A Level Physics Online

OCR Physics Specification A - H556

Module 5: Newtonian Word and Astrophysics

You should be able to demonstrate and show your understanding of:	Progress and understanding:			
	1	**2**	**3**	**4**
5.1 Thermal Physics				
Thermal equilibrium.				
Absolute scale of temperature (i.e. the thermodynamic scale) that does not depend on property of any particular substance.				
Temperature measurements both in degrees Celsius (°C) and in kelvin (K).				
$T\ (K) \approx \theta\ (^{o}C) = 273$				
Solids, liquids and gases in terms of the spacing, ordering and motion of atoms or molecules.				
Simple kinetic model for solids, liquids and gases.				
Brownian motion in terms of the kinetic model of matter and a simple demonstration using smoke particles suspended in air.				
Internal energy as the sum of the random distribution of kinetic and potential energies associated with the molecules of a system.				
Absolute zero (0 K) as the lowest limit for temperature; the temperature at which a substance has minimum internal energy.				
Increase in the internal energy of a body as its temperature rises.				
Changes in the internal energy of a substance during change of phase; constant temperature during change of phase.				
Specific heat capacity of a substance; the equation; $E = mc\Delta\theta$				
An electrical experiment to determine the specific heat capacity of a metal or a liquid.				
Techniques and procedures used for an electrical method to determine the specific heat capacity of a metal block and a liquid.				

You should be able to demonstrate and show your understanding of:	Progress and understanding:			
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Specific latent heat of fusion and specific latent heat of vaporisation; $E = mL$				
An electrical experiment to determine the specific latent heat of fusion and vaporisation.				
Techniques and procedures used for an electrical method to determine the specific latent heat of a solid and a liquid.				
Amount of substance in moles; Avogadro constant N_A equals 6.02×10^{23} mol^{-1}				
Model of kinetic theory of gases; Assumptions for the model: • 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 and the time of the collisions is negligible compared to the time between collisions. • Negligible forces between particles except during collision.				
Pressure in terms of this model of kinetic theory of gases.				
The equation of state of an ideal gas; $pV = nRT$ Where n is the number of moles.				
Techniques and procedures used to investigate PV = constant (Boyle's law) and P / T = constant.				
An estimation of absolute zero using variation of gas temperature with pressure.				
The equation; $pV = \frac{1}{3} Nm\overline{c^2}$ *W*here N is the number of particles (atoms or molecules) and $\overline{c^2}$ is the mean square speed.				
Root mean square (r.m.s.) speed; mean square speed. You should know about the general characteristics of the Maxwell-Boltzmann distribution.				

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The Boltzmann constant; $k = R / N_A$				
The equations; $pV = NkT$ $\frac{1}{2} m\overline{c^2} = \frac{3}{2} kT$ You will also be expected to know the derivation of the equation $\frac{1}{2} m\overline{c^2} = \frac{3}{2} kT$ from $pV = \frac{1}{3} Nm\overline{c^2}$ and $pV = NkT$				
Internal energy of an ideal gas.				
5.2 Circular Motion				
The radian as a measure of angle.				
Period and frequency of an object in circular motion.				
Angular velocity ω; $\omega = 2\pi / T$ and $\omega = 2\pi f$				
A constant net force perpendicular to the velocity of an object causes it to travel in a circular path.				
Constant speed in a circle; $v = \omega r$				
Centripetal acceleration; $a = v^2/r$ and $a = \omega^2 r$				
Centripetal force; $F = mv^2/r$ and $F = m\omega^2 r$				
Techniques and procedures used to investigate circular motion using a whirling bung.				
5.3 Oscillations				
Displacement, amplitude, period, frequency, angular frequency and phase difference.				
Angular frequency ω; $\omega = 2\pi / T$ and $\omega = 2\pi f$				

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Simple harmonic motion; defining equation; $a = - \omega^2 x$				
Techniques and procedures used to determine the period/frequency of simple harmonic oscillations.				
Solutions to the equation $a = - \omega^2 x$ for example; $x = A \cos \omega t$ or $x = A \sin \omega t$				
Velocity; $v = \pm \omega \sqrt{A^2 - x^2}$ Hence $v_{max} = \omega A$				
The period of a simple harmonic oscillator is independent of its amplitude (isochronous oscillator).				
Graphical methods to relate the changes in displacement, velocity and acceleration during simple harmonic motion.				
Interchange between kinetic and potential energy during simple harmonic motion.				
Energy-displacement graphs for a simple harmonic oscillator.				
Free and forced oscillations.				
The effects of damping on an oscillatory system.				
Observe forced and damped oscillations for a range of systems.				
Resonance; natural frequency.				
Amplitude-driving frequency graphs for forced oscillators.				
Practical examples of forced oscillations and resonance.				
5.4 Gravitational Fields				
Gravitational fields are due to objects having mass.				
Modelling the mass of a spherical object as a point mass at its centre.				
Gravitational field lines to map gravitational fields.				
Gravitational field strength; $g = F / m$				

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The concept of gravitational fields as being one of a number of forms of field giving rise to a force.				
Newton's law of gravitation for the force between two point masses; $F = - GMm / r^2$				
Gravitational field strength for a point mass; $g = - GM / r^2$				
Gravitational field strength is uniform close to the surface of the Earth and numerically equal to the acceleration of free fall.				
Kepler's three laws of planetary motion.				
The centripetal force on a planet is provided by the gravitational force between it and the Sun.				
The equation; $T^2 = (4\pi^2 / GM)\, r^3$ You will also be expected to derive this equation from first principles.				
The relationship for Kepler's third law $T^2 \propto r^3$ applied to systems other than our solar system.				
Geostationary orbit; uses of geostationary satellites.				
Gravitational potential at a point as the work done in bringing unit mass from infinity to the point; gravitational potential is zero at infinity.				
Gravitational potential at a distance *r* from a point mass *M*; changes in gravitational potential; $V_g = - GM / r$				
Force–distance graph for a point or spherical mass; work done is area under graph.				
Gravitational potential energy at a distance *r* from a point mass *M;* $E = mV_g = -GMm / r$				
Escape velocity.				
5.5 Astrophysics and Cosmology				
The terms planets, planetary satellites, comets, solar systems, galaxies and the Universe.				

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Formation of a star from interstellar dust and gas in terms of gravitational collapse, fusion of hydrogen into helium, radiation and gas pressure.				
Evolution of a low-mass star like our Sun into a red giant and white dwarf; planetary nebula.				
Characteristics of a white dwarf; electron degeneracy pressure; Chandrasekhar limit.				
Evolution of a massive star into a red super giant and then either a neutron star or black hole; supernova.				
Characteristics of a neutron star and a black hole.				
Hertzsprung–Russell (HR) diagram as luminosity-temperature plot; main sequence; red giants; super red giants; white dwarfs.				
Energy levels of electrons in isolated gas atoms.				
The idea that energy levels have negative values.				
Emission spectral lines from hot gases in terms of emission of photons and transition of electrons between discrete energy levels.				
The equations; $hf = \Delta E$ and $hc / \lambda = \Delta E$				
Different atoms have different spectral lines which can be used to identify elements within stars.				
Continuous spectrum, emission line spectrum and absorption line spectrum.				
Transmission diffraction grating used to determine the wavelength of light.				
The condition for maxima $d \sin \theta = n\lambda$ where d is the grating spacing.				
Use of Wien's displacement law to estimate the peak surface temperature (of a star); $\lambda_{max} \propto 1 / T$				
Luminosity L of a star; Stefan's law: $L = 4\pi r^2 \sigma T^4$ Where σ is the Stefan constant.				
Use of Wien's displacement law and Stefan's law to estimate the radius of a star.				

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Distances measured in astronomical unit (AU), light-year (ly) and parsec (pc).				
Stellar parallax; distances the parsec (pc).				
The equation; $p = 1 / d$ Where p is the parallax in seconds of arc and d is the distance in parsec.				
The Cosmological principle; universe is homogeneous, isotropic and the laws of physics are universal.				
Doppler effect; Doppler shift of electromagnetic radiation.				
Doppler equation; $\Delta\lambda / \lambda \approx \Delta f / f \approx v / c$ For a source of electromagnetic radiation moving relative to an observer.				
Hubble's law; $v \approx H_0 d$ for receding galaxies Where H_0 is the Hubble constant.				
Model of an expanding universe supported by galactic red shift.				
Hubble constant H_0 in both units - km s^{-1} Mpc^{-1} and s^{-1}				
The Big Bang theory.				
Experimental evidence for the Big Bang theory from microwave background radiation at a temperature of 2.7 K.				
The idea that the Big Bang gave rise to the expansion of space-time.				
Estimation for the age of the universe; $t \approx H_0^{-1}$				
Evolution of the universe after the Big Bang to the present.				
Current ideas; universe is made up of dark energy, dark matter, and a small percentage of ordinary matter.				

The material in this checklist is based on the OCR Physics A Specification published at ocr.org.uk/**alevelphysicsa** by Oxford, Cambridge and RSA Examinations.