Question	Answer	Marks
3(a)	$E_{(P)} = ½kx^2$ **or** $E_{(P)} = ½Fx$ **and** $F = kx$	**C1**
	$0.048 = ½ \times k \times (2.1 \times 10^{-2})^2$ $k = 220\ \text{N m}^{-1}$	**A1**
3(b)	$E_{(K)} = ½mv^2$	**C1**
	$0.048 = ½ \times 7.5 \times 10^{-3} \times v^2$ $v = 3.6\ \text{m s}^{-1}$	**A1**
3(c)(i)	$(\Delta)E = mg(\Delta)h$	**C1**
	$0.039 = 7.5 \times 10^{-3} \times 9.81 \times (\Delta)h$ $\Delta h = 0.53\ \text{m}$	**A1**
3(c)(ii)	$F \times 0.53 = 0.048 - 0.039$	**C1**
	$F = 0.02\ \text{N}$	**A1**
3(d)	sketch: curved line from the origin	**M1**
	curved line has increasing gradient	**A1**

Question	Answer	Marks
4(a)(i)	component of momentum = $0.25 \times 3.7 \times \sin 27°$	**C1**
	= 0.42 N s	**A1**
4(a)(ii)	$m_{(Z)} \times 5.5 \times \sin 44° = 0.42$ **or** $m_{(Z)} \times 5.5 \times \sin 44° = 0.25 \times 3.7 \times \sin 27°$ $m_Z = 0.11$ kg	**A1**
4(a)(iii)	magnitudes: equal	**B1**
	directions: opposite	**B1**
4(b)	$4 + 6 = 2 + v$ $v = 8$ m s^{-1}	**A1**

Question	Answer	Marks
5(a)(i)	light intensity has maximum value at 0°, 180°, 360° and zero intensity at 90°, 270°	**M1**
	'sinusoidally-shaped' curve	**A1**
5(a)(ii)	$4.2 = 7.6 \cos^2\theta$	**C1**
	$\theta = 42°$	**A1**
5(b)	wave passes (through) an aperture **or** wave passes (by / through / around) an edge	**B1**
	wave spreads (into geometrical shadow)	**B1**
5(c)(i)	$n\lambda = d \sin\theta$	**C1**
	$d = (3 \times 4.3 \times 10^{-7}) / \sin 68°$ $= 1.4 \times 10^{-6}$ m	**A1**
5(c)(ii)	$1.4 \times 10^{-6} \times \sin 68° = 2 \times \lambda$ **or** $3 \times 4.3 \times 10^{-7} = 2 \times \lambda$	**C1**
	$\lambda = 6.5 \times 10^{-7}$ m	**A1**

Question	Answer	Marks
6(a)	$R = \rho L / A$	**C1**
	$\rho = 0.92 \times 5.3 \times 10^{-7}$ $= 4.9 \times 10^{-7}\ \Omega\,\text{m}$	**A1**
6(b)(i)	(current =) $6.4 / 1600 = 4.0 \times 10^{-3}$ (A)	**A1**
6(b)(ii)	charge $= 4.0 \times 10^{-3} \times 3.2 \times 60$ $(= 0.768\ \text{C})$	**C1**
	number $= 0.768 / 1.6 \times 10^{-19}$ $= 4.8 \times 10^{18}$	**A1**
6(b)(iii)	$6.4 / E = 1600 / (1400 + 1600)$ **or** $E = 6.4 + (4.0 \times 10^{-3} \times 1400)$ **or** $E = 4.0 \times 10^{-3}\ (1600 + 1400)$	**C1**
	$E = 12\ \text{V}$	**A1**
6(b)(iv)	$P = I^2R$ **or** $P = VI$ **or** $P = V^2 / R$	**C1**
	ratio $= (6.4^2 / 1600) / [(4.0 \times 10^{-3})^2 \times 1400]$ $= 1.1$	**A1**
6(c)(i)	increase	**B1**
6(c)(ii)	increase	**B1**
6(c)(iii)	decrease	**B1**

Question	Answer	Marks
7(a)	only baryon **and** nucleon underlined	**B1**
7(b)	number of α-particles = 6	**B1**
	number of β^- particles = 4	**B1**
7(c)	charm antiquark (charge) = $-\frac{2}{3}(e)$ **or** $-\frac{2}{3}(e) + q = -1(e)$	**B1**
	(other quark $q = -\frac{1}{3}(e)$ so) down / strange / bottom	**B1**