9	The only correct answer is **B** **A** is not correct because there should be an antineutrino and not a neutrino **C** is not correct because charge is not conserved **D** is not correct because charge is not conserved	1

2	**C is the correct answer** because $\Delta(mv) = F\Delta t$	1

7	**The only correct answer is B** (conserved , not conserved) A is not correct because total kinetic energy is not conserved C is not correct because total momentum is conserved and total kinetic energy is not conserved D is not correct because total momentum is conserved	1

9	**The only correct answer is C** $(\sqrt{2})$ A is not correct because $E = \frac{p^2}{2m}$ B is not correct because this would be the ration of $\frac{\text{momentum of S}}{\text{momentum of T}}$ D is not correct because $E = \frac{p^2}{2m}$	1

20(a)	Total momentum remains constant **Or** Total momentum before a collision = Total momentum after a collision Provided no (resultant) external force acts **Or** In an isolated / closed system	(1) (1)	2

20(b)(i)	Velocities/momenta resolved into components Use of $p = mv$ Use of principle of conservation of momentum $v = 5.64 \times 10^6$ (m s^{-1}) <u>Example of calculation</u> $v \times 6.64 \times 10^{-27}\text{kg} \times \sin 70^0 = 1.55 \times 10^7 \text{ m s}^{-1} \times 6.64 \times 10^{-27}\text{kg} \sin 20^0$ $v = \frac{1.55 \times 10^7 \text{ m s}^{-1} \times 0.342}{0.940} = 5.641 \times 10^6 \text{ m s}^{-1}$	(1) (1) (1) (1)	4
20(b)(ii)	Use of $E_k = \frac{1}{2}mv^2$ Correct calculation of one kinetic energy 9.04×10^{-13} (J) $\approx 9.01 \times 10^{-13}$ (J), so collision is elastic (ecf from (b)(i) and show that value gives 9.02×10^{-13} J) <u>Example of calculation</u> $E_k = \frac{1}{2} \times 6.64 \times 10^{-27} \text{ kg} \times (1.55 \times 10^7 \text{ m s}^{-1})^2$ $+ \frac{1}{2} \times 6.64 \times 10^{-27} \text{ kg} \times (5.64 \times 10^6 \text{ m s}^{-1})^2$ $E_k = 7.98 \times 10^{-13} \text{ J} + 1.06 \times 10^{-13} \text{ J}$ $E_k = 9.04 \times 10^{-13} \text{ J}$	(1) (1) (1)	3

12	Use of $p = mv$ (1) Use of conservation of momentum (1) $\theta = 51°$ (1)	Example of calculation $0.40\ \text{ms}^{-1} \times 0.035\ \text{kg} = 2 \times 0.21\ \text{ms}^{-1} \times 0.037\ \text{kg}\ \cos\left(\frac{\theta}{2}\right)$ [conversion to kg not essential] $\frac{\theta}{2} = \cos^{-1}\left(\frac{0.0140}{0.0155}\right) = 25.7°$ $\theta = 51.4°$	3

19(a)	Use of $p = mv$ Use of trigonometrical function for x or y component of momentum for either stone Applies conservation of momentum in x direction or y direction $v = 1.32\ (\text{m s}^{-1})$ (3 sf reqd) if x components considered Or $v = 1.33\ (\text{m s}^{-1})$ (3 sf reqd) if y components considered Example of calculation $p = 19.1\ \text{kg} \times 0.87\ \text{m s}^{-1} = 16.6\ \text{kg m s}^{-1}$ y component for upper stone $= 16.6\ \text{kg m s}^{-1} \times \sin 50° = 12.7\ \text{kg m s}^{-1}$ y component for lower stone $= 12.7\ \text{kg m s}^{-1} = 19.1\ \text{kg} \times v \sin 30°$ $v = \frac{12.7\ \text{kg m s}^{-1}}{0.5 \times 19.1\ \text{kg}} = 1.33\ \text{m s}^{-1}$	(1) (1) (1) (1)	4

19(b)	Use of $E_k = \frac{1}{2}mv^2$ **Or** use of $E_k = \frac{p^2}{2m}$ Correct calculation of one kinetic energy (e.c.f from (a)) Comparison and conclusion consistent with correctly calculated values of kinetic energy Example of calculation $E_k = \frac{1}{2} \times 19.1\ \text{kg} \times (1.7\ \text{m s}^{-1})^2 = 27.6\ \text{J}$ before $E_k = \frac{1}{2} \times 19.1\ \text{kg} \times (0.87\ \text{m s}^{-1})^2 + \frac{1}{2} \times 19.1\ \text{kg} \times (1.33\ \text{m s}^{-1})^2$ $\therefore E_k = 7.2\ \text{J} + 16.9\ \text{J} = 24.1\ \text{J}$ after Initial $E_k = 28\ \text{J}$ so kinetic energy is not the same and collision is not elastic	(1) (1) (1)	3