

Syllabus checklist

MODULE 5 Advanced Mechanics

PH12–12

- How can models that are used to explain projectile motion be used to analyse and make predictions?**
- ☐ analyse the motion of projectiles by resolving the motion into horizontal and vertical components, making the following assumptions:...
 - ☐ apply the modelling of projectile motion to quantitatively derive the relationships between the following variables:...
 - ☐ conduct a practical investigation to collect primary data in order to validate the relationships derived above.
 - ☐ solve problems, create models and make quantitative predictions by applying the equations of motion relationships for uniformly accelerated and constant rectilinear motion

Why do objects move in circles?

- ☐ conduct investigations to explain and evaluate, for objects executing uniform circular motion, the relationships that exist between:...
- ☐ analyse the forces acting on an object executing uniform circular motion in a variety of situations, for example:...
- ☐ solve problems, model and make quantitative predictions about objects executing uniform circular motion in a variety of situations, using the following relationships:...
- ☐ investigate the relationship between the total energy and work done on an object executing uniform circular motion
- ☐ investigate the relationship between the rotation of mechanical systems and the applied torque

How does the force of gravity determine the motion of planets and satellites?

- ☐ apply qualitatively and quantitatively Newton's Law of Universal Gravitation to:...
- ☐ determine the force of gravity between two objects $F = \frac{GMm}{r^2}$
- ☐ investigate the factors that affect the gravitational field strength $g = \frac{GM}{r^2}$
- ☐ predict the gravitational field strength at any point in a gravitational field, including at the surface of a planet (ACSPH094, ACSPH095, ACSPH097)
- ☐ investigate the orbital motion of planets and artificial satellites when applying the relationships between the following quantities:...
- ☐ predict quantitatively the orbital properties of planets and satellites in a variety of situations, including near the Earth and geostationary orbits, and relate these to their uses (ACSPH101)
- ☐ investigate the relationship of Kepler's Laws of Planetary Motion to the forces acting on, and the total energy of, planets in circular and non-circular orbits using: (ACSPH101)
- ☐ derive quantitatively and apply the concepts of gravitational force and gravitational potential energy in radial gravitational fields to a variety of situations, including but not limited to:...

MODULE 6 Electromagnetism

PH12–13

- What happens to stationary and moving charged particles when they interact with an electric or magnetic field?**
- ☐ investigate and quantitatively derive and analyse the interaction between charged particles and uniform electric fields, including: (ACSPH083)
 - ☐ model qualitatively and quantitatively the trajectories of charged particles in electric fields and compare them with the trajectories of projectiles in a gravitational field
 - ☐ analyse the interaction between charged particles and uniform magnetic fields, including: (ACSPH083)
 - ☐ compare the interaction of charged particles moving in magnetic fields to:...

Under what circumstances is a force produced on a current-carrying conductor in a magnetic field?

- ☐ investigate qualitatively and quantitatively the interaction between a current-carrying conductor and a uniform magnetic field $F = Il \times B = IlB \sin \theta$ to establish: (ACSPH080, ACSPH081)
- ☐ conduct a quantitative investigation to demonstrate the interaction between two parallel current-carrying wires
- ☐ analyse the interaction between two parallel current-carrying wires $F/l = (\mu_0/2\pi) \frac{I_1 I_2}{r}$ and determine the relationship between the International System of Units (SI) definition of an ampere and Newton's Third Law of Motion (ACSPH081, ACSPH106)

How are electric and magnetic fields related?

- ☐ describe how magnetic flux can change, with reference to the relationship $\Phi = B \cdot A = BA \cos \theta$ (ACSPH083, ACSPH107, ACSPH109)
- ☐ analyse qualitatively and quantitatively, with reference to energy transfers and transformations, examples of Faraday's Law and Lenz's Law $\epsilon = -N \Delta \Phi / \Delta t$, including but not limited to: (ACSPH081, ACSPH110)
- ☐ analyse quantitatively the operation of ideal transformers through the application of: (ACSPH110)
- ☐ evaluate qualitatively the limitations of the ideal transformer model and the strategies used to improve transformer efficiency, including but not limited to:...
- ☐ analyse applications of step-up and step-down transformers, including but not limited to:...

How has knowledge about the Motor Effect been applied to technological advances?

- ☐ investigate the operation of a simple DC motor to analyse:...
- ☐ analyse the operation of simple DC and AC generators and AC induction motors (ACSPH110)
- ☐ relate Lenz's Law to the law of conservation of energy and apply the law of conservation of energy to:...

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MODULE 7

The Nature of Light

PH12–14

What is light?

- ☐ investigate Maxwell's contribution to the classical theory of electromagnetism, including:...
- ☐ describe the production and propagation of electromagnetic waves and relate these processes qualitatively to the predictions made by Maxwell's electromagnetic theory (ACSPH112, ACSPH113)
- ☐ conduct investigations of historical and contemporary methods used to determine the speed of light and its current relationship to the measurement of time and distance (ACSPH082)
- ☐ conduct an investigation to examine a variety of spectra produced by discharge tubes, reflected sunlight or incandescent filaments
- ☐ investigate how spectroscopy can be used to provide information about:...
- ☐ investigate how the spectra of stars can provide information on:...

What evidence supports the classical wave model of light and what predictions can be made using this model?

- ☐ conduct investigations to analyse qualitatively the diffraction of light (ACSPH048, ACSPH076)
- ☐ conduct investigations to analyse quantitatively the interference of light using double slit apparatus and diffraction gratings $d\sin\theta=m\lambda$ (ACSPH116, ACSPH117, ACSPH140)
- ☐ analyse the experimental evidence that supported the models of light that were proposed by Newton and Huygens (ACSPH050, ACSPH118, ACSPH123)
- ☐ conduct investigations quantitatively using the relationship of Malus' Law $I=I_{\text{max}}\cos^2\theta$ for plane polarisation of light, to evaluate the significance of polarisation in developing a model for light (ACSPH050, ACSPH076, ACSPH120)

What evidence supports the particle model of light and what are the implications of this evidence for the development of the quantum model of light?

- ☐ analyse the experimental evidence gathered about black body radiation, including Wien's Law related to Planck's contribution to a changed model of light (ACSPH137)
- ☐ investigate the evidence from photoelectric effect investigations that demonstrated inconsistency with the wave model for light (ACSPH087, ACSPH123, ACSPH137)
- ☐ analyse the photoelectric effect $K_{\text{max}}=hf-\phi$ as it occurs in metallic elements by applying the law of conservation of energy and the photon model of light, (ACSPH119)

How does the behaviour of light affect concepts of time, space and matter?

- ☐ analyse and evaluate the evidence confirming or denying Einstein's two postulates:...
- ☐ investigate the evidence, from Einstein's thought experiments and subsequent experimental validation, for time dilation $t=t_0/\sqrt{1-v^2/c^2}$ and length contraction $l=l_0\sqrt{1-v^2/c^2}$, and analyse quantitatively situations in which these are observed, for example:...
- ☐ describe the consequences and applications of relativistic momentum with reference to:...
- ☐ Use Einstein's mass–energy equivalence relationship $E=mc^2$ to calculate the energy released by processes in which mass is converted to energy, for example: (ACSPH134)

MODULE 8

From the Universe to the Atom

PH12–15

What evidence is there for the origins of the elements?

- ☐ investigate the processes that led to the transformation of radiation into matter that followed the 'Big Bang'
- ☐ investigate the evidence that led to the discovery of the expansion of the Universe by Hubble (ACSPH138)
- ☐ analyse and apply Einstein's description of the equivalence of energy and mass and relate this to the nuclear reactions that occur in stars (ACSPH031)
- ☐ account for the production of emission and absorption spectra and compare these with a continuous black body spectrum (ACSPH137)
- ☐ investigate the key features of stellar spectra and describe how these are used to classify stars
- ☐ investigate the Hertzsprung–Russell diagram and how it can be used to determine the following about a star:...
- ☐ investigate the types of nucleosynthesis reactions involved in Main Sequence and Post–Main Sequence stars, including but not limited to:...

How is it known that atoms are made up of protons, neutrons and electrons?

- ☐ investigate, assess and model the experimental evidence supporting the existence and properties of the electron, including:...
- ☐ investigate, assess and model the experimental evidence supporting the nuclear model of the atom, including:...

How is it known that classical physics cannot explain the properties of the atom?

- ☐ assess the limitations of the Rutherford and Bohr atomic models
- ☐ investigate the line emission spectra to examine the Balmer series in hydrogen (ACSPH138)
- ☐ relate qualitatively and quantitatively the quantised energy levels of the hydrogen atom and the law of conservation of energy to the line emission spectrum of hydrogen using:...
- ☐ investigate de Broglie's matter waves, and the experimental evidence that developed the following formula:...
- ☐ analyse the contribution of Schrödinger to the current model of the atom

How can the energy of the atomic nucleus be harnessed?

- ☐ analyse the spontaneous decay of unstable nuclei, and the properties of the alpha, beta and gamma radiation emitted (ACSPH028, ACSPH030)
- ☐ examine the model of half–life in radioactive decay and make quantitative predictions about the activity or amount of a radioactive sample using the following relationships:...
- ☐ model and explain the process of nuclear fission, including the concepts of controlled and uncontrolled chain reactions, and account for the release of energy in the process (ACSPH033, ACSPH034)
- ☐ analyse relationships that represent conservation of mass–energy in spontaneous and artificial nuclear transmutations, including alpha decay, beta decay, nuclear fission and nuclear fusion (ACSPH032)
- ☐ account for the release of energy in the process of nuclear fusion (ACSPH035, ACSPH036)
- ☐ predict quantitatively the energy released in nuclear decays or transmutations, including nuclear fission and nuclear fusion, by applying: (ACSPH031, ACSPH035, ACSPH036)

How is it known that human understanding of matter is still incomplete?

- ☐ analyse the evidence that suggests:...
- ☐ investigate the Standard Model of matter, including:...
- ☐ investigate the operation and role of particle accelerators in obtaining evidence that tests and/or validates aspects of theories, including the Standard Model of matter (ACSPH120, ACSPH121, ACSPH122, ACSPH146)