The University Of Sheffield.

DEPARTMENT OF PHYSICS AND ASTRONOMY

Autumn Semester 2010-11 **2 hours**

OUR EVOLVING UNIVERSE
SECTION A

Answer ALL questions in this section. At the end of the examination, tie this paper to your answer book for Sections B and C and hand them in together. Remember to fill in your anonymous number in the space below.

You should not spend more than 45–50 minutes on this section of the examination paper.

Candidate's anonymous number: ……

Desk number: …….. Date: …….

Each question is worth 1 mark.

Multiple choice questions have four possible answers labelled (a) to (d). Circle the letter corresponding to your selected answer. If you change your mind, cross out your original circle and circle your new choice, as in the example below.
A multiple-choice question with more than one choice circled will get no marks.

Example:

A0 This is an example question.


(a) your original choice

(b) another answer


(c) your new choice

(d) another answer

In other (non-multiple-choice) questions, follow the instructions given in the question.

A1 The star Regulus is a blue-white main-sequence star. Which of the following statements about Regulus *must* be true? [Tick or circle *all* that apply.]

(i) Regulus is more massive than the Sun.
(ii) Regulus is less massive than the Sun.
(iii) Regulus is older than the Sun.
(iv) Regulus is younger than the Sun.
(v) Regulus is of similar age to the Sun.
(vi) Regulus is hotter than the Sun.
(vii) Regulus is cooler than the Sun.
(viii) Regulus is intrinsically fainter than the Sun.
(ix) Regulus is intrinsically brighter than the Sun.

A2 A particular astronomical object, viewed in visible light using a spectrometer, is found to have a continuous spectrum which is brightest in the red part of the spectrum. Which of the following statements about the object *must* be true? (Tick *all* that apply.)

(i) It consists of high-density gaseous or solid material.
(ii) It consists of low-density gas.
(iii) It is at a high temperature.
(iv) It is at a low temperature.
(v) It is a nearby object.
(vi) It is a distant object.

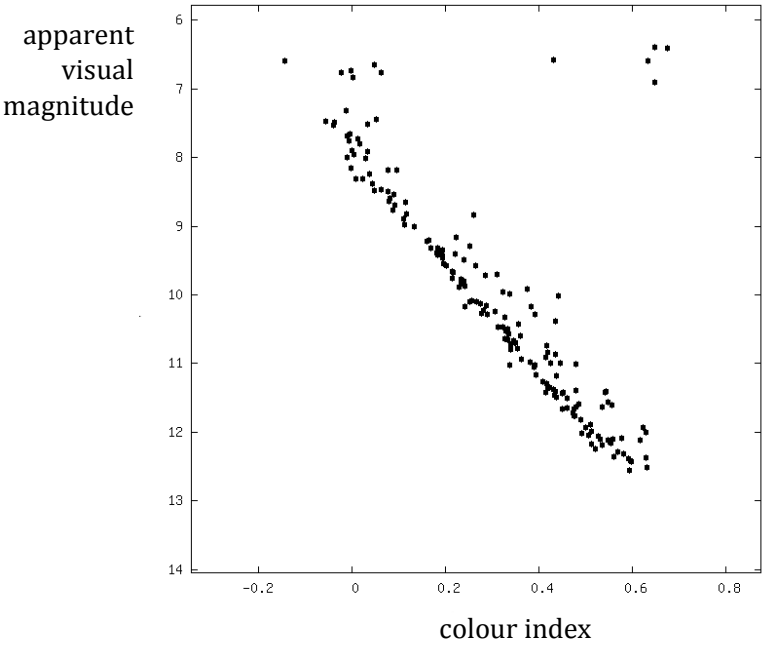
A3 The majority of stars near the Sun are

(a) somewhat less massive and much fainter than the Sun;
(b) about the same mass and luminosity as the Sun;
(c) somewhat more massive and much more luminous than the Sun;
(d) none of the above: there are all kinds of stars near the Sun and no one type predominates.

A4 The star Deneb has absolute magnitude –7.2 and apparent magnitude 1.25. This tells us that

(a) it is intrinsically faint but very close to us;
(b) it is intrinsically faint and far away from us;
(c) it is intrinsically bright but far away from us;
(d) it is intrinsically bright and close to us.

The picture below shows the Hertzsprung-Russell diagram of a stellar cluster.



A5 Label the *largest* star in the cluster L.

A6 Label the *hottest* star H and the *coolest* star C.

A7 This cluster is

(a) old;
(b) young;
(c) made up of stars of different ages;
(d) impossible to specify the age of, because we do not know its distance.

A8 This cluster is probably located

(a) near the centre of the Milky Way Galaxy;
(b) in the halo of the Milky Way Galaxy;
(c) near the plane of the Milky Way Galaxy;
(d) none of the above – it could be anywhere in the Galaxy.

The following table is to be used for questions A9 - A11. It shows the isotopes of rubidium (Rb), krypton (Kr), bromine (Br) selenium (Se), and astatine (As). The top row of the table lists the number of neutrons in the isotope; the number by the element symbol is the number of protons.

	39	40	41	42	43	44	45	46	47	48	49	50	51	52
$_{37}$Rb							ε	ε	ε	72.2	β	27.8	β	β
$_{36}$Kr	ε	ε	ε	0.4	ε	2.3	ε	11.6	11.5	57.0	β	17.3	β	β
$_{35}$Br			ε	ε	ε	50.7	β	49.3	β	β	β	β		
$_{34}$Se	ε	0.9	ε	9.0	7.6	23.5	β	49.8	β	9.2	β	β		
$_{33}$As	ε	ε	ε	100	β	β	β	β						

Unstable isotopes decay by electron capture (ε), converting a proton to a neutron, or by beta decay (β) converting a neutron to a proton. The numbers give the percentage abundance of *stable* isotopes: for example, natural bromine is 50.7% bromine-79 (with 44 neutrons) and 49.3% bromine-81. Blank spaces are nuclei that do not exist in nature.

A9 The line starting from astatine-75 is the **s-process path**. Continue this line from the arrow until it runs off the edge of the table.

A10 Label with a P a **stable** isotope which *must* be formed by the **p-process**.

A11 Label with an S a **stable** isotope which *must* be formed by the **s-process**.

A12 Compared to an E6 galaxy, an E1 galaxy is:

(a) larger;
(b) older;
(c) more elongated;
(d) more circular (less elongated).

A13 The four galaxies on the attached sheet have Hubble types S0, Sb, SBc and Sc. Fill in the spaces below to indicate which type corresponds to which image.

(i) ……..

(ii) ……..

(iii) ……..

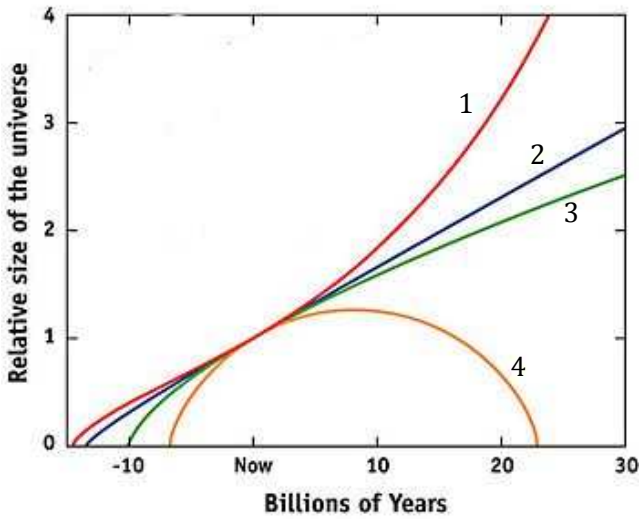
(iv) ……..

A14 In the standard model of cosmology, which of the following events happened *first*?

(a) Annihilation of all antimatter.
(b) Emission of the cosmic microwave background.
(c) Inflation.
(d) Formation of the first galaxies.

A15 The diagram on the right shows various ways in which the universe might evolve in the future. Which of the four options below is most likely to correspond to line 1?

(a) Open geometry with zero cosmological constant.
(b) Flat geometry with zero cosmological constant.
(c) Closed geometry with zero cosmological constant.
(d) Flat geometry with positive cosmological constant.



A16 Hubble's law, $v = H_0 d$, shows

(a) that the universe began with a big bang;
(b) that we are near the centre of the universe;
(c) that the universe is infinitely large;
(d) none of the above.

A17 Evidence from analysis of distant Type Ia supernovae suggests that

(a) the universe is not flat;
(b) the universe is flat;
(c) there is a small positive cosmological constant;
(d) there is a small negative cosmological constant.

A18 If searching for extrasolar planets using the **transit** method, you are most likely to detect (tick *all* that apply)

(i) massive planets;
(ii) low-mass planets;
(iii) planets orbiting far from their stars;
(iv) planets orbiting close to their stars;
(v) planets orbiting high-mass stars;
(vi) planets orbiting low-mass stars;
(vii) planets in orbits edge on to your line of sight;
(viii) planets in orbits face on to your line of sight.

A19 Planned studies of the atmospheres of extrasolar planets are designed to look for ozone (O_3) rather than ordinary oxygen (O_2) because

(a) ozone is more common than oxygen;
(b) an ozone layer is essential for life to evolve;
(c) oxygen can be produced without life whereas ozone is only produced by living organisms;
(d) ozone is easier to detect than oxygen.

A20 An extraterrestrial civilisation could detect evidence of a technological civilisation on Earth

(a) only if they visited the solar system, or happened to pick up one of our space probes;
(b) from within a light year or so, if their technology is sensitive enough;
(c) from within about 50 or 60 light years, if their technology is sensitive enough;
(d) from anywhere in the Galaxy, if their technology is sensitive enough.

END OF SECTION A

SECTIONS B AND C ARE IN A SEPARATE BOOKLET