Section B

Answer **one** question from this Section in the spaces provided.

7 (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 as shown in Figure 7.1.

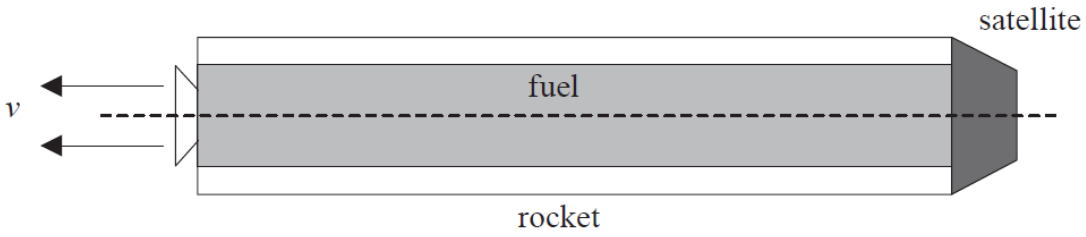

Fig. 7.1

(i) 1. Explain, in terms of Newton's laws of motion, why the rocket will accelerate.

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.....[2]

2. Outline how the conservation of momentum applies to the motion of the rocket.

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.....[2]

3. 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]

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(ii) Figure 7.2 below shows a two-stage rocket that is used to accelerate a satellite that has the same mass as in (i). The rocket has the same mass as the single stage rocket and carries the same mass of fuel as in (i).

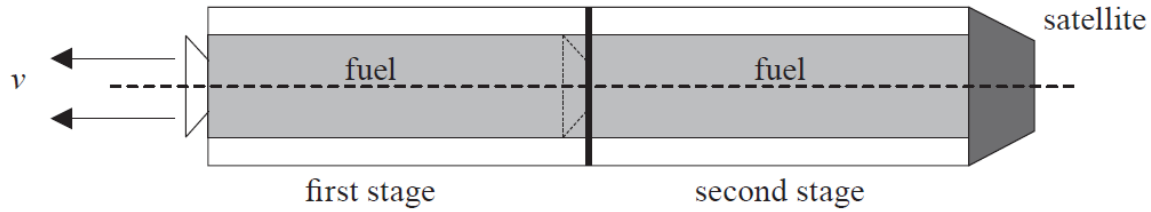

Fig. 7.2

Each stage is discarded after all its fuel has been used. Explain, using your answer to **(i)3**, whether the final speed of the satellite will be larger, equal or smaller than that of the satellite accelerated by the single stage rocket.

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.....[2]

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(b) A girl falls from rest on to the horizontal surface of a trampoline.
Figure 7.3 below shows the variation with time *t* of the net force *F* exerted on the girl before, during and after contact with the trampoline.

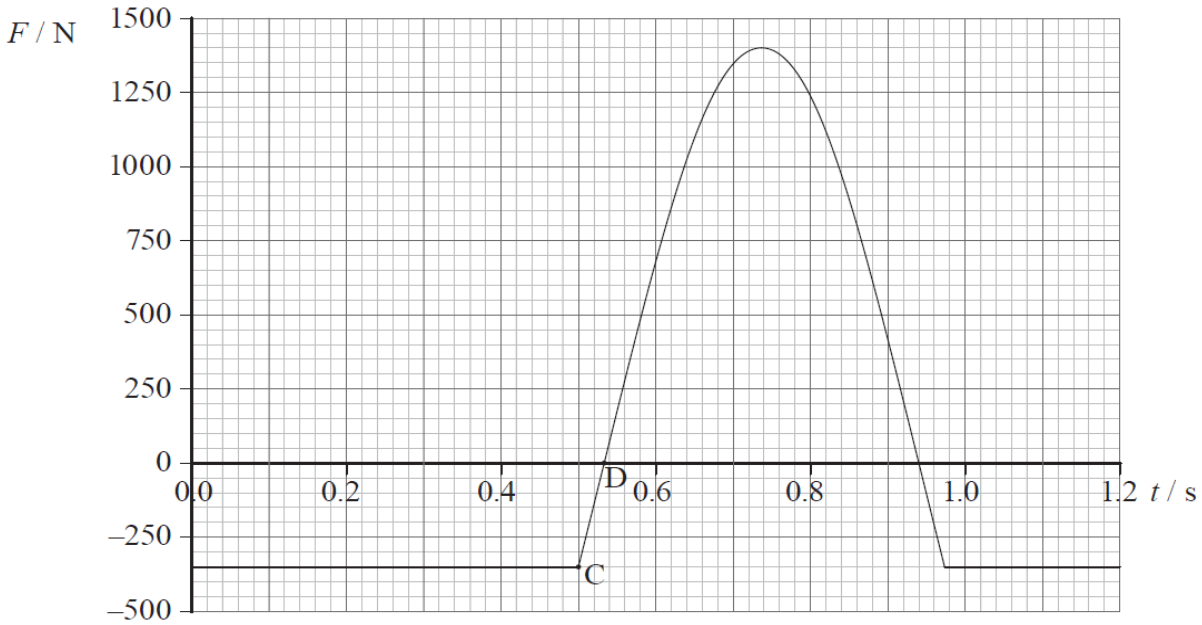

Fig. 7.3

(i) The girl first makes contact with the trampoline at point C. Use data from the graph to

1. show that the mass of the girl is 36 kg. [1]

2. calculate the speed of the girl just before she lands on the trampoline.

speed of the girl just before landing = ... m s^{-1} [1]

3. calculate the maximum contact force on the girl when she is in contact with the trampoline.

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maximum contact force = ...N [2]

(ii) From the time between point C and point D,

1. state and explain, with reference to forces acting on the girl, how the speed of the girl is changing.

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..... [3]

2. show that the change in momentum of the girl is approximately 5 Ns [2]

3. estimate the speed of the girl at point D.

speed of the girl at D = ... $m\ s^{-1}$ [2]

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