

**Western Australian Certificate of Education**

**ATAR course examination, 2018**

**Question/Answer Booklet**

12 PHYSICS

Name

**Practical Test - Gravity Investigation**

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| Student Number: In figures |  |  |  |  |  |  |  |  |  |  |

**Mark:**  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:

1. Planets follow plane elliptical paths with the sun at one focus.
2. A radial line between the sun and a planet will sweep out equal areas of the ellipse in equal times.
3. The square of the period of a planet varies directly as the cube of the radius (the semi-major axis). The constant k = r3/T2is the same for all planets.

**9.** Show, by using the principles of horizontal motion and Newton’s universal law of gravity, that the ratio ***r3/T2*** 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]**

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| **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 x 1024 kg) [mass of the earth]

Radius = (1.00 x 106 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 x 106 km.

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| EXO1 |
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(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]**