

2 A student observes the orbits of some of the moons around the planet Saturn, as shown in Fig. 2.1.

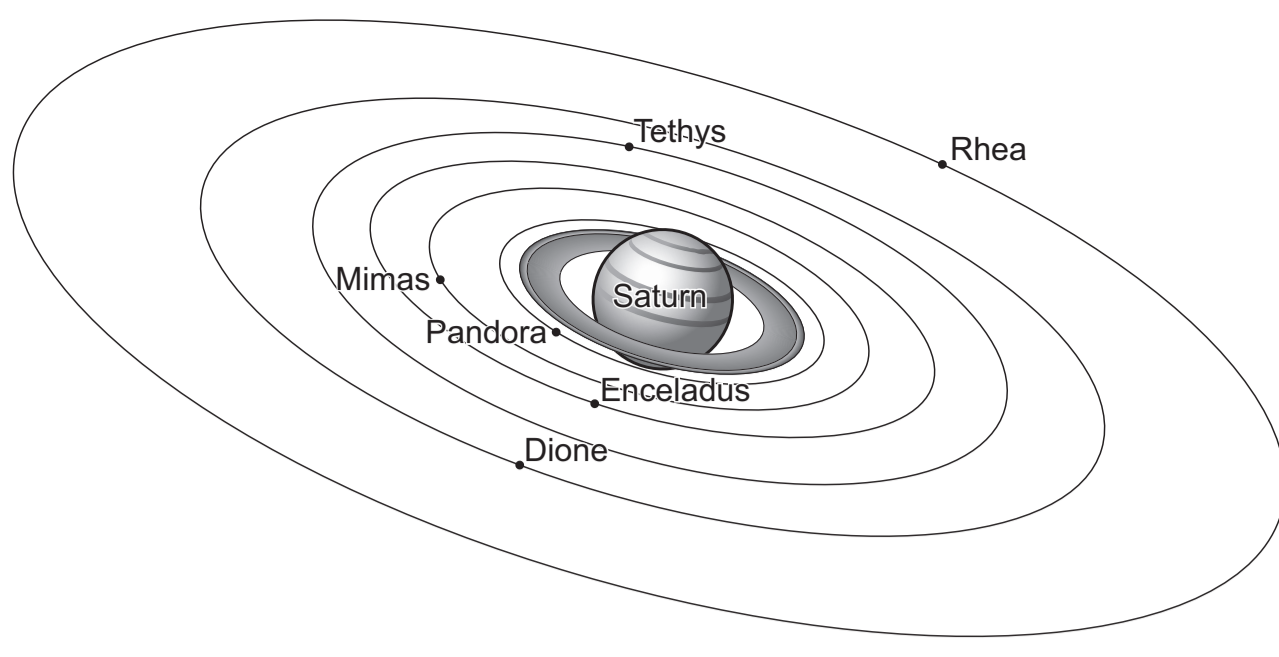


Fig. 2.1 (not to scale)

For the moon Pandora, the period of the orbit and the mean distance from the centre of Saturn are determined.

The measurements of period  $T$  and mean distance  $r$  are repeated for other moons.

It is suggested that  $T$  and  $r$  are related by the equation

$$T = \frac{2\pi r^n}{k}$$

where  $n$  and  $k$  are constants.

(a) A graph is plotted of  $\lg T$  on the  $y$ -axis against  $\lg r$  on the  $x$ -axis.

Determine expressions for the gradient and  $y$ -intercept.

gradient = .....

$y$ -intercept = ..... [1]

(b) Values of  $r$  and  $T$  are given for different moons in Table 2.1.

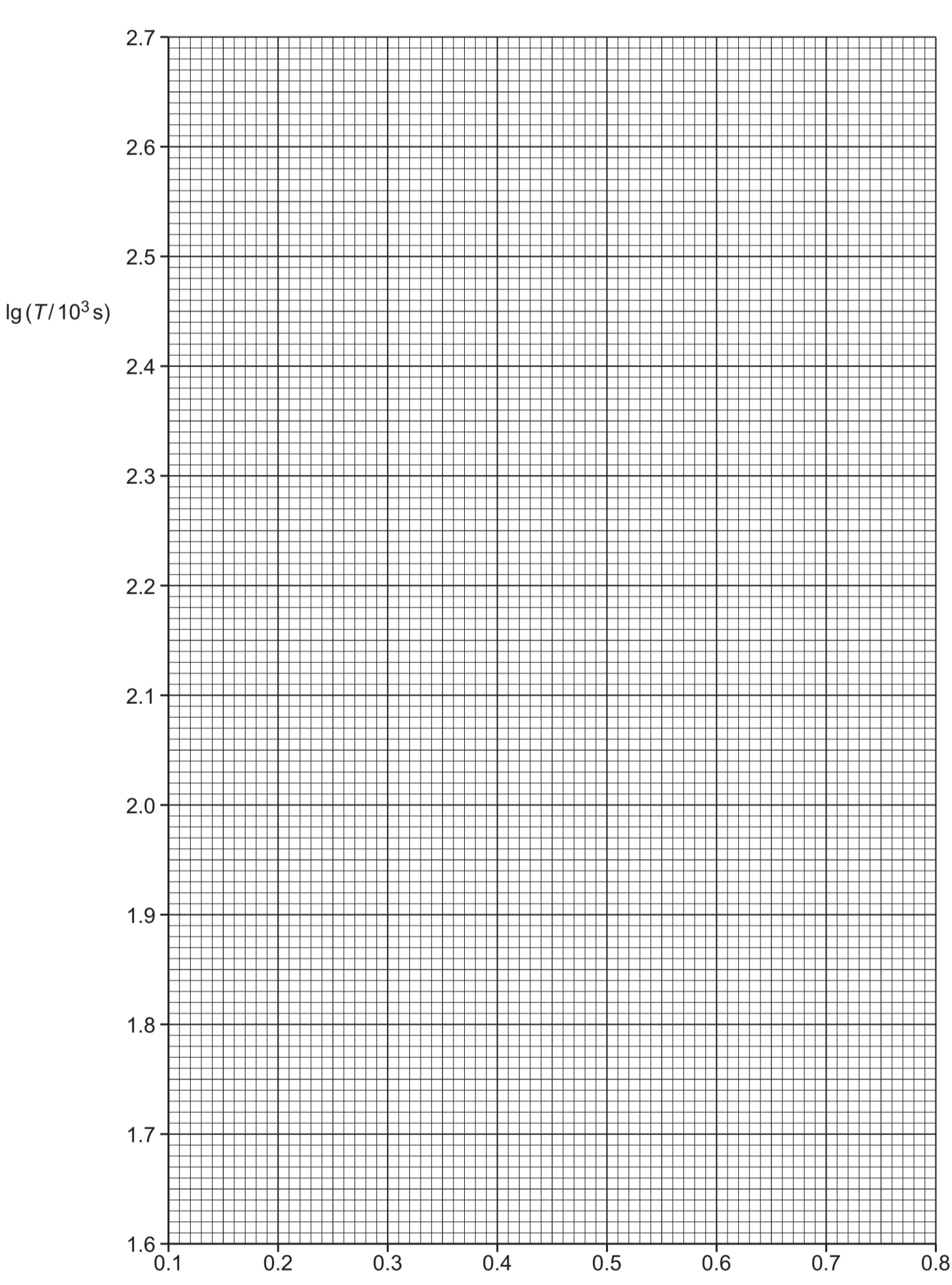
Table 2.1

moon	$r/10^8 \text{ m}$	$T/10^3 \text{ s}$	$\lg(r/10^8 \text{ m})$	$\lg(T/10^3 \text{ s})$
Pandora	1.42	$52 \pm 5$		
Mimas	1.86	$81 \pm 5$		
Enceladus	2.38	$120 \pm 10$		
Tethys	2.95	$170 \pm 10$		
Dione	3.77	$240 \pm 20$		
Rhea	5.28	$390 \pm 30$		

Calculate and record values of  $\lg(r/10^8 \text{ m})$  and  $\lg(T/10^3 \text{ s})$  in Table 2.1. Include the absolute uncertainties in  $\lg(T/10^3 \text{ s})$ . [2]

(iii) Determine the gradient of the line of best fit. Include the absolute uncertainty in your answer.

gradient = ..... [2]



(iv) Determine the  $y$ -intercept of the line of best fit. Include the absolute uncertainty in your answer.

$y$ -intercept = ..... [2]

(d) Using your answers to (a), (c)(iii) and (c)(iv), determine the values of  $n$  and  $k$ . Include the absolute uncertainties in  $n$  and  $k$ . You need not be concerned with units.

$n = \dots\dots\dots$

$k = \dots\dots\dots$  [3]

(e) Titan is another moon of Saturn. The orbit of Titan has a period of  $1.38 \times 10^6 \text{ s}$ .

Determine the value of  $r$  for Titan.

$r = \dots\dots\dots \text{ m}$  [1]

[Total: 15]