Question 30 – Astrophysics

a) i). An eclipsing binary can not always be seen as a pair visually, but as each star eclipses one another it is possible to tell each stars diameter from the difference in the two when eclipsing. It would appear the star is changing size regularly, when they exchange places, and so from this it can be said they are eclipsing binaries.

ii) The total mass of a binary system can be calculated mathematically using the equation $m_1 + m_2 = \frac{4\pi^2 r^3}{GT^2}$,

which is derived from ~~the~~ Kepler's Third Law of Periods. m_1 and m_2 combine to make up the total mass of the system. By using the known radius from the common centre of mass, the period of their orbits, and the universal gravitation constant the total mass can be simply calculated.

b) i) Lalande 21185

$M = m - 5\log(\frac{d}{10})$

ii) $M_{ROSS154} = (10.37) - 5\log(\frac{2.97}{10})$

$M = 13.01$

$M_{PC} = (11.01) - 5\log(\frac{1.29}{10})$

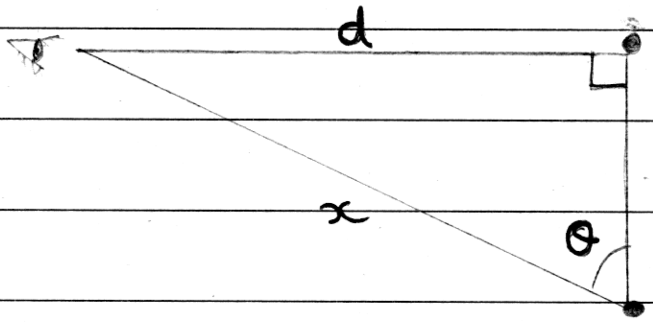
$M_{PC} = 15.46$.

3. $\frac{I_A}{I_B} = 100^{(m_B - m_A)/5}$

$\frac{I_A}{I_B} = 100^{(-10.37 + 11.01)/5}$

$I_A = 1.8 I_B$

∴ ROSS154 is 1.8 times brighter than Proxima Centauri.



θ = parallax angle (arcsecs)
d = apparent distance.
x = distance to star.
• = star's apparent positions

c) i) White dwarves could be found in position S, as they have a solar mass of less than 5 and have a high surface temperature, but are not very luminous.

ii) A white dwarf is in a stable condition because it is composed of degenerate matter from only the core of a former red giant. It is densely packed and has no unreacting outer shells, which were lost in the planetary nebula stage, would make it unstable and able to shrink further. As it is only a core it cannot lose any shells + cannot shrink.

iii) A star located on the main sequence would be fusing hydrogen into helium through either the proton-proton chain or the CNO cycle

a). Ground based astronomy, for a long time was limited by less than adequate technology and the problem of atmospheric blurring. Modern technology has become very advanced and has tried to rectify such problems. Atmospheric blurring greatly hampered the resolution of stars, and so made it difficult to make accurate observations. The development of adaptive optics, active optics, and interferometry have improved the resolution and sensitivity of ground based astronomy. Adaptive optics involves a slow response feedback system which corrected deformities in the collecting plate of the telescope. The mirror had such deformities due to heat exposure and even impurities in the glass. The computer "fixed" the image accordingly because of the deformities. This process is used in telescopes Keck I and II in Hawaii. This meant improved resolution of images and improved sensitivity of the telescope so that data collected

was actually reliable.
Another system being trialled is active optics. This involves the fast feedback - many times a second - of corrections to the image. This is even more sensitive than adaptive optics, as it continually updates the data needed to correct an image. It uses two mirrors which move, and are digitally "fixed" by the computer, using a known star as a guide. This also gives a vastly improved image, perhaps the best resolution to date. However due to the advanced technology required it still needs development before it can be adequate ~~way~~ for use and economically viable.
Another development was that of interferometry. This uses many

antennae signals ~~an~~ over a certain distance and combines them to make a reliable radio telescope image. This greatly reduces atmospheric blurring and hence improves the resolution. It is not as sensitive as the active optics system, but still, ~~ground~~ between the three methods ground based astronomy has vastly improved and has increasingly better resolution and has become much more sensitive than ever before. It can now produce accurate, and reliable data for astronomers to use in their work.