

- 4 A distant star S of mass  $M$  and its planet P of mass  $0.12M$  orbit in circular orbits about a fixed point O with angular velocity  $\omega$  as shown in Fig. 4.1.



**Fig. 4.1**

- (a) (i) On Fig 4.1, draw circles that represent the orbits of star S and planet P. [1]
- (ii) Explain why the centripetal forces acting on star S and planet P are equal in magnitude.

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[2]

- (iii) Show that the ratio of the radius  $r_S$ , of the orbit of star S to the radius  $r_P$  of the orbit of planet P is

$$\frac{r_S}{r_P} = 0.12.$$

[1]

(b) The period of star S is 1500 days and its speed is  $70 \text{ m s}^{-1}$ . Determine

(i) the angular velocity  $\omega$  of star S,

$$\omega = \dots \text{ rad s}^{-1} \quad [1]$$

(ii) the radius  $r_s$  of the orbit of star S,

$$r_s = \dots \text{ m} \quad [1]$$

(iii) the separation between the centers of star S and planet P,

$$\text{separation} = \dots \text{ m} \quad [1]$$

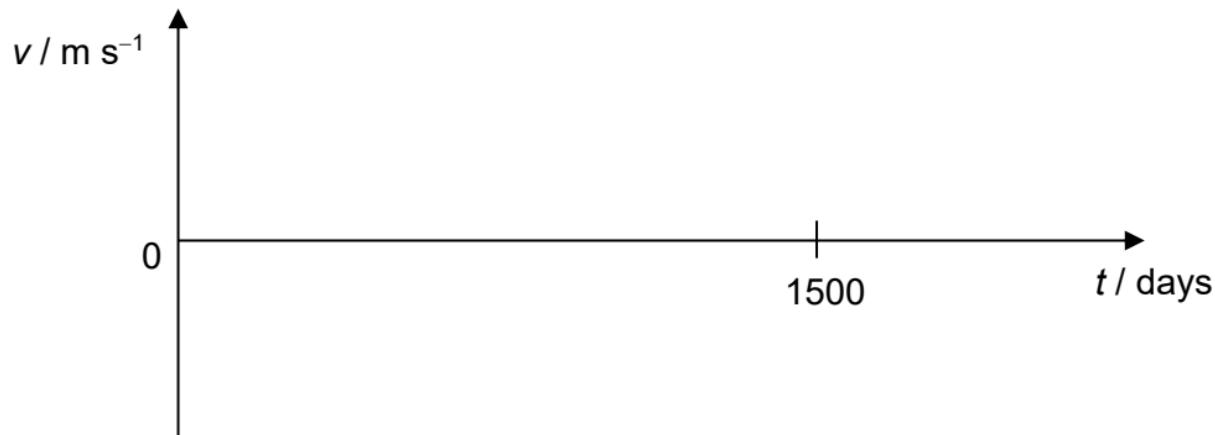
(iv) the mass  $M$ .

$$M = \dots \text{ kg} \quad [2]$$

**12**

- (c) The plane of orbits of star S and planet P is parallel to the line of sight from Earth.

On the axes of Fig. 4.2, sketch the variation with time  $t$  of the apparent speed  $v$  of star S as viewed from the Earth.



**Fig. 4.2**

[1]

[Total: 10]