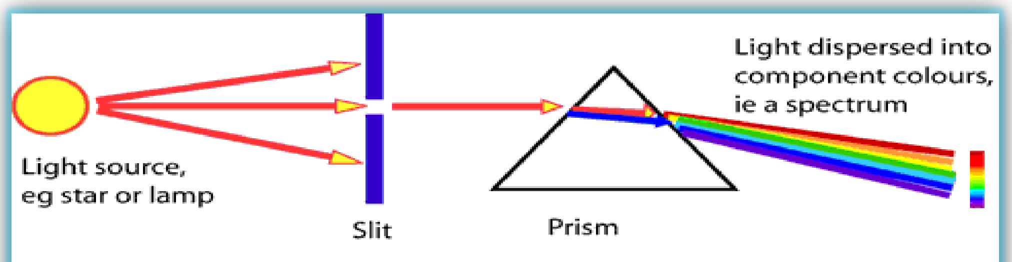
3.2 Describe the technology needed to measure astronomical spectra –

- **Astronomical Spectra consists of the range of wavelengths of light, viewed using a spectroscope**
- **A spectroscope (spreads light into its spectrum) has 3 basic components:**
  1. **The Collimator → several narrow slits and lenses that form parallel beams of light**
  2. **The Dispersive Element → a triangular prism or diffracting grating that disperses light into its spectrum (different wavelengths have different refractive indexes** (blue light travels slower through glass than red light and thus is refracted more)
  3. **The Recording Device → views, records, analyses the different wavelengths formed. Spectrum can be recorded:**
     - **Using Photographic Plates that records stellar spectra but each photographic film only converts 1% of incident photons into an image**
     - **By passing it through a small telescope with an electronic sensor called a photometer attached, which measures the intensity of each wavelength and produces an intensity graph**



Dispersion of light through a prism

4.3 Outline spectroscopic parallax –

- **Spectroscopic Parallax uses the H-R diagram and distance modulus formula to find the approximate distance of a star by determining the star's apparent & absolute magnitudes**

1. **Using photometry (e.g. photomultipliers), measure the apparent magnitude of the star**
2. **Using spectroscopy, determine the star's spectral class and luminosity class (e.g. O, B, A)**
3. **Use star's spectral class and luminosity class and the H-R diagram to determine the star's absolute magnitude →** draw a vertical line from spectral class (e.g. O, A) on x-axis until it intercepts the centre of the luminosity class (star group). Here, draw a horizontal line until it meets the y-axis, representing absolute magnitude of star
4. **Use the m and M values in the distance-modulus formula**

- This method is only accurate to 10% and to a max. distance of 10megaparsecs as:
  i. Determination of the absolute magnitude carries large % error, especially as luminosity classes are usually broad bands on H-R diagram
  ii. Interstellar gases or dust (seeing) affects accuracy of brightness measurements

5.4 Classify variable stars as either intrinsic or extrinsic and periodic or non-periodic –

- Variable Stars: Stars which vary in brightness (apparent magnitude) over time from Earth
- Classified by cause of variation (intrinsic/extrinsic) or pattern of variation (periodic/non-periodic)

Intrinsic Variable Stars	• Vary in brightness due to a cause internal to the star • Either periodic or non-periodic e.g. Pulsating, Eruptive/Explosive Variables
Extrinsic Variable Stars	• Vary in brightness due to a cause external to the star • May be intrinsic as well e.g. Eclipsing Binaries, Rotating Variables
Periodic Variable Stars	• Variation in brightness displays a regular pattern over time • All extrinsic variables are periodic e.g. Eclipsing Binaries, Rotating Variable Stars • Cepheids are periodic variables (they are intrinsic)
Non-Periodic Variable Stars	• Variation in brightness is not repeating over time (irregular variation) • E.g. Novae, Supernovas, Eruptive Variables

6.3 Describe the types of nuclear reactions involved in Main-Sequence and Post-Main Sequence Stars -

- Both CNO and pp reactions have same net equation and release same amounts of energy
- **Main sequence stars fuse hydrogen to helium with net equation:**

$$4{}_1^1H \rightarrow {}_2^4He + 2e^+ + 2v + \gamma$$

  - **4 Hydrogens → Helium + 2 Positrons + 2 Neutrinos + Energy**
- **Smaller, cooler main sequence stars achieve this via the proton-proton chain reactions where protons are added successively to produce the helium.** This reaction is the starting point of zero-age main sequence stars
- **Larger, hotter main sequence stars, operating at higher core temperatures, can fuse hydrogen via the CNO cycle where carbon, nitrogen and oxygen act as catalysts in the reaction steps to produce helium.** Process is cyclical
- **Red-Giants (Post-main sequence) fuse heavier elements successively in their core if sufficient temperature and pressure is present to initiate ignition of the reaction**
- **Most red-giants begin fusing helium in their cores by the triple-alpha reaction when temperatures are high enough:**

$$3{}_2^4He \rightarrow {}_6^{12}C + \gamma$$

- **Surrounding a red-giants core is a shell where hydrogen is fusing to form helium**