

2 A spacecraft in deep space uses jets of hot gas from its thrusters to change its velocity. Fig. 2.1 shows a side view of the spacecraft and some of its thrusters.

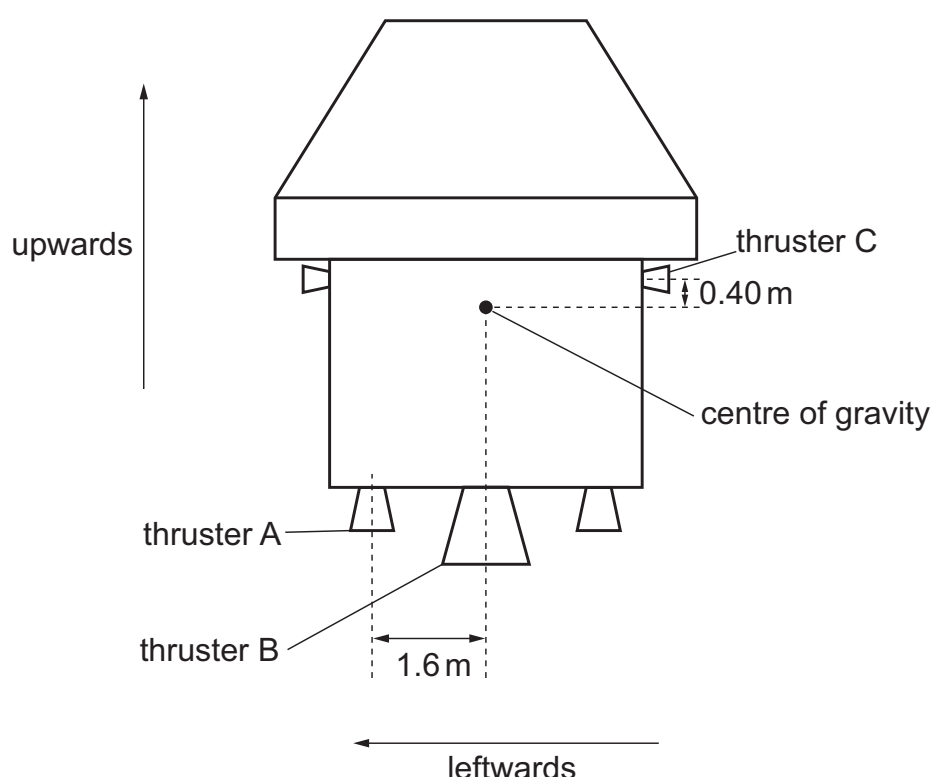


Fig. 2.1 (not to scale)

Thruster A is a distance of 1.6 m leftwards from the centre of gravity of the spacecraft. Thruster C is a distance of 0.40 m upwards from the centre of gravity of the spacecraft.

Thrusters A and B can produce forces on the spacecraft in the upwards direction only. Thruster C can produce a force on the spacecraft in the leftwards direction only. All the thrusters shown produce forces entirely in the same plane as the centre of gravity.

- (a) (i) Thruster A is activated, producing a force of 60 N upwards on the spacecraft. Thruster C is also activated, producing a force of 220 N in the leftwards direction on the spacecraft.

Calculate the resultant moment due to these forces about the centre of gravity.

resultant moment = ..... Nm [2]

- (ii) State and explain whether the forces from A and C are a couple.

.....  
 .....  
 ..... [1]

- (c) The spacecraft now splits apart into a carrier and a payload as shown in Fig. 2.3.

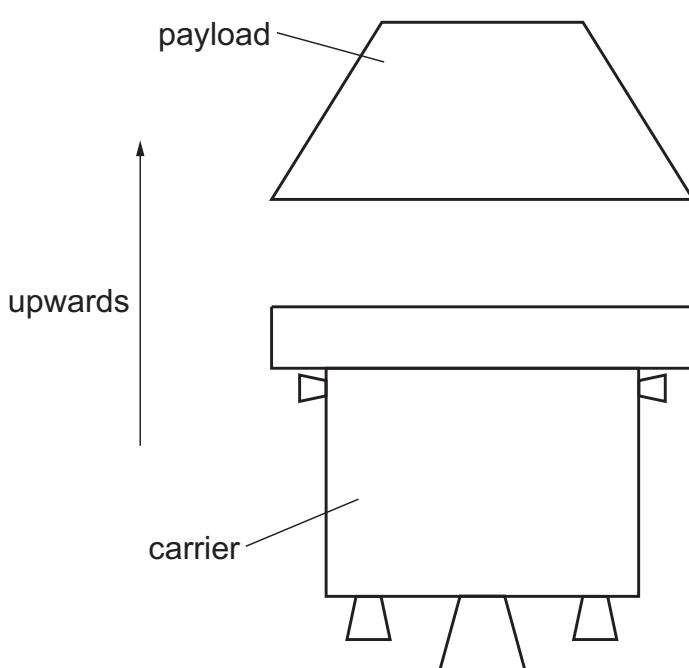


Fig. 2.3

During the split, an average force of 5500 N acts on the payload for a time of 0.36 s. The velocity of the payload increases by  $8.5 \text{ m s}^{-1}$  in the upwards direction.

The combined mass of the carrier and payload is  $2.5 \times 10^3 \text{ kg}$ .

- (i) State the principle of conservation of momentum.

.....  
 .....  
 ..... [2]

- (ii) Show that the mass of the payload is 230 kg.

[2]

- (iii) Calculate the magnitude of the change in velocity of the carrier.

change in velocity = .....  $\text{ms}^{-1}$  [3]