





















Question	Answer	Marks
4(a)	Hooke's (law)	<b>B1</b>
4(b)	$k = F/x$ <b>or</b> $k = \text{gradient}$	<b>C1</b>
	= e.g. $12.0 / (0.240 - 0.08)$ = $75 \text{ N m}^{-1}$	<b>A1</b>
4(c)	$E = \frac{1}{2}Fx$ <b>or</b> $E = \frac{1}{2}kx^2$ <b>or</b> $E = \text{area under graph}$	<b>C1</b>
	$E = \frac{1}{2} \times 6.0 \times 0.080$ <b>or</b> $\frac{1}{2} \times 75 \times 0.08^2$  = $0.24 \text{ J}$	<b>A1</b>

Question	Answer	Marks
5(a)(i)	(they are) perpendicular	<b>B1</b>
5(a)(ii)	(they are) parallel	<b>B1</b>
5(b)(i)	$\lambda = v / f$	<b>C1</b>
	$= 340 / 1700$ $= 0.20 \text{ m}$	<b>A1</b>
5(b)(ii)	$L = \frac{3}{4} \times \lambda = \frac{3}{4} \times 0.20$ $= 0.15 \text{ m}$	<b>A1</b>
5(b)(iii)	$\lambda = 4 \times 0.15$ <b>or</b> $0.20 \times 3$ $= 0.60 \text{ m}$	<b>A1</b>
5(c)(i)	$(I =) 8.5 \times \cos^2 35^\circ = 5.7 \text{ (W m}^{-2}\text{)}$	<b>A1</b>
5(c)(ii)	$5.2 = 5.7 \cos^2 \theta$ $(\theta = 17^\circ)$	<b>C1</b>
	$\alpha = 35^\circ + 17^\circ$ $= 52^\circ$	<b>A1</b>



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6(a)	temperature decreases (so) resistance decreases	<b>B1</b>
6(b)(i)	current = $V/R$	<b>A1</b>
6(b)(ii)	$I = Anvq$ $n = N/V$ <b>or</b> $n = N/AL$	<b>C1</b>
	$v = (V/R) / [(V/L)(N/V)e]$ <b>or</b> $(V/R) / [A(N/AL)e]$ $= VL/RNe$	<b>A1</b>
	<b>or</b>	
	$v = L/t$ $= L/(Q/I)$	<b>(C1)</b>
	$= LI/Q$ $= L(V/R)/Ne$ $= VL/RNe$	<b>(A1)</b>
6(b)(iii)	time = distance / speed <b>or</b> $Q/I$ $= L/(VL/RNe)$ <b>or</b> $Ne/(V/R)$ time = $RNe/V$	<b>A1</b>



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7(a)	$V/9.0 = 1800/(1800 + 1200)$	<b>C1</b>
	$V = 5.4 \text{ V}$	<b>A1</b>
	<b>or</b>	
	$I = 9.0/(1800 + 1200) = 3.0 \times 10^{-3} \text{ (A)}$ $V = 3.0 \times 10^{-3} \times 1800$	<b>(C1)</b>
	$= 5.4 \text{ V}$	<b>(A1)</b>
7(b)(i)	$L/1.2 = 5.4/9.0$ <b>or</b> $XZ/1.2 = 5.4/9.0$	<b>C1</b>
	$L = 0.72 \text{ m}$	<b>A1</b>
	<b>or</b>	
	$L/1.2 = 1800/(1800 + 1200)$ <b>or</b> $XZ/1.2 = 1.8/(1.8 + 1.2)$	<b>(C1)</b>
	$L = 0.72 \text{ m}$	<b>(A1)</b>
7(b)(ii)	<ul style="list-style-type: none"> <li>• (intensity) increase</li> </ul>	<b>B1</b>
	<ul style="list-style-type: none"> <li>• (power) increase</li> </ul>	<b>B1</b>
	<ul style="list-style-type: none"> <li>• (length XZ) decrease</li> </ul>	<b>B1</b>



Question	Answer	Marks
8(a)(i)	number of protons: equal/same	<b>B1</b>
	number of neutrons: unequal/different	<b>B1</b>
8(a)(ii)	down (quark) changes to up (quark) <b>or</b> up down down (quarks) change to up up down (quarks)	<b>B1</b>
8(a)(iii)	(electron) antineutrino	<b>B1</b>
8(b)	charm (quark charge) is $(+)2/3(e)$ <b>or</b> 2 charm (quark charges) is $(+)4/3(e)$ <b>or</b> bottom (quark charge) is $-1/3(e)$	<b>C1</b>
	charge = $+2/3(e) + 2/3(e) - 1/3(e)$  $= (+)1(e)$	<b>A1</b>

