94

Question 3

This question relates to Unit 12 and carries 40% of the marks for this assignment. Your answer should be laid out in the format described in the Problem Book and the rubric for TMA 01, with distinct stages of preparation, working and checking. (Although the question has two parts, you need only set out one preparation stage, and show one check.)

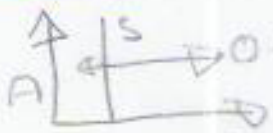
Note that 12 of the 40 marks for this question are allocated to 'good problem solving techniques'.

A spaceship is travelling in a straight line away from a small asteroid, with a constant speed of 0.50 c relative to the asteroid. A small rocket of mass 5.0×10^3 kg is launched from the spaceship, directly towards the asteroid and with an initial speed relative to the spaceship of 0.60 c. The booster engines of the rocket, which exert a constant force of 1.0×10^6 N, are operated while the rocket travels a distance of 4.0×10^{14} m (as measured in the spaceship's frame of reference).

What is the final constant speed of the rocket

(i) according to an observer on the spaceship? (*hint*: think about energy changes), and

(ii) according to an observer on the asteroid?



$\frac{1}{2}mv^2 \quad \frac{mc^2}{\sqrt{1-v^2/c^2}} = 4E20 + \frac{mc^2}{\sqrt{1-v^2/c^2}} = 4E20 + \frac{45E19}{\sqrt{1-0.5^2}}$

$= 4E20 + = 9.2E20$

$0.4 \quad 1-v^2/c^2$