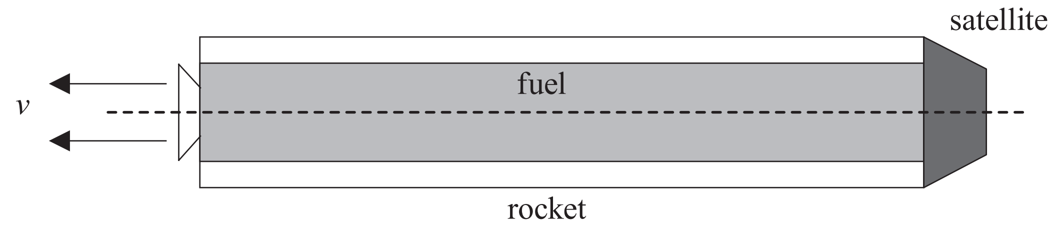
A2. This question is about momentum.

(a) A rocket in outer space far from any other masses is used to propel a satellite. At $t=0$ the engines are turned on and gases leave the rear of the rocket with speed v relative to the rocket.



(i) Explain, in terms of Newton's laws of motion, why the rocket will accelerate. *[2]*

. . . .

. . . .

. . . .

. . . .

(ii) Outline how the law of conservation of momentum applies to the motion of the rocket. *[2]*

. . . .

. . . .

. . . .

(iii) The gases leave the rear of the rocket at a constant rate of R kg per second. The mass of the rocket (including fuel) at $t=0$ is M.

Deduce that the initial acceleration, a, of the rocket is given by the expression

$$a = \frac{Rv}{M}.$$ *[3]*

. . . .

. . . .

. . . .

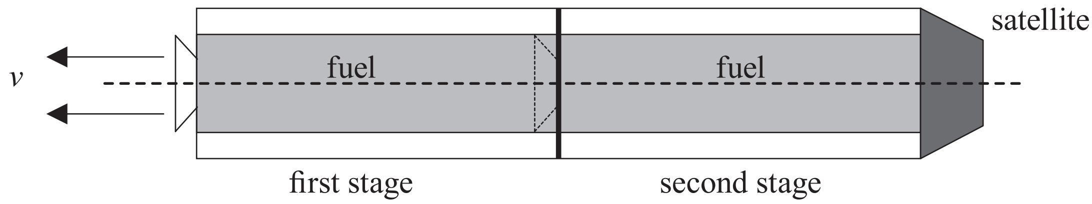
. . . .

. . . .

(This question continues on the following page)

(Question A2 continued)

(b) The diagram below shows a two-stage rocket that is used to accelerate a satellite that has the same mass as in (a). The rocket has the same mass as the single stage rocket and carries the same mass of fuel as in (a).



Each stage is discarded after all its fuel has been used. Explain, using the answer in (a)(iii), whether the final speed of the satellite will be larger, equal **or** smaller than that of the satellite accelerated by the single stage rocket. *[2]*

. . . .

. . . .

. . . .

. . . .