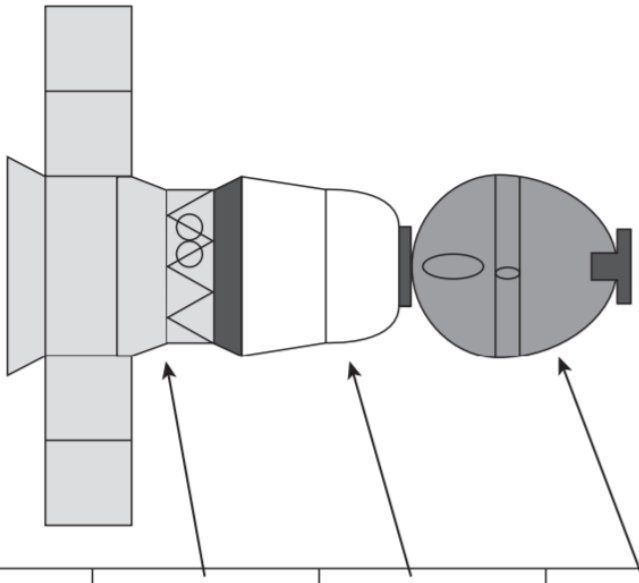
**1** A spacecraft is used to transport astronauts to and from an orbiting space station. The spacecraft is made up of three sections as shown in Fig. 1.1.



| Section | Service module | Descent module | Orbital module |
|---|---|---|---|
| Mass / kg | 2600 | 2900 | 1300 |

**Fig. 1.1**

**(a)** On leaving the space station the spacecraft is given an initial horizontal thrust of 1400 N.
Calculate the initial acceleration of the spacecraft during the firing of the thruster engines.

initial acceleration = …….. m $s^{-2}$ [2]

**(b)** The horizontal thrust provided by the engine is due to the combustion of fuel inside the fuel engine. The spacecraft loses mass continously as exhaust gases are produced by the engine.

Use momentum considerations to explain why the spacecraft is able to be propelled.

…….

…….

…….

…….

…….....[3]

**(c)** When the spacecraft returns to the Earth's atmosphere the orbital module and the service module are separated from the descent module. This descent module has its speed greatly reduced by drag from the atmosphere.

Fig. 1.2 shows two of the forces acting on the descent module as it travels down through the atmosphere.

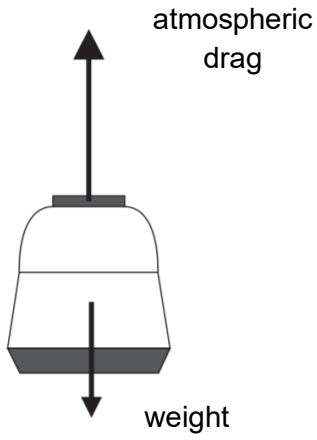



**Fig. 1.2**

State and suggest one reason if the two forces shown in Fig. 1.2 are a pair of forces as referred to in Newton's Third Law.

…….

…….....[2]

**(d)** In one particular descent, the descent module has its speed reduced to 5.5 m $s^{-1}$ by parachutes. The descent module also releases its empty tanks and shield to reduce its mass to 890 kg.

A final speed reduction can be carried out by using engines which operate for a maximum time of 3.5 s. When the engines are in use, the resultant upward force on the descent module is 670 N. The safe landing speed of the descent module is 3.0 m $s^{-1}$. At these safe landing speed, assume that atmospheric drag is neligible.

Determine whether these engines are able to reduce the speed of the descent module to its safe value.

[3]

[Total: 10]