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Topic 1: Physics and physical measurement

1.1 The realm of physics

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
Range of magnitudes of quantities in our universe			
1.1.1	State and compare quantities to the nearest order of magnitude.	Vectors	
1.1.2	State the ranges of magnitude of distances, masses and times that occur in the universe, from smallest to greatest.	Vectors	
1.1.3	State ratios of quantities as differences of orders of magnitude.		
1.1.4	Estimate approximate values of everyday quantities to one or two significant figures and/or to the nearest order of magnitude.		

1.2 Measurement and uncertainties

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
The SI system of fundamental and derived units			
1.2.1	State the fundamental units in the SI system.		
1.2.2	Distinguish between fundamental and derived units and give examples of derived units.		
1.2.3	Convert between different units of quantities.		
1.2.4	State units in the accepted SI format.		
1.2.5	State values in scientific notation and in multiples of units with appropriate prefixes.		
1.2.6	Describe and give examples of random and systematic errors.		
1.2.7	Distinguish between precision and accuracy.		
1.2.8	Explain how the effects of random errors may be reduced.		
1.2.9	Calculate quantities and results of calculations to the appropriate number of significant figures.		
1.2.10	State uncertainties as absolute, fractional and percentage uncertainties.		
1.2.11	Determine the uncertainties in results.		
1.2.12	Identify uncertainties as error bars in graphs.		
1.2.13	State random uncertainty as an uncertainty range (±) and represent it graphically as an “error bar”.		
1.2.14	Determine the uncertainties in the gradient and intercepts of a straight-line graph.		

1.3 Vectors and scalars

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
1.3.1	Distinguish between vector and scalar quantities, and give examples of each.	Vectors	
1.3.2	Determine the sum or difference of two vectors by a graphical method.	Vectors	
1.3.3	Resolve vectors into perpendicular components along chosen axes.	Vectors	

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Topic 2: Mechanics

2.1 Kinematics

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
2.1.1	Define *displacement*, *velocity*, *speed* and *acceleration*.	Vectors Kinematics	
2.1.2	Explain the difference between instantaneous and average values of speed, velocity and acceleration.		
2.1.3	Outline the conditions under which the equations for uniformly accelerated motion may be applied.	Kinematics	
2.1.4	Identify the acceleration of a body falling in a vacuum near the Earth's surface with the acceleration g of free fall.	Kinematics	
2.1.5	Solve problems involving the equations of uniformly accelerated motion.	Kinematics	
2.1.6	Describe the effects of air resistance on falling objects.		
2.1.7	Draw and analyse distance–time graphs, displacement–time graphs, velocity–time graphs and acceleration–time graphs.	Kinematics	
2.1.8	Calculate and interpret the gradients of displacement–time graphs and velocity–time graphs, and the areas under velocity–time graphs and acceleration–time graphs.	Kinematics	
2.1.9	Determine relative velocity in one and in two dimensions.		

2.2 Forces and dynamics

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
2.2.1	Calculate the weight of a body using the expression $W = mg$.	Dynamics	
2.2.2	Identify the forces acting on an object and draw free-body diagrams representing the forces acting.	Dynamics	
2.2.3	Determine the resultant force in different situations.	Dynamics	
2.2.4	State Newton's first law of motion.	Dynamics	
2.2.5	Describe examples of Newton's first law.	Dynamics	
2.2.6	State the condition for translational equilibrium.		
2.2.7	Solve problems involving translational equilibrium.		
2.2.8	State Newton's second law of motion.	Dynamics	
2.2.9	Solve problems involving Newton's second law.	Dynamics	
2.2.10	Define *linear momentum* and *impulse*.		Momentum and Collisions
2.2.11	Determine the impulse due to a time-varying force by interpreting a force–time graph.		Momentum and Collisions

2.2.12	State the law of conservation of linear momentum.		Momentum and Collisions
2.2.13	Solve problems involving momentum and impulse.		Momentum and Collisions
2.2.14	State Newton's third law of motion.	Dynamics	
2.2.15	Discuss examples of Newton's third law.	Dynamics	

2.3 Work, energy and power

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
2.3.1	Outline what is meant by work.	Work, Energy and Power	
2.3.2	Determine the work done by a non-constant force by interpreting a force–displacement graph.		
2.3.3	Solve problems involving the work done by a force.	Work, Energy and Power	
2.3.4	Outline what is meant by kinetic energy.	Work, Energy and Power	
2.3.5	Outline what is meant by change in gravitational potential energy.	Work, Energy and Power	
2.3.6	State the principle of conservation of energy.	Work, Energy and Power	
2.3.7	List different forms of energy and describe examples of the transformation of energy from one form to another.	Work, Energy and Power	
2.3.8	Distinguish between elastic and inelastic collisions.		Momentum and Collisions
2.3.9	Define *power*.	Work, Energy and Power	
2.3.10	Define and apply the concept of *efficiency*.	Work, Energy and Power	
2.3.11	Solve problems involving momentum, work, energy and power.	Work, Energy and Power	Momentum and Collisions

2.4 Uniform circular motion

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
2.4.1	Draw a vector diagram to illustrate that the acceleration of a particle moving with constant speed in a circle is directed towards the centre of the circle.		Circular Motion
2.4.2	Apply the expression for centripetal acceleration.		Circular Motion
2.4.3	Identify the force producing circular motion in various situations.		Circular Motion

2.4.4	Solve problems involving circular motion.		Circular Motion

Topic 3: Thermal physics

3.1 Thermal concepts

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
3.1.1	State that temperature determines the direction of thermal energy transfer between two objects.		Thermal Physics
3.1.2	State the relation between the Kelvin and Celsius scales of temperature.		Thermal Physics
3.1.3	State that the internal energy of a substance is the total potential energy and random kinetic energy of the molecules of the substance.		Thermal Physics
3.1.4	Explain and distinguish between the macroscopic concepts of temperature, internal energy and thermal energy (heat).		Thermal Physics
3.1.5	Define the *mole* and *molar mass*.		Thermal Physics
3.1.6	Define the *Avogadro constant*.		Thermal Physics

3.2 Thermal properties of matter

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
Specific heat capacity, phase changes and latent heat			
3.2.1	Define *specific heat capacity* and *thermal capacity*.		Thermal Physics
3.2.2	Solve problems involving specific heat capacities and thermal capacities.		Thermal Physics
3.2.3	Explain the physical differences between the solid, liquid and gaseous phases in terms of molecular structure and particle motion.		Thermal Physics
3.2.4	Describe and explain the process of phase changes in terms of molecular behaviour.		Thermal Physics
3.2.5	Explain in terms of molecular behaviour why temperature does not change during a phase change.		Thermal Physics
3.2.6	Distinguish between evaporation and boiling.		
3.2.7	Define *specific latent heat*.		Thermal Physics
3.2.8	Solve problems involving specific latent heats.		Thermal Physics
Kinetic model of an ideal gas			
3.2.9	Define *pressure*.		Thermal Physics
3.2.10	State the assumptions of the kinetic model of an ideal gas.		Thermal Physics
3.2.11	State that temperature is a measure of the average random kinetic energy of the molecules of an ideal gas.		Thermal Physics
3.2.12	Explain the macroscopic behaviour of an ideal gas in terms of a molecular model.		Thermal Physics

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Topic 4: Oscillations and waves

4.1 Kinematics of simple harmonic motion (SHM)

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
4.1.1	Describe examples of oscillations.	Waves	Oscillations
4.1.2	Define the terms *displacement*, *amplitude*, *frequency*, *period* and *phase difference*.	Waves	Oscillations
4.1.3	Define *simple harmonic motion* (*SHM*) and state the defining equation as $a = -\omega^2 x$.		Oscillations
4.1.4	Solve problems using the defining equation for SHM.		Oscillations
4.1.5	Apply the equations $v = v_o \sin\omega t$, $v = v_o \cos\omega t$, $v = \pm\omega\sqrt{(x_o^2 - x^2)}$, $x = x_o \cos\omega t$ and $x = x_o \sin\omega t$ as solutions to the defining equation for SHM.		Oscillations
4.1.6	Solve problems, both graphically and by calculation, for acceleration, velocity and displacement during SHM.		Oscillations

4.2 Energy changes during simple harmonic motion (SHM)

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
4.2.1	Describe the interchange between kinetic energy and potential energy during SHM.		Oscillations
4.2.2	Apply the expressions $E_K = \frac{1}{2}m\omega^2(x_o^2 - x^2)$ for the kinetic energy of a particle undergoing SHM, $E_T = \frac{1}{2}m\omega^2 x_o^2$ for the total energy and $E_P = \frac{1}{2}m\omega^2 x^2$ for the potential energy.		Oscillations
4.2.3	Solve problems, both graphically and by calculation, involving energy changes during SHM.		

4.3 Forced oscillations and resonance

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
4.3.1	State what is meant by damping.		Oscillations
4.3.2	Describe examples of damped oscillations.		Oscillations
4.3.3	State what is meant by natural frequency of vibration and forced oscillations.		Oscillations
4.3.4	Describe graphically the variation with forced frequency of the amplitude of vibration of an object close to its natural frequency of vibration.		Oscillations
4.3.5	State what is meant by resonance.		Oscillations

4.3.6	Describe examples of resonance where the effect is useful and where it should be avoided.		Oscillations

4.4 Wave characteristics

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
4.4.1	Describe a wave pulse and a continuous progressive (travelling) wave.	Waves	
4.4.2	State that progressive (travelling) waves transfer energy.	Waves	
4.4.3	Describe and give examples of transverse and of longitudinal waves.	Waves	
4.4.4	Describe waves in two dimensions, including the concepts of wavefronts and of rays.	Waves	
4.4.5	Describe the terms crest, trough, compression and rarefaction.	Waves	
4.4.6	Define the terms *displacement*, *amplitude*, *frequency*, *period*, *wavelength*, *wave speed* and *intensity*.	Waves	
4.4.7	Draw and explain displacement–time graphs and displacement–position graphs for transverse and for longitudinal waves.	Waves	
4.4.8	Derive and apply the relationship between wave speed, wavelength and frequency.	Waves	
4.4.9	State that all electromagnetic waves travel with the same speed in free space, and recall the orders of magnitude of the wavelengths of the principal radiations in the electromagnetic spectrum.	Optics	

4.5 Wave properties

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
4.5.1	Describe the reflection and transmission of waves at a boundary between two media.	Waves	
4.5.2	State and apply Snell's law.	Optics	
4.5.3	Explain and discuss qualitatively the diffraction of waves at apertures and obstacles.	Optics	
4.5.4	Describe examples of diffraction.	Optics	
4.5.5	State the principle of superposition and explain what is meant by constructive interference and by destructive interference.	Waves	
4.5.6	State and apply the conditions for constructive and for destructive interference in terms of path difference and phase difference.	Waves	

4.5.7	Apply the principle of superposition to determine the resultant of two waves.	Waves	

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Topic 5: Electric currents

5.1 Electric potential difference, current and resistance

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
Electric potential difference			
5.1.1	Define *electric potential difference*.	Simple Circuits Resistance and Resistivity	
5.1.2	Determine the change in potential energy when a charge moves between two points at different potentials.	Simple Circuits	
5.1.3	Define the *electronvolt*.	Quantum Physics	
5.1.4	Solve problems involving electric potential difference.	Simple Circuits	
Electric current and resistance			
5.1.5	Define *electric current*.	Simple Circuits	
5.1.6	Define *resistance*.	Simple Circuits Resistance and Resistivity	
5.1.7	Apply the equation for resistance in the form $R = \rho L / A$ where ρ is the resistivity of the material of the resistor.	Resistance and Resistivity	
5.1.8	State Ohm's law.	Simple Circuits Resistance and Resistivity	
5.1.9	Compare ohmic and non-ohmic behaviour.	Simple Circuits	
5.1.10	Derive and apply expressions for electrical power dissipation in resistors.		
5.1.11	Solve problems involving potential difference, current and resistance.	Simple Circuits Resistance and Resistivity	

5.2 Electric circuits

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
5.2.1	Define *electromotive force* (*emf*).	Resistance and Resistivity	
5.2.2	Describe the concept of internal resistance.	Resistance and Resistivity	
5.2.3	Apply the equations for resistors in series and in parallel.	Resistance and Resistivity	

5.2.4	Draw circuit diagrams.	Simple Circuits Resistance and Resistivity	
5.2.5	Describe the use of ideal ammeters and ideal voltmeters.		
5.2.6	Describe a potential divider.	Using Electricity	
5.2.7	Explain the use of sensors in potential divider circuits.	Using Electricity	
5.2.8	Solve problems involving electric circuits.	Simple Circuits Resistance and Resistivity Using Electricity	

Topic 6: Fields and forces

6.1 Gravitational force and field

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
6.1.1	State Newton's universal law of gravitation.		Gravitation
6.1.2	Define *gravitational field strength*.		Gravitation
6.1.3	Determine the gravitational field due to one or more point masses.		Gravitation
6.1.4	Derive an expression for gravitational field strength at the surface of a planet, assuming that all its mass is concentrated at its centre.		Gravitation
6.1.5	Solve problems involving gravitational forces and fields.		Gravitation

6.2 Electric force and field

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
6.2.1	State that there are two types of electric charge.		Electric Fields
6.2.2	State and apply the law of conservation of charge.		
6.2.3	Describe and explain the difference in the electrical properties of conductors and insulators.	Resistance and Resistivity	
6.2.4	State Coulomb's law.		Electric Fields
6.2.5	Define *electric field strength*.		Electric Fields
6.2.6	Determine the electric field strength due to one or more point charges.		Electric Fields
6.2.7	Draw the electric field patterns for different charge configurations.		Electric Fields
6.2.8	Solve problems involving electric charges, forces and fields.		Electric Fields

6.3 Magnetic force and field

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
6.3.1	State that moving charges give rise to magnetic fields.		Magnetic Fields
6.3.2	Draw magnetic field patterns due to currents.		Magnetic Fields
6.3.3	Determine the direction of the force on a current-carrying conductor in a magnetic field.		Magnetic Fields
6.3.4	Determine the direction of the force on a charge moving in a magnetic field.		Magnetic Fields
6.3.5	Define the *magnitude* and *direction* of a magnetic field.		Magnetic Fields

6.3.6	Solve problems involving magnetic forces, fields and currents.		Magnetic Fields

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Topic 7: Atomic and nuclear physics

7.1 The atom

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
Atomic structure			
7.1.1	Describe a model of the atom that features a small nucleus surrounded by electrons.	Particle Physics	Radioactive Decay
7.1.2	Outline the evidence that supports a nuclear model of the atom.	Particle Physics	Radioactive Decay
7.1.3	Outline one limitation of the simple model of the nuclear atom.		
7.1.4	Outline evidence for the existence of atomic energy levels.	Quantum Physics	
Nuclear structure			
7.1.5	Explain the terms nuclide, isotope and nucleon.	Particle Physics	
7.1.6	Define *nucleon number A*, *proton number Z* and *neutron number N*.	Particle Physics	
7.1.7	Describe the interactions in a nucleus.	Particle Physics	Radioactive Decay

7.2 Radioactive decay

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
Radioactivity			
7.2.1	Describe the phenomenon of natural radioactive decay.		Radioactive Decay
7.2.2	Describe the properties of alpha (α) and beta (β) particles and gamma (γ) radiation.		Radioactive Decay
7.2.3	Describe the ionizing properties of alpha (α) and beta (β) particles and gamma (γ) radiation.		Radioactive Decay
7.2.4	Outline the biological effects of ionizing radiation.		
7.2.5	Explain why some nuclei are stable while others are unstable.		Radioactive Decay
Half-life			
7.2.6	State that radioactive decay is a random and spontaneous process and that the rate of decay decreases exponentially with time.		Radioactive Decay
7.2.7	Define the term *radioactive half-life*.		Radioactive Decay
7.2.8	Determine the half-life of a nuclide from a decay curve.		
7.2.9	Solve radioactive decay problems involving integral numbers of half-lives.		

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7.3 Nuclear reactions, fission and fusion

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
Nuclear reactions			
7.3.1	Describe and give an example of an artificial (induced) transmutation.		Nuclear Energy
7.3.2	Construct and complete nuclear equations.		Nuclear Energy
7.3.3	Define the term *unified atomic mass unit*.		Nuclear Energy
7.3.4	Apply the Einstein mass–energy equivalence relationship.		Nuclear Energy
7.3.5	Define the concepts of *mass defect*, *binding energy* and *binding energy per nucleon*.		Nuclear Energy
7.3.6	Draw and annotate a graph showing the variation with nucleon number of the binding energy per nucleon.		Nuclear Energy
7.3.7	Solve problems involving mass defect and binding energy.		Nuclear Energy
Fission and fusion			
7.3.8	Describe the processes of nuclear fission and nuclear fusion.		Nuclear Energy
7.3.9	Apply the graph in 7.3.6 to account for the energy release in the processes of fission and fusion.		Nuclear Energy
7.3.10	State that nuclear fusion is the main source of the Sun's energy.		Nuclear Energy
7.3.11	Solve problems involving fission and fusion reactions.		Nuclear Energy

Topic 8: Energy, power and climate change

8.1 Energy degradation and power generation

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
8.1.1	State that thermal energy may be completely converted to work in a single process, but that continuous conversion of this energy into work requires a cyclical process and the transfer of some energy from the system.		
8.1.2	Explain what is meant by degraded energy.		
8.1.3	Construct and analyse energy flow diagrams (Sankey diagrams) and identify where the energy is degraded.		
8.1.4	Outline the principal mechanisms involved in the production of electrical power.		

8.2 World energy sources

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
8.2.1	Identify different world energy sources.		
8.2.2	Outline and distinguish between renewable and non-renewable energy sources.		
8.2.3	Define the *energy density* of a fuel.		
8.2.4	Discuss how choice of fuel is influenced by its energy density.		
8.2.5	State the relative proportions of world use of the different energy sources that are available.		
8.2.6	Discuss the relative advantages and disadvantages of various energy sources.		

8.3 Fossil power production

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
8.3.1	Outline the historical and geographical reasons for the widespread use of fossil fuels.		
8.3.2	Discuss the energy density of fossil fuels with respect to the demands of power stations.		
8.3.3	Discuss the relative advantages and disadvantages associated with the transportation and storage of fossil fuels.		
8.3.4	State the overall efficiency of power stations fuelled by different fossil fuels.		

8.3.5	Describe the environmental problems associated with the recovery of fossil fuels and their use in power stations.		

8.4 Non-fossil power production

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
Nuclear power			
8.4.1	Describe how neutrons produced in a fission reaction may be used to initiate further fission reactions (chain reaction).		Nuclear Energy
8.4.2	Distinguish between controlled nuclear fission (power production) and uncontrolled nuclear fission (nuclear weapons).		Nuclear Energy
8.4.3	Describe what is meant by fuel enrichment.		Nuclear Energy
8.4.4	Describe the main energy transformations that take place in a nuclear power station.		
8.4.5	Discuss the role of the moderator and the control rods in the production of controlled fission in a thermal fission reactor.		Nuclear Energy
8.4.6	Discuss the role of the heat exchanger in a fission reactor.		
8.4.7	Describe how neutron capture by a nucleus of uranium-238 (^{238}U) results in the production of a nucleus of plutonium-239 (^{239}Pu).		Nuclear Energy
8.4.8	Describe the importance of plutonium-239 (^{239}Pu) as a nuclear fuel.		Nuclear Energy
8.4.9	Discuss safety issues and risks associated with the production of nuclear power.		Nuclear Energy
8.4.10	Outline the problems associated with producing nuclear power using nuclear fusion.		Nuclear Energy
8.4.11	Solve problems on the production of nuclear power.		Nuclear Energy
Solar power			
8.4.12	Distinguish between a photovoltaic cell and a solar heating panel.		
8.4.13	Outline reasons for seasonal and regional variations in the solar power incident per unit area of the Earth's surface.		
8.4.14	Solve problems involving specific applications of photovoltaic cells and solar heating panels.		
Hydroelectric power			
8.4.15	Distinguish between different hydroelectric schemes.		
8.4.16	Describe the main energy transformations that take place in hydroelectric schemes.		
8.4.17	Solve problems involving hydroelectric schemes.		
Wind power			

8.4.18	Outline the basic features of a wind generator.		
8.4.19	Determine the power that may be delivered by a wind generator, assuming that the wind kinetic energy is completely converted into mechanical kinetic energy, and explain why this is impossible.		
8.4.20	Solve problems involving wind power.		
Wave power			
8.4.21	Describe the principle of operation of an oscillating water column (OWC) ocean-wave energy converter.		
8.4.22	Determine the power per unit length of a wavefront, assuming a rectangular profile for the wave.		
8.4.23	Solve problems involving wave power.		

8.5 Greenhouse effect

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
Solar radiation			
8.5.1	Calculate the intensity of the Sun's radiation incident on a planet.		
8.5.2	Define *albedo*.		
8.5.3	State factors that determine a planet's albedo.		
The greenhouse effect			
8.5.4	Describe the greenhouse effect.		
8.5.5	Identify the main greenhouse gases and their sources.	Green Chemistry (*AS Chemistry*)	
8.5.6	Explain the molecular mechanisms by which greenhouse gases absorb infrared radiation.		
8.5.7	Analyse absorption graphs to compare the relative effects of different greenhouse gases.		
8.5.8	Outline the nature of black-body radiation.		Astrophysics
8.5.9	Draw and annotate a graph of the emission spectra of black bodies at different temperatures.		
8.5.10	State the Stefan–Boltzmann law and apply it to compare emission rates from different surfaces.		Astrophysics
8.5.11	Apply the concept of emissivity to compare the emission rates from the different surfaces.		
8.5.12	Define *surface heat capacity* C_s.		
8.5.13	Solve problems on the greenhouse effect and the heating of planets using a simple energy balance climate model.		

8.6 Global warming

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	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
Global warming			
8.6.1	Describe some possible models of global warming.	Green Chemistry (*AS Chemistry*)	
8.6.2	State what is meant by the enhanced greenhouse effect.		
8.6.3	Identify the increased combustion of fossil fuels as the likely major cause of the enhanced greenhouse effect.	Green Chemistry (*AS Chemistry*)	
8.6.4	Describe the evidence that links global warming to increased levels of greenhouse gases.	Green Chemistry (*AS Chemistry*)	
8.6.5	Outline some of the mechanisms that may increase the rate of global warming.	Green Chemistry (*AS Chemistry*)	
8.6.6	Define *coefficient of volume expansion*.		
8.6.7	State that one possible effect of the enhanced greenhouse effect is a rise in mean sea-level.	Green Chemistry (*AS Chemistry*)	
8.6.8	Outline possible reasons for a predicted rise in mean sea-level.	Green Chemistry (*AS Chemistry*)	
8.6.9	Identify climate change as an outcome of the enhanced greenhouse effect.	Green Chemistry (*AS Chemistry*)	
8.6.10	Solve problems related to the enhanced greenhouse effect.		
8.6.11	Identify some possible solutions to reduce the enhanced greenhouse effect.		
8.6.12	Discuss international efforts to reduce the enhanced greenhouse effect.	Green Chemistry (*AS Chemistry*)	

Topic 9: Motion in fields

9.1 Projectile motion

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
9.1.1	State the independence of the vertical and the horizontal components of velocity for a projectile in a uniform field.	Kinematics	
9.1.2	Describe and sketch the trajectory of projectile motion as parabolic in the absence of air resistance.	Kinematics	
9.1.3	Describe qualitatively the effect of air resistance on the trajectory of a projectile.		
9.1.4	Solve problems on projectile motion.	Kinematics	

9.2 Gravitational field, potential and energy

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
9.2.1	Define *gravitational potential* and *gravitational potential energy*.		Gravitation
9.2.2	State and apply the expression for gravitational potential due to a point mass.		Gravitation
9.2.3	State and apply the formula relating gravitational field strength to gravitational potential gradient.		Gravitation
9.2.4	Determine the potential due to one or more point masses.		Gravitation
9.2.5	Describe and sketch the pattern of equipotential surfaces due to one and two point masses.		
9.2.6	State the relation between equipotential surfaces and gravitational field lines.		
9.2.7	Explain the concept of escape speed from a planet.		
9.2.8	Derive an expression for the escape speed of an object from the surface of a planet.		
9.2.9	Solve problems involving gravitational potential energy and gravitational potential.		Gravitation

9.3 Electric field, potential and energy

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
9.3.1	Define *electric potential* and *electric potential energy*.		Electric Fields
9.3.2	State and apply the expression for electric potential due to a point charge.		Electric Fields
9.3.3	State and apply the formula relating electric field strength to electric potential gradient.		Electric Fields

9.3.4	Determine the potential due to one or more point charges.		Electric Fields
9.3.5	Describe and sketch the pattern of equipotential surfaces due to one and two point charges.		Electric Fields
9.3.6	State the relation between equipotential surfaces and electric field lines.		Electric Fields
9.3.7	Solve problems involving electric potential energy and electric potential.		Electric Fields

9.4 Orbital motion

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
9.4.1	State that gravitation provides the centripetal force for circular orbital motion.		Gravitation
9.4.2	Derive Kepler's third law.		Gravitation
9.4.3	Derive expressions for the kinetic energy, potential energy and total energy of an orbiting satellite.		
9.4.4	Sketch graphs showing the variation with orbital radius of the kinetic energy, gravitational potential energy and total energy of a satellite.		
9.4.5	Discuss the concept of "weightlessness" in orbital motion, in free fall and in deep space.		
9.4.6	Solve problems involving orbital motion.		Circular Motion Gravitation

Topic 10: Thermal physics

10.1 Thermodynamics

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
Gas laws			
10.1.1	State the equation of state for an ideal gas.		Thermal Physics
10.1.2	Describe the difference between an ideal gas and a real gas.		Thermal Physics
10.1.3	Describe the concept of the absolute zero of temperature and the Kelvin scale of temperature.		Thermal Physics
10.1.4	Solve problems using the equation of state of an ideal gas.		Thermal Physics

10.2 Processes

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
The first law of thermodynamics			
10.2.1	Deduce an expression for the work involved in a volume change of a gas at constant pressure.		
10.2.2	State the first law of thermodynamics.		
10.2.3	Identify the first law of thermodynamics as a statement of the principle of energy conservation.		
10.2.4	Describe the isochoric (isovolumetric), isobaric, isothermal and adiabatic changes of state of an ideal gas.		
10.2.5	Draw and annotate thermodynamic processes and cycles on P–V diagrams.		
10.2.6	Calculate from a P–V diagram the work done in a thermodynamic cycle.		
10.2.7	Solve problems involving state changes of a gas.		

10.3 Second law of thermodynamics and entropy

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
10.3.1	State that the second law of thermodynamics implies that thermal energy cannot spontaneously transfer from a region of low temperature to a region of high temperature.		
10.3.2	State that entropy is a system property that expresses the degree of disorder in the system.		
10.3.3	State the second law of thermodynamics in terms of entropy changes.		

10.3.4	Discuss examples of natural processes in terms of entropy changes.		

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Topic 11: Wave phenomena

11.1 Standing (stationary) waves

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
11.1.1	Describe the nature of standing (stationary) waves.	Waves	
11.1.2	Explain the formation of one-dimensional standing waves.	Waves	
11.1.3	Discuss the modes of vibration of strings and air in open and in closed pipes.	Waves	
11.1.4	Compare standing waves and travelling waves.	Waves	
11.1.5	Solve problems involving standing waves.	Waves	

11.1 Doppler effect

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
11.2.1	Describe what is meant by the Doppler effect.		Astrophysics
11.2.2	Explain the Doppler effect by reference to wavefront diagrams for moving-detector and moving-source situations.		
11.2.3	Apply the Doppler effect equations for sound.		
11.2.4	Solve problems on the Doppler effect for sound.		
11.2.5	Solve problems on the Doppler effect for electromagnetic waves using the approximation $\Delta f = v / c f$.		Astrophysics
11.2.6	Outline an example in which the Doppler effect is used to measure speed.		

11.3 Diffraction

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
Diffraction at a single slit			
11.3.1	Sketch the variation with angle of diffraction of the relative intensity of light diffracted at a single slit.	Optics	
11.3.2	Derive the formula $\theta = \lambda / b$ for the position of the first minimum of the diffraction pattern produced at a single slit.	Optics	
11.3.3	Solve problems involving single-slit diffraction.	Optics	

11.4 Resolution

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
11.4.1	Sketch the variation with angle of diffraction of the relative intensity of light emitted by two point sources that has been diffracted at a single slit.		Lenses and Telescopes
11.4.2	State the Rayleigh criterion for images of two sources to be just resolved.		Lenses and Telescopes
11.4.3	Describe the significance of resolution in the development of devices such as CDs and DVDs, the electron microscope and radio telescopes.		Lenses and Telescopes
11.4.4	Solve problems involving resolution.		

11.5 Polarization

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
11.5.1	Describe what is meant by polarized light.	Waves	Organic Synthesis (*A2 Chemistry*)
11.5.2	Describe polarization by reflection.		
11.5.3	State and apply Brewster's law.		
11.5.4	Explain the terms polarizer and analyser.	Waves	
11.5.5	Calculate the intensity of a transmitted beam of polarized light using Malus' law.	Waves	
11.5.6	Describe what is meant by an optically active substance.		Organic Synthesis (*A2 Chemistry*)
11.5.7	Describe the use of polarization in the determination of the concentration of certain solutions.		
11.5.8	Outline qualitatively how polarization may be used in stress analysis.		
11.5.9	Outline qualitatively the action of liquid-crystal displays (LCDs).		
11.5.10	Solve problems involving the polarization of light.		

Topic 12: Electromagnetic induction

12.1 Induced electromotive force (emf)

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
12.1.1	Describe the inducing of an emf by relative motion between a conductor and a magnetic field.		Magnetic Fields
12.1.2	Derive the formula for the emf induced in a straight conductor moving in a magnetic field.		Magnetic Fields
12.1.3	Define *magnetic flux* and *magnetic flux linkage*.		Magnetic Fields
12.1.4	Describe the production of an induced emf by a time-changing magnetic flux.		Magnetic Fields
12.1.5	State Faraday's law and Lenz's law.		Magnetic Fields
12.1.6	Solve electromagnetic induction problems.		Magnetic Fields

12.2 Alternating current

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
12.2.1	Describe the emf induced in a coil rotating within a uniform magnetic field.		Magnetic Fields
12.2.2	Explain the operation of a basic alternating current (ac) generator.		Magnetic Fields
12.2.3	Describe the effect on the induced emf of changing the generator frequency.		
12.2.4	Discuss what is meant by the root mean squared (rms) value of an alternating current or voltage.	Using Electricity	
12.2.5	State the relation between peak and rms values for sinusoidal currents and voltages.	Using Electricity	
12.2.6	Solve problems using peak and rms values.	Using Electricity	
12.2.7	Solve ac circuit problems for ohmic resistors.		
12.2.8	Describe the operation of an ideal transformer.		Magnetic Fields
12.2.9	Solve problems on the operation of ideal transformers.		Magnetic Fields

12.3 Transmission of electrical power

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
12.3.1	Outline the reasons for power losses in transmission lines and real transformers.		
12.3.2	Explain the use of high-voltage stepup and step-down transformers in the transmission of electrical power.		

12.3.3	Solve problems on the operation of real transformers and power transmission.		
12.3.4	Suggest how extra-low-frequency electromagnetic fields, such as those created by electrical appliances and power lines, induce currents within a human body.		
12.3.5	Discuss some of the possible risks involved in living and working near high-voltage power lines.		

Topic 13: Quantum physics and nuclear physics

13.1 Quantum physics

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
The quantum nature of radiation			
13.1.1	Describe the photoelectric effect.	Quantum Physics	
13.1.2	Describe the concept of the photon, and use it to explain the photoelectric effect.	Quantum Physics	
13.1.3	Describe and explain an experiment to test the Einstein model.	Quantum Physics	
13.1.4	Solve problems involving the photoelectric effect.	Quantum Physics	
The wave nature of matter			
13.1.5	Describe the de Broglie hypothesis and the concept of matter waves.	Quantum Physics	
13.1.6	Outline an experiment to verify the de Broglie hypothesis.	Quantum Physics	
13.1.7	Solve problems involving matter waves.		
Atomic spectra and atomic energy states			
13.1.8	Outline a laboratory procedure for producing and observing atomic spectra.	Quantum Physics	
13.1.9	Explain how atomic spectra provide evidence for the quantization of energy in atoms.	Quantum Physics	
13.1.10	Calculate wavelengths of spectral lines from energy level differences and vice versa.		
13.1.11	Explain the origin of atomic energy levels in terms of the "electron in a box" model.		
13.1.12	Outline the Schrödinger model of the hydrogen atom.		
13.1.13	Outline the Heisenberg uncertainty principle with regard to position–momentum and time–energy.		

13.2 Nuclear physics

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
13.2.1	Explain how the radii of nuclei may be estimated from charged particle scattering experiments.		
13.2.2	Describe how the masses of nuclei may be determined using a Bainbridge mass spectrometer.		
13.2.3	Describe one piece of evidence for the existence of nuclear energy levels.		
Radioactive decay			

13.2.4	Describe β^+ decay, including the existence of the neutrino.	Particle Physics	Radioactive Decay
13.2.5	State the radioactive decay law as an exponential function and define the *decay constant*.		Radioactive Decay
13.2.6	Derive the relationship between decay constant and half-life.		Radioactive Decay
13.2.7	Outline methods for measuring the half-life of an isotope.		Radioactive Decay
13.2.8	Solve problems involving radioactive half-life.		Radioactive Decay

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Topic 14: Digital technology

14.1 Analogue and digital signals

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
14.1.1	Solve problems involving the conversion between binary numbers and decimal numbers.		
14.1.2	Describe different means of storage of information in both analogue and digital forms.		
14.1.3	Explain how interference of light is used to recover information stored on a CD.		
14.1.4	Calculate an appropriate depth for a pit from the wavelength of the laser light.		
14.1.5	Solve problems on CDs and DVDs related to data storage capacity.		
14.1.6	Discuss the advantage of the storage of information in digital rather than analogue form.		
14.1.7	Discuss the implications for society of ever-increasing capability of data storage.		

14.2 Data capture; digital imaging using charge-coupled devices (CCDs)

	Assessment statements	Boardworks AS Physics	Boardworks A2 Physics
14.2.1	Define *capacitance*.		Capacitors
14.2.2	Describe the structure of a charge-coupled device (CCD).		Lenses and Telescopes
14.2.3	Explain how incident light causes charge to build up within a pixel.		Lenses and Telescopes
14.2.4	Outline how the image on a CCD is digitized.		Lenses and Telescopes
14.2.5	Define *quantum efficiency* of a pixel.		
14.2.6	Define *magnification*.		
14.2.7	State that two points on an object may be just resolved on a CCD if the images of the points are at least two pixels apart.		
14.2.8	Discuss the effects of quantum efficiency, magnification and resolution on the quality of the processed image.		
14.2.9	Describe a range of practical uses of a CCD, and list some advantages compared with the use of film.		Lenses and Telescopes
14.2.10	Outline how the image stored in a CCD is retrieved.		
14.2.11	Solve problems involving the use of CCDs.		