# Support material for scheme of work planning

### Support material for lesson planning – AS content

The following guidance sets out suggested teaching times for the Physics A, AS Level specification from 2015 (H156). This information can also be used in the context of teaching the Physics A, A Level specification from 2015 (H556).

Please note that the timings and ordering are suggestions only and that individual centres should always 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.

An online [scheme of work builder](http://www.ocr.org.uk/qualifications/as-a-level-gce-physics-a-h156-h556-from-2015/scheme-of-work/) is available at the OCR website, which will allow centres to create a specific Scheme of Work for their teaching. The guidance below follows the order of the specification. It is not necessarily implied or recommended that centres teach the specification in the order show here.

Further ideas on ordering of the topics of the AS and A Level across a two-year course, can be found in the [co-teaching guide](http://www.ocr.org.uk/Images/180370-as-a-level-physics-a-co-teaching-guide.pdf).

### Delivery guides

The column ‘Delivery guides’ refers to individual teacher guides available from the OCR online Delivery Guide, accessed from the [subject page](http://www.ocr.org.uk/qualifications/as-a-level-gce-physics-a-h156-h556-from-2015/) under the planning and teaching tab.

These Delivery guides provide a significant source of 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

Module 1.1 (Practical skills assessed in a written examination) is not included explicitly in the guidance below. The expectation is that practical skills are developed through the practical work done throughout the course and in support of conceptual understanding.

Suggestions for suitable practical work are included throughout this document. This is by no means an exhaustive list of potential practical activities.

In the guidance, the abbreviation ‘PAG’ stands for ‘Practical Activity Group’, and refers to the groups defined in Appendix 5h of the A Level specification (H556). These PAGs form part of the Practical Endorsement in Physics, which is part of the A Level qualification only. There is no internally assessed practical assessment in the AS qualification. This does not mean that the development of practical skills should not form part of the teaching and learning at this level. Practical skills will be assessed in the written examinations at both AS and A Level. All PAG activities are available via the ‘Practical activities’ tab on the [planning and teaching page](https://www.ocr.org.uk/qualifications/as-and-a-level/physics-a-h156-h556-from-2015/planning-and-teaching/).

AS learners will benefit from taking part in the practical activities, and will be able to count their performance (as long as adequate records are kept) towards the A Level Practical Endorsement if they decide to proceed to the full A Level after taking the AS examinations. OCR recommends that AS learners join in with any Practical Endorsement activities undertaken in the first year of the A Level course.

The ‘PAG’ references in the guidance indicate topics where completion of individual PAGs would support teaching of the content. It is not compulsory to complete PAGs at these points.

### Assessment resources

[Exemplar candidate responses](https://teachcambridge.org/b7152c31-5591-439b-85fc-0e2d9b8abb89/candidate-exemplars?unit=all&subject=7e8b0ebc-9f2c-40bb-b84e-34d3343b6481) to marked questions at AS and A level may be used to inform teaching or as a learning resource. A wide range of multiple choice questions are available for [Measurements, materials, forces and motion](https://teachcambridge.org/item/b0720c52-eb6c-4f08-b5ea-efd94b88dac4), [Electricity waves and quantum physics](https://teachcambridge.org/item/6c9703d1-45d7-4739-b6d1-baaf9aa3c0ef) , [Newtonian world and astrophysics](https://teachcambridge.org/item/2a0ba742-694e-445c-add4-87b861f9bfb4) and [Particles and medical physics](https://teachcambridge.org/item/cb10af53-ab31-48c6-b55a-b1f2b15d5629). In addition to the [Sample Assessment Materials](https://teachcambridge.org/1d202bc6-862e-44ad-a7b5-cb187d720e3c/sample-assessment-materials?subject=7e8b0ebc-9f2c-40bb-b84e-34d3343b6481&unit=all), there are the most recent past papers and practice papers for AS and A level available from the [Practice materials section of Teach Cambridge](https://teachcambridge.org/8a0b5633-4f0c-4de1-bb0c-f4da077ac5a4/practice-materials?subject=7e8b0ebc-9f2c-40bb-b84e-34d3343b6481&unit=all).

### Feedback

If you have any comments or questions, please contact the Subject Team at ScienceGCE@ocr.org.uk

| Specification reference | Suggested teaching time (hrs) | Delivery guide | Practical work | Notes |
| --- | --- | --- | --- | --- |
| 2.1.1Physical quantities2.1.2S.I. Units | 10(ongoing) | [Foundations of physics](https://teachcambridge.org/item/77ee78f5-8cf7-499f-b9ed-5640b59d0e18)  | Short practical involving measurement A ‘circus’ where learners are asked to estimate the following quantities and assign appropriate units: mass of an calculator, a rock, a person, etc.; the time of fall of a ball, a toy car down a ramp, etc.; length of a table, height of person, width of the laboratory, length of their pen, etc.; and temperature of a water in a mug; their body temperature, temperature of a flame, etc. Learners are then given appropriate measuring tools (top-pan balance, scales, thermometer, metre rule, temperature probe, etc.) to check their estimates. This is followed by discussion of quantities, their units, uncertainties and prefixes. | Many virtual laboratory type resources or on-line simulations are available.Practical activity also to introduce new devices (micrometers, vernier calipers) and to allow discussion of accuracy of measurement and errorsLearner resource 2 from kinematics and dynamics on [quantities and units](https://www.ocr.org.uk/qualifications/as-a-level-gce-physics-a-h156-h556-from-2015/delivery-guide/Images/123-242847-asa-physics-a-kyn-dyn-lr2.pdf).A [topic exploration pack on computation](https://teachcambridge.org/item/3eba4c51-2118-4547-8943-b498e11b9270) is useful in introducing use of fractions, percentage changes, calculations and rearranging equations. The pack has an associated [computation learner activity](https://teachcambridge.org/item/0e5bb56c-d003-44d9-a673-8a75f8211a1a). |
| 2.2.1Measurements & uncertainties | 10(ongoing) | [Foundations of physics](https://teachcambridge.org/item/77ee78f5-8cf7-499f-b9ed-5640b59d0e18)  | Learners can measure the same item (e.g. a length) using different instruments of differing resolution.Calculating densities from section 3.2.4 and including uncertainties gives practice with standard form, uncertainties and combining uncertainties.  | Practical activity also to introduce new devices (micrometers, vernier calipers) and systematic and zero errorsError bars can be demonstrated for measurements taken to link to future practical work and graphical analysis.A topic exploration pack on [sketching graphs](https://teachcambridge.org/item/8ccede40-1ef3-4195-a794-4048f43eca90) is available with an associated [sketching learner activity](https://teachcambridge.org/item/963540ee-c563-4def-9880-46d66c1f8cc1). |
| 2.3.1Scalars & vectors | 3 | [Foundations of physics](https://teachcambridge.org/item/77ee78f5-8cf7-499f-b9ed-5640b59d0e18)  | Any system of forces, eg. A rubber band suspended between two nails on a board and a mass hung from a loop of string at the centre of the band. Angles can be measured by placing a piece of paper on the board and marking the positions.A mass suspended from a newtonmeter and then displaced by a second newton meter pulling horizontally. The vertical force is the weight of the mass, the horizontal force and resultant can be measured giving the triangle of forces.  | Learners expected to give examples of each.A resource detailing activities for a range of aspects including [scalars and vectors](https://teachcambridge.org/item/7288aacf-4164-4f04-af13-955a1b1c3715). |
| 3.1.1Kinematics | 3 | [Kinematics and dynamics](https://teachcambridge.org/item/24c71a86-7973-4c4c-a1fd-6c0f91b7b74c) | Use data gathered experimentally or by demonstration in previous section to illustrate the motion graphically.Investigate the motion of a pull-backtoy car or similar toy.[Time, distance and speed](http://practicalphysics.org/time-distance-and-speed.html) from the Institute of Physics Practical Physics website. | There are opportunities to discuss systematic and random errors.Graphical representations of motion as distance-time, displacement-time and velocity-time can be produced and interpreted. This topic is an excellent opportunity to introduce or revise the use of data-loggers. |
| 3.1.2Linear motion | 3 | [Kinematics and dynamics](https://teachcambridge.org/item/24c71a86-7973-4c4c-a1fd-6c0f91b7b74c) | Electromagnet and trapdoor, ticker-timer attached to heavy object, light gates or other methods. Graphical analysis to find *g*.An introduction to the use of light-gates and data loggers. Speed from A to B, speed at A (using intercept card), speed from the gradient using ultrasonic distance sensor. Link these to the types of speed camera in use and discuss the method giving the closest to the measure of instantaneous speed. Is a car accelerating from 0 to 60 mph ever actually travelling at 30 mph? | A historical approach can be taken illustrated by the work of Galileo to emphasise HSW. Compare to Aristotle’s ideas. Historical point of the need to understand the motion of a cannon ball was important in a turbulent Europe of the time.There are opportunities to discuss systematic and random errors.A [topic exploration pack on suvat](https://teachcambridge.org/item/ebc0bda3-ee5f-4875-b143-6d5d83564176) is available with an associated [suvat learner activity](https://teachcambridge.org/item/963540ee-c563-4def-9880-46d66c1f8cc1).***HSW 4, 5, 7, 9, 10, 11, 12*** |
| 3.1.3Projectile motion | 3 | [Kinematics and dynamics](https://teachcambridge.org/item/24c71a86-7973-4c4c-a1fd-6c0f91b7b74c) | A range of ideas for demonstration and student investigation on the Institute of Physics Teaching Advanced Physics (TAP) website for [projectile motion](https://spark.iop.org/episode-207-projectile-motion#gref). | A [transition guide on Mechanics](https://teachcambridge.org/item/3c4f99d9-c4e1-4d0a-ad0e-aab19d7be529) incorporates ideas on the progression from A level to university mechanics. |
| 3.2.1Dynamics3.2.2Motion with non-uniform acceleration3.2.3 Equilibrium | 3 | [Kinematics and dynamics](https://teachcambridge.org/item/24c71a86-7973-4c4c-a1fd-6c0f91b7b74c) | Low-friction trolley (or with friction-compensated slope) accelerated with mass pulling on cord over a pulley. Additional masses to add to trolley.This [activity](https://spark.iop.org/collections/force-mass-and-acceleration-newtons-second-law) from the Institute of Physics gives an activity to confirm [Newton’s second law of motion](http://tap.iop.org/mechanics/newton/211/page_46369.html).Legacy tasks on balancing are [available](https://teachcambridge.org/261d2944-6808-4590-82d7-292eb8ddfba7/quizzes-and-topic-tests?subject=7e8b0ebc-9f2c-40bb-b84e-34d3343b6481&unit=all). | Common misconceptions on the distinction between mass and weight may continue even to sixth form. Use of language is very important, “use the balance to determine the mass of….” Instead of “weigh”. Ideas on [forces in equilibrium](https://spark.iop.org/episode-202-forces-equilibrium) from Teaching Advanced Physics.Learners are expected to recall *F=ma.* |
| 3.2.4Density & pressure | 3 | [Kinematics and dynamics](https://teachcambridge.org/item/24c71a86-7973-4c4c-a1fd-6c0f91b7b74c) | Different faces of rectangular block placed on plasticine or modelling clay and loaded with different massesDetermine the weight of a set of masses in air and submerged in a beaker of water. Legacy controlled assessments are now [available](https://teachcambridge.org/261d2944-6808-4590-82d7-292eb8ddfba7/quizzes-and-topic-tests?subject=7e8b0ebc-9f2c-40bb-b84e-34d3343b6481&unit=all), including one on forces when immersed. | ***HSW 4, 7, 11*** |
| 3.3.1Work and conservation of energy | 4 | [Work,](https://teachcambridge.org/item/f5441cb2-bc8e-4104-89bc-b831acd9b944) energy, [and](https://www.ocr.org.uk/qualifications/as-a-level-gce-physics-a-h156-h556-from-2015/delivery-guide/module-pam03-module-3-forces-and-motion/delivery-guide-padg003-work-energy-power-and-momentum) [power](https://www.ocr.org.uk/Images/208965-work-energy-and-power-delivery-guide.pdf) | **PAG 1.3** Stopping distances | A video which provides interesting stimulation on [What is energy?](http://www.feynmanlectures.caltech.edu/I_04.html)The Institute of Physics comments on [Energy: common knowledge, hard concept.](https://spark.iop.org/energy-common-knowledge-hard-concept)Power/efficiency section (3.3.3 a, c) can link here.***HSW 2*** |
| 3.3.2Kinetic and potential energies | 3 | [Work,](https://www.ocr.org.uk/Images/208965-work-energy-and-power-delivery-guide.pdf) energy, [and](https://www.ocr.org.uk/qualifications/as-a-level-gce-physics-a-h156-h556-from-2015/delivery-guide/module-pam03-module-3-forces-and-motion/delivery-guide-padg003-work-energy-power-and-momentum) [power](https://teachcambridge.org/item/f5441cb2-bc8e-4104-89bc-b831acd9b944) | Use a motion sensor or light gates to determine the speed of a toy car or a trolley down a ramp to show KE ≈ GPE.Legacy controlled assessments are now [available](https://teachcambridge.org/261d2944-6808-4590-82d7-292eb8ddfba7/quizzes-and-topic-tests?subject=7e8b0ebc-9f2c-40bb-b84e-34d3343b6481&unit=all), including one using a curved track and ball bearing.[Galileo’s pin and pendulum](https://spark.iop.org/galileos-pin-and-pendulum#gref) is an interesting activity to signpost what is yet to come in simple harmonic motion. | Learners will be expected to recall and to be able to derive *Ek* == 1/2 *mv2*and *Ep* = *mgh*.PhET has many Physics simulations including this [“Energy Skate Park”](https://phet.colorado.edu/en/simulation/legacy/energy-skate-park).Learner resource 1 reviews quantities and units.***HSW 5, 6*** |
| 3.3.3Power | 3 | [Work,](https://www.ocr.org.uk/Images/208965-work-energy-and-power-delivery-guide.pdf) energy, [and](https://www.ocr.org.uk/qualifications/as-a-level-gce-physics-a-h156-h556-from-2015/delivery-guide/module-pam03-module-3-forces-and-motion/delivery-guide-padg003-work-energy-power-and-momentum) [power](https://teachcambridge.org/item/f5441cb2-bc8e-4104-89bc-b831acd9b944) | Pulley system with mechanical advantage, measuring effort, load and distances moved. | Learners will be expected to derive *P = Fv* from first principles.Learner resource 2 gives students the opportunity to estimate values of work, energy and power.Teaching Advanced Physics on IOPSpark considers [mechanical power](https://spark.iop.org/episode-218-mechanical-power). |
| 3.4.1Springs | 4 | [Understanding materials](https://www.ocr.org.uk/Images/232934-understanding-materials-delivery-guide.pdf)  | Learners in different groups could use springs with different spring constants to get different gradients, then discuss physical meaning of this and relate to different values of *k*.**PAG 2.2** Springs in series and parallel | ***HSW 5, 6*** |
| 3.4.2Mechanical properties of matter | 4 | [Understanding materials](https://teachcambridge.org/item/12f87c12-f9b5-4a95-8fe9-fc03e6cd23d8)  | Learner resource 3, Breaking stress.As an alternative to traditional activities try this activity to determine the [Young Modulus of a Marshmallow.](http://content.teachengineering.org/content/nyu_/activities/nyu_neworleans/nyu_neworleans_activity1_marshmallow_lab_v2_jly.pdf)**PAG 2.1** Young modulus**PAG 2.3** Properties of a plastic bag | Learner resource 1 supports the key definitions used in this topic. |
| 3.5.1Newton’s laws of motion | 3 | [Work,](https://www.ocr.org.uk/Images/208965-work-energy-and-power-delivery-guide.pdf) energy, [and](https://www.ocr.org.uk/qualifications/as-a-level-gce-physics-a-h156-h556-from-2015/delivery-guide/module-pam03-module-3-forces-and-motion/delivery-guide-padg003-work-energy-power-and-momentum) [power](https://teachcambridge.org/item/f5441cb2-bc8e-4104-89bc-b831acd9b944) |  | Learners expected to estimate the area under non-linear graphs.***HSW 3, 7, 9, 10*** |
| 3.5.2Collisions | 3 | [Work,](https://www.ocr.org.uk/Images/208965-work-energy-and-power-delivery-guide.pdf) energy, [and](https://www.ocr.org.uk/qualifications/as-a-level-gce-physics-a-h156-h556-from-2015/delivery-guide/module-pam03-module-3-forces-and-motion/delivery-guide-padg003-work-energy-power-and-momentum) [power](https://teachcambridge.org/item/f5441cb2-bc8e-4104-89bc-b831acd9b944) | Use of linear air track or “frictionless” pucks (e.g. balloon on CD) to investigate various collisions. | [Momentum](http://social.ocr.org.uk/groups/science/resources/momentum-physics-physics-and-b) is covered in a resource on the OCR community written to cover topics which were new to the specification. This resource may be used by teachers or learners.***HSW 1, 2, 6, 7*** |
| 4.1.1Charge and current | 2 | [Electricity](https://teachcambridge.org/item/489d2fb4-8f85-43eb-afd5-8d181f0fcf64) | Colourful electrolysis experiment at <http://www.nuffieldfoundation.org/practical-chemistry/colourful-electrolysis>. | Interesting demonstrations of [current as flow of charge](https://spark.iop.org/episode-102-current-flow-charge) with van der Graaf or other H.T. supply.Learner resource 1 gives exercises on Kirchhoff’s first law.Learner resource 2 considers the flow of charge carriers. ***HSW 7*** |
| 4.1.2Mean drift velocity | 2 | [Electricity](https://teachcambridge.org/item/489d2fb4-8f85-43eb-afd5-8d181f0fcf64) |  | ***HSW 1, 2*** |
| 4.2.1Circuit symbols | 1(ongoing) | [Electricity](https://teachcambridge.org/item/489d2fb4-8f85-43eb-afd5-8d181f0fcf64) |  | See ASE publication Signs, Symbols and Systematics (The ASE Companion to 16–19 Science, 2000).***HSW 8*** |
| 4.2.2e.m.f. and p.d. | 2 | [Electricity](https://teachcambridge.org/item/489d2fb4-8f85-43eb-afd5-8d181f0fcf64) | Cell, voltmeter and lamp/other components in a circuit to demonstrate and serve as a focus for discussion. |  |
| 4.2.3Resistance | 2 | [Electricity](https://teachcambridge.org/item/489d2fb4-8f85-43eb-afd5-8d181f0fcf64) | **PAG 3.2** Investigating electrical characteristics | PhET simulation on [Ohm’s law](https://phet.colorado.edu/en/simulation/ohms-law).Learners will be expected to recall R = V/I.A transition guide on [Resistance](https://teachcambridge.org/item/325ce056-3756-4234-b9ed-19c3b2d14d09) incorporates ideas on the progression from GCSE to A level.***HSW 3, 4, 5, 8, 9*** |
| 4.2.4Resistivity | 3 | [Electricity](https://teachcambridge.org/item/489d2fb4-8f85-43eb-afd5-8d181f0fcf64) | Wires of different lengths/diameter/materials and water-baths at different temperatures in circuits with cells or power supplies, ammeter, voltmeter.Measuring *R* against *θ* for a thermistor can be investigated using thermistor, water-bath and circuit as above.Estimate thickness of a pencil line using resistivity of graphite using a pencil, paper, ruler, 2 jockeys, cell (or variable DC power supply), voltmeter and ammeter. Investigation of different pencil hardness is possible.**PAG 3.1** Resistivity | Resistance, resistivity and the factors affecting them are covered in [this page](http://www.physicsclassroom.com/class/circuits/Lesson-3/Resistance) from the Physics Classroom.***HSW 2, 5*** |
| 4.2.5Power | 2 | [Electricity](https://teachcambridge.org/item/489d2fb4-8f85-43eb-afd5-8d181f0fcf64) | Practical/demo of a joule meter is useful. E.g. with a bulb and a 12V supply. Challenge students to predict energy use when two bulbs are used in series or in parallel to lead on to next section. | Learners will be expected to link the kWh as a unit of energy to section 3.3.3.***HSW 10, 12*** |
| 4.3.1Series & parallel circuits | 3 | [Electricity](https://teachcambridge.org/item/489d2fb4-8f85-43eb-afd5-8d181f0fcf64) | Investigate empirically and/or derive theoretically (from Kirchhoff’s laws) equations for two or more resistors in series or in parallel.**PAG 4.1** Investigating circuits (resistor in series and parallel)**PAG 4.2** Electrical circuits with more than one source of e.m.f. |  |
| 4.3.2Internal resistance | 3 | [Electricity](https://teachcambridge.org/item/489d2fb4-8f85-43eb-afd5-8d181f0fcf64) | Investigate the internal resistance of a power supply and e.m.f. of a supply using Learner Resource 3.**PAG 3.3** Determining e.m.f. and internal resistance of a cell and maximum power transfer | ***HSW 4, 5, 6, 8, 9, 12*** |
| 4.3.3Potential dividers | 3 | [Electricity](https://teachcambridge.org/item/489d2fb4-8f85-43eb-afd5-8d181f0fcf64) | Why do we use a [potential divider](https://spark.iop.org/episode-118-potential-dividers) rather than variable resistor to give a variable p.d. supply?**PAG 4.1** Investigating circuits (the principle of the potential divider)**PAG 4.3** Using non-ohmic devices as sensors | Learners are expected to know about the potentiometer as a potential divider.***HSW 4*** |
| 4.4.1Wave motion | 5 | [Waves](https://teachcambridge.org/item/88df3e24-91d8-4251-b20d-bbd5540fd33b) | **PAG 5.3** Using an oscilloscope | Teaching and learning resources on phase difference can be found [here](https://teachcambridge.org/item/5025230c-8a98-4db4-9175-91eaee3cdaf5).***HSW 1, 4, 5, 8*** |
| 4.4.2Electromagnetic waves | 5 | [Waves](https://teachcambridge.org/item/88df3e24-91d8-4251-b20d-bbd5540fd33b) | Polarising filters and a trip to a local pond/river to see polarisation of reflected light. Also observe light from laptops and stressed material (crossed filters needed).Microwave transmitter and receiver with metal grill. As a Stretch and Challenge task some students can investigate how the transmitted power (as recorded by the receiver) depends on the angle. Show re-emergence of light when a polarising filter is placed at 45° between cross filters. See if students can explain in terms of vector components being allowed through**PAG 6.2** Experiments with light**PAG 6.3** Experiments with polarisation | PhET has a [simulation](https://phet.colorado.edu/sims/html/bending-light/latest/bending-light_en.html) on refraction with different materials.OCR has an interactive Snell’s law [spreadsheet](https://teachcambridge.org/item/5025230c-8a98-4db4-9175-91eaee3cdaf5). ***HSW 9*** |
| 4.4.3Superposition  | 4 | [Waves](https://teachcambridge.org/item/88df3e24-91d8-4251-b20d-bbd5540fd33b) | Demonstrate interference using two coherent loudspeakers. Students to move around a room and hear high and low intensity sound from a pair of speakers.**PAG 5.1 and 5.4** Diffraction, 5.1 as the classic double slit or diffraction grating and 5.4 as a more qualitative investigation using a CD as the grating. | Learners could take opposing sides and debate classic particle theory (Newton) against wave theory (Young). Discuss how influence of Newton in Britain hampered wave model here but how the idea developed quickly in France.The AS specification at this point only includes the double slit, however many teachers take the opportunity to include the diffraction grating from 5.5.2(h) as a natural follow on.***HSW 7*** |
| 4.4.4Stationary waves | 4 | [Waves](https://teachcambridge.org/item/88df3e24-91d8-4251-b20d-bbd5540fd33b) | String or cord, vibrator and signal generator, possibly with stroboscope.**PAG 5.2** Determining the speed of sound from a resonance tube |  |
| 4.5.1Photons | 3 | [Quantum and photoelectric effects](https://teachcambridge.org/item/bbb2323d-4c7f-4386-9c72-8fdca60a22c3) | Possibly show 12V bulb at different temperatures from variable supply, quickly showing red/orange/yellow/white hot and drawing spectra to illustrate black body radiation.Show how a GM tube clicks when detecting ‘gamma waves’ from a radioactive source. Discuss the implication of the ‘clicks’.**PAG 6.1** Determining Planck constant | IOPSpark(TAP) resource on [spectra and energy levels](https://spark.iop.org/episode-501-spectra-and-energy-levels#gref).***HSW 11*** |
| 4.5.2The photoelectric effect | 3 | [Quantum and photoelectric effects](https://teachcambridge.org/item/bbb2323d-4c7f-4386-9c72-8fdca60a22c3) |  | PhET simulations of the [photoelectric effect](https://phet.colorado.edu/en/simulation/photoelectric) and [black body radiation](https://phet.colorado.edu/en/simulation/blackbody-spectrum).IOPSpark(TAP) resource on the [photoelectric effect](https://spark.iop.org/episode-502-photoelectric-effect).***HSW 1, 2, 3, 7, 11*** |
| 4.5.3Wave-particle duality | 3 | [Quantum and photoelectric effects](https://teachcambridge.org/item/bbb2323d-4c7f-4386-9c72-8fdca60a22c3) | TELTRON Electron diffraction tube demo. | IOPSpark(TAP) resource on [particles as waves](https://spark.iop.org/collections/wave-particle-duality) including the Teltron tube demo. |
| 5.1.1 Temperature, 5.1.2 Solid, liquid and gas, 5.1.3 Thermal properties of materials | 5 | [Thermal physics](https://teachcambridge.org/item/f8063d73-539f-47e7-b8af-da82805fdca9) | **PAG 11.2** Determining specific heat capacity[Learner activity 1](https://teachcambridge.org/item/3e9e0a51-72f9-47bb-9489-3a67244af258) investigates designs for a liquid in glass thermometer.[Learner activity 2](https://teachcambridge.org/item/3e9e0a51-72f9-47bb-9489-3a67244af258) covers the method of mixtures for determining specific heat capacity and specific latent heat. | [Latent heat resource](https://spark.iop.org/episode-608-latent-heat) for new content to specification.How science works, considering the different [types of thermometers](http://www.atp-instrumentation.co.uk/blog/different-types-of-thermometer/).How science works, [Learner resource 3](https://teachcambridge.org/item/3e9e0a51-72f9-47bb-9489-3a67244af258) relates to the operation of a refrigerator.***HSW1,2,4,5,7*** |
| 5.1.4 Ideal gases | 5 | [Thermal physics](https://teachcambridge.org/item/f8063d73-539f-47e7-b8af-da82805fdca9) | **PAG 8.1, 8.2** Classic gas law experiments**PAG 8.3** Investigation of work done by a gas when heated**PAG 8.4** Verifying *pV*=*NkT* using bicycle tubeExcellent new [CLEAPSS materials](http://science.cleapss.org.uk/Resource-Info/PP028-Investigating-gas-laws-1-pressure-volume-Boyle-s-law.aspx) on investigating the gas laws. | Learners are expected to understand the assumptions for the model of kinetic theory:large number of molecules in random, rapid motion* particles (atoms or molecules) occupy negligible volume compared to the volume of gas
* all collisions are perfectly elastic
* the time of collisions is negligible compared to the time between collisions
* the forces between particles are negligible except during collisions

PhET simulations on [balloons and buoyancy](https://phet.colorado.edu/en/simulation/legacy/balloons-and-buoyancy) and [gas properties](https://phet.colorado.edu/en/simulation/legacy/gas-properties).[“Next Time” questions](http://www.arborsci.com/next-time-questions) referenced in the delivery guide.The IOPSpark(TAP) guide to [kinetic theory](https://spark.iop.org/collections/kinetic-theory) and [thermal physics](https://spark.iop.org/collections/thermal-physics).Learners should know about the general characteristics of the Maxwell-Boltzmann distribution.Learners will be expected to know the derivation of the equation for mean kinetic energy being equal to 3/2kT.HSW1,2 |
| 5.2 Circular motion | 4 | [Circular and simple harmonic motion](https://teachcambridge.org/item/2d613f5c-f24f-4e3c-9491-6f08661f796e) | [Whirling a rubber bung on a string](http://practicalphysics.org/whirling-rubber-bung-string.html) | [Learner resource 1](https://teachcambridge.org/item/9bd09efb-3efa-421b-b5aa-93dd4a100377) contains formulae and units relating to circular motion.Demonstrations involving [circular motion](https://spark.iop.org/episode-224-describing-circular-motion).A resource on [Fairground rides](http://www.schoolphysics.co.uk/age16-19/Mechanics/Circular%20motion/text/Fairground_rides/index.html).***HSW1,2,5,9*** |
| 5.3 Oscillations | 5 | [Circular and simple harmonic motion](https://teachcambridge.org/item/2d613f5c-f24f-4e3c-9491-6f08661f796e) | **PAG 10.1** Investigating simple harmonic motion**PAG 10.2** Investigating damped oscillations**PAG 10.3** Comparing static and dynamic values for the spring constant | [Introduction to oscillations](https://spark.iop.org/introduction-oscillations) from Nuffield and the IoP.***HSW1,2,5,6,9,12*** |
| 5.4 Gravitational fields | 5 | [Gravitational fields](https://teachcambridge.org/item/05095049-1b9b-4356-bc21-a621b0c2ac5a) |  | IOPSpark (TAP) has some [resources](https://spark.iop.org/collections/gravitational-fields) on gravitational fields and gravitational potential. Learners are expected to link their understanding of gravitational and electric fields.Learners are expected to be able to derive Kepler’s equation linking T2 to r3.Learners are expected to be able to predict geostationary orbits using Newtonian laws.Learners are expected to be able to link the concept of escape velocity to the escape of atoms from the atmosphere of planets.***HSW1,2,5,7,9,10*** |
| 5.5 Astrophysics and cosmology | 10 | [Astrophysics and cosmology](https://teachcambridge.org/item/cb8623dd-8f34-445f-bc60-0d7edd4d30e4) |  | Learners will be expected to link earlier knowledge from sections 3 and 4 to this topic.[Wien's and Stefan’s law](http://www.schoolphysics.co.uk/age16-19/Astrophysics/text/Luminosity_and_brightness/index.html) resources for new content to specification.As part of ***HSW7*** and ***11*** learners should understand the development of and acceptance by the scientific community of the Big Bang theory.***HSW1,2,5,6,7,8,9,10,11,12*** |
| 6.1 Capacitors | 5 | [Capacitors](https://teachcambridge.org/item/958154dd-501f-4ec6-b944-d289f53a651a) | **PAG 9.1** Investigating charging and discharging a capacitor**PAG 9.2** Capacitors in series and parallel**PAG 9.3** Factors affecting capacitanceLearner resource 1, a book capacitor.Legacy task on capacitor discharge is available on [Teach Cambridge](https://teachcambridge.org/a93efea2-be7b-4ebb-8f43-8674b1a02443/practical-activity-groups-pags?subject=7e8b0ebc-9f2c-40bb-b84e-34d3343b6481&unit=all). | Learners will be expected to know how ln*x*–*t* graphs can be used to determine CR.PhET simulation of [charging a capacitor](https://phet.colorado.edu/en/simulation/capacitor-lab).Simple [capacitance and combination](http://hyperphysics.phy-astr.gsu.edu/hbase/electric/capac.html) resource.IOPSpark(TAP) [capacitors](https://spark.iop.org/collections/capacitors) resources.Core activities are integrated into the delivery guide.A lesson element is available with the [activity sheet for students](https://teachcambridge.org/item/233a5814-dfb6-4de0-acff-e21ef15318b3),as well as powerpoint and teacher sheets. ***HSW2,5,6,9*** |
| 6.2 Electric fields | 5 | [Electric and magnetic fields](https://teachcambridge.org/item/7b45ae6c-2d03-4f04-afaf-403d7e3d190e) |  | Learners are expected to apply knowledge from sections 3 and 5 to this topic.[Electric field potential resource](https://www.cyberphysics.co.uk/topics/electricity/higher_electricity/electric_potential.htm) for new content to specification.IOPSpark(TAP) [preparation for teaching electric fields](https://spark.iop.org/episode-405-preparation-electric-fields-topic). IOPSpark(TAP) resource on [uniform electric fields](https://spark.iop.org/episode-409-uniform-electric-fields).Derivation for the capacitance of an isolated sphere from *Q=VC* is expected.***HSW1,5*** |
| 6.3 Electromagnetism | 10 | [Electric and magnetic fields](https://teachcambridge.org/item/7b45ae6c-2d03-4f04-afaf-403d7e3d190e) | **PAG 11.1** Investigating transformers**PAG 11.3** Determining the strength of a magnetic field[Electromagnetic braking of a copper pipe.](https://spark.iop.org/electromagnetic-braking-copper-pipe#gref)The legacy qualitative task of magnets falling through a copper pipe is also available from [Teach Cambridge](https://teachcambridge.org/a93efea2-be7b-4ebb-8f43-8674b1a02443/practical-activity-groups-pags?subject=7e8b0ebc-9f2c-40bb-b84e-34d3343b6481&unit=all). | IOPSpark(TAP) [force on a conductor in a magnetic field.](https://spark.iop.org/episode-412-force-conductor-magnetic-field)IOPSpark(TAP) [electric motors](https://spark.iop.org/episode-415-electric-motors).PhET simulation of [Faraday’s law](https://phet.colorado.edu/en/simulation/faradays-law).[Learner resource 1](https://www.ocr.org.uk/Images/583321-electric-and-magnetic-fields-teacher-and-learner-resources.zip) covers terminology and units for capacitors, electric and magnetic fields.***HSW1,2,6,7,8,9*** |
| 6.4 Nuclear and particle physics | 10 | [Nuclear and particle physics](https://teachcambridge.org/item/4b3766d3-4f0d-41be-b823-6e0762bed022) | **PAG 7.1** The random nature of radioactive decay**PAG 7.2** Absorption of radioactive particles**PAG 7.3** Half-life of radioactive materials | Learner resource 1 [atomic nomenclature](https://teachcambridge.org/item/3f0dc9bf-eef4-4d36-aec4-e98346d5e2c7).Learner resource 2 [plotting neutrons](https://teachcambridge.org/item/3f0dc9bf-eef4-4d36-aec4-e98346d5e2c7).[Nuclear physics](http://www.physbot.co.uk/nuclear-physics.html) on the physbot website.TAP and [the particle zoo](https://spark.iop.org/episode-533-particle-zoo).[Particle interactions](http://physicsnet.co.uk/a-level-physics-as-a2/particles-radiation/particle-interactions/).[Half-life and decay.](http://hyperphysics.phy-astr.gsu.edu/hbase/Nuclear/halfli2.html)[The mathematics of decay](http://www.schoolphysics.co.uk/age16-19/Nuclear%20physics/Radioactivity/text/Radioactive_decay_mathematical/index.html).Learner resource 3, [nuclear binding energy](https://teachcambridge.org/item/3f0dc9bf-eef4-4d36-aec4-e98346d5e2c7).Learner resource 4, [mass defect](https://teachcambridge.org/item/3f0dc9bf-eef4-4d36-aec4-e98346d5e2c7).[Decay equations](http://www.s-cool.co.uk/a-level/physics/atomic-structure/revise-it/decay-equations).PhET [Nuclear fission simulation](https://phet.colorado.edu/en/simulation/nuclear-fission). [Nuclear reactor simulation](http://www.nuclearinst.com/Nuclear-Reactor-Simulator).[Nuclear power plant illustrations.](http://www.animatedsoftware.com/environm/nukequiz/nukequiz_one/nuke_parts/reactor_parts.swf)***HSW7,9,10,12*** |
| 6.5 Medical imaging | 10 | [Medical imaging](https://teachcambridge.org/item/7ff9a5a7-4043-4874-a3b9-0ee08613c8c9) |  | How an [X-ray tube](http://www.schoolphysics.co.uk/age16-19/Medical%20physics/text/X_rays/index.html) works.[IoP document](http://www.iop.org/education/teacher/resources/teaching-medical-physics/xray/page_56315.html) on X-ray imaging, ultrasound, Gamma cameras and PET scanners.Open University [videos on medical imaging](https://www.youtube.com/watch?v=3fpieHnbU68), this overview is supported by a full range of videos, all detailed in the Delivery Guide.Learner resource 1, [Medical Physics – Nuclear radiation](https://teachcambridge.org/item/9f2c7d6b-a871-4ee5-a399-59b63df12a36).Learner resource 3, [ultrasound](https://teachcambridge.org/item/9f2c7d6b-a871-4ee5-a399-59b63df12a36).Learner resource 2, [matching images](https://teachcambridge.org/item/9f2c7d6b-a871-4ee5-a399-59b63df12a36) and procedures.***HSW9,10,12*** |



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