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

Year Group: 12
Specification: AQA 7407

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	**3.1.1 Use of SI units and their prefixes** To recognise that a system of measurement depends on the selection of several base units. To recall the base units of the SI system. To name and use standard prefixes. To be able to convert between	• Students know that base units are needed in a system of measurement. • Students demonstrate that they can convert between different units of the same quantity, eg J and eV, J and kW h.	Use of dimensional analysis to predict relationships between quantities eg the speed of a wave, *v*, in water in terms of depth, *d*, and *g* MS0.1 MS0.2 MS2.2	Exampro. SAMs AS and A-level Q on same topic	http://www.npl.co.uk/educate-explore/	C3

	different units for the same quantity.					
2	**3.1.2 Limitation of physical measurements** To recognise the terms: precision, repeatability, reproducibility, and accuracy. To be able to estimate absolute uncertainties and to calculate fractional and percentage uncertainties. To be able to combine absolute and percentage	• Students explain the difference between precision and accuracy. • Students explain the difference between repeatability and reproducibility. • Students can estimate uncertainties in measurements • Students are able to calculate percentage uncertainties from absolute uncertainties. • Students are able to combine absolute and percentage uncertainties. Students can use error bars on graphs to estimate uncertainties in gradients and intercepts.	Practical: investigate the relationship between time period and length for a pendulum. Give students the opportunity to estimate uncertainties in the measurement of length and time. MS1,1 MS1.5 MS3.4 PS2.1 PS2.2 PS2.3 PS3.1 PS3.3		https://www.youtube.com/watch?v=1dTn2pt5PuA	C3

	uncertainties. To be able to use error bars on graphs.					
3	3.1.3 Estimation of Physical Quantities To understand and to use orders of magnitude. **To derive estimates using knowledge of physics**	Students are able to make order of magnitude estimates.	Students participate in group learning by designing their own order of magnitude estimates. MS1.4 PS1.2 Extend to estimates outside physics eg estimate how many piano tuners there are in Chicago.		http://physics.info/orders-magnitude/problems.shtml http://powersof10.com/film	C3 C3
4	**3.2.1.1 Constituents of the atom** Simple model of the atom, including the proton, neutron and electron. Charge and mass of the proton,	• Describe a model of the atom including protons, neutrons and electrons. • Identify the charge and mass of the proton, neutron and electron in SI and relative units. • Define specific charge and calculate the specific charges of the proton and the electron and of nuclei and ions.	**Learning activities:** • GCSE baseline assessment. • Present pictures of atomic models and ask students to identify the neutrons, protons and electrons. • Compare the charges and masses of protons, neutrons and electrons in SI and relative units. • Introduce specific charge and practice calculations involving the specific charges of protons and electrons and of nuclei and ions.	Past exam paper materials: PHYA1 May 2013 Q1 PHYA1 January 2013 Q1(a) PHYA1 June 2012 Q2(a) PHYA1 June 2012 Q2(b) PHYA1 May 2014 Q2(a)(i), (ii) and (iii)	http://phet.colorado.edu/en/simulation/build-an-atom **Rich questions:** Why was specific charge important in the discovery of the electron by J.J. Thomson?	C3

	neutron and electron in SI units and relative units. Specific charge of the proton and the electron, and of nuclei and ions. Proton number *Z*, nucleon number *A*, nuclide notation. Students should be familiar with the $^{A}_{Z}X$ notation. Meaning of isotopes and the use of isotopic data	• Identify the unit of specific charge. • Define proton number and nucleon number and recognise nuclear notation. • Explain the meaning of isotopes. • Analyse isotopic data.	• Review atomic number and nucleon number and practice using nuclide notation. • Review isotopes and practise analysing isotopic data to deduce neutron number. **Skills developed by learning activities:** AO1: Demonstration of knowledge of simple models of the atom. PS2.2: Present masses in SI and relative units. MS2.3: Substitute numerical values into algebraic equations to calculate specific charge. MS2.4: Solve algebraic equations involving masses and charges of nuclei and ions. AO2: Demonstrate knowledge and understanding isotopes and analyse isotope data.			
5	**3.2.1.2 Stable and unstable nuclei** The strong nuclear force; its	• Describe the strong nuclear force and its role in keeping the nucleus stable. • Recognise that the strong nuclear force has a short range	**Learning activities:** • Show the graph of the variation of the strong nuclear force with distance. • Discuss the key features of the graph, contrasting it with the electromagnetic interaction between two point charges.	Past exam paper materials: PHYA1 May 2013 Q2(b)(i) PHYA1 May 2013 Q2(a)(iv)	http://www.walter-fendt.de/ph14e/decayseries.htm **Rich question**: Identify a radioactive decay series and analyse the types of	C3

	role in keeping the nucleus stable; short-range attraction up to approximately 3 fm, very-short range repulsion closer than approximately 0.5 fm. Unstable nuclei; alpha and beta decay. Equations for alpha decay, β^- decay including the need for the neutrino. The existence of the neutrino was hypothesised to account for conservation of energy in beta decay.	attraction and a very short range repulsion. • Associate distance below 0.5 fm with repulsion and between 0.5 and 3.0 fm with attraction. • Describe alpha decay and beta decay. • Illustrate alpha beta decay using equations. • Deduce why the neutrino is necessary in beta decay.	• Explain what is meant by unstable nuclei and contrast alpha and beta decay. • Demonstrate alpha and beta tracks in a cloud chamber. • Demonstrate the difference in absorption properties of alpha and beta. • Practise writing equations to represent alpha and beta decay. • Compare the energy of alpha particles with beta particles and discuss why this led to the existence of neutrinos being hypothesised. **Skills developed by learning activities:** AO1**:** Demonstration of knowledge of strong nuclear force. AO2: Apply knowledge and understanding of scientific ideas, processes, techniques and procedures when handling quantitative data. AO2: Apply knowledge and understanding of alpha and beta decay to analyse and complete equations representing the decay. MS0.2: Recognise and use the distances associated with the strong nuclear force in standard form. ATI: Use of ionising radiation, including detectors.	PHYA1 May 2011 Q2 PHYA1 May 2010 Q2(b) and (c) SAM 013	decay taking place that lead to the series.	

6	**3.2.1.3 Particles, antiparticles and photons** For every type of particle, there is a corresponding antiparticle. Knowledge of particle antiparticle pairs and a comparison of their properties. The photon model of electromagnetic radiation. The energy of photons. The mechanisms of annihilation of matter and	• Recall that every particle has a corresponding antiparticle. • Contrast the properties of particles and antiparticles. • Give examples of particle antiparticle pairs. • Describe the photon model of electromagnetic radiation. • Calculate the energy of photons from wavelength and frequency. • Describe the processes of annihilation and pair production.	**Learning activity:** • Show table which compares properties of particles and antiparticles • Highlight similarities (rest mass) and differences (quantum numbers) • Introduce the photon as a particle of light whose energy depends on frequency. • Calculations involving photon energy using both frequencies and wavelengths. • Look at examples of annihilation of matter and antimatter. • Calculations linking the frequencies of photons produced in the annihilation of matter and antimatter. • Look at examples of pair production. • Calculations on the energy of photons necessary for pair production. **Skills developed by learning activities:** AO1**:** Demonstration of knowledge of matter and antimatter. AO2: Apply knowledge and understanding of the factors affecting the energy of photons. MS2.3: Substitute numerical values into algebraic equations to calculate energies of photons using frequency and wavelength. MS2.2, 2.4: Solve algebraic equations to calculate energy of photons from frequency	PHYA1 January 2013 Q2 PHYA1 May 2013 Q4(b	QED – Richard Feynman **Rich question:** How is annihilation of matter and antimatter used in forming a PET scan?	C3

	antimatter and pair production.		and wavelength. AO1**:** Demonstration of knowledge of the process of pair production. MS2.3: Substitute numerical values into algebraic equations to calculate the frequencies of photons required for pair production. AO1**:** Demonstration of knowledge of the process of annihilation. MS2.4: Solve algebraic equations to calculate the frequency of the photons released during annihilation.			
7	**3.2.1.4 Particle interactions** The four fundamental interactions. The fundamental interactions in terms of exchange particles. The weak interaction. Diagrams to represent the fundamental interactions.	• Name the four fundamental interactions. • Describe the fundamental interactions in terms of exchange particles. • Identify the virtual photon as the exchange particle in the electromagnetic interaction. • Distinguish between β^- and β^+ decay identifying them both as examples of the weak interaction. • Analyse electron capture and electron positron collisions as examples of the weak interaction and identify the appropriate	**Learning activity:** • List the four fundamental forces together with the appropriate exchange particle. • Give examples of the weak interaction and let students verifying that charge, lepton number and baryon number are conserved in these interactions. • Practise the construction of simple Feynman diagrams. Emphasise the importance of the conservation laws at the points where lines in the diagrams meet. **Skills developed by learning activities:** AO1: Demonstration of knowledge of the fundamental interactions. AO2: Apply knowledge and understanding of conservation laws in particle interactions. AO2: Apply knowledge and understanding in the importance of conservation laws when constructing Feynman diagrams	PHYA1 June 2014 Q2(b) PHYA1 June 2013 Q2(a) and (b)	http://hyperphysics.phy-astr.gsu.edu/hbase/forces/funfor.html https://www.youtube.com/watch?v=3P-FGw5KUeo	C3 C3

		exchange particle (W+ or W^-) in each case. Draw simple diagrams to represent interactions.				
8	**3.2.1.5 Classification of particles** Hadrons are subject to the strong interaction. There are two classes of hadrons. Baryon number and its conservation. The proton as the only stable baryon. The pion as the exchange particle of the strong nuclear force.	• Associate hadrons with the strong interaction. • Classify hadrons into baryons and mesons. • Differentiate between baryons and mesons in terms of baryon number and are able to demonstrate baryon number conservation in interactions. • Explain that the proton is the only stable hadron and that all other baryons eventually decay into protons. • Identify the pion as the exchange particle of the strong nuclear force. • Recognise and describe kaon decay. • Identify leptons and how they can interact through the weak interaction. • Identify the lepton numbers of electrons, muons and neutrinos and demonstrate	**Learning activity:** • Practise dividing particles into hadrons and leptons and then hadrons into baryon and mesons. • Give examples of baryons and emphasise that the proton is the only stable baryon. • Provide the opportunity to analyse baryon decay equations. • Provide the opportunity to analyse the decay routes of the mesons such as the kaon. • Give practise at identifying possible decays of mesons and baryons by applying conservation laws. • Provide a list of leptons with associated lepton numbers and use this to analyse lepton interactions through the weak interaction. • Give examples of strange particles and demonstrate how have to be in the weak interaction. **Skills developed by learning activities:** AO1: Demonstration of knowledge of the classification of hadrons, baryons and mesons.	SAM 1 PHYA1 May 2013 Q3(a) PHYA1 May 2014 Q1 PHYA1 May 2012 Q3	http://www.particleadventure.org/quarks_leptons.html **Rich questions:** What is the Higg's-boson particle and why is it so important to the standard model?	C3

	The decay of kaons into pions. Examples of leptons and their antiparticles. Lepton number and its conservation. The decay of muons into electrons. Strange particles and their production through the strong interaction and their decay through the weak interaction. Strangeness and its conservation in strong interactions.	lepton number conservation in examples of the weak interaction. • Describe the decay of muons into electrons. • Identify strange particles and describe their production and decay. • Demonstrate the conservation of strangeness in strong interactions. • Explain that strangeness does not have to be conserved in the weak interaction.	AO2: Apply knowledge and understanding of how decay equations can be analysed to predict if they can occur. AO1: Demonstration of knowledge of leptons. AO1: Demonstration of knowledge of the classification of strange particles. AO2: Apply knowledge and understanding of how strangeness does not have to be conserved in the weak interaction.			

	Strangeness does not have to be conserved in the weak interaction.					
9	**3.2.1.6 Quarks and antiquarks** Properties of quarks and antiquarks. Combinations of quarks and antiquarks required for baryons, antibaryons and mesons.	• Recognise charge, baryon number and strangeness as properties of quarks and antiquarks. Analyse the quark structure of protons, neutrons, antiprotons, antineutrons, pions and kaons.	• Provide a table of properties of quarks and antiquarks. • Provide the opportunity to deduce the quark structure of a wide range of particles. **Skills developed by learning activities:** AO1: Demonstration of knowledge and understanding of quark and antiquark properties. AO2: Apply knowledge and understanding of quark properties to deduce quark structures.	PHYA1 May 2014 Q1 PHYA1 May 2012 Q1(a) PHYA1 Jan 2013 Q3(a)	http://sciencepark.etacude.com/particle/introduction.php http://hyperphysics.phy-astr.gsu.edu/hbase/particles/quark.html http://hyperphysics.phy-astr.gsu.edu/hbase/particles/meson.html	C3 C3 C3
10	**3.2.1.7 Applications of conservation laws** Change of quark nature in β^- and β^+ decay. Application of conservation laws for charge, baryon	• Identify the change in quark character in β^- and β^+ decay. • Apply the conservation laws for charge, baryon number, lepton number and strangeness for particle interactions. Recall that momentum and energy are conserved in interactions.	**Learning activity:** • Demonstrate beta minus decay using a radioactive source. Distinguish between beta minus and beta plus decay. • Provide a list of decay equations and ask students to identify which are possible decays by applying conservation laws. • Provide incomplete decay equations and ask students to the missing particles. **Skills developed by learning activities:** AO1: Demonstration of knowledge and understanding of beta plus and beta minus decay.	PHYA1 May 2014 Q1(c) PHYA1 May 2012 Q1(b)	http://hyperphysics.phy-astr.gsu.edu/hbase/particles/parint.html	C3

	number, lepton number and strangeness for particle interactions. Conservation of energy and momentum in interactions.		AO2: Apply knowledge and understanding of conservation laws to analyse decay equations.			
11	**3.2.2.1 The photoelectric effect** Description of the photoelectric effect. Explanation of threshold frequency in terms of the photon model. Explanation of work function and stopping potential. The photoelectric equation	• Describe the photoelectric effect. • Recognise that the threshold frequency cannot be explained by the wave model of light and can deduce an explanation of threshold frequency in terms of the photon model. • Explain the terms work function and stopping potential. • Analyse the photoelectric effect using the photoelectric equation and calculate the maximum kinetic energy of emitted electrons. • Deduce that the emitted electrons have a range of kinetic energies up to the maximum value	**Learning activity:** • Demonstrate the photoelectric effect using a zinc plate on the cap of an electroscope and an ultraviolet light source. • Discuss the predictions made by the wave theory of light and explain how the threshold frequency cannot be explained with this model. Explain that applying scientific method means that the theory of light needs to be changed to explain the experimental observations of the photoelectric effect. • Outline the photon model of light and how this explains threshold frequency. • Practise using the photoelectric equation to calculate the maximum kinetic energy of emitted electrons. • Provide the opportunity to deduce the effect of changing the intensity of the incident light and the frequency of the incident light. • Plot graphs of maximum kinetic energies of emitted electrons against frequency of incident light for different metal surfaces. Analyse the graph to find a value for the	SAM 02 PHYA1 May 2013 Q4 PHYA1 May 2012 Q4	http://physics.info/photoelectric/ https://www.youtube.com/watch?v=0qKrOF-gJZ4 https://www.youtube.com/watch?v=kcSYV8bJox8	C3 C3 C3

		calculated using the photoelectric equation.	Planck constant, the threshold frequency and the work function. **Skills developed by learning activities:** AO1: Demonstration of knowledge and understanding of beta. AO2: Apply knowledge and understanding of the photoelectric effect both qualitatively and quantitatively. AO3: Analyse, interpret and evaluate scientific ideas and evidence to see why the wave model of light does not explain the photoelectric effect. MS0.2: Recognise expressions in decimal and standard form when applying the photoelectric equation. MS2.3: Substitute numerical values into the photoelectric equation. PS3.2: Process and analyse data from photoelectric experiments. MS2.4: Solve the photoelectric equation to determine maximum kinetic energies of electrons. MS3.2: Plot maximum kinetic energy against frequency of incident light. PS3.1: Plot and interpret graphs of maximum kinetic energy of emitted electrons against frequency of incident light. MS3.4: Determine the intercept and gradient of the maximum kinetic energy against frequency graph to find a value for Planck's			

			constant, threshold frequency and work function.			
12	**.2.2.2 Collisions of electrons with atoms** Ionisation and excitation. Application in the fluorescent tube. The electron volt.	• Describe the processes of excitation and ionisation • Explain how excitation and ionisation apply in the fluorescent tube. • Define the electron volt Convert energies from eV to J and vice versa	**Learning activity:** • Show examples of line spectra with the use of discharge tubes and diffraction gratings or direct view spectroscopes. • Examine the structure of the fluorescent tube. • Practise calculations converting energy from joules to electron volts. **Skills developed by learning activities:** AO1: Demonstration of knowledge and understanding of nature of line spectra. AO1: Demonstration of knowledge and understanding of the structure of the fluorescent tube. AO2: Apply knowledge and understanding of the electron volt to perform calculations to convert energies in joules to electron voltsMS0.2: Recognise expressions in decimal and standard form when using energies in electron volt	PHYA1 May 2014 Q4 PHYA1 Jan 2013 Q4	http://astronomy.swin.edu.au/cosmos/S/Spectral+Line http://www.colorado.edu/physics/2000/quantumzone/ https://www.youtube.com/watch?v=QI50GBUJ48s **Rich questions:** How are line spectra used to measure the rotational speeds of stars? How do line spectra provide evidence of the Big Bang?	C3 C3 C3
13	**3.2.2.3 Energy levels and photon emission** Line spectra as evidence of discrete energy levels. Calculation of the	• Demonstrate how line spectra implies discrete energy levels in atoms. Calculate the frequencies of emitted photons using the energies associated with different discrete energy levels.	**Learning activity:** • Contrast continuous spectra with line spectra and establish that line spectra are a consequence of discrete energy levels in atoms. • Practise using the energy differences between levels to calculate frequencies and wavelengths of emitted photons. • Analyse different energy level diagrams to predict the transitions responsible for a particular characteristic frequency.	PHYA1 May 2014 Q4	http://hyperphysics.phy-astr.gsu.edu/hbase/hyde.html - c2 http://physics.nist.gov/PhysRefData/ASD/lines_form.html	C3 C3

	frequency of emitted photons.		**Skills developed by learning activities:** AO1: Demonstration of knowledge and understanding of discrete energy levels and how these lead to line spectra. AO2: Apply knowledge and understanding of discrete energy levels and the energies associated with them to calculate frequencies and wavelengths of emitted photons. MS0.1, 0.2, 2.4: Solve the equation relating the energy differences between levels to the frequencies and wavelengths of emitted photons. understanding of discrete energy levels and the energies associated with them to calculate frequencies and wavelengths of emitted photons. MS0.1, 0.2, 2.4: Solve the equation relating the energy differences between levels to the frequencies and wavelengths of emitted photons.			
14	**3.2.2.4 Wave-particle duality** Electron diffraction as a demonstration that particles possess wave properties.	• Identify that electron diffraction provides evidence of particles having wave properties. • Analyse the photoelectric effect and deduce that it demonstrates the particulate nature of electromagnetic waves. • Calculate the wavelength of a	**Learning activity:** • Demonstrate electron diffraction and compare with diffraction of a laser through a single slit. • Discuss the photoelectric effect and how it provides evidence of the dual nature of light. • Practise calculations using the de Broglie equation. **Skills developed by learning activities:** AO1: Demonstration of knowledge and understanding of electron diffraction.	PHYA1 May 2014 Q3	http://hyperphysics.phy-astr.gsu.edu/hbase/mod1.html - c1 **Rich questions:** Is there experimental evidence for the diffraction of protons or neutrons? Why do electron microscopes have a much better resolving	C3

	The photoelectric effect as a demonstration that electromagnetic waves have a particulate nature. The de Broglie wavelength.	particle using the de Broglie equation. Explain how and why the amount of diffraction changes when the momentum of a particle is changed.	PS1.2: Demonstration using electron diffraction tube. AO1: Demonstration of knowledge and understanding of the dual nature of light. AO2: Apply of knowledge and understanding of the de Broglie equation to calculate the de Broglie wavelength. MS1.1, 2.3: Use prefixes when expressing wavelength values		power than optical microscopes?	