



Western Australian Certificate of Education ATAR course examination, 2018

Question/Answer Booklet

12 PHYSICS

Name

Practical Test - Gravity Investigation

Student Number: In figures

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Mark: 48

In words

Time allowed for this paper

Reading time before commencing work: five minutes

Working time for paper: sixty minutes

Materials required/recommended for this paper

To be provided by the supervisor

This Question/Answer Booklet

Formulae and Data Booklet

To be provided by the candidate

Standard items: pens, (blue/black preferred), pencils (including coloured), sharpener, correction fluid/tape, eraser, ruler, highlighters

Special items: non-programmable calculators satisfying the conditions set by the School Curriculum and Standards Authority for this course

Important note to candidates

No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised notes or other items of a non-personal nature in the examination room. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

1. How many metres are there in one light-year?

[3 marks]

2. How close is Ross128b to our solar system?

[1 mark]

3. Briefly explain how Ross128b was discovered.

[2 marks]

4. Why is Ross128b of such great interest to astronomers?

[2 marks]

On 22 February 2017, astronomers announced that the planetary system of this star is composed of seven temperate terrestrial planets, of which five (*b*, *c*, *e*, *f* and *g*) are similar in size to Earth, and two (*d* and *h*) are intermediate in size between Mars and Earth. Three of the planets (*e*, *f* and *g*) orbit within the habitable zone.

5. To which planetary system is this statement referring? **[2 marks]**

6. What is meant by the term, 'habitable zone'? **[2 marks]**

7. What type of stars do these planets orbit? **[2 marks]**

8. What telescope will take the place of the Hubble Space Telescope and where will it be positioned? **[2 marks]**

Johannes Kepler brought the power of mathematics to bear on the observations of the solar system by his mentor Tycho Brahe. By 1619 Kepler had stated three laws:

- i. Planets follow plane elliptical paths with the sun at one focus.
 - ii. A radial line between the sun and a planet will sweep out equal areas of the ellipse in equal times.
 - iii. The square of the period of a planet varies directly as the cube of the radius (the semi-major axis). The constant $k = r^3/T^2$ is the same for all planets.
9. Show, by using the principles of horizontal motion and Newton's universal law of gravity, that the ratio r^3/T^2 is a constant for all planets. **[5 marks]**

10. Using data you collected during your research, calculate the mass of the star about which Ross128b orbits. **[5 marks]**

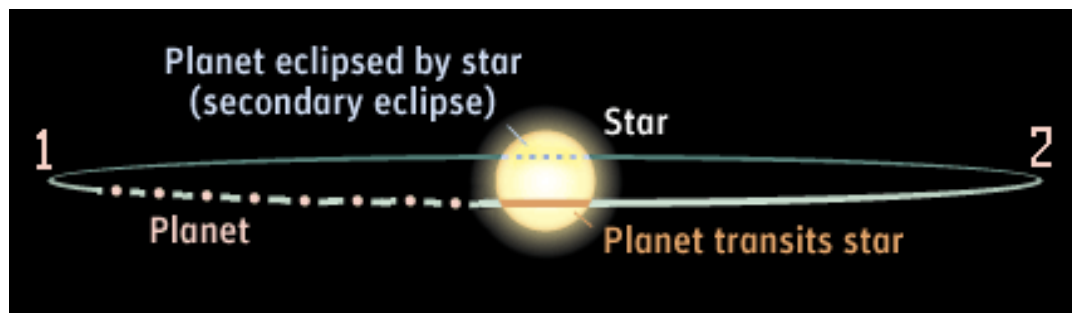
Planet	Neptune	Jupiter	Earth	Mercury
Mass (m)	17.23	317.893	1.00	0.0558
Radius (r)	4496.6	778.3	149.6	57.9
Period (T)	60189	4332.589	365.256	87.969

Where: Mass = $(5.976 \times 10^{24} \text{ kg})$ [mass of the earth]
 Radius = $(1.00 \times 10^6 \text{ km})$ [orbital radius around the sun]
 Period = (23 h 56 m 04.098 s) [sidereal day]

11. Calculate the gravitational force between Earth and Mercury when they are only a distance apart equal to the difference between their solar orbits. **[7 marks]**

12. Calculate the radius of Earth which will correspond with a gravitational force of 9.801 N acting on a mass of 1.00 kg on the surface. Give your answer to the nearest kilometre. **[4 marks]**

13. Astrophysicists searching the cosmos for possible 'earth-like' planets have discovered a new exoplanet. Each night they take observational data and track the orbiting planet moving from position 1 to position 2 in 14.0 days. The central star diameter has been measured at 1.39×10^6 km.



- (a) By using the scale of the diagram and the diameter of the star to determine the radius of orbit, calculate the mass of the star. **[7 marks]**

- (b) Find the gravitational field strength at the star's surface. **[4 marks]**