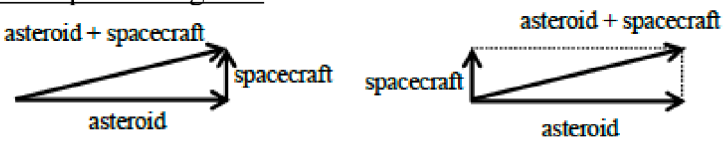
Question number	Answer	Mark
15 (a)	• Resultant on correct triangle or parallelogram including arrows with a clear right angle between initial asteroid momentum and initial spacecraft momentum (1) • Fully labelled (dependent on MP1) (1) Example of diagram: 	**2**
15 (b)	• Use of $p = mv$ (1) • $p = 1.1 \times 10^7$ (N s) (minimum 2 s.f.) (1) Example of calculation $p = 920\ \text{kg} \times 12\,000\ \text{m s}^{-1} = 1.1 \times 10^7\ \text{N s}$	**2**
15 (c)	• Use of correct trigonometry (1) • Angle = 1.5×10^{-7} (rad) (minimum 2 s.f.) (1) Allow ecf from (b) Example of calculation $\tan\theta = 1.1 \times 10^7\ \text{N s} \div 7.6 \times 10^{13}\ \text{N s} = 1.45 \times 10^{-7}$ $(\theta = 8.3°)$ $\theta = 1.45 \times 10^{-7}$ rad (Answer depends on rounding from (b), accept 1.4 or 1.5 rad)	**2**
15 (d)	• Apply principle of conservation of momentum along path at 90° to original path of asteroid (1) • Component of velocity = $3.9 \times 10^{-3}\ \text{m s}^{-1}$ (1) Allow ecf from (b) or (c) Example of calculation Component of velocity = spacecraft momentum ÷ (mass of spacecraft + mass of asteroid) $= 1.1 \times 10^7\ \text{N s} \div (920\ \text{kg} + 2.8 \times 10^9\ \text{kg})$ $= 3.9 \times 10^{-3}\ \text{m s}^{-1}$	**2**
15 (e)	• Use of impulse = $F\,\Delta t = \Delta p$ (1) • Concludes 1.8×10^9 N s change in momentum from rocket engines is greater than 1.1×10^7 N s change from impact (1) Allow ecf from (b) Example of calculation Impulse = $5.1 \times 10^6\ \text{N} \times 6 \times 60\ \text{s} = 1.8 \times 10^9\ \text{N s}$	**2**
	Total for question 15	**10**