Scheme of Work 2020 – 2021 (HT1)
Subject: A2 Physics

Year Group: 13
Specification: AQA 7408

Lesson No	Topic & Objectives	Big Question – What will students learn?	Key Activities & Specialist Terminology (Do Now Task / Starter/Tasks/Plenary	Planned Assessment	Homework or flipped learning resources DODDLE resources	Lit Num SMSC Codes
1	**3.6.1.1 Circular motion** Motion in a circular path at constant speed implies there is an acceleration and requires a centripetal force. Magnitude of angular speed $\omega = v / r = 2\pi f$ Radian measure of angle. Direction of angular velocity will not be considered.	Motion in a circular path at Understand and explain why circular motion is an accelerated motion and needs a centripetal force. Recall and use equations $\omega = v / r = 2\pi f$, $a = v^2/r = \omega^2 r$, $F = mv^2/r = m\omega^2 r$, to solve circular motion problems. Use radian as a measure of angle and convert between radians and degrees Identify and calculate centripetal forces in contexts such as a mass whirled on a string and a car rounding a bend.	Discussion and demonstration of circular motion, for example stone/bucket of water on a string, helium balloon in car. Student experiment: Verification of the centripetal force experiment with a whirling bung. Rehearse circular motion problems (including use of radians) from IOP. **Skills developed by learning activities:** AO1: Demonstrate knowledge and understanding of circular motion as an accelerated motion AO2: Apply knowledge and understanding of forces to identify and calculate centripetal forces. MS4.7: Understand the relationship between degrees and radians and translate from one to the other in circular motion problems. ATc: Use methods to increase accuracy of measurements, such as timing over multiple rotations in circular motion experiment. AO2: Apply knowledge and understanding of forces to identify and calculate centripetal forces. MS4.7: Understand the relationship between degrees and radians and translate from one to the other in circular motion problems.	. Exampro QSP.4A.06 QBS04.4.02	**Rich question:** What forces do you experience when travelling round a corner at constant speed? Helium Balloon in a car video clip. Verification of the centripetal force experiment with a whirling bung – schoolphysics.co.uk Circular motion problems from IOP	C3 C3

	Centripetal acceleration The derivation of the centripetal acceleration formula will not be examined. Centripetal force $F = mv^2/r = m\omega^2 r$		ATc: Use methods to increase accuracy of measurements, such as timing over multiple rotations in circular motion experiment.			
2	3.6.1.2 Simple harmonic motion (SHM) Analysis of characteristics of simple harmonic motion (SHM). Condition for SHM: $a \propto -x$ Defining equation: $a = -\omega^2 x$ $x = A\cos(\omega t)$ and $v = \pm\omega\sqrt{A^2 -$	Recall the condition for SHM : $a \propto -x$ Solve problems using the equations of SHM : $x = A\cos(\omega t)$ and $v = \pm\omega\sqrt{A^2 - x^2}$ $v_{max} = \omega A$ $a_{max} = \omega^2 A$ Recognise and use the concept of the gradient of the $x - t$ graph leading to the $v - t$ graph, and the gradient of the v - t graph leading to the $a - t$ for SHM.	Students observe examples of SHM (IOP observing oscillations). They describe the characteristics observed eg velocity is maximum at centre; period is independent of amplitude; need for a restoring force directed to the centre of the motion. Give the condition for SHM as $a \propto -x$. Discuss relationship between x, v and a using observations and an animation such as that provided by University of New South Wales. Students use motion sensors and/or spreadsheets to plot $v - t$ and $x -$ graphs for SHM. Students should use the relationship between x, v and a graphs when explaining and processing the results of this work. Use Exampro questions to rehearse problem solving using SHM equations and knowledge and understanding of graphs. **Skills developed by learning activities:** AO1: Demonstrate knowledge and understanding of conditions for SHM by investigating different examples of oscillations.	Exampro QBW05.5.04 QW124A06 QS11.4A.07 QW11.4A.04 QW11.4A.05 QSP.4A.08	**Rich questions:** What characteristics do oscillating systems share? IOP observing oscillations SHM animation University of New South Wales. Nuffield Foundation investigating SHM	C3 C3 C3

	Graphical representations linking the variations of x, v and a with time. Appreciation that the $v - t$ graph is derived from the gradient of the $x - t$ graph and that the $a - t$ graph is derived from the gradient of the $v - t$ graph. Maximum speed $v_{max} = \omega A$ **Maximum acceleration $a_{max} = \omega^2 A$**		AO3: Analyse and interpret data from to reach conclusions on the relationship between x, v and a in a system executing SHM. MS3.9: Apply the concepts underlying calculus by finding the velocity/acceleration from $x - t$ / $v - t$ graphs of SHM. ATk: Use ICT such as computer modelling, or data logger to collect data, or use of software to process data on SHM experiments.			
3	**3.6.1.3 Simple harmonic systems** Study of mass-spring system:	structure and support students should be able to derive the equations for mass-spring and simple pendulum. Use the mass-spring and pendulum equations to solve SHM problems.	With support students derive the equations for the mass-spring system and pendulum. Rehearse mass-spring, pendulum and other harmonic oscillator problem solving using Exampro questions. Required practical investigation using a mass-spring and pendulum system. Students confirm	Exampro QS13.4A.09 QW11.4A.07 QS13.4.03 QBS04.4.03	**Rich questions:** How should a suspension system work to give the smoothest possible ride? Mass-spring resources from IOP	C3

	$T = 2\pi\sqrt{\frac{m}{k}}$ Study of simple pendulum: $T = 2\pi\sqrt{\frac{l}{g}}$ Questions may involve other harmonic oscillators (Eg liquid in U-tube) but full information will be provided in questions where necessary. Variation of E_k , E_p , and total energy with both displacement and time. Effects of damping on oscillations. **Required practical 7:** Investigation into simple harmonic	Recognise other harmonic oscillators and apply knowledge and understanding of mass-spring and pendulum to solve problems in different contexts. Describe the energy changes that take place in SHM and sketch graphs of variation of E_k, E_p and total energy with displacement and time. Describe the effects of damping on oscillations including sketching appropriate graphs of damped systems.	mathematical relationships between variables, for period and mass in the mass-spring system. Students compare the form of the mass-spring and pendulum systems. Discuss the energy changes that occur during SHM using the Nothing Nerdy simulation. Students observe damped systems such as water in a U-tube or a damped spring. Different degrees of damping illustrated practically or with a simulator. **Skills developed by learning activities:** AO2: Apply knowledge and understanding of scientific ideas to derive the equations for the mass spring and pendulum systems. AO3: Analyse and interpret data from to reach conclusions on the relationship between variables in oscillating systems. **MS 4.6 / AT b, c** Students should recognise the use of the small-angle approximation in the derivation of the time period for examples of approximate SHM. A step method using a spread sheet to model SHM and damped SHM. The exponential decay of a damped system investigated mathematically.		Pendulum resources from IOP Nothing Nerdy Energy simulation Practical investigation of damped motion from school physics.co.uk Damped motion simulator	C3 C3 C3 C3

	motion using a mass–spring system and a simple pendulum					
4	**3.6.1.4 Forced vibrations and resonance** Qualitative treatment of free and forced vibrations. Resonance and the effects of damping on the sharpness of resonance. Examples of these effects in mechanical systems and situations involving stationary waves.	Recognise free and forced vibrations and describe the difference between them. Sketch a typical frequency response curve for a forced vibration to show the sharpness of response and the effect of damping.	Demonstration and discussion of Barton's pendulum. Student experiments on resonance from IOP (hacksaw blade, book on string etc.). Students report back to group on one of the experiments. Students investigate the effect of damping on resonance curves using a simulation from PHET. Student experiment: Determination of the Speed of Sound using resonance of an air column. Resonance case studies: car suspension system questions and resources from IOP; Tacoma bridge disaster; shattering a glass with your voice. **Skills developed by learning activities:**	Exampro QSP.4A.10 Antonine education questions on vibrations.	**Rich question:** Is it possible to shatter a glass with your voice alone? Scientific American Article– Fact or Fiction Opera Singer breaking a glass Mythbuster Shattering a glass with your voice from YouTube Student experiments on resonance from IOP PHET resonance simulation Determining the speed of sound using an air column Car suspension systems and Tacoma bridge from IOP	C3 C3 C3 C3 C3 C3
5	**3.6.2.1 Thermal energy transfer** Calculations involving	Recall the definition of specific heat capacity and specific latent. Understand and apply the equation $Q = mc\Delta\theta$ to solve thermal energy transfer	Discuss the difference between temperature and heat. Demonstration of the 'Fire proof balloon' leading to concept and definition of specific heat capacity. Students measure the heat capacity of different substances using a variety of methods.	Exampro QS13.5.03 QS12501 QAS03.2.01	**Rich questions:** You can put out a candle with moist fingers (800 ˚C) but putting your hand in boiling water is very dangerous (100 ˚C). Explain how.	

	transfer of energy. For a change of temperature: $Q = mc\Delta\theta$ Where *c* is specific heat capacity. Calculations including continuous flow. For a change of state $Q = ml$ where *l* is the specific latent heat.	problems including in continuous flow. Understand and apply the equation $Q = ml$ to solve thermal energy transfer problems where there	Demonstration and discussion of changes of state without temperature change eg water boiling, stearic acid freezing. Students measure a specific latent heat, for example ice. Rehearsal of specific heat and latent heat examination questions from cyberphysics.co.uk. **Skills developed by learning activities:** AO1: Demonstrate knowledge and understanding of specific heat and specific latent heat. AO2: Apply knowledge and understanding of scientific ideas to solve problems involving transfer of thermal energy. **MS 1.5 / PS 2.3 / AT a, b, d, f** Investigate the factors that affect the change in temperature of a substance using an electrical method or the method of mixtures. Students should be able to identify random and systematic errors in the experiment and suggest ways to remove them. **PS 1.1, 4.1 / AT k** Investigate, with a data logger and temperature sensor, the change in temperature with time of a substance undergoing a phase change when energy is supplied at a constant rate.		Fire proof balloon demonstration and notes. Measuring Heat Capacity from IOP Measuring Latent heat of ice from IOP Specific Heat and Latent heat questions from Cyberphysics.co.uk	C3 C3 C3 C3
6	**3.6.2.2 Ideal gases** Gas laws as experimental relationships between p, V, T and the mass of the gas.	that give the relationships between p, V and T and the mass of a gas. Express these in words, algebraically and graphically. Understand the concept of absolute zero of temperature and how the gas laws lead to	Students investigate Boyle's Law and Charles's Law. Students extrapolate their results to find absolute zero and evaluate the experiment. Discuss the Kelvin temperature scale and students practise converting between ^oC and K. Discussion of how to combine the gas law expressions to find the Ideal gas equation. Students	Exampro QS13.5.04 QS12504	**Rich questions:** What is the best scale for measuring temperature? Boyle's Law and Charles Law investigations from CLEAPPS	C3

	Concept of absolute zero of temperature. Ideal gas equation: $pV = nRT$ for n moles and $pV = NkT$ for N molecules. $Work\ done = p\,\Delta\,V$ Avogadro constant NA, molar gas constant R, Boltzmann constant k. Molar mass and molecular mass. **Required practical 8:** Investigation of Boyle's law (constant temperature) and Charles's law (constant pressure) for a gas.	the existence of this temperature. Derive the equation $Work\ done = p\,\Delta\,V$ Understand and use the terms: Avogadro constant, molar mass, molecular mass. Use the gas law equations $Work\ done = p\,\Delta\,V$ to solve problems on the behaviour of gases.	to be familiar with all of the relevant terms: N, k, N_A, R, Molar Mass and molecular mass. Write a science dictionary entry for each. With support students derive the equation for the work done on/by a gas: $Work\ done = p\,\Delta\,V$. Rehearsal of calculations using IOP and www.s-cool.co.uk questions		IOP questions on Ideal Gases. www.s-cool.co.uk examination style questions	C3 C3

7	**3.6.2.3 Molecular kinetic theory model** Brownian motion as evidence for existence of atoms. Explanation of relationships between *p*, *V* and *T* in terms of a simple molecular model. Students should understand that the gas laws are empirical in nature whereas the kinetic theory model arises from theory. Assumptions leading to $pV = \frac{1}{3}N\,m\,(c_{rms})$ including derivation of the equation and calculations.	Describe Brownian motion and understand how it provides evidence for the existence of atoms. Explain relationships between p, V and *T* in terms of a simple molecular model. Understand that the gas laws are empirical in nature whereas the kinetic theory model arises from theory. Know the assumptions of the kinetic theory and the derivation of $pV = \frac{1}{3}N\,m\,(c_{rms})^2$ Use the equations the kinetic theory to solve problems. Describe how knowledge and understanding of gaseous behaviour has changed over time.	Observe Brownian motion through a microscope or a video clip. Students explain the observation and discussion of correct explanation using Brownian motion simulator. Demonstration: Kinetic theory model with ball bearings to demonstrate how particle collisions lead the relationship p, V and T. Students rehearse explanations in writing. With support students discuss the assumptions and derivation of the kinetic theory. Students write a short essay on the development of the gas laws from an experimental and theoretical perspective. They peer assess work before handing in for marking. Question practice using examination questions from Cyberphysics. **Skills developed by learning activities:** AO1: Demonstrate knowledge and understanding of Brownian motion and the development of kinetic theory. AO2: Apply knowledge and understanding of mechanics to derive the kinetic theory equations. **Skills developed by learning activities:** AO1: Demonstrate knowledge and understanding of Brownian motion and the development of kinetic theory. AO2: Apply knowledge and understanding of mechanics to derive the kinetic theory equations.	Exampro QAW03.2.04 QBS04.4.01 QBSOB6.4.06 SAMs Paper 2 Q 3	**Rich questions:** Suggest and explain conditions under which the kinetic theory would fail to describe the behaviour of a gas? YouTube video clip of Brownian motion Brownian motion simulator Cyberphysics Kinetic theory examination style questions.	 C3 C3 C3

	A simple algebraic approach involving conservation of momentum is required. Appreciation that for an ideal gas internal energy is kinetic energy of the atoms. Use of average molecular kinetic energy $\frac{1}{2}m\,(c_{rms})^2 = \frac{3}{2}kT$ $= \frac{3RT}{2N_A}$ Appreciation of how knowledge and understanding of the behaviour of gas has changed over time.					