A2 Physics – Orbits and the Wider Universe (ABP) — Year 13 LP 4

This half term: Skills, Knowledge and Understanding to be developed:

Skills (students will be able to by the end of the Learning Programme): Will be able to define Kepler's three laws of orbit, calculate the orbital period and speed of a planet orbiting a star, how radial velocities of stars inside a galaxy indicates the existence of dark matter, calculate the distance and period of orbits of bodies in mutual orbit.
Knowledge (students will know by the end of the Learning Programme): Will know that planets have an elliptical orbit, sweeps out equal area in equal time, r^3 is proportional to T^2, that the universe is expanding, galaxies are moving away from each other therefore frequency of the light observed is in the red end of the spectrum, the age of universe and it critical density.
Understanding (students will demonstrate their understanding): By answering past A2 exam papers on the subject orbits and the wider universe.

Key Terms/Words:
Kepler
Gravitation
Centripetal
Acceleration
Spiral Galaxy
Higgs Boson
Doppler Effect
Hubble Constant
Critical Density
Dark Matter

LP 3 – Week 1 & 2 Learning Outcomes:

Unit 4.3: Orbits and the Wider Universe

Lesson 1 – Students will be able to define Kepler's 1st, 2nd and third law:
Kepler's 1st Law – Each planet moves in an ellipse with the Sun at one focus.
Kepler's 2nd Law – The line joining a planet to the center of the Sun sweeps out equal areas in equal times.
Kepler's 3rd Law - T^2, the square of the period of the planet's motion, is proportional to r^3, in which r is the semi-major axis of its ellipse.

Lesson 2 – Students will be able to apply Newton's law of gravitation in simple examples, including the motion of planets and satellites.

Lesson 3 - Students will be able to derive Kepler's 3rd Law, for the case of a circular orbit from Newton's law of gravity and the formula for centripetal acceleration. Students will know how to use data on orbital motion, such as period or orbital speed, to calculate the mass of the central object.

Lesson 4 – Students will be able to explain that the orbital speeds of objects in spiral galaxies implies the existence of dark matter.

Independent study hour: Students will be completing questions on……

Success criteria:

1. Students will write the definitions of Kepler's law in their notes

2. Students will calculate the constant of T^2 / r^3 of planets in the Solar System

3. Students will derive the equation for the orbital period of planets

4. Students will draw a graph of v^2 against r of the planets in the Solar System

Homework LP3 1 /3

Past Paper Questions on Kepler's Laws

Mark:

LP 3 – Week 3 & 4 Learning Outcomes:

Lesson 5 – Students will be able to explain how the recently discovered Higgs boson may be related to dark matter.

Lesson 6 – **Students will apply and demonstrate new knowledge and skills in APP1 assessment.**
Students will be able to determine the position of the centre of mass of two spherically symmetric objects, given their masses and separation, and calculate their mutual orbital period in the case of circular orbits.

Lesson 7 – Students will be able to use the Doppler equation to answer past exam questions - $\frac{\Delta\lambda}{\lambda} = \frac{v}{c}$

Assessment

APP1

Mark

Success criteria:

1. Students will calculate orbital period, masses and separation of objects in a binary system

2. Students will calculate radial velocity of different stars by using Doppler's effect

APP1 (10 marks)

Homework LP3 2 /3

Lesson 8 – Students will be able to determine a star's radial velocity from data about the Doppler shift of spectral lines. Independent study hour: Students will be completing questions on…..			
LP 3 – Week 5 & 6 Learning Outcomes: **Lesson 9** – Students will be able to use the data on the variation of the radial velocities of the bodies in a double system and their orbital period to determine the masses of the bodies for the case of a circular orbit edge as viewed from the Earth. **Lesson 10** – Students will be able to identify that the Hubble constant (H_0) relates galactic radial velocity (v) to distance (D) and it is defined by $v = H_0 D$. Students will be able to explain why $\frac{1}{H_0}$ the age of the universe approximates. **Lesson 11** – Students will be able to explain how the equation $\rho_c = \frac{3{H_0}^2}{8\pi G}$ for the critical density of a 'flat' universe can be derived very simply using conservation of energy. **Lesson 12** – **Summative Assessment - Students will be able to apply and demonstrate new knowledge and skills.** Students will be able to answer the feedback given by the teacher on their SA in the form of a star and a question. Students will be able to correct their work by using the marking scheme **Independent study hour**: Students will be carrying out a Specified Practical or completing questions on	Assessment **SA** **Mark** **Grade**	**Success criteria:** 1. Students will use the Hubble Constant to estimate the age of the universe 2. Students will use the conservation of energy to derive the equation for critical density	**Homework LP3 3/3** Prepare for SA