

Astronomy
Standard level
Paper 1

Friday 29 April 2016 (morning)

Candidate session number

45 minutes

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Instructions to candidates

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all of the questions.
- Write your answers in the boxes provided.
- A calculator is required for this paper.
- The maximum mark for this examination is **[30 marks]**.



You may find the following information useful

$$1 \text{ AU} = 1.5 \times 10^{11} \text{ m}$$

$$1 \text{ light year} = 0.31 \text{ parsecs} = 9.5 \times 10^{15} \text{ m}$$

$$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$$

$$L_{\odot} \approx 3.84 \times 10^{26} \text{ W}$$

$$M_{\odot} \approx 1.99 \times 10^{30} \text{ kg}$$

$$k = 1.38 \times 10^{-23} \text{ JK}^{-1}$$

$$1 \text{ parsec} = 206265 \text{ AU} = 3.1 \times 10^{16} \text{ m} = 3.3 \text{ light years}$$

$$1^{\circ} = 3600 \text{ arc-sec} = 1.75 \times 10^{-2} \text{ rads}$$

$$H_0 \approx 72 \text{ km s}^{-1} \text{ Mpc}^{-1}$$

$$c = 3.00 \times 10^8 \text{ m s}^{-1}$$

$$\sigma = 5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$$

$$T_{\odot} \approx 5770 \text{ K}$$

$$R_{\odot} \approx 6.96 \times 10^8 \text{ m}$$

$$M_{\oplus} = 5.98 \times 10^{24} \text{ kg}$$

$$M_J = \frac{9}{4} \left(\frac{1}{2\pi n} \right)^{\frac{1}{2}} \frac{1}{m^2} \left(\frac{kT}{G} \right)^{\frac{3}{2}}$$

$$e = \sqrt{1 - \left(\frac{b}{a} \right)^2}$$

$$z = \frac{H_0}{c} d = \frac{\lambda_{\text{obs}} - \lambda_{\text{em}}}{\lambda_{\text{em}}}$$

$$c = f \lambda$$

$$\lambda_{\text{max}} = \frac{2.90 \times 10^{-3}}{T}$$

$$v_{\text{esc}} = \sqrt{\frac{2GM}{R}}$$

$$\text{PE} = -\frac{GMm}{r}$$

$$L \approx 4\pi R^2 \sigma T^4$$

$$f = \frac{[a - b]}{a}$$

$$L\theta = d$$

$$F = \frac{GM_1 M_2}{r^2}$$

$$v = \frac{d}{t}$$

$$F = ma$$

$$\text{KE} = \frac{1}{2} mv^2$$

$$\text{GPE} = mgh$$

$$m_B - m_A = -2.5 \log \left[\frac{b_B}{b_A} \right]$$

$$E = mc^2$$

$$L = F \cdot 4\pi d^2$$

$$N = R \cdot f_p \cdot n_e \cdot f_1 \cdot f_i \cdot f_c \cdot L$$



Please **do not** write on this page.

Answers written on this page
will not be marked.



08EP03

Turn over

Answer **all** questions. Write your answers in the boxes provided.

The Stars

1. Define the following terms. [2]

One year:

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Solar differential rotation:

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2. Calculate the radiation flux density at the surface of the Sun. [2]

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3. State the name of the predominant fusion reaction occurring in the core of the Sun. [1]

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4. Outline **two** differences between the observed motion of a planet and a star in the night sky. [2]

Difference 1:

.....

Difference 2:

.....



The Planets

5. Define the following terms. [2]

Planetary differentiation:

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Terrestrial planet:

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6. The eccentricity (e) of the orbit of Mars around the Sun is 0.0935.
- Calculate the ratio of the semi-major to semi-minor axis expressing your answer to the appropriate number of significant figures. [3]

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7. State the names of the **two** planets in the solar system which are **not** thought to have moons. [2]

Planet 1:

Planet 2:

8. Assuming that the escape velocity for the Earth is 11 km s^{-1} , calculate the maximum collisional energy released when an asteroid of mass 100 kg collides with the Earth. [2]

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Galaxies

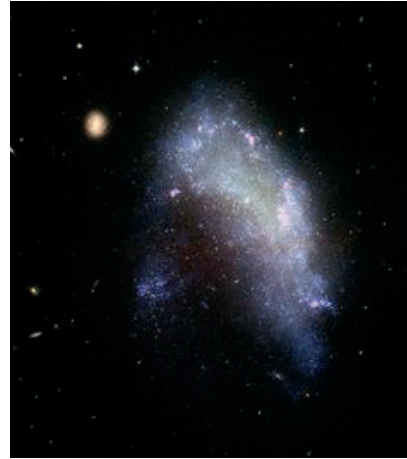
9. **Figure 1** shows two different types of galaxy. Using the Hubble classification for naming galaxies, state what types of galaxy are shown. [2]

Figure 1: Two different types of galaxy



M91

[Source: <https://www.noao.edu>]



NGC 1427A

[Source: <http://apod.nasa.gov>]

M91:

NGC 1427A:

10. Complete the following list, giving the **two** other basic parts of the Milky Way galaxy. [2]

1. Nuclear Bulge
2.
3.



11. Outline what is meant by the term Active Galaxy. [2]

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12. The red-shift of a distant galaxy is 0.100. If the wavelength of light from hydrogen should be 656.3 nm, calculate the observed wavelength. [2]

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Cosmology

13. Explain the difference between red-shift and cosmological red-shift. [2]

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14. Identify which **one** of the following statements is correct when the geometry of spacetime is saddle shaped. [1]

- A. Parallel lines converge
- B. Parallel lines intersect
- C. The circumference of a circle = $2\pi r$
- D. The circumference of a circle $< 2\pi r$
- E. Straight lines continue to infinity
- F. The internal angles of a triangle $> 180^\circ$

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15. An accepted value for Hubble's constant is $67.8 \text{ km s}^{-1} \text{ Mpc}^{-1}$.

Some people state that the universe was created approximately 6000 years ago.

Calculate the value of Hubble's constant for such a universe assuming that the expansion rate is constant. Express your answer in the same units as those given in the accepted value. [3]

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