranging equations and converting between units.  **Evaluate:** SAMs question [J259-03](http://www.ocr.org.uk/Images/234635-unit-j259-03-breadth-in-physics-higher-tier-sample-assessment-material.pdf) question 12 | Link to delivery guide [explaining motion](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/)  Link to [SAM](http://www.ocr.org.uk/Images/234635-unit-j259-03-breadth-in-physics-higher-tier-sample-assessment-material.pdf) |
| 3 (1hr for separate and combined) | P4.2.5 explain the vector-scalar distinction as it applies to displacement and distance, velocity and speed | **Engage:** Scalars and vectors  A mid-length (12 minutes) video about scalars and vectors and the differences between them.  [View full activity in P4.2 How can we describe motion? – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/delivery-guide-gpbdg015-p42-how-can-we-describe-motion?activity=291044#291044)  **Explore:** Misconceptions: Leicester University Resources: <https://spark.iop.org/misconceptions#gref>  A number of videos which focus on misconceptions that learners have during the teaching of Physics  **Explain:** Learner activity the Olympians guide to success  [www.ocr.org.uk/Images/288974-forces-learner-activity.docx](http://www.ocr.org.uk/Images/288974-forces-learner-activity.docx)  **Extend:** Discuss the vector-scalar distinction as it applies to distance and displacement, speed and velocity. Get pupils to write their own definitions of these then give pupils other physics quantities and get pupils to decide whether they are a scalar or a vector.  **Evaluate:** vectors and scalars worksheet:  <https://www.tes.com/teaching-resource/vectors-and-scalars-6172007> | Link to delivery guide [explaining motion](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/) |
| 4 (1hr for separate and combined) | P4.2.6 a) recall and apply the relationship: acceleration (m/s2) = change in speed (m/s) ÷ time taken (s)  M1c, M3b, M3c, M3d  b) explain how to use appropriate apparatus and techniques to investigate acceleration  *PAG 3*  PAG3 Motion | **Starter:** Demo PAG activity to class  **Main:** PAG 3: Investigating acceleration  **Plenary**: Give pupils the [learner record sheet](https://www.ocr.org.uk/Images/295647-gcse-physics-learner-record-sheet.doc). Pupils to tick of skills covered. | Link to delivery guide [explaining motion](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/)  Link to [PAG activity](https://www.ocr.org.uk/Images/309690-pag-activity-physics-motion-suggestion-1.docx):  Link to [Learner record sheet](https://www.ocr.org.uk/Images/295647-gcse-physics-learner-record-sheet.doc) |
| 5 (1hr for separate and combined) | P4.2.7 select and apply the relationship:  (final speed (m/s))2 – (initial speed(m/s))2 = 2 × acceleration (m/s2 ) × distance (m)  M1a, M1c, M3b, M3c, M3d | **Engage**: Demonstration of acceleration inside the international space station during a reboost  A demonstration of acceleration during a short period of velocity adjustment on the ISS.  [View full activity in P4.2 How can we describe motion? – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/delivery-guide-gpbdg015-p42-how-can-we-describe-motion?activity=291040#291040)  **Explore:** Rocket sledder interactive  A simple interactive applet which allows the user to accelerate a rocket sled under various conditions.  [View full activity in P4.2 How can we describe motion? – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/delivery-guide-gpbdg015-p42-how-can-we-describe-motion?activity=291048#291048)  **Explain:** Reproducing Galileo’s constant acceleration experiment  A version of Galileo’s inclined plane experiment using rubber bands.  [View full activity in P4.2 How can we describe motion? – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/delivery-guide-gpbdg015-p42-how-can-we-describe-motion?activity=291052#291052)  **Extend:** Introduce the required equations to the pupils. Pupils should work through example calculations with the teacher first before being given the opportunity to practice using these. Make sure pupils are comfortable rearranging equations and converting between units.  **Evaluate:** SAMs question [J259-01](http://www.ocr.org.uk/Images/234632-unit-j259-01-breadth-in-physics-foundation-tier-sample-assessment-material.pdf) Question 5 | Link to delivery guide [explaining motion](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/)  Link to [SAM](http://www.ocr.org.uk/Images/234632-unit-j259-01-breadth-in-physics-foundation-tier-sample-assessment-material.pdf) |
| 6 (1hr for separate and combined) | P4.2.8 draw and use graphs of distances and speeds against time to determine the speeds and accelerations involved  P4.2.9 interpret distance-time and velocity-time graphs, including relating the lines, slopes and enclosed areas in such graphs to the motion represented  M4a, M4b, M4c, M4d  P4.2.10 interpret enclosed areas in velocity-time graphs  M4a, M4b, M4c, M4d, M4f | **Engage**: Why distance is area under velocity-time line  As the title suggests, video explains why distance is area under a velocity/time graph.  [View full activity in P4.2 How can we describe motion? – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/delivery-guide-gpbdg015-p42-how-can-we-describe-motion?activity=291046#291046)  **Explore:** Hare and the tortoise distance-time graph game  A resource that involves drawing different distance-time graphs and a card matching activity.  [View full activity in 2.1 Motion – Online delivery guide](https://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat002-p2-forces/delivery-guide-gpadg004-p21-motion?activity=294664#294664)  **Explain:** Velocity-time graphs  [A web page](https://mathsmadeeasy.co.uk/gcse-maths-revision/velocity-time-graphs-gcse-revision-and-worksheets/) with a number of questions at the bottom to test learners on the interpretation of velocity-time graphs.  **Evaluate:** SAMs question [J259-01](http://www.ocr.org.uk/Images/234632-unit-j259-01-breadth-in-physics-foundation-tier-sample-assessment-material.pdf) Question 13 | Link to delivery guide [explaining motion](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/)  Link to [SAM](http://www.ocr.org.uk/Images/234632-unit-j259-01-breadth-in-physics-foundation-tier-sample-assessment-material.pdf) |
| 7 (1hr for separate and combined) | **P4.2.11 explain that inertial mass is a measure of how difficult it is to change the velocity of an object and that it is defined as the ratio of force over acceleration** | **Engage:** What is inertia? See this [video](https://www.youtube.com/watch?v=2LDQuslvn4E).  **Explore:** Practical activity 1  “What effect does mass have on the inertia of an object?”  **Problem:** You are given a piece of card, a beaker, and three objects that have different masses (low, medium, high). You will place the card on top of the beaker and the object on top of the card. Try to remove the card and get the object to fall into the beaker. Will the mass of the object have an effect if it will land in the beaker?  **Explain:** Practical activity 2  <http://serc.carleton.edu/sp/mnstep/activities/35687.html>  **Extend:** Quick quiz  <http://study.com/academy/practice/quiz-worksheet-the-laws-of-inertia.html>  **Evaluate:** Get pupils to add to their Newton’s laws fact sheet. What have they learnt today? What is inertia? Pupils to write relevant information and start their fact sheet. | Link to delivery guide [explaining motion](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/) |

# Outline Scheme of Work: P4 – Explaining motion

## Total suggested teaching time – 28 hours

### P4.3 What is the connection between force and motion? (12 / 8 hours)

|  |  |
| --- | --- |
| Links to KS3 Subject content  * using force arrows in diagrams, adding forces in one dimension, balanced and unbalanced forces * moment as the turning effect of a force * forces being needed to cause objects to stop or start moving, or to change their speed or direction of motion (qualitative only) * change depending on direction of force and its size | |
| Links to Mathematical Skills  * M1c * M1d * M2c * M2h * M3b * M3c * M3d * M4a * M5a * M5b | Links to Practical Activity Groups (PAGs)  * N/A |

# Overview of P4.3 What is the connection between force and motion?

| Lesson | Statements | Teaching activities | Notes |
| --- | --- | --- | --- |
| 1 (1hr for separate and combined) | P4.3.1 describe examples of the forces acting on an isolated solid object or system  P4.3.2 describe, using free body diagrams, examples where several forces lead to a resultant force on an object and the special case of balanced forces (equilibrium) when the resultant force is zero  *qualitative only* | **Engage:** Free-body diagrams  A medium-length video about the construction of free-body diagrams.  [View full activity in P4.3 What is the connection between forces and motion? – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/delivery-guide-gpbdg016-p43-what-is-the-connection-between-forces-and-motion?activity=291089#291089)  **Explore:** Free body diagrams  This is a useful self-study or group activity for learners, both as an introduction to and to practice drawing free body diagrams. [View full activity in 2.2 Newton’s Laws – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat002-p2-forces/delivery-guide-gpadg005-p22-newtons-laws?activity=294696#294696)  **Explain:** Give pupils images or do a circus activity when pupils go around the room observing an object moving, stationary, falling etc. Pupils identify the forces acting on the objects and draw a diagram.  **Extend:** Worksheet <http://www.nuffieldfoundation.org/sites/default/files/files/FSMQ%20Force%20diagrams.pdf>  **Evaluate:** Free-body diagram interactive  A short set of tests in which users construct a free-body diagram for a set of given situations, using only parallel, opposing and perpendicular forces.  [View full activity in P4.3 What is the connection between forces and motion? – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/delivery-guide-gpbdg016-p43-what-is-the-connection-between-forces-and-motion?activity=291087#291087) | Link to delivery guide [explaining motion](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/) |
| 2 (1hr for separate and combined) | **P4.3.3 use scale drawings of vector diagrams to illustrate the addition of two or more forces, in situations when there is a net force, or equilibrium**  ***– Limited to parallel and perpendicular vectors only.***  M4a, M5a, M5b | **Engage:** Aristotle, Copernicus and Galileo on motion  A [short video](https://www.youtube.com/watch?v=yf_iEKBvYAc) about the history of our thinking about the nature of motion, from Aristotle to Galileo.  **Explore:** Give pupils the scenario of two forces acting on an object where the forces are not in a straight line. How would you work out the resultant force here? Illicit ideas from pupils, the brighter may think about Pythagoras.  **Explain:** Pupils should be shown how to draw vector diagrams to illustrate resolution of forces and given plenty of opportunity to practice drawing them. The following [video](https://www.youtube.com/watch?v=Hjc8WwqqF6s) may help.  **Extend:** This [website](https://mrbscigladstone.files.wordpress.com/2012/10/vectors-scalars.pdf) gives a revision sheet with some vector question to extend the students.  **Evaluate:** Give the students two forces that are not acting in a straight line and ask them to work out the resultant force. | Link to delivery guide [explaining motion](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/) |
| 3 (1hr for separate and combined) | **P4.3.4 recall and apply the equation for momentum and describe examples of the conservation of momentum in collisions:**  **momentum (kg m/s) = mass (kg) × velocity (m/s)**  M1c, M3b, M3c, M3d  **P4.3.5 recall and apply Newton’s second law in calculations relating force, change in momentum and time:**  **change in momentum (kg m/s) = resultant force (N) × time for which it acts (s)**  M1c, M3b, M3c, M3d | **Engage:** Collision lab. This simulation is particularly useful if an air track is not available to demonstrate elastic and inelastic collisions. [View full activity in 2.2 Newton’s Laws – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat002-p2-forces/delivery-guide-gpadg005-p22-newtons-laws?activity=294702#294702)  **Explore:** give pupils equation then do some flash card questions <https://www.tes.com/teaching-resource/momentum-starter-6178662>  **Explain:** Practical Momentum inelastic collisions  <https://spark.iop.org/inelastic-collision-trolleys>  Practical Momentum elastic collisions  <https://spark.iop.org/trolley-collisions>  **Extend:** The physics of Newton’s cradle  A short video explaining the patterns made by Newton’s Cradle. [View full activity in P4.3 What is the connection between forces and motion? – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/delivery-guide-gpbdg016-p43-what-is-the-connection-between-forces-and-motion?activity=291101#291101)  **Evaluate:** Get pupils to add to their Newton’s laws fact sheet. What have they learnt today? What is momentum and how does it relate to Newton’s 2nd law?  SAM question [J260-07](http://www.ocr.org.uk/Images/234667-unit-j260-07-physics-higher-tier-paper-3-sample-assessment-material.pdf) Question 10 | Link to delivery guide [explaining motion](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/)  Link to [SAM](http://www.ocr.org.uk/Images/234667-unit-j260-07-physics-higher-tier-paper-3-sample-assessment-material.pdf) |
| 4 (1hr for separate and combined) | P4.3.6 apply Newton’s first law to explain the motion of objects moving with uniform velocity and also the motion of objects where the speed and/or direction changes | **Engage:** [video](https://www.youtube.com/watch?v=LEHR8YQNm_Q) Newton’s first law  **Explore:** Space shuttle landing  A resource from NASA which allows learners to apply the laws of motion, force, work and energy to a space shuttle.  [View full activity in 2.2 Newton’s Laws – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat002-p2-forces/delivery-guide-gpadg005-p22-newtons-laws?activity=294712#294712)  **Explain:** Possible demonstration to cover Newton’s first law  <https://spark.iop.org/newtons-first-law-demonstration>  **Extend:** Forces dance mat  This could be used as a plenary activity to summarise resultant forces and a good revitaliser during a lesson which could be quite calculation heavy.  [View full activity in 2.2 Newton’s Laws – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat002-p2-forces/delivery-guide-gpadg005-p22-newtons-laws?activity=294710#294710)  **Evaluate:** Get pupils to add to their newton’s laws fact sheet. What have they learnt today? What is Newton’s 1st law? Pupils to write relevant information. | Link to delivery guide [explaining motion](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/) |
| 5 (1hr for separate and combined) | **P4.3.7 explain with examples that motion in a circular orbit involves constant speed but changing velocity**  ***qualitative only*** | **Engage:** Intro to circular motion! (a tribute to Lou Reed)  A medium-length (nine minutes) video introducing circular motion.  [View full activity in P4.3 What is the connection between forces and motion? – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/delivery-guide-gpbdg016-p43-what-is-the-connection-between-forces-and-motion?activity=291099#291099)  **Explore:** Practical 1: introducing circular motion  <https://spark.iop.org/circular-motion>  <https://spark.iop.org/episode-224-describing-circular-motion>  **Explain:** Practical 2: Whirling a rubber bung on a string <https://spark.iop.org/whirling-rubber-bung-string>  **Extend:** [Worksheet](http://www.wsfcs.k12.nc.us/cms/lib/NC01001395/Centricity/Domain/7743/Circular%20Motion%20Worksheet%20F10.pdf)  **Evaluate**: Circular motion  A worksheet with answers to answer questions of circular motion.  [View full activity in 2.2 Newton’s Laws – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat002-p2-forces/delivery-guide-gpadg005-p22-newtons-laws?activity=294706#294706) | Link to delivery guide [explaining motion](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/) |
| 6 (1hr separate science only) | P4.3.8 describe examples in which forces cause rotation  P4.3.9 define and calculate the moment of examples of rotational forces using the equation:  moment of a force (N m) = force (N) × distance (m) (normal to direction of the force)  M1c, M3b, M3c, M3d | **Engage:** Moments  [Video](https://www.youtube.com/watch?v=22VGQM1jCn8) tutorial explaining moments with example moment calculations applied to a seesaw scenario.  **Explore:** Investigating turning forces  <https://www.stem.org.uk/elibrary/resource/27345/investigating-turning-forces-moments>  **Explain:** Practical  <https://spark.iop.org/balancing-beam>  **Extend**: Introduce the required equations to the pupils, pupils should work through example calculations with the teacher first before being given the opportunity to practice using these. Make sure pupils are comfortable rearranging equations and converting between units.  **Evaluate:** [worksheet](https://www.tes.com/teaching-resource/moments-and-calculations-11527519) | Link to delivery guide [explaining motion](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/) |
| 7 (1hr separate science only) | P4.3.10 explain, with examples, how levers and gears transmit the rotational effects of forces | **Engage**: The mighty mathematics of the lever  A short animated video about the mechanisms of levers.  [View full activity in P4.3 What is the connection between forces and motion? – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/delivery-guide-gpbdg016-p43-what-is-the-connection-between-forces-and-motion?activity=291093#291093)  **Explore**: Cars: Engine power and transmission 3D animation  A short CGI animation explaining why having a selection of gears is useful in vehicles.  [View full activity in P4.3 What is the connection between forces and motion? – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/delivery-guide-gpbdg016-p43-what-is-the-connection-between-forces-and-motion?activity=291097#291097)  **Explain:** Worksheet:  <https://www.tes.com/teaching-resource/moments-levers-and-pivots-introduction-with-star-wars-11204405>  **Extend:** Gears – How do they work?: Different types explained and compared. [View full activity in P4.3 What is the connection between forces and motion? – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/delivery-guide-gpbdg016-p43-what-is-the-connection-between-forces-and-motion?activity=291095#291095)  **Evaluate:** Pupils to explain in their own words how levers and gears transmit rotational effects of forces. | Link to delivery guide [explaining motion](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/) |
| 8 (1hr for separate and combined) | **P4.3.11 explain that inertial mass is a measure of how difficult it is to change the velocity of an object and that it is defined as the ratio of force over acceleration**  P4.3.12 recall and apply the equation relating force, mass and acceleration:  force (N) = mass (kg) × acceleration (m/s2)  M1c, M3b, M3c, M3d | **Engage:** Newtons 2nd law with air cannons  <https://www.youtube.com/watch?v=iwP4heWDhvw>  **Explore:** Quick quiz  <http://study.com/academy/practice/quiz-worksheet-the-laws-of-inertia.html>  **Explain:** Practical Investigating Newton’s second law  <https://spark.iop.org/investigating-newtons-second-law-motion>  **Extend:** Introduce the required equations to the pupils, pupils should work through example calculations with the teacher first before being given the opportunity to practice using these. Make sure pupils are comfortable rearranging equations and converting between units.  **Evaluate:** Forces  PowerPoint with worksheets on forces, mass and acceleration.  [View full activity in 2.2 Newton’s Laws – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-physics-a-j249-from-2016/delivery-guide/topic-gpat002-p2-forces/delivery-guide-gpadg005-p22-newtons-laws?activity=294700#294700)  Get pupils to add to their Newton’s laws fact sheet. What have they learnt today? What is Newton’s 2nd law? Pupils to write relevant information. | Link to delivery guide [explaining motion](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/) |
| 9 (1hr for separate and combined) | P4.3.13 Use and apply equations relating force, mass, velocity, acceleration, **and momentum** to explain relationships between the quantities  M3b, M3c, M3d | **Engage:** Mini white board quiz, using equations met so far  **Explore:** As this is quite a maths heavy lesson I would start with a fun activity. A selection of fun short activities can be found here  <http://www.arborsci.com/cool/introducing-newtons-laws-with-learning-cycles>  **Explain:** Introduce the required equations to the pupils, pupils should work through example calculations with the teacher first before being given the opportunity to practice using these. Make sure pupils are comfortable rearranging equations and converting between units.  **Extend:** Worksheet covering Newton’s laws and the calculations involved. <http://www.sas.upenn.edu/~kennethp/nkdievid2.pdf>  **Evaluate:** Pupils to write their own questions one easy, one standard demand and one hard. Swap between pupils and peer mark. | Link to delivery guide [explaining motion](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/) |
| 10 (1hr for separate and combined) | P4.3.14 explain methods of measuring human reaction times and recall typical results | **Engage:** Measuring your dumbness with a ruler in slow motion!  A short video in which reaction times are tested and filmed in slow motion and the results discussed with a neurologist.  [View full activity in P4.3 What is the connection between forces and motion? – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/delivery-guide-gpbdg016-p43-what-is-the-connection-between-forces-and-motion?activity=291106#291106)  **Explore:** reaction time discussion: what factors affect it?  **Explain:** ruler drop experiment  <http://www.education.com/science-fair/article/biology_oops/>  **Extend:** take previous experiment further by changing variables, could include caffeinated drinks, sensory deprivation (using blindfolds and waiting for sound cue), or distraction techniques.  **Evaluate:** sheep dash reaction timer <http://www.bbc.co.uk/science/humanbody/sleep/sheep/reaction_version5.swf> | Link to delivery guide [explaining motion](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/) |
| 11 (1hr for separate and combined) | P4.3.15 explain the factors which affect the distance required for road transport vehicles to come to rest in emergencies and the implications for safety  M2c  P4.3.16 explain the dangers caused by large decelerations **and estimate the forces involved in typical situations on a public road** | **Engage:** GCSE Braking distances distance: Time and speed-time graphs  A short video about braking distances at various speeds.  [View full activity in P4.3 What is the connection between forces and motion? – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/delivery-guide-gpbdg016-p43-what-is-the-connection-between-forces-and-motion?activity=291108#291108)  **Explore**: relate previous lesson to driving. Discuss the factors that affect stopping distances  **Explain**: research task: in groups get pupils to research the dangers of large decelerations in cars and relate to the safety features in place in cars to reduce the impact of these.  **Extend:** learners feedback findings to class as presentation/poster  **Evaluate:** SAM [J260-03](http://www.ocr.org.uk/Images/234663-unit-j260-03-physics-foundation-tier-paper-3-sample-assessment-material.pdf) question 2 | Link to delivery guide [explaining motion](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/)  Link to [SAM](http://www.ocr.org.uk/Images/234663-unit-j260-03-physics-foundation-tier-paper-3-sample-assessment-material.pdf) |
| 12 (1hr separate science only) | P4.3.17 given suitable data, estimate the distance required for road vehicles to stop in an emergency, and describe how the distance varies over a range of typical speeds  M1c, M1d, M2c, M2h, M3b, M3c  P4.3.18 in the context of everyday road transport, use estimates of speeds, times and masses to calculate the accelerations and forces involved in events where large accelerations occur  M1d, M2b, M2h, M3c | **Engage:** Jeremy Clarkson on stopping distances  <https://www.youtube.com/watch?v=KGkKDaYd3Mo>  **Explore:** thinking/braking distances <https://www.tes.com/teaching-resource/stopping-distances-6396559>  **Explain:** cause of an accident task <https://www.tes.com/teaching-resource/stopping-distances-6396559>  **Extend:** Get pupils to complete their Newton’s law fact sheet.  **Evaluate:** SAM [J259/03](http://www.ocr.org.uk/Images/234635-unit-j259-03-breadth-in-physics-higher-tier-sample-assessment-material.pdf) Question 12 | Link to delivery guide [explaining motion](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/)  Link to [SAM](http://www.ocr.org.uk/Images/234635-unit-j259-03-breadth-in-physics-higher-tier-sample-assessment-material.pdf) |

# Outline Scheme of Work: P4 – Explaining motion

## Total suggested teaching time – 28 hours

### P4.4 How can we describe force in terms of energy transfer? (5 / 5 hours)

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| --- | --- |
| Links to KS3 Subject content  * Work done and energy changes on deformation | |
| Links to Mathematical Skills  * M1a * M1c * M3b * M3c * M3d | Links to Practical Activity Groups (PAGs)  * N/A |

# Overview of P4.4 How can we describe forces in terms of energy transfer?

| Lesson | Statements | Teaching activities | Notes |
| --- | --- | --- | --- |
| 1 (1hr for separate and combined) | P4.4.1 describe the energy transfers involved when a system is changed by work done by forces including  a) to raise an object above ground level  b) to move an object along the line of action of the force  P4.4.2 recall and apply the relationship to calculate the work done (energy transferred) by a force:  work done (Nm or J) = force (N) × distance (m) (along the line of action of the force)  M1a, M3b, M3c, M3d | **Engage:** When a physics teacher knows his stuff! A video of a physics teacher risking his life for science. [View full activity in P4.4 How do we describe motion in terms of energy transfers? – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/delivery-guide-gpbdg017-p44-how-do-we-describe-motion-in-terms-of-energy-transfers?activity=291140#291140)  **Explore:** Practical work done by a force:  <https://www.stem.org.uk/elibrary/resource/26336/episode-214-work-done-force>  **Explain:** Introduce the required equations to the pupils; pupils should work through example calculations with the teacher first before being given the opportunity to practice using these. Make sure pupils are comfortable rearranging equations and converting between units.  **Extend:** The ramp: Force, energy, work  A simple interactive applet in which objects can be pushed, pulled or allowed to slide up or down a ramp, with various adjustable parameters.  [View full activity in P4.4 How do we describe motion in terms of energy transfers? – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/delivery-guide-gpbdg017-p44-how-do-we-describe-motion-in-terms-of-energy-transfers?activity=291136#291136)  **Evaluate:** SAM Question [J259-01](http://www.ocr.org.uk/Images/234632-unit-j259-01-breadth-in-physics-foundation-tier-sample-assessment-material.pdf) Question 10 | Link to delivery guide [explaining motion](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/)  Link to [SAM](http://www.ocr.org.uk/Images/234632-unit-j259-01-breadth-in-physics-foundation-tier-sample-assessment-material.pdf) |
| 2 (1hr for separate and combined) | P4.4.3 recall the equation and calculate the amount of energy associated with a moving object:  kinetic energy (J) = 0.5 × mass (kg) × (speed (m/s))2  M1a, M3b, M3c, M3d  P4.4.5 make calculations of the energy transfers associated with changes in a system, recalling relevant equations for mechanical processes  M1a, M1c, M3c  P4.4.6 calculate relevant values of stored energy and energy transfers; convert between newton-metres and joules  M1c, M3c | **Engage:** What is potential energy?  A short video containing a slightly deeper exploration of the concept of potential energy.  [View full activity in P4.4 How do we describe motion in terms of energy transfers? – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/delivery-guide-gpbdg017-p44-how-do-we-describe-motion-in-terms-of-energy-transfers?activity=291134#291134)  **Explore:** simple demonstrations of kinetic energy <https://spark.iop.org/simple-energy-transfers-involving-motion>  **Explain:** nice innovative practical with lollypop sticks  <http://www.stevespanglerscience.com/lab/experiments/popsicle-stick-chain-reaction/>  **Extend:** Introduce the required equations to the pupils, pupils should work through example calculations with the teacher first before being given the opportunity to practice using these. Make sure pupils are comfortable rearranging equations and converting between units.  **Evaluate:** SAM question [J260-03](http://www.ocr.org.uk/Images/234663-unit-j260-03-physics-foundation-tier-paper-3-sample-assessment-material.pdf) Question 3 | Link to delivery guide [explaining motion](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/)  Link to [SAM](http://www.ocr.org.uk/Images/234663-unit-j260-03-physics-foundation-tier-paper-3-sample-assessment-material.pdf) |
| 3 (1hr for separate and combined) | P4.4.4 recall the equation and calculate the amount of energy associated with an object raised above ground level  gravitational potential energy (J) = mass (kg) × gravitational field strength (N/kg) × height (m)  M1a, M3b, M3c, M3d  P4.4.5 make calculations of the energy transfers associated with changes in a system, recalling relevant equations for mechanical processes  M1a, M1c, M3c  P4.4.6 calculate relevant values of stored energy and energy transfers; convert between newton-metres and joules  M1c, M3c  P4.4.7 describe all the changes involved in the way energy is stored when a system changes, for common situations: including an object projected upwards or up a slope, a moving object hitting an obstacle, an object being accelerated by a constant force, a vehicle slowing down | **Engage:** [base jumping](https://www.youtube.com/watch?v=SPPxxAg2rRM)  **Explore:** The orbit simulator  An interactive app in which the user can add a planet “X” to the existing solar system, adjust its average orbital distance and eccentricity and compare it to the existing planetary orbits.  [View full activity in P4.4 How do we describe motion in terms of energy transfers? – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/delivery-guide-gpbdg017-p44-how-do-we-describe-motion-in-terms-of-energy-transfers?activity=291138#291138)  **Explain:** Measure the GPE transferred to KE  <https://spark.iop.org/trolley-and-falling-mass>  **Extend:** Pendulum lab: Motion, pendulum, simple harmonic motion  A simple interactive involving the relationship between a pendulum’s motion and associated forces.  [View full activity in P4.4 How do we describe motion in terms of energy transfers? – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/delivery-guide-gpbdg017-p44-how-do-we-describe-motion-in-terms-of-energy-transfers?activity=291142#291142)  **Evaluate:** Introduce the required equations to the pupils; pupils should work through example calculations with the teacher first before being given the opportunity to practice using these. Make sure pupils are comfortable rearranging equations and converting between units. | Link to delivery guide [explaining motion](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/) |
| 4 (1hr for separate and combined) | P4.4.8 explain, with reference to examples, the definition of power as the rate at which energy is transferred (work done) in a system  P4.4.9 recall and apply the relationship:  power (W) = energy transferred (J) ÷ time (s)  M1a, M3b, M3c, M3d | **Engage:** Richard Garriott space video blog: Conservation of momentum  A short video in which the conservation of momentum is demonstrated in space using tennis balls.  [View full activity in P4.4 How do we describe motion in terms of energy transfers? – Online delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/delivery-guide-gpbdg017-p44-how-do-we-describe-motion-in-terms-of-energy-transfers?activity=291132#291132)  **Explore:** Power is one of the terms pupils tend to have misconceptions about due to its use in the English language. Discussion and questioning can help here.  **Explain:** Practical pupil power  <https://spark.iop.org/student-power>  **Extend:** Introduce the required equations to the pupils, pupils should work through example calculations with the teacher first before being given the opportunity to practice using these. Make sure pupils are comfortable rearranging equations and converting between units.  **Evaluate:** Worksheet  <http://www.physicsclassroom.com/getattachment/curriculum/energy/energy1.pdf> | Link to delivery guide [explaining motion](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/) |
| 5 (1hr for separate and combined) | Chapter P4 end of chapter quiz | Pupils to complete the [End of chapter quiz P**4**](https://interchange.ocr.org.uk/Downloads/Twenty-First-Century-Physics-Quizzes.zip). After completion pupils to swap and mark quizzes.  Pupils use their quizzes to create a revision list from Chapter 4 | Link to delivery guide [explaining motion](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/delivery-guide/topic-gpbt04-p4-explaining-motion/)  [End of chapter quiz P4](https://interchange.ocr.org.uk/Downloads/Twenty-First-Century-Physics-Quizzes.zip) are available on OCR interchange, a login will be required |

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