Oxford Cambridge and RSA

# A Level Physics A

## H556/01 Modelling physics

## Question Set 28

**1 (a)*** In 2017, an ultra-cool star TRAPPIST-1 was discovered with at least five of its own orbiting planets. Astronomers are interested about the possibility of finding life on some of the planets orbiting TRAPPIST-1.

The table below shows some data.

| | **TRAPPIST-1** | **Sun** |
|---|---|---|
| **Luminosity *L* / W** | $2.0 \times 10^{23}$ | $3.8 \times 10^{26}$ |
| **Surface temperature *T* / K** | 2500 | 5800 |
| **Radius of star / m** | *R* | $7.0 \times 10^{8}$ |
| **Distance between Earth and Sun / m** | | $1.5 \times 10^{11}$ |
| **Distance between planets and TRAPPIST-1 / m** | $1.6 \times 10^{9}$ to $9.0 \times 10^{9}$ | |

The temperature *T* in kelvin of a planet, its distance *d* from the star and the luminosity *L* of the star are related by the expression

$$\frac{T^4 d^2}{L} = \text{constant.}$$

- The average temperature of the Earth is about 290 K. Explain how life may be possible on some of the planets orbiting TRAPPIST-1.
- Use your knowledge of luminosity to show that the radius *R* of TRAPPIST-1 is smaller than the Sun.
- Support your answers by calculations. **[6]**

**(b)** Kepler's third law can be applied to a satellite in a geostationary orbit around the Earth.

**(i)** Complete the equation for Kepler's third law below.
You do not need to define any of the terms.

$$\text{.....} = \frac{4\pi^2}{GM} \text{.....}$$

**[1]**

**(ii)** The mass of Earth is $6.0 \times 10^{24}$ kg.
Calculate the radius of the circular path of a satellite in a geostationary orbit around the Earth.

radius = ..... m **[2]**

## Total Marks for Question Set 28: 9