# PLANNING SUPPORT BOOKLET

**J249, J250**

**For first teaching in 2016**

This support material booklet is designed to accompany the OCR GCSE (9–1) specification in Physics A and Combined Science A (Gateway 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 A (Gateway) 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 A 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.

## Practical Work

Specification topic p9 (Practical skills) is not included explicitly in the Planning Guidance table. The expectation is that the practical skills are developed throughout the course and in support of conceptual understanding.

Suggestions for where the PAG techniques can be are included throughout the table. This is by no means and exhaustive list of potential practical activities.

| **Topic** | **Teaching hours**  separate / combined | **Delivery Guides** | **PAG opportunities** | |
| --- | --- | --- | --- | --- |
| **Topic 1: Matter** | | | | |
| 1.1 The particle model | 3 / 3 hours | Matter – delivery guide | PAG1: Determine the densities of a variety of objects both solid and liquid | |
| 1.2 Changes of state | 5 / 5 hours | Matter – delivery guide | PAG5: Determine the specific heat capacity of a metal (Activity 1)  PAG5: Kettle design (Activity 2) | |
| **1.3 Pressure (separate science only)** | 6 / 0 hours | Matter – delivery guide |  | |
| **Total for topic 1 = 14 / 8 hours** | | | | |
| **Topic 2: Forces** | | | | |
| 2.1 Motion | 5 / 5 hours | Forces and Motion – delivery guide | PAG3: Investigate acceleration of a trolley down a ramp (Activity 1)  PAG3: Investigating fluid flow (Activity 2) | |
| 2.2 Newton’s laws | 12 / 11 hours | Forces and Motion – delivery guide |  | |
| 2.3 Forces in action | 8 / 4 hours | Forces and Motion – delivery guide | PAG 2: Investigate the effect of forces on springs (Activity 1)  PAG 2: Investigating the effects of forces on the compression of a sample (Activity 2) | |
| **Total for topic 2 = 25 / 20 hours** | | | | |
| **Topic 3 Electricity** | | | | |
| 3.1 Static and Charge | 4 / 3 hours | Electricity – delivery guide |  | |
| 3.2 Simple circuits | 7 / 7 hours | Electricity – delivery guide | PAG6: Investigate the I-V characteristics of circuit elements (Activity 1)  PAG6: Mystery circuit elements (Activity 2)  PAG7: Investigate the brightness of bulbs in series and parallel | |
| **Total for topic 3 = 11 / 10 hours** | | | | |
| **Topic 4 Magnetism** | | | | |
| 4.1 Magnets and magnetic fields | 5 / 5 hours | Magnetism – delivery guide |  | |
| 4.2 Uses of magnetism | 8 / 2 hours | Magnetism – delivery guide |  | |
| **Total for topic 4 = 13 / 7 hours** | | | | |
| **Topic 5 Waves** | | | | |
| 5.1 Wave behaviour | 7 / 4 hours | Waves – delivery guide | PAG4: Measuring the speed, frequency and wavelength of a wave (Activity 1)  PAG4: Tsunami (Activity 2)PAG4: Measuring the speed, frequency and wavelength of a wave | |
| 5.2 The electromagnetic spectrum | 4 / 4 hours | Waves – delivery guide |  | |
| 5.3 Wave interactions | 5 / 1 hours | Waves – delivery guide | PAG8: Investigate the reflection of light off a plane mirror and the refraction of light through prisms (Activity 1)  PAG8: Reflection within a material (Activity 2) | |
| **Total for topic 5 = 16 / 9 hours** | | | | |
| **Topic 6 Radioactivity** | | | | |
| 6.1 Radioactive emissions | 6 / 6 hours | Radioactivity – delivery guide |  | |
| 6.2 Uses and Hazards | 5 / 1 hours | Radioactivity –delivery guide |  | |
| **Total for topic 6 = 11 / 7 hours** | | | | |
| **Topic 7 Energy** | | | | |
| 7.1 Work done | 5 / 5 hours | Energy – delivery guide |  | |
| 7.2 Power and efficiency | 6 / 6 hours | Energy – delivery guide |  | |
| **Total for topic 7 = 11 / 11 hours** | | | | |
| **Topic 8 Global Challenges** | | | | |
| 8.1 Physics on the move | 5 / 4 hours | Global challenges – delivery guide |  | |
| 8.2 Powering Earth | 6 / 5 hours | Global challenges – delivery guide |  | |
| **8.3 The Earth and beyond (separate science only)** | 8 / 0 hours | Global challenges – delivery guide |  | |
| **Total for topic 8 = 19 / 9 hours** | | | | |
| **Total teaching hours = 120 / 81 hours** | | | |

🗹 This symbol indicates content that is found only in the physics separate science qualification.

# Outline Scheme of Work: P2 – Forces

## Total suggested teaching time – 25 hours

### P2.1 Motion (5 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 * M3c * M4a * M4b * M4c * M4d * M4f | Links to Practical Activity Groups (PAGs)  * PAG 3: Investigation of acceleration of a trolley down a ramp |

# Overview of P2.1 Motion

| Lesson | Statements | Teaching activities | Notes |
| --- | --- | --- | --- |
| 1 (1hr for separate and combined) | P2.1a describe how to measure distance and time in a range of scenarios  P2.1b describe how to measure distance and time and use these to calculate speed  P2.1c make calculations using ratios and proportional reasoning to convert units and to compute rates (M1c, M3c)  PM2.1i recall and apply: distance travelled (m) = speed (m/s) x time (s) | **Starter:** Usain Bolt’s world record beating 100m  <https://www.youtube.com/watch?v=By1JQFxfLMM>  **Main:** Practical pupil speed  Get pupils outside timing each other running or walking over a set distance and calculating their speeds  **Plenary:** Applying the speed distance time triangle  Two pages - including 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 Force and motion  <http://www.ocr.org.uk/Images/268095-dg-forces-v7.pdf>  Link to transition guide Forces  <http://www.ocr.org.uk/Images/289189-forces-ks3-ks4-transition-guide.pdf> |
| 2 (1hr for separate and combined) | P2.1d explain the vector-scalar distinction as it applies to displacement and distance, velocity and speed | **Starter:**  Vector and scalar video <https://www.youtube.com/watch?v=50tCDw6gIQY>  **Main options:** [Learner activity](http://www.ocr.org.uk/Images/288974-forces-learner-activity.docx) the Olympians guide to success  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.  **Plenary options:** vectors and scalars worksheet:  <https://www.tes.com/teaching-resource/vectors-and-scalars-6172007>  [SAM](http://www.ocr.org.uk/Images/234625-unit-j249-01-physics-foundation-tier-paper-1-sample-assessment-material.pdf) question J249-01 Question 16 | Link to delivery guide [Force and motion](http://www.ocr.org.uk/Images/268095-dg-forces-v7.pdf)  Link to transition guide [Forces](http://www.ocr.org.uk/Images/289189-forces-ks3-ks4-transition-guide.pdf)  Link to Olympian guide to success Forces – [learner activity](http://www.ocr.org.uk/Images/288974-forces-learner-activity.docx)  Link to [SAM](http://www.ocr.org.uk/Images/234625-unit-j249-01-physics-foundation-tier-paper-1-sample-assessment-material.pdf) |
| 3 (1hr for separate and combined) | P2.1e relate changes and differences in motion to appropriate distance-time, and velocity-time graphs; and interpret lines, slopes (M4a, M4b, M4c, M4d)  **P2.1f interpret enclosed area in velocity-time graphs (M4a, M4b, M4c, M4d, M4f)** | **Starter:**  **The moving man**  An interactive distance-time graph PhET simulation.  <https://phet.colorado.edu/en/simulation/moving-man>  **Main Options:** **Describing velocity**  This online resources uses animations and activities to help learners understand velocity and motion graphs.  [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=294660#294660)  **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](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=294664#294664)  **Plenary Options:** **Graph shots 1**  Learners watch clips of a football game, linking the movement of highlighted players to motion graphs. There is a corresponding worksheet and a quiz at the end to check understanding.  [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=294662#294662)  **Velocity-time graphs**  A web page with a number of questions at the bottom to test learners on the interpretation of velocity-time graphs.  [View full activity in 2.1 Motion - Online delivery guide](http://dev.physicslab.org/Document.aspx?doctype=3&filename=Kinematics_AcceleratedMotionVelocityTimeGraphs.xml) | Link to delivery guide [Force and motion](http://www.ocr.org.uk/Images/268095-dg-forces-v7.pdf)  Link to transition guide [Forces](http://www.ocr.org.uk/Images/289189-forces-ks3-ks4-transition-guide.pdf) |
| 4 (1hr for separate and combined) | P2.1h apply formulae relating distance, time and speed, for uniform motion, and for motion with uniform acceleration (M1a, M1c, M2b, M3c)  PM2.1ii recall and apply: acceleration (m/s2) = change in velocity (m/s) / time (s)  P2.1g calculate average speed for non-uniform motion (M1a, M1c, M2b, M3c)  PM2.1iii apply: (final velocity (m/s))2 - (initial velocity (m/s))2 = 2 x acceleration (m/s2) x distance (m) | **Starter:** Video measuring acceleration with ticker tape  <https://www.youtube.com/watch?v=MW152L4fFzI>  **Main options**: Practical, measuring non-uniform acceleration with ticker tape  <https://spark.iop.org/non-uniform-acceleration-ticker-timer>  Pupils should be given plenty of opportunity to practise applying and rearranging the equations. Go through examples with pupils first.  **Plenary options:** [SAM](http://www.ocr.org.uk/Images/234629-unit-j249-03-physics-higher-tier-paper-3-sample-assessment-material.pdf) question J249-03 Question 24  **Calculations practice:**  <https://d3jc3ahdjad7x7.cloudfront.net/XpWzXT5v05sun6HASsf7QUmz76jwjDlmMjMjKMG0WTexMCaI.pdf> | Link to delivery guide [Force and motion](http://www.ocr.org.uk/Images/268095-dg-forces-v7.pdf)  Link to transition guide [Forces](http://www.ocr.org.uk/Images/289189-forces-ks3-ks4-transition-guide.pdf)  Link to [SAM](http://www.ocr.org.uk/Images/234629-unit-j249-03-physics-higher-tier-paper-3-sample-assessment-material.pdf) |
| 5 (1hr for separate and combined) | P2.1h apply formulae relating distance, time and speed, for uniform motion, and for motion with uniform acceleration (M1a, M1c, M2b, M3c)  PM2.1ii recall and apply: acceleration (m/s2) = change in velocity (m/s) / time (s)  PM2.1iii apply: (final velocity (m/s))2 - (initial velocity (m/s))2 = 2 × acceleration (m/s2) × distance (m) | **Starter:** Demo PAG activity to class  **Main:** PAG 3: Investigating acceleration  **Plenary**: Give pupils the candidate progress sheet, from the reference materials section of the webpage. Pupils to tick off skills covered. | Link to [PAG](https://www.ocr.org.uk/Images/309690-pag-activity-physics-motion-suggestion-1.docx) activity:  PAG P3 – Investigation acceleration of a trolley down a ramp can be found in the practical activities section  Link to [Candidate progress sheet](https://www.ocr.org.uk/Images/295647-gcse-physics-learner-record-sheet.doc) |

|  |  |  |
| --- | --- | --- |
| Additional online learning opportunities ***As a response to the Covid-19 outbreak, additional online learning opportunities were identified for each topic in June 2020.*** | | |
| Lesson | Statement | Teaching activities |
| 1 | P2.1b, PM2.1i | 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. |
| 3 | P2.1e, P2.1h | [Video](https://www.youtube.com/watch?v=RM02SnuJ0MY) describing distance-time graphs to use as flipped learning. |
| 3 | P2.1e | Cambridge International [Video](https://ocr.org.uk/rpgphys4) on experiment used to plot a speed-time graph which can be used as flipped learning. |
| 3 | P2.1e, P2.1f, PM2.1ii | [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. |

# Outline Scheme of Work: P2 – Forces

## Total suggested teaching time – 25 hours

### P2.2 Newton’s laws (12 / 11 hours)

|  |  |
| --- | --- |
| Links to KS3 Subject content  * Forces as pushes or pulls, arising from the interaction between two objects * Using force arrows in diagrams, adding forces in one dimension, balanced and unbalanced forces * 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 size | |
| Links to Mathematical Skills  * M1a * M1c * M2a * M3a * M3b * M3c * M3d * M4a * M5a * M5b | Links to Mathematical Skills  * N/A |

# Overview of P2.2 Newton’s laws

| Lesson | Statements | Teaching activities | Notes |
| --- | --- | --- | --- |
| 1 (1hr for separate and combined) | P2.2a recall examples of ways in which objects interact  P2.2b describe how such examples involve interactions between pairs of objects which produce a force on each object | Starter: The forces song  <https://www.youtube.com/watch?v=2OJjbztWitk>  Main Options: 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.  **Free body forces worksheet**  <http://www.sfponline.org/Uploads/71/free%20body%20diagram%20worksheet.pdf>  Plenary options: **Interaction pairs**  This could be used as a self-assessment tool or plenary quiz to check understanding of interaction pairs.  [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=294704#294704)  **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) | Link to delivery guide [Force and motion](http://www.ocr.org.uk/Images/268095-dg-forces-v7.pdf)  Link to transition guide [Forces](http://www.ocr.org.uk/Images/289189-forces-ks3-ks4-transition-guide.pdf) |
| 2 (1hr for separate and combined) | **P2.2f describe examples of the forces acting on an isolated solid object or system**  **P2.2g describe, using free body diagrams, examples where two or more forces lead to a resultant force on an object**  **P2.2h describe, using free body diagrams, examples of the special case where forces balance to produce a resultant force of zero (qualitative only)** | **Starter:** Free body force diagrams  <https://www.youtube.com/watch?v=nDis6HbXxjg>  **Main options:** 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)  Worksheet  <http://www.nuffieldfoundation.org/sites/default/files/files/FSMQ%20Force%20diagrams.pdf>  **Plenary options:** Pupils to write down instructions for others on how to draw free-body force diagrams.  The below website may help  <http://physics.wku.edu/~bonham/Talks/CPE_talk/ProblemSolving/ForceDiagrams.html>  Self test  <https://www.physicsclassroom.com/Physics-Interactives/Newtons-Laws/Free-Body-Diagrams/Free-Body-Diagram-Interactive> | Link to delivery guide [Force and motion](http://www.ocr.org.uk/Images/268095-dg-forces-v7.pdf)  Link to transition guide [Forces](http://www.ocr.org.uk/Images/289189-forces-ks3-ks4-transition-guide.pdf) |
| 3 (1hr for separate and combined) | P2.2c represent such forces as vectors  **P2.2e use vector diagrams to illustrate resolution of forces, a net force (resultant force), and equilibrium situations (M4a, M5a, M5b)** | **Starter:** 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 more able may think about Pythagoras.  **Main:** 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 may help.  <https://www.youtube.com/watch?v=Hjc8WwqqF6s>  **Plenary options:** Vector diagram worksheet (some are above the required level).  <https://www.tes.com/teaching-resource/resolving-forces-6147402>  Bitesize questions.  <https://www.bbc.co.uk/bitesize/guides/zcrccdm/revision/2> | Link to delivery guide [Force and motion](http://www.ocr.org.uk/Images/268095-dg-forces-v7.pdf)  Link to transition guide [Forces](http://www.ocr.org.uk/Images/289189-forces-ks3-ks4-transition-guide.pdf) |
| 4 (1hr for separate and combined) | P2.2d apply Newton’s First Law to explain the motion of an object moving with uniform velocity and also an object where the speed and/or direction change | **Starter:** video Newton’s first law  <https://www.youtube.com/watch?v=LEHR8YQNm_Q>  **Main options:** 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)  Possible class practical’s to cover newton’s first law  <https://spark.iop.org/galileos-rolling-ball>  **Plenary:**  Get pupils to start a Newtons laws fact sheet. What have they learnt today? What is Newtons first law? Pupils to write relevant information and start their fact sheet. | Link to delivery guide [Force and motion](http://www.ocr.org.uk/Images/268095-dg-forces-v7.pdf)  Link to transition guide [Forces](http://www.ocr.org.uk/Images/289189-forces-ks3-ks4-transition-guide.pdf) |
| 5 (1hr for separate and combined) | P2.2i apply Newton's second law in calculations relating forces, masses and accelerations  PM2.2i recall and apply: force (N) = mass (kg) x acceleration (m/s2) | **Starter:** Newton’s 2nd law with air cannons  <https://www.youtube.com/watch?v=iwP4heWDhvw>  **Main options:** Practical Investigating Newton’s second law  <https://spark.iop.org/investigating-newtons-second-law-motion#gref>  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)  **Plenary options**: [SAM](http://www.ocr.org.uk/Images/234629-unit-j249-03-physics-higher-tier-paper-3-sample-assessment-material.pdf) question J249-03 Q20  Get pupils to add to their newton’s laws fact sheet. What have they learnt today? What is Newton’s second law? Pupils to write relevant information and start their fact sheet. | Link to delivery guide [Force and motion](http://www.ocr.org.uk/Images/268095-dg-forces-v7.pdf)  Link to transition guide [Forces](http://www.ocr.org.uk/Images/289189-forces-ks3-ks4-transition-guide.pdf) |
| 6 (1hr for separate and combined) | **P2.2j explain that inertia is a measure of how difficult it is to change the velocity of an object and that the mass is defined as the ratio of force over acceleration** | **Starter:** What is inertia?  <https://www.youtube.com/watch?v=2LDQuslvn4E>  **Main options:** 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?  Practical activity 2  <http://serc.carleton.edu/sp/mnstep/activities/35687.html>  **Plenary:** 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.  Quick quiz  <http://study.com/academy/practice/quiz-worksheet-the-laws-of-inertia.html> | Link to delivery guide [Force and motion](http://www.ocr.org.uk/Images/268095-dg-forces-v7.pdf)  Link to transition guide [Forces](http://www.ocr.org.uk/Images/289189-forces-ks3-ks4-transition-guide.pdf) |
| 7 (1hr for separate and combined) | **P2.2k define momentum and describe examples of momentum in collisions to include an idea of the law of conservation of momentum in elastic collisions**  **PM2.2ii recall and apply: momentum (kgm/s) = mass (kg) x velocity (m/s)** | **Starter:** give pupils equation then do some flash card questions  <https://www.tes.com/teaching-resource/momentum-starter-6178662>  **Main options:** 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)  Collisions practical from IOPSpark  <https://spark.iop.org/investigating-momentum-during-collisions#gref>  Practical Momentum inelastic collisions  <https://spark.iop.org/inelastic-collision-trolleys#gref>  Practical Momentum elastic collisions  <https://spark.iop.org/episode-221-elastic-collisions#gref>  **Plenary options:** [SAM](http://www.ocr.org.uk/Images/234629-unit-j249-03-physics-higher-tier-paper-3-sample-assessment-material.pdf) J249-03 Question 22  Get pupils to add to their newton’s laws fact sheet. What have they learnt today? What is momentum? Pupils to write relevant information and start their fact sheet. | Link to delivery guide [Force and motion](http://www.ocr.org.uk/Images/268095-dg-forces-v7.pdf)  Link to transition guide [Forces](http://www.ocr.org.uk/Images/289189-forces-ks3-ks4-transition-guide.pdf)  Link to [SAM](http://www.ocr.org.uk/Images/234629-unit-j249-03-physics-higher-tier-paper-3-sample-assessment-material.pdf) |
| 8 (1hr for separate and combined) | P2.2l apply formulae relating force, mass, velocity and acceleration to explain how the changes involved are inter-related (M3b, M3c, M3d)  PM2.2i recall and apply: force (N) = mass (kg) x acceleration (m/s2) | **Starter:** 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>  **Main options:** 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.  Worksheet covering Newtons laws and the calculations involved. <http://www.sas.upenn.edu/~kennethp/nkdievid2.pdf>  **Plenary:** Pupils to write their own questions one easy, one standard demand and one hard. Swap between pupils and peer mark. | Link to delivery guide [Force and motion](http://www.ocr.org.uk/Images/268095-dg-forces-v7.pdf)  Link to transition guide [Forces](http://www.ocr.org.uk/Images/289189-forces-ks3-ks4-transition-guide.pdf) |
| 9 (1hr for separate and combined) | P2.2m use the relationship between work done, force, and distance moved along the line of action of the force and describe the energy transfer involved  P2.2n calculate relevant values of stored energy and energy transfers; convert between newton-metres and joules (M1c, M3c)  PM2.2iii recall and apply: work done (J) = force (N) x distance (m) (along the line of action of the force) | **Starter:** work done and power  <https://www.youtube.com/watch?v=OyGG1Lm6L2Y>  **Main**: Practical work done by a force:  <https://www.stem.org.uk/elibrary/resource/26336/episode-214-work-done-force>  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.  **Plenary:** [SAM](http://www.ocr.org.uk/Images/234625-unit-j249-01-physics-foundation-tier-paper-1-sample-assessment-material.pdf) question J249-01 Question 18  Worksheet  <https://www.tes.com/teaching-resource/work-done-6196661> | Link to delivery guide [Force and motion](http://www.ocr.org.uk/Images/268095-dg-forces-v7.pdf)  Link to transition guide [Forces](http://www.ocr.org.uk/Images/289189-forces-ks3-ks4-transition-guide.pdf)  Link to [SAM](http://www.ocr.org.uk/Images/234625-unit-j249-01-physics-foundation-tier-paper-1-sample-assessment-material.pdf) |
| 10 (1hr for separate and combined) | P2.2o explain, with reference to examples, the definition of power as the rate at which energy is transferred  PM2.2iv recall and apply: power (W) = work done (J) / time (s) | **Starter:** [Song](https://www.youtube.com/watch?v=vVSb-Cq2H20)  <https://www.youtube.com/watch?v=8hviR-kXu3E>  **Main:** Practical pupil power  <https://spark.iop.org/student-power#gref>  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.  **Plenary:** Worksheet  <http://www.physicsclassroom.com/getattachment/curriculum/energy/energy1.pdf> | Link to delivery guide [Force and motion](http://www.ocr.org.uk/Images/268095-dg-forces-v7.pdf)  Link to transition guide [Forces](http://www.ocr.org.uk/Images/289189-forces-ks3-ks4-transition-guide.pdf) |
| 11 (1hr for separate and combined) | P2.2p recall and apply Newton’s third law to include application to situations of equilibrium and non-equilibrium | **Starter:** Newton’s law of motion: YouTube Resources: <https://www.youtube.com/watch?v=cP0Bb3WXJ_k>  A video which clearly explains Newton’s third law or action and reaction. Lots of examples are provided in the clip.  **Main options**: 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>  Worksheet  <http://www.physicsclassroom.com/getattachment/curriculum/newtlaws/newtl16.pdf>  **Plenary options**: Get pupils to add to their 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.  Quick quiz  <http://study.com/academy/practice/quiz-worksheet-properties-of-newton-s-third-law-of-motion.html> | Link to delivery guide [Force and motion](http://www.ocr.org.uk/Images/268095-dg-forces-v7.pdf)  Link to transition guide [Forces](http://www.ocr.org.uk/Images/289189-forces-ks3-ks4-transition-guide.pdf) |
| 12 (1hr for separate and combined) | **P2.2q explain why an object moving in a circle with a constant speed has a changing velocity (qualitative only)** | **Starter:** circular motion with a sparkler  <https://www.youtube.com/watch?v=ID0R43My4Co>  **Main Options:** Practical 1: introducing circular motion  <https://spark.iop.org/circular-motion>  Practical 2: Whirling a rubber bung on a string  <https://spark.iop.org/whirling-rubber-bung-string>  Worksheet  <http://www.wsfcs.k12.nc.us/cms/lib/NC01001395/Centricity/Domain/7743/Circular%20Motion%20Worksheet%20F10.pdf>  **Plenary:** 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 [Force and motion](http://www.ocr.org.uk/Images/268095-dg-forces-v7.pdf)  Link to transition guide [Forces](http://www.ocr.org.uk/Images/289189-forces-ks3-ks4-transition-guide.pdf) |

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| Additional online learning opportunities ***As a response to the Covid-19 outbreak, additional online learning opportunities were identified for each topic in June 2020.*** | | |
| Lesson | Statement | Teaching activities |
| 7 | P2.2k, PM2.2ii | Short [video](https://www.youtube.com/watch?v=ZtQhlwPxE28) to use as flip learning on momentum and using the equation. |

# Outline Scheme of Work: P2 – Forces

## Total suggested teaching time – 25 hours

### P2.3 Forces in action (8 / 4 hours)

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| --- | --- |
| Links to KS3 Subject content  * Moment as the turning effect of a force * Forces: associated with deforming objects; stretching and squashing – springs; with rubbing and friction between surfaces, with pushing things out of the way; resistance to motion of air and water * Force measured in Newton, measurements of stretch or compression as force is changing * Force-extension linear relation; Hooke’s law as a special case | |
| Links to Mathematical Skills  * M1a * M1c * M2a * M3a * M3b * M3c * M3d * M4a * M4b * M4c * M4f | Links to Practical Activity Groups (PAGs)  * PAG P2 – Investigation of the effect of forces on springs * PAG P2 ­– Investigating the effects of forces on the compression of a sample |

# Overview of P2.3 Forces in action

| Lesson | Statements | Teaching activities | Notes |
| --- | --- | --- | --- |
| 1 (1hr for separate and combined) | P2.3a explain that to stretch, bend or compress an object, more than one force has to be applied  P2.3b describe the difference between elastic and plastic deformation (distortions) caused by stretching forces | **Starter:** the difference between elastic and plastic deformation  <https://www.youtube.com/watch?v=Oz8fW68RY6I>  **Main:** stretching copper wire practical  <https://spark.iop.org/stretching-copper-wire-measuring-extension-quantitative>  **Plenary:** Revision  A good starting point for Hooke’s law and calculations of work done, spring constant. Includes a quiz at the end.  [View full activity in 2.3 Forces in action - 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-gpadg006-p23-forces-in-action?activity=294741#294741) | Link to delivery guide [Force and motion](http://www.ocr.org.uk/Images/268095-dg-forces-v7.pdf)  Link to transition guide [Forces](http://www.ocr.org.uk/Images/289189-forces-ks3-ks4-transition-guide.pdf) |
| 2 (1hr for separate and combined) | P2.3c describe the relationship between force and extension for a spring and other simple systems  P2.3d describe the difference between linear and non-linear relationships between force and extension  P2.3e calculate a spring constant in linear cases  PM2.3i recall and apply: force exerted by a spring (N) = extension (m) × spring constant (N/m) | **Starter:** Demo PAG activity to class  **Main:** PAG 2: Investigating the effect of forces on the extension of a spring  **Plenary**: Give pupils the [candidate progress sheet](https://www.ocr.org.uk/Images/295647-gcse-physics-learner-record-sheet.doc), from the practical activities section of the webpage. Pupils to tick of skills covered. | Link to delivery guide [Force and motion](http://www.ocr.org.uk/Images/268095-dg-forces-v7.pdf)  Link to transition guide [Forces](http://www.ocr.org.uk/Images/289189-forces-ks3-ks4-transition-guide.pdf)  Link to [PAG activity](https://www.ocr.org.uk/Images/311701-pag-activity-physics-forces-suggestion-1.docx):  PAG P2 – Investigating the effect of forces on the extension of a spring can be found in the practical activities section |
| 3 (1hr for separate and combined) | P2.3f calculate the work done in stretching  PM2.3ii apply: energy transferred in stretching (J) = 0.5 × spring constant (N/m) x (extension (m))2 | **Starter:** elastic of plastic – show pupils objects and graphs and get them to say whether it shows or would undergo plastic or elastic deformation  **Main:** Stretching rubber  Here is a selection of practical’s that can be used to explain Hooke’s law, and PM2.3i, PM2.3ii.  [View full activity in 2.3 Forces in action – 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-gpadg006-p23-forces-in-action?activity=294739#294739)  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.  **Plenary:**  SAM question J249-01 question 20 | Link to delivery guide [Force and motion](http://www.ocr.org.uk/Images/268095-dg-forces-v7.pdf)  Link to transition guide [Forces](http://www.ocr.org.uk/Images/289189-forces-ks3-ks4-transition-guide.pdf)  Link to [SAM](http://www.ocr.org.uk/Images/234625-unit-j249-01-physics-foundation-tier-paper-1-sample-assessment-material.pdf) |
| 4 (1hr for separate and combined) | P2.3g describe that all matter has a gravitational field that causes attraction, and the field strength is much greater for massive objects  P2.3h define weight, describe how it is measured and describe the relationship between the weight of an object and the gravitational field strength (g) (and) has a value of 10N/kg at the Earth’s surface  PM2.3iii recall and apply: gravity force (N) = mass (kg) × gravitational field strength, g (N/kg) | **Starter:** weight vs. mass song  <https://www.youtube.com/watch?v=1whMAIGNq7E>  **Main:**  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.  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.  **Plenary:**  Get pupils to calculate their own weight on different planets | Link to delivery guide [Force and motion](http://www.ocr.org.uk/Images/268095-dg-forces-v7.pdf)  Link to transition guide [Forces](http://www.ocr.org.uk/Images/289189-forces-ks3-ks4-transition-guide.pdf) |
| 5 (separate science only) | P2.3i recall the acceleration in free fall  P2.3j apply formulae relating force, mass and relevant physical constants, including gravitational field strength (g), to explore how changes in these are inter-related (M1c, M3b, M3c) 🗹  PM2.3iv recall and apply: (in a gravity field) potential energy (J) = mass (kg) × height (m) × gravitational field strength, g (N/kg) 🗹 | **Starter:** base jumping  <https://www.youtube.com/watch?v=SPPxxAg2rRM>  **Main:** Acceleration due to gravity  Here is a selection of simple practicals that can be used to explain acceleration and gravity.  [View full activity in 2.3 Forces in action - 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-gpadg006-p23-forces-in-action?activity=294745#294745)  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.  **Plenary options:** [SAM](http://www.ocr.org.uk/Images/234629-unit-j249-03-physics-higher-tier-paper-3-sample-assessment-material.pdf) question J249-03 Question 24  Roller Coaster Design activity: TES Resources:  <https://www.tes.com/teaching-resource/design-a-rollercoaster-worksheet-gpe-and-ke-6331447>  Learners design a new rollercoaster. The learner can calculate Gravitational Potential Energy, Kinetic Energy and Velocity. | Link to delivery guide [Force and motion](http://www.ocr.org.uk/Images/268095-dg-forces-v7.pdf)  Link to transition guide [Forces](http://www.ocr.org.uk/Images/289189-forces-ks3-ks4-transition-guide.pdf)  Link to [SAM](http://www.ocr.org.uk/Images/234629-unit-j249-03-physics-higher-tier-paper-3-sample-assessment-material.pdf)  **For combined science teach P2.3i with lesson 4** |
| 6 (separate science only) | P2.3k describe examples in which forces cause rotation 🗹  P2.3l define and calculate the moment of the force in such examples 🗹  PM2.3vi recall and apply: moment of a force (Nm) = force (N) × distance (m) (normal to direction of the force) 🗹 | **Starter:** Moments  Video on moments to be used as flipped learning before the lesson.  <https://learning.cambridgeinternational.org/classroom/course/view.php?id=2981>  **Main:** Practical  <https://spark.iop.org/balancing-beam>  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.  **Plenary:** worksheet <https://www.educationquizzes.com/gcse/physics/forces-moments/> | Link to delivery guide [Force and motion](http://www.ocr.org.uk/Images/268095-dg-forces-v7.pdf)  Link to transition guide [Forces](http://www.ocr.org.uk/Images/289189-forces-ks3-ks4-transition-guide.pdf) |
| 7 (separate science only) | P2.3m explain how levers and gears transmit the rotational effects of forces 🗹 | **Starter:** Gears basics  Video tutorial explaining gear rotation and ratio and how it can control speed.  [View full activity in 2.3 Forces in action - 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-gpadg006-p23-forces-in-action?activity=294737#294737)  **Main:** Gears  A description of how gears and levers work with good and simplified illustrations.  [View full activity in 2.3 Forces in action - 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-gpadg006-p23-forces-in-action?activity=294735#294735)  Worksheet:  <https://www.tes.com/teaching-resource/moments-levers-and-pivots-introduction-with-star-wars-11204405>  **Plenary:** Pupils to explain in their own words how levers and gears transmit rotational effects of forces. | Link to delivery guide [Force and motion](http://www.ocr.org.uk/Images/268095-dg-forces-v7.pdf)  Link to transition guide [Forces](http://www.ocr.org.uk/Images/289189-forces-ks3-ks4-transition-guide.pdf) |
| 8 (separate science only) | P2.3n recall that the pressure in fluids (gases and liquids) causes a net force at right angles to any surface 🗹  P2.3o use the relationship between the force, the pressure and the area in contact 🗹  PM2.3v recall and apply: pressure (Pa) = force normal to a surface (N) / area of that surface (m2) 🗹 | **Starter:** pressure and pascal  <https://www.youtube.com/watch?v=Pn5YEMwQb4Y>  **Main:** 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.  Practical  <https://www.tes.com/teaching-resource/pressure-lesson-puzzles-practical-and-quiz-6312655>  **Plenary**: SAM J249-03 Q18  <http://www.ocr.org.uk/Images/234629-unit-j249-03-physics-higher-tier-paper-3-sample-assessment-material.pdf>  Force, pressure, hydraulics revision  This website is a useful source of revision, it also includes an interactive program that gives a visual representation.  [View full activity in 2.3 Forces in action - 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-gpadg006-p23-forces-in-action?activity=294743#294743) | Link to delivery guide [Force and motion](http://www.ocr.org.uk/Images/268095-dg-forces-v7.pdf)  Link to transition guide [Forces](http://www.ocr.org.uk/Images/289189-forces-ks3-ks4-transition-guide.pdf)  Link SAM  <http://www.ocr.org.uk/Images/234629-unit-j249-03-physics-higher-tier-paper-3-sample-assessment-material.pdf> |

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| Additional online learning opportunities ***As a response to the Covid-19 outbreak, additional online learning opportunities were identified for each topic in June 2020.*** | | |
| Lesson | Statement | Teaching activities |
| 2/3 | P2.3c, P2.3d, P2.3e, PM2.3i, PM2.3ii | PAG P2 ­– Investigating the effects of forces on the compression of a sample – alternative [practical activity](https://ocr.org.uk/Images/472160-pag-activity-physics-forces-suggestion-2.docx) |



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