# IB Physics: Summer Holiday HW for Rising IB-Seniors

## Option D: Astrophysics

## Assignment # 1

Dear IB-Y2 seniors,

You will need to get started on this work now in order to be prepared when you return. If you wait until the last minute you will probably not get the work finished. You need to focus on mastering the material over the summer. **On the first day back, you are expected to submit your work.** You will receive a grade for this assignment. To avoid receiving a zero on your first grade, schedule a couple of hours of your summer holidays to complete the summer assignment.

**Write** all your answers on a separate sheet of paper and submit it (no typing!). Your written answers should be neat and legible (I should be able to read your answers and give you credit. If I cannot read, I will not be able to award you any credit!!

I have included 4 previous exam questions to make you aware of the rigor and format of the questions on Paper-3. This unit is also memory based and you have to remember all the vocabulary terms. I have listed important vocabulary terms that you need to know!

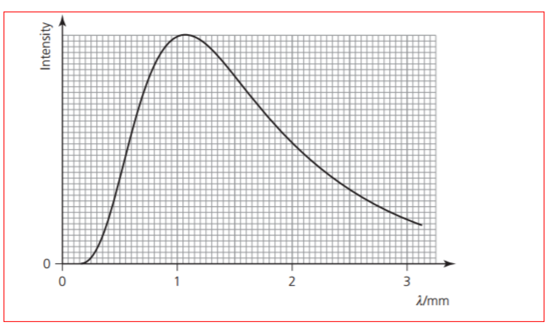
So, answer the questions and define/state/explain the given vocabulary terms.

**Note: You are welcome to refer Kognity/ThinkIB/Oxford Textbook to complete your HW.**

## PRT A: Paper 3 IB questions and IB style questions

Q1 a i What is the main energy source of a star? (1)
ii Explain how it is possible for a main sequence star to remain stable for billions of years. (2)
b i Define the luminosity of a star. (1)
ii Explain why main sequence stars can have very different luminosities. (2)
c i Define the apparent brightness of a star. (2)
ii Give two reasons why stars may have different apparent bright nesses. (2)
d Antares is a red supergiant 170pc from Earth. Its luminosity is $2.5 \times 10^{31}$W and its surface temperature is 3400K.
i Calculate the apparent brightness of Antares as seen from Earth. (2)
ii Explain what is meant by the term red supergiant. (2)
iii At what wavelength is the maximum intensity of the spectrum from Antares? (2)

Q2 The following question is about cosmic microwave background radiation. The graph shows the spectrum of the cosmic microwave background radiation.




The shape of the graph suggests a black-body spectrum, i.e. a spectrum to which the Wien displacement law applies.
(2) a Use the graph to estimate the black-body temperature.
(2) b Explain how your answer to a is evidence in support of the Big Bang model.
(2) c State and explain another piece of experimental evidence in support of the Big Bang model. (2)

Q3 This question is about the mass–luminosity relation and also the evolution of stars.

The mass–luminosity relation for main sequence stars is assumed to be L ∝ M3.5, where L is the luminosity and M is the mass. Star X is 8 × 104 times more luminous than the Sun and 25 times more massive than the Sun.

a Deduce that star X is a main sequence star. (2)

b Outline with reference to the Oppenheimer–Volkoff limit, the evolutionary steps and the fate of star X after it leaves the main sequence. (3) 

Q4 This question is about Hubble's law and the expansion of the universe.

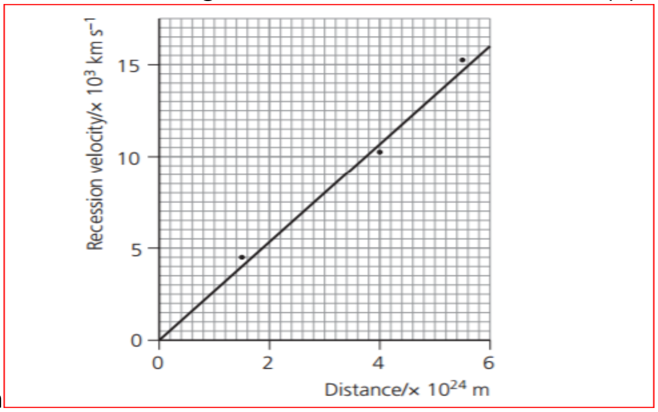
a The spectrum of the cluster of galaxies Pegasus I shows a shift of 5.04nm in the wavelength of the K-line. The wavelength of this line from a laboratory source is measured as 396.8nm. Calculate the velocity of recession of the cluster. (2)

b The graph shows the recession velocities of a number of clusters of galaxies as a function of their approximate distances.

i State one method by which the distances shown on the graph could have been determined. (1)

ii Use the graph to show that the age of the universe is about $10^{17}$ s. (2)






## PART-B: Write definitions, mathematical equations, and examples:

1. Accelerating universe
2. Apparent brightness, b
3. Arc-second
4. Astronomical unit (AU)
5. Big Bang model
6. Binary star system
7. Black hole
8. Blue-shift
9. Cepheid variable star
10. Chandrasekhar limit
11. Cluster of galaxies
12. Constellation
13. Cosmic microwave background (CMB)
14. Cosmic scale factor, R
15. Dark energy
16. Electron degeneracy pressure
17. Gravitational pressure (star)
18. Hertzsprung–Russell (HR) diagram
19. Hubble's law
20. Instability strip
21. Interstellar matter
22. Isotropic
23. Luminosity, L
24. Main sequence
25. Mass–luminosity relationship
26. Prtostar
27. Nebula (plural: nebulae)
28. Neutron stars
29. Newton's model of the universe
30. Pulsar
31. Oppenheimer–Volkoff limit
32. Parallax angle (stellar), P
33. Parsec, pc
34. Period–luminosity relationship Graph
35. Planetary nebula
36. Proton-Proton cycle
37. Radiation pressure
38. Recession speed
39. Red giant (and red supergiant) stars
40. Red-shift Displacement
41. Wien's (displacement) law
42. White dwarf stars
43. Supernova
44. Super cluster (of galaxies)
45. Main sequence star
46. Stellar spectra
47. Stellar parallax Method
48. Stellar equilibrium
49. Open clusters
50. Stellar cluster