1	**B is the correct answer** A is incorrect because gradient is velocity, not acceleration C is incorrect because gradient is rate of change of acceleration,not velocity D is incorrect because gradient is rate of change of acceleration, not displacement	1

10	**The only correct answer is C** because taking upwards as positive, force of floor of lift on student – weight of student = mass × acceleration $800 - 70g = 70a$ **A** *is not the correct answer because the force of the lift on the student was omitted and the direction of the weight is incorrect* **B** *is not the correct answer because the weight of the student has been omitted* **D** *is not the correct answer because the weight and the force of the lift on the student are in the wrong direction*	**(1)**

8	**B is the correct answer** A is incorrect because the factor 9.81 = g / (N kg^{-1}) is not needed since it is already included in the weight, $\Delta E_{grav} = mg\Delta h = W\Delta h$ C is incorrect because dividing by 9.81 removes g from the calculation D is incorrect because dividing by 9.81 removes g and the factor 25 = Δh / m is missing from the calculation	1

9	**D is the correct answer** A is not the correct answer as the stiffness constant only applies to objects B is not the correct answer as the Young modulus only applies to materials C is not the correct answer as the stiffness constant only applies to objects and the Young modulus only applies to materials	**(1)**

1	**The only correct answer is D (J s^{-1})** A is not correct because this is equivalent to the joule B is not correct because this is the unit for stiffness C is not correct because the watt is the joule per second	1

10	**A 4σ**	1
	Incorrect Answers: $\sigma \propto 1/A$ so if the thinner string has half the diameter, its cross-sectional area will be ¼ that of the thicker string. 1 ÷ ¼ = 4 so σ is 4 times larger B – factor of ½ not squared when diameter squared in area equation C – inverse of distractor B, assumes $\sigma \propto$ diameter D – inverse of correct answer, assumes $\sigma \propto$ area	

2	**C drag + weight – upthrust = 0**	1
	Incorrect Answers: A – incorrect re-arrangement of correct equation B – incorrect re-arrangement of correct equation D – incorrect re-arrangement of correct equation	

2	**2. The only correct answer is C** ***A** is not correct as ductile behaviour is only exhibited under a tensile force and not a compressive force* ***B** is not correct as hardness is a measure of a material's resistance to being scratched* ***D** is not correct because a stiff material would not exhibit as much compression under a compressive force*	**(1)**

Question Number	Answer	Additional Guidance	Mark
14(a)	The total momentum (of a system) is constant **(1)** When no external forces act (dependent on MP1) **Or** In a closed system (dependent on MP1) **(1)**		**2**
14(b)	Use of $E_k = \frac{1}{2}mv^2$ to determine initial velocity of rock B **(1)** Use of $p = mv$ **(1)** Use of principle of conservation of momentum **(1)** $v = 11\ \text{m s}^{-1}$ **(1)**	Example calculation $v_B = \sqrt{\frac{2 \times 4.1 \times 10^3\ \text{J}}{56\ \text{kg}}} = 12.1\ \text{m s}^{-1}$ $p_B = 56\ \text{kg} \times 12.1\ \text{m s}^{-1} = 678\ \text{kg m s}^{-1}$ $p_A = 43\ \text{kg} \times 7.8\ \text{m s}^{-1} = 335\ \text{kg m s}^{-1}$ $335\ \text{kg m s}^{-1} + 678\ \text{kg m s}^{-1} = 43\ \text{kg} \times v_A + 530\ \text{kg m s}^{-1}$ $v_A = \frac{1013\ \text{kg m s}^{-1} - 530\ \text{kg m s}^{-1}}{43\ \text{kg}} = 11.2\ \text{m s}^{-1}$	**4**
	Total for question 14		**6**

18(a)	No resultant force No resultant moment (about any point)	**(1)** **(1)**	**2**
18(b)	The point at which the weight of an object is considered to act	**(1)**	**1**
18(c)(i)	Use of $W = mg$ Horizontal distance from edge of door to centre of gravity identified as $\frac{w}{2}$ Use of moment of force $= Fx$ Use of clockwise moment = anticlockwise moment Horizontal component of force of hinge Y on door = 37.5 (N) **OR** Use of $W = mg$ Use of tan θ with dimensions of door Use of vertical component of force of hinge Y on door = W/2 Use of tan θ with vertical and horizontal components of force of hinge Y on door Horizontal component of force of hinge Y on door = 37.5 (N) <u>Example of calculation</u> $W = 14.4\ \text{kg} \times 9.81\text{N kg}^{-1} = 141\ \text{N}$ $141\ \text{N} \times \frac{0.85\ \text{m}}{2} = F_{\text{horizontal}} \times 1.60\ \text{m}$ $F_{\text{horizontal}} = \frac{60.0\ \text{N m}}{1.60\ \text{m}} = 37.5\ \text{N}$	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**5**

18(a)	No resultant force No resultant moment (about any point)	**(1)** **(1)**	**2**
18(b)	The point at which the weight of an object is considered to act	**(1)**	**1**
18(c)(i)	Use of $W = mg$ Horizontal distance from edge of door to centre of gravity identified as $\frac{w}{2}$ Use of moment of force $= Fx$ Use of clockwise moment = anticlockwise moment Horizontal component of force of hinge Y on door = 37.5 (N) **OR** Use of $W = mg$ Use of tan θ with dimensions of door Use of vertical component of force of hinge Y on door = W/2 Use of tan θ with vertical and horizontal components of force of hinge Y on door Horizontal component of force of hinge Y on door = 37.5 (N) <u>Example of calculation</u> $W = 14.4\ \text{kg} \times 9.81\text{N kg}^{-1} = 141\ \text{N}$ $141\ \text{N} \times \frac{0.85\ \text{m}}{2} = F_{\text{horizontal}} \times 1.60\ \text{m}$ $F_{\text{horizontal}} = \frac{60.0\ \text{N m}}{1.60\ \text{m}} = 37.5\ \text{N}$	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**5**

18(c)(ii)	Use of appropriate trigonometry to determine θ	**(1)**	
	$\theta = 28°$ (allow ecf from 18(c)(i)) (show that answer gives 30°)	**(1)**	
	Use of Pythagoras' theorem to determine F **Or** Use of appropriate trigonometry to determine F	**(1)**	
	$F = 80$ N (allow ecf from 18(c)(i)) (show that answer gives 81 N)	**(1)**	**4**
	<u>Example of calculation</u> $\theta = \tan^{-1}\left(\frac{37.5}{\left(\frac{141}{2}\right)}\right) = 28.0°$ $F = \sqrt{(37.5\text{ N})^2 + \left(\frac{141\text{ N}}{2}\right)^2} = 80.0\text{ N}$		
18(c)(iii)	Moment of weight of door (about X) remains the same. **Or**		
	$mg \times \frac{w}{2} = F_{\text{horizontal}} \times L$ (and m, g and w remain the same).	**(1)**	
	(So) horizontal (component of) force increases (when L decreases).	**(1)**	
	Vertical (component of) force remains the same. **Or** Each hinge still holds half the weight of the door.	**(1)**	
	(So) F increases and θ increases.	**(1)**	**4**
	Total for question 18		**16**