Module 5 Newtonian World & Astrophysics

Module 5: Newtonian world and astrophysics

The aim of this module is to show the impact Newtonian mechanics has on physics. The microscopic motion of atoms can be modelled using Newton's laws and hence provide us with an understanding of macroscopic quantities such as pressure and temperature. Newton's law of gravitation can be used to predict the motion of planets and distant galaxies. In the final section we explore the intricacies of stars and the expansion of the Universe by analysing the electromagnetic radiation from space. As such, it lends itself to the consideration of how the development of the scientific model is improved based on the advances in the means of observation (HSW1, 2, 5, 6, 7, 8, 9, 11).

In this module, learners will learn about thermal physics, circular motion, oscillations, gravitational field, astrophysics and cosmology.

Module 5 Newtonian World & Astrophysics

Unit 5 Astrophysics & Cosmology

5.5 Astrophysics and cosmology

This section provides knowledge and understanding of stars, Wien's displacement law, Stefan's law, Hubble's law and the Big Bang.

Learners have the opportunity to appreciate how scientific ideas of the Big Bang developed over time and how its validity is supported by research and experimental work carried out by the scientific community (HSW2, 7, 8, 11).

You are here! →

Module 5 – Newtonian world and astrophysics

5.1 Thermal physics

5.2 Circular motion

5.3 Oscillations

5.4 Gravitational fields

5.5 Astrophysics and cosmology

Module 6 – Particles and medical physics

6.1 Capacitors

6.2 Electric fields

6.3 Electromagnetism

6.4 Nuclear and particle physics

6.5 Medical imaging

Your task:
Produce a Series of posters/PowerPoint slides which show each of the following objectives.

5.4 Gravitational Fields

- 5.5.1 Stars
- 5.5.2 EM Radiation from Stars
- 5.5.3 Cosmology

5.5.1 Stars

Learning outcomes

Learners should be able to demonstrate and apply their knowledge and understanding of:

(a) the terms planets, planetary satellites, comets, solar systems, galaxies and the universe

(b) formation of a star from interstellar dust and gas in terms of gravitational collapse, fusion of hydrogen into helium, radiation and gas pressure

(c) evolution of a low-mass star like our Sun into a red giant and white dwarf; planetary nebula

(d) characteristics of a white dwarf; electron degeneracy pressure; Chandrasekhar limit

(e) evolution of a massive star into a red super giant and then either a neutron star or black hole; supernova

(f) characteristics of a neutron star and a black hole

(g) Hertzsprung–Russell (HR) diagram as luminosity-temperature plot; main sequence; red giants; super red giants; white dwarfs.

5.5.2 Electromagnetic radiation from stars

Learning outcomes

Learners should be able to demonstrate and apply their knowledge and understanding of:

(a) energy levels of electrons in isolated gas atoms

(b) the idea that energy levels have negative values

(c) emission spectral lines from hot gases in terms of emission of photons and transition of electrons between discrete energy levels

(d) the equations $hf = \Delta E$ and $\frac{hc}{\lambda} = \Delta E$

(e) different atoms have different spectral lines which can be used to identify elements within stars

(f) continuous spectrum, emission line spectrum and absorption line spectrum

(g) transmission diffraction grating used to determine the wavelength of light

(h) the condition for maxima $d \sin\theta = n\lambda$, where d is the grating spacing

(i) use of Wien's displacement law $\lambda_{max} \propto \frac{1}{T}$ to estimate the peak surface temperature (of a star)

(j) luminosity L of a star; Stefan's law $L = 4\pi r^2 \sigma T^4$ where σ is the Stefan constant

(k) use of Wien's displacement law and Stefan's law to estimate the radius of a star.

5.5.3 Cosmology

Learning outcomes

Learners should be able to demonstrate and apply their knowledge and understanding of:

(a) distances measured in astronomical unit (AU), light-year (ly) and parsec (pc)

(b) stellar parallax; distances the parsec (pc)

(c) the equation $p = \frac{1}{d}$, where p is the parallax in seconds of arc and d is the distance in parsec

(d) the Cosmological principle; universe is homogeneous, isotropic and the laws of physics are universal

(e) Doppler effect; Doppler shift of electromagnetic radiation

(f) Doppler equation $\frac{\Delta\lambda}{\lambda} \approx \frac{\Delta f}{f} \approx \frac{v}{c}$ for a source of electromagnetic radiation moving relative to an observer

(g) Hubble's law; $v \approx H_0 d$ for receding galaxies, where H_0 is the Hubble constant

(h) model of an expanding universe supported by galactic red shift

(i) Hubble constant H_0 in both $\mathrm{km\,s^{-1}\,Mpc^{-1}}$ and $\mathrm{s^{-1}}$ units

(j) the Big Bang theory

(k) experimental evidence for the Big Bang theory from microwave background radiation at a temperature of 2.7 K

(l) the idea that the Big Bang gave rise to the expansion of space-time

(m) estimation for the age of the universe; $t \approx H_0^{-1}$

(n) evolution of the universe after the Big Bang to the present

(o) current ideas; universe is made up of dark energy, dark matter, and a small percentage of ordinary matter.

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5.4 Gravitational fields

Complete! → 5.5 Astrophysics and cosmology

Module 6 – Particles and medical physics

6.1 Capacitors

6.2 Electric fields

6.3 Electromagnetism

6.4 Nuclear and particle physics

6.5 Medical imaging