

- 5 (a)(i) A cargo spacecraft of mass m has an initial circular orbit of radius R_1 about a planet of mass M . A Hohmann transfer orbit is used to transfer it to a final circular orbit of radius R_2 using two engine burns.

Determine an expression for the minimum speed of the spacecraft required to enter the transfer orbit from the initial circular orbit in terms of m , M , R_1 and R_2 .

[3 marks]

- (a)(ii) Show that the increase in total energy of the spacecraft for the first burn is given by

$$\frac{GMm}{2R_1} \left(\frac{R_2 - R_1}{R_2 + R_1} \right)$$

[2 marks]

- (a)(iii) Determine an expression for the time of flight for the transfer from the initial to the final orbit in terms of m , M , R_1 and R_2 . [2 marks]