# PHY111 HOMEWORK

This homework is based on questions from Sections B and C of the exam paper, and is intended to help you prepare for the exam. It is worth 5% of your module grade.

## DEADLINE

**This work is due in to G floor on Monday December 2.**

## SECTION B QUESTIONS

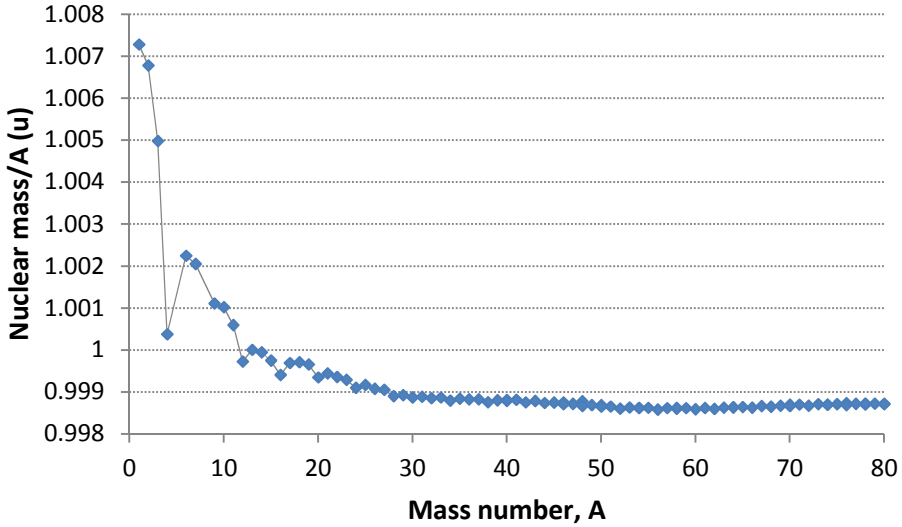
**B1** The image shows the spectrum of an astronomical object. It is a negative image, i.e. the dark lines are actually bright lines on a dark background. It covers a range of wavelengths from about 450 nm at the left-hand end to 670 nm on the right.

**(a)** Is this object likely to be a star? Carefully explain and justify your answer. [2]

**(b)** The six most prominent lines in this spectrum (from left to right) come from hydrogen, doubly ionised oxygen (twice), singly ionised nitrogen, hydrogen and singly ionised nitrogen (again). Is it safe to assume from this that the object is composed primarily of hydrogen, nitrogen and oxygen in roughly equal proportions? Explain your answer. [2]

**(c)** Give an example of a type of astronomical object which might produce a spectrum like this. [1]

**B2** The plot below shows the mass per nucleon for nuclei with atomic masses up to 80.




**(a)** Explain carefully which features of this plot show that

**(i)** energy can be generated by fusing nuclei with masses up to 56, but not beyond 56; [1]

**(ii)** hydrogen fusion will power a star for longer than fusion of other elements; [1]

**(iii)** the light elements lithium, beryllium and boron (with atomic masses from 6 to 11) cannot be made in stars. [1]

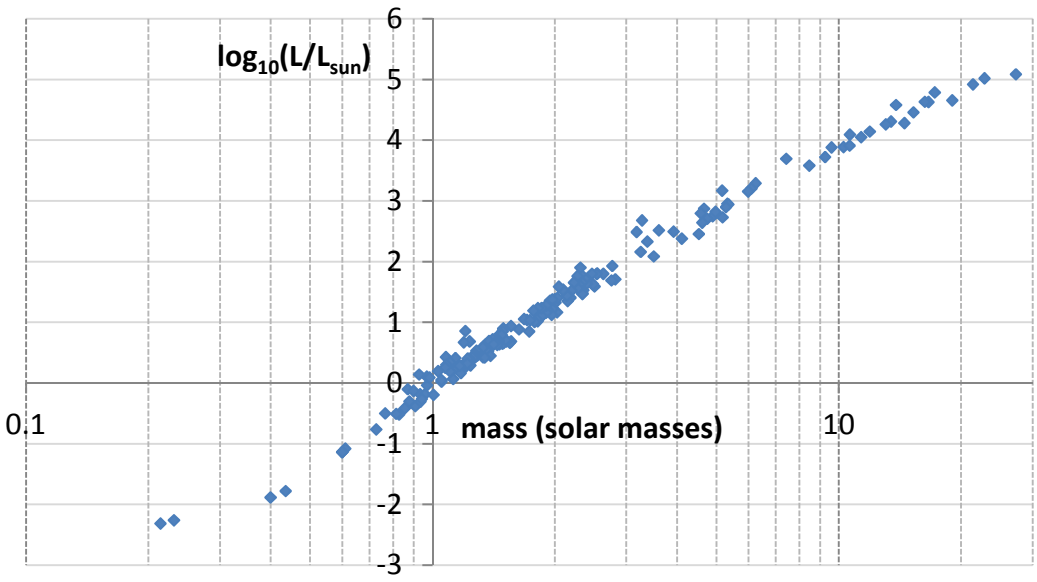
**(b)** The plot shows that there are no stable isotopes with atomic mass 5 or 8. Explain the significance of this fact in the context of the Big Bang theory of cosmology. [2]

**B3** Explain how the *cosmic microwave background* is produced in the Big Bang cosmological model, indicating how your explanation accounts for its observed features. [4]

Briefly explain why the Steady State cosmological model does *not* expect a cosmic microwave background with these features. [1]

## SECTION C QUESTION

**C1** The plot below shows the observed mass-luminosity relation for main-sequence stars.




**(a)** The stars used to make this plot have a particular property. What is it, and why is it necessary? [2]

**(b)** Carefully explain how you can tell from this plot, *without* using any theoretical input,

**(i)** that massive stars have shorter main-sequence lifetimes than low-mass stars; [3]

**(ii)** that the intrinsic luminosities of stars do not change much during their time on the main sequence. [2]

In each case, state any assumptions that you have made in your explanation.

**(c)** Make careful drawings of the Hertzsprung-Russell diagrams of (i) a young star cluster and (ii) an old star cluster low in heavy elements. Label the branches of the HR diagram shown in your drawings. [5]

With reference to the mass-luminosity diagram above, explain what feature of your diagrams defines the clusters as young and old, respectively, and briefly comment on how the other features of the diagrams shed light on the likely progress of stellar evolution. [2]

What feature of your "old star cluster" diagram indicates that the cluster is low in heavy elements? [1]

**In the exam, you are expected to answer three Section B questions and one Section C question, as here, although you do have a choice (three out of five in Section B, one out of three in C). This should take you approximately 1¼ hours.**