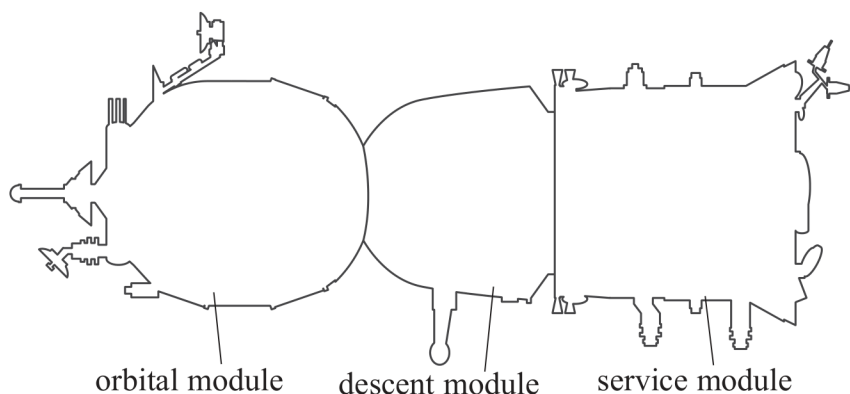**16** A spaceship is used to take astronauts and equipment to the International Space Station. The spaceship consists of an orbital module, a descent module and a service module, as shown.

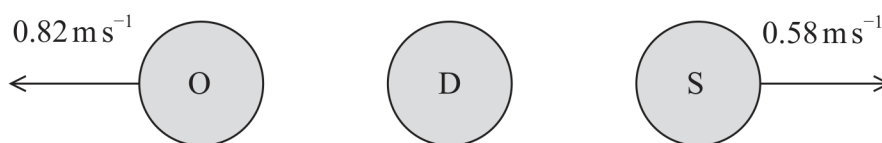orbital module   descent module   service module

(Source: © NASA)

The astronauts return to Earth in the descent module.

Before entering the Earth's atmosphere, the modules separate.

The orbital module (O) and service module (S) move away from the descent module (D) in opposite directions, as shown below.

$0.82 \, \mathrm{m\,s^{-1}}$ O   D   S $0.58 \, \mathrm{m\,s^{-1}}$

(a) Determine the velocity v of the descent module after separation.

You should only consider momentum along a horizontal line through the centres of the three modules.

mass of O = 1350 kg
mass of D = 2950 kg
mass of S = 2100 kg

(4)

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....

....

Magnitude of v = ... Direction of v = ...

(b) The velocity of the descent module can be changed using a rocket motor. The rocket motor ejects hot gases at high velocity.

(i) Explain why the velocity of the descent module changes when the rocket motor is used.

Your answer should refer to Newton's laws of motion.

(3)

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....

....

(ii) When the rocket motor is operating, the velocity of the descent module changes by $0.58\,m\,s^{-1}$ during a time of 5.0 seconds.

mass of descent module = $2950\,kg$

Calculate the average force exerted on the hot gas during this time.

(3)

....

....

....

....

Average force = ...

(Total for Question 16 = 10 marks)