For Examiner's Use

2 **(a)** A man wants to knock down a coconut from the tree by throwing a stone at it as shown in Fig. 2.1. The coconut is 18.0 m above the ground. The man's hand is 2.2 m above the ground when he releases the stone with an initial velocity of 20.0 m s^{-1}. Assume that air resistance is negligible.

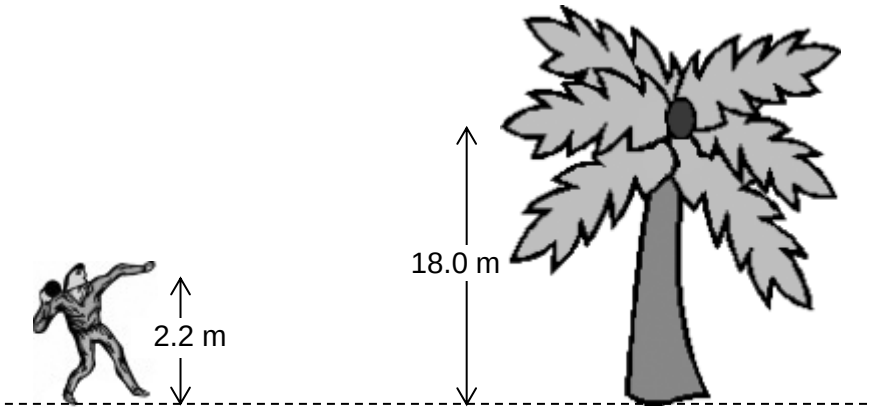

Fig. 2.1 (not to scale)

(i) Explain qualitatively, in terms of acceleration and velocity, why the path taken by the stone is *parabolic*.

……

……

…….. [1]

(ii) Show that the angle at which the stone should be released from the horizontal so that it would hit the coconut horizontally is 62°.

[2]

For Examiner's Use

(iii) Hence, calculate the time taken for the stone to reach its maximum height when it is projected at the angle in **(a)(ii)**.

time taken = ... s [2]

(b) A spaceship engine uses solar power to ionise and eject xenon atoms from the spaceship. The speed of the ejected xenon ions is 3.0×10^4 m s^{-1} relative to the spaceship as shown in Fig. 2.2.

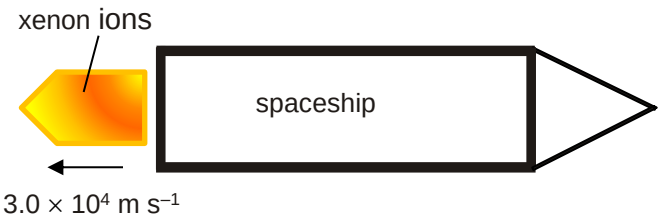

Fig. 2.2

Fig. 2.3 shows the variation with time t of the acceleration a of the spaceship due to the ejection of xenon ions.

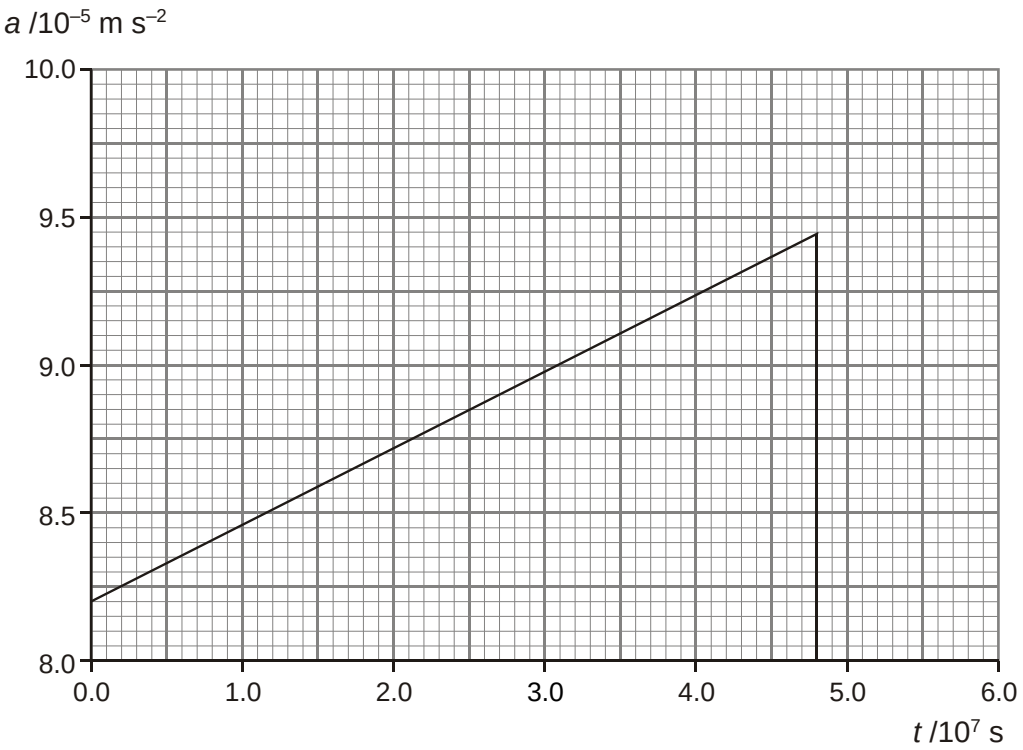

Fig. 2.3

[Turn over

For Examiner's Use

(i) Explain why the acceleration of the spaceship is increasing.

……

……

……... [1]

(ii) Given that the ions are ejected at a constant rate of 1.7×10^{-6} kg s^{-1}, calculate the magnitude of the force exerted on the spaceship by the ions.

magnitude of force = …… N [2]

(iii) The spaceship is initially stationary and its engine is switched on at time $t = 0$ s.

Using Fig. 2.3, calculate the final velocity of the spaceship when the xenon ions run out completely.

velocity = …… m s^{-1} [2]

For Examiner's Use

(iv) On Fig. 2.4, draw the corresponding variation with time t of the velocity v of the spaceship from $t = 0$ to $t = 6.0 \times 10^7$ s.

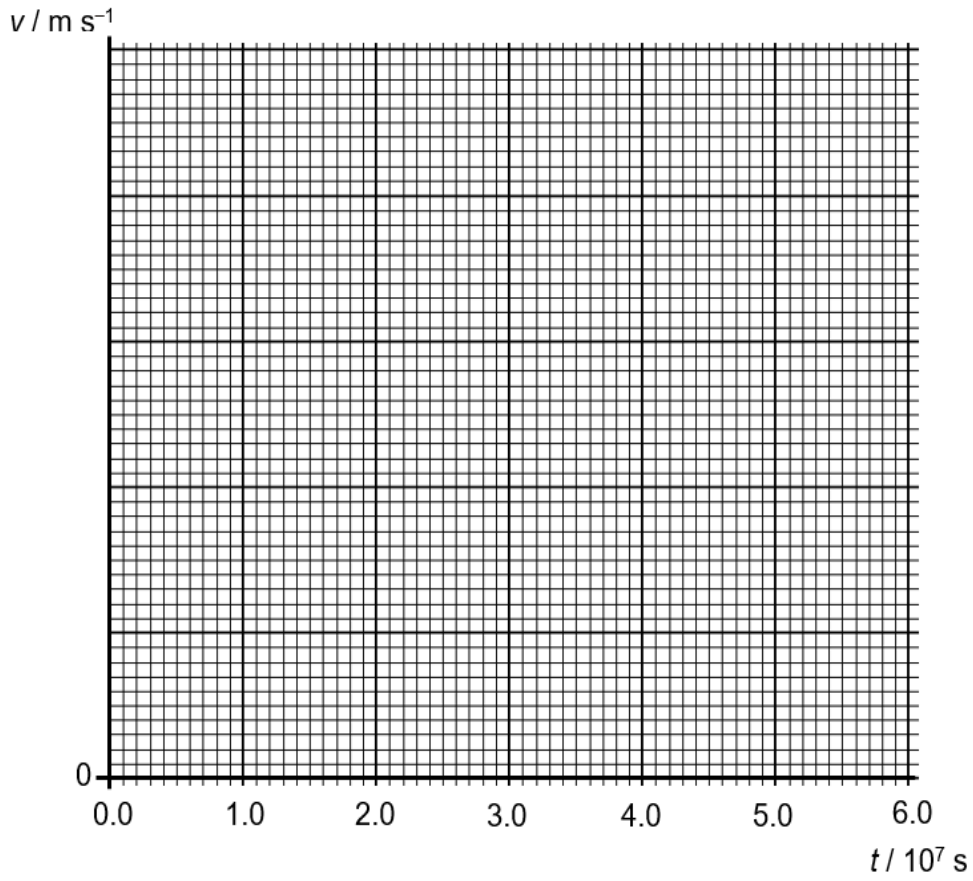

Fig. 2.4

[2]

[Total: 12]

[Turn over