PRIFYSGOL ABERYSTWYTH UNIVERSITY

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DEPARTMENT OF PHYSICS

SEMESTER 1 EXAMINATIONS, JANUARY 2026

PH28620 – STARS AND PLANETS

Time allowed – 3 hours

- **Full marks can be attained for complete answers to ALL eight questions in Section A and TWO questions from Section B**
- **The numbers in brackets after the questions indicate the allocation of marks for each question.**
- **Only calculators from the Casio FX83, FX85 or FX991 range may be used.**
- **A booklet of mathematical formulae and standard constants will be provided.**
- **Only a 1 side of A4 summary sheet is allowed.**
- **MAE MODD I FYFYRWYR GYFLWYNO ATEBION I'R PAPUR HWN NAILL AI YN Y GYMRAEG NEU'R SAESNEG**
- **STUDENTS MAY SUBMIT ANSWERS TO THIS PAPER IN EITHER WELSH OR ENGLISH**

Once seated, students may complete the front cover of the answer book(s) and the attendance slip ONLY.

DO NOT TURN THE EXAMINATION QUESTION PAPER OVER UNTIL INSTRUCTED TO DO SO.

Section A

Attempt ALL questions in the booklets provided

1 State True or False: [5]

a) It can snow above the poles of Mars

b) Spider features on Mars can result from methane ice sublimation

c) A yardang is a sand dune

d) Dust particles can become charged in martian dust devils

e) An ice sheet is half the thickness, 1 km from the edge, than it is at 4 km from the edge

2 What is the effective temperature on a spherical asteroid with an albedo of 5%, with no internal heat source and lying at a distance of $3\ A.U.$ from the Sun? You may assume the luminosity of the Sun is $3.83 \times 10^{26} W$. [5]

3 Describe, briefly, five methods of discovering exoplanets. [5]

4 Calculate the Roche limit in km, above the surface of the Sun, for a solid asteroid of density $1.5\ gcm^{-3}$. [5]

5 Describe briefly five methods measuring/determining the angular diameter of a star. [5]

6 Some old visual variable star observations have been found of a nova, called N. On a particular night the visually estimated brightness of N was recorded using the Pogson Step method, as A(2)N(3)B, where star A was magnitude +9.2 and star B was magnitude +10.3. Show how you can calculate the magnitude of N. What might be the limitations of this visual technique? [5]

7 State True or False: [5]

a) Low-mass stars ($< 0.4\ M_{\odot}$) never enter the red giant phase.

b) The helium flash occurs in stars above $8\ M_{\odot}$.

c) AGB stars experience strong mass loss and pulsations.

d) Planetary nebulae come from massive stars ($> 10\ M_{\odot}$).

e) The CNO cycle dominates hydrogen burning in high-mass stars.

8 Describe how accretion disks form around compact objects and explain why they emit strongly in X-rays. [5]

Section B

Answer TWO questions

9

a) What is the “self-compression model” of a planet and what assumptions are made?

[5]

b) Integrate the equation below, to derive an equation to determine the pressue P_r for a given radius out from the centre of a planet.

$$dP = -\rho \frac{4\pi G r^3 \overline{\rho}}{3} r\, dr$$

[5]

c) Calculate the pressure at the centre of Jupiter, using the equation derived above for the self-compression model. The mean density of Jupiter is $1.33 \times 10^3\ kg\ m^{-3}$ and its radius is 69910 km.

[5]

d) How does the internal structure of Jupiter compare to that of Uranus?

[5]

10 a) A spherical asteroid at $1.5AU$ from Earth occults a background star as seen from Earth. The angular velocity of the asteroid across the sky is 0.008 arcsec per sec. The occultation across the asteroid's equatorial region lasts 5 sec. What is the asteroid's diameter in km?

[4]

b) The star has an apparent magnitude of $+10.0$ and an absolute magnitude of -6.0

What is its distance from us in light years?

[4]

c) If the star has a temperature of $30{,}000K$, what is its luminosity?

[5]

d) What is the star's angular diameter, in $milliarcsec$, as seen from Earth?

[7]

11 Describe briefly the following stages in the evolution of a 1 solar mass star.

a) Molecular cloud & collapse (Jeans instability);

[3]

b) Protostar and pre-main-sequence tracks;

[3]

c) Main sequence and core evolution;

[2]

d) Post-main-sequence: red giant branch;

[3]

e) Helium flash and horizontal branch;

[3]

f) Asymptotic giant branch;

[3]

g) Planetary nebula and white dwarf.

[3]

END OF PAPER