Question	Answer	Marks
1(a)(i)	force × perpendicular distance (of line of action of force to the point)	**B1**
1(a)(ii)	units: kg m s^{-2} m = kg m^2 s^{-2}	**A1**
1(b)	$W = \rho Vg$ **or** $W = \rho ALg$	**C1**
	$A = 5.2 / (790 \times 2.4 \times 9.81)$ $(= 2.8 \times 10^{-4}$ (m^2))	**C1**
	$= 2.8 \times 10^2$ mm^2	**A1**
1(c)(i)	(component =) 5.2 sin 56° = 4.3 (N) **or** 5.2 cos 34° = 4.3 (N)	**A1**
1(c)(ii)	$(T \times 2.4)$ **or** (4.3×1.2) **or** (4.6×1.8)	**C1**
	$(T \times 2.4) + (4.3 \times 1.2) = (4.6 \times 1.8)$	**C1**
	$T = 1.3$ N	**A1**

Question	Answer	Marks
2(a)	constant gradient	**B1**
2(b)	(displacement until 0.20 s =) ½ × 1.96 × 0.20 (= 0.196 m) **or** (displacement after 0.20 s =) ½ × 6.86 × 0.70 (= 2.401 m)	**C1**
	height = 2.401 – 0.196	**C1**
	= 2.2 m (*alternative methods are possible using equations of uniformly accelerated motion*)	**A1**
2(c)	$(\Delta)E = mg(\Delta)h$ **or** $W(\Delta)h$	**C1**
	$(\Delta)E$ = 0.86 × 2.2 = 1.9 J	**A1**
2(d)	curved line from the origin	**M1**
	gradient of curved line decreases and is zero at t = 0.20 s only	**A1**
2(e)	acceleration (of free fall) is unchanged/is not dependent on mass <u>and</u> (so) no effect	**B1**

Question	Answer	Marks
3(a)	(force =) rate of change of momentum	**B1**
3(b)(i)	$E = ½mv^2$ **or** $½ \times 0.062 \times 3.8^2$ **or** $½ \times 0.062 \times 1.7^2$	**C1**
	loss of KE $= ½ \times 0.062 \times (3.8^2 - 1.7^2)$ $= 0.36$ J	**A1**
3(b)(ii)	$p = mv$ **or** 0.062×3.8 **or** 0.062×1.7	**C1**
	change in momentum $= 0.062 \times (1.7 + 3.8)$ $= 0.34$ N s	**A1**
3(b)(iii)	(average resultant force =) 0.34 / 0.081 = 4.2 (N) **or** (average resultant force =) $0.062 \times (1.7 + 3.8) / 0.081 = 4.2$ (N)	**A1**
3(b)(iv)	**1.** average force = $4.2 + (0.062 \times 9.81)$ = 4.8 N	**A1**
	2. average force = 4.8 N	**A1**

Question	Answer	Marks
4(a)(i)	(stress =) force / cross-sectional area	**B1**
4(a)(ii)	(strain =) extension / original length	**B1**
4(b)(i)	$E = FL / Ax$	**C1**
	$= GL / A$	**A1**
4(b)(ii)	straight line from origin above the original line	**M1**
	line ends at point (4 small squares, F_1).	**A1**
4(b)(iii)	**1.** shaded area below the graph line and between the two vertical dashed lines	**B1**
	2. remove the force/F/F_2 and the wire goes back to original length/zero extension	**B1**
4(b)(iv)	values have a large range	**B1**

Question	Answer	Marks
5(a)	$v = \lambda / T$ **or** $v = f\lambda$ **and** $f = 1 / T$	**C1**
	$v = 8.0 \times 10^{-2} / 0.40$ $= 0.20\ \text{m s}^{-1}$	**A1**
5(b)	$I \propto A^2$	**C1**
	ratio $= 2^2 / 4^2$	**C1**
	$= 0.25$	**A1**

Question	Answer	Marks
6(a)	the waves (of the same type) move in opposite directions and overlap	**B1**
	the waves have the same (speed and) frequency/wavelength	**B1**
6(b)(i)	zero amplitude	**B1**
6(b)(ii)	distance $= 6.0 \times 4$ $= 24$ cm	**A1**
6(b)(iii)	180°	**A1**

Question	Answer	Marks
7(a)	volt / ampere	**B1**
7(b)	$R = \rho L / A$	**C1**
	$A = 460 \times 10^{-9} \times 2.5 / 3.2$	**C1**
	$= 3.6 \times 10^{-7}$ m^2	**A1**
7(c)(i)	energy is dissipated in the internal resistance/r	**B1**
7(c)(ii)	$E = IR + Ir$ **or** $E = I(R + r)$	**B1**
7(c)(iii)	$P = I^2R$ **or** $P = I^2r$	**C1**
	$I = E / 2r$ (so) $P = E^2 / 4r$	**A1**

Question	Answer	Marks
8(a)	similarity: same/equal mass **or** same/equal (magnitude of) charge **or** both fundamental (particles)	**B1**
	difference: opposite (sign of) charge **or** one is matter and the other is antimatter	**B1**
8(b)(i)	number of protons = 13 **and** number of neutrons = 12	**A1**
8(b)(ii)	(charge =) $13 \times 1.60 \times 10^{-19}$ (C) = 2.1×10^{-18} (C)	**A1**
8(c)	force = $11 \times 10^{3} \times 2.1 \times 10^{-18}$	**C1**
	work done = $11 \times 10^{3} \times 2.1 \times 10^{-18} \times 0.04$	**C1**
	= 9.2×10^{-16} J	**A1**

