Knowledge Organiser Year 13 Semester 1: Measurements and Movement

5.2 Circular motion	
Use the radian as a measure of angle	
Determine the period and frequency of an object in circular motion	
Use the equation: $\omega = 2\pi/T$ or $\omega = 2\pi f$ for angular velocity ω	
Describe how a constant net force perpendicular to the velocity of an object causes it to travel in a circular path	
Use the equation: $v = \omega r$ for constant speed in a circle	
Use the equations: $a = v^2/r$; $a = \omega^2 r$ for centripetal acceleration	
Use the equations: $F = mv^2/r$; $F = m\omega^2 r$ for centripetal force	
Use techniques and procedures to investigate circular motion using a whirling bung	
5.3 Oscillations	
Recall and define the terms displacement, amplitude, period, frequency, angular frequency and phase difference	
Use the equation: $\omega = 2\pi/T$ or $\omega = 2\pi f$ for angular frequency ω	
Define simple harmonic motion and use the equation: $a = -\omega^2 x$	
Use techniques and procedures to determine the period/frequency of simple harmonic oscillations	
Determine solutions to the equation $a = \omega^2 x$ e.g. $x = A \cos \omega t$ or $x = A \sin \omega t$	
Use the equations: $v = \omega\sqrt{A^2 - x^2}$ hence $v_{max} = \omega A$	
Recall that the period of a simple harmonic oscillator is independent of its amplitude (isochronous oscillator)	
Use graphical methods to relate the changes in displacement, velocity and acceleration during simple harmonic motion	
Describe the interchange between kinetic and potential energy during simple harmonic motion	
Draw energy-displacement graphs for a simple harmonic oscillator	
Recall what free and forced oscillations are describe the effects of damping on an oscillatory system	
Describe observe forced and damped oscillations for a range of systems	
Define the terms: resonance and natural frequency	
Draw and interpret amplitude-driving frequency graphs for forced oscillators	
Describe practical examples of forced oscillations and resonance	
5.4 Gravitational fields	
Recall that gravitational fields are due to objects having mass	
Use modelling the mass of a spherical object as a point mass at its centre	
Use gravitational field lines to map gravitational fields	
Use the equation: $g = F/m$ for gravitational field strength	
Explain the concept of gravitational fields as being one of a number of forms of field giving rise to a force	

Use the equation: Newton's law of gravitation; $F = -GMm/r^2$ for the force between two point masses	
Use the equation: gravitational field strength $g = -GM/r^2$ for a point mass	
Recall that gravitational field strength is uniform close to the surface of the Earth and numerically equal to the acceleration of free fall	
Recall Kepler's three laws of planetary motion	
Recall that the centripetal force on a planet is provided by the gravitational force between it and the Sun	
Use the equation: $T^2 = (4\pi^2/GM)r^3$ and be able to derive it from first principles	
Describe the relationship for Kepler's third law $T^2 \propto r^3$ and apply it to systems other than our solar system	
Recall what a geostationary orbit is and describe the uses of geostationary satellites	
Predict geostationary orbits using Newtonian laws	
Describe gravitational potential at a point as the work done in bringing unit mass from infinity to the point	
Recall that gravitational potential is zero at infinity	
Apply the equation for gravitational potential $V_g = -GM/r$ at a distance r from a point mass M	
Describe changes in gravitational potential for given circumstances	
Draw force–distance graph for a point or spherical mass and recall that work done is the area under graph	
Apply the equation for gravitational potential energy $E = mV_g = -GMm/r$ at a distance r from a point mass M	
Define escape velocity	
Predict the escape velocity of atoms from the atmosphere of planets	
5.5 Astrophysics and cosmology	
Define the terms planets, planetary satellites, comets, solar systems, galaxies and the universe	
Describe formation of a star from interstellar dust and gas in terms of gravitational collapse, fusion of hydrogen into helium, radiation and gas pressure	
Describe evolution of a low-mass star like our Sun into a red giant and white dwarf and describe planetary nebula	
Describe characteristics of a white dwarf, define electron degeneracy pressure and discuss Chandrasekhar limit	
Describe the evolution of a massive star into a red super giant and then either a neutron star or black hole and describe supernova	
Describe characteristics of a neutron star and a black hole	
Describe and explain the Hertzsprung–Russell (HR) diagram as luminosity-temperature plot for main sequence; red giants; super red giants; white dwarfs	
For stars describe energy levels of electrons in isolated gas atoms	
Describe energy levels of electrons in isolated gas atoms	
Recall the idea that energy levels have negative values	
Describe emission spectral lines from hot gases in terms of emission of photons and transition of electrons between discrete energy levels	
Use the equations $hf = \Delta E$ and $hc/\lambda = \Delta E$	
Recall that different atoms have different spectral lines which can be used to identify elements within stars	

Recall what continuous spectrum, emission line spectrum and absorption line spectrum are	
Describe how transmission diffraction grating is used to determine the wavelength of light	
Describe the condition for maxima $d \sin \theta = n\lambda$, where d is the grating spacing	
Use of Wien's displacement law $\lambda_{max} \propto 1/T$ to estimate the peak surface temperature (of a star)	
Use the equation: for luminosity L of a star in Stefan's law $L = 4\pi^2 \sigma T^4$ where σ is the Stefan constant	
Use Wien's displacement law and Stefan's law to estimate the radius of a star	
Recall that distances in cosmology are measured in astronomical unit (AU), light-year (ly) and parsec (pc)	
Define stellar parallax; distances the parsec (pc)	
Use the equation $p = 1/d$, where p is the parallax in seconds of arc and d is the distance in parsec	
Recall the Cosmological principle; universe is homogeneous, isotropic and the laws of physics are universal	
Describe the Doppler effect and the Doppler shift of electromagnetic radiation	
Use the Doppler equation: $\Delta \lambda/\lambda \approx \Delta f/f \approx v/c$ for a source of electromagnetic radiation moving relative to an observer	
Use the equation for: Hubble's law; $v \approx H_0 d$ for receding galaxies, where H_0 is the Hubble constant	
Describe the model of an expanding universe supported by galactic red shift	
Recall and use the Hubble constant H_0 in both km s^{-1} Mpc^{-1} and s^{-1} units	
Recall and describe the principles of the Big Bang theory	
Recall experimental evidence for the Big Bang theory from microwave background radiation at a temperature of 2.7 K	
Discuss the development and acceptance of Big Bang theory by the scientific community	
Recall the idea that the Big Bang gave rise to the expansion of space-time	
Describe the estimation for the age of the universe; $t \approx H_0^{-1}$	
Describe the evolution of the universe after the Big Bang to the present	
Describe the current ideas of universe is made up of dark energy, dark matter, and a small percentage of ordinary matter	

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