

Question number	Answer	Mark
18(a)	<ul style="list-style-type: none"> <li>Thermionic emission 1</li> <li>Electrons in the heated metal gain energy and leave the surface 1</li> </ul>	2
18 (b) (i)	<ul style="list-style-type: none"> <li>Use of <math>E_k = \frac{1}{2} mv^2</math> 1</li> <li>Use of <math>1.6 \times 10^{-19} \text{ C}</math> to convert eV to J or J to eV 1</li> <li>Energy = <math>7.6 \times 10^{-13} \text{ J}</math> (Accept 4.7 MeV) 1</li> </ul> <p><u>Example of calculation</u>  <math>E_k = 0.5 \times 9.11 \times 10^{-31} \text{ kg} \times (2.5 \times 10^6 \text{ m s}^{-1})^2</math>  <math>= 2.8 \times 10^{-18} \text{ J}</math>  Additional <math>E_k = 59 \times 80 \times 10^3 \text{ V} \times 1.6 \times 10^{-19} \text{ C}</math>  <math>= 7.55 \times 10^{-13} \text{ J}</math></p>	3
18 (b) (ii)	<ul style="list-style-type: none"> <li>As the electrons approach the speed of light there is no appreciable increase in speed 1</li> <li><math>v</math> is constant and the electrons spend the same time in(/between) drift tubes, so <math>s = vt</math> must be constant 1</li> </ul>	2
18 (c)	<ul style="list-style-type: none"> <li>Waves travelling in opposite direction (meet and) superpose/interfere  <b>Or</b> a wave and a reflected wave (meet and) superpose/interfere 1</li> <li>At points where waves in antiphase destructive interference takes place  <b>Or</b> At points where waves in phase constructive interference takes place 1</li> <li>Zero/minimum amplitude at points where destructive interference takes place  <b>Or</b> Maximum amplitude at points where constructive interference takes place  <b>Or</b> Nodes at points where destructive interference takes place  <b>Or</b> Antinodes at points where constructive interference takes place 1</li> </ul>	3

18 (d)	<ul style="list-style-type: none"> <li>• Use of <math>1.6 \times 10^{-19} \text{ C}</math> to convert eV to J 1</li> <li>• Use of <math>E_k = p^2 / 2m</math> 1</li> <li>• Use of <math>r = p/BQ</math> 1</li> <li>• <math>B = 0.0028 \text{ T}</math> 1</li> </ul> <p><u>Example of calculation</u></p> $(2.5 \times 10^3) \text{ eV} \times 1.6 \times 10^{-19} \text{ C} = p^2 / 2 \times 9.11 \times 10^{-31} \text{ kg}$ $p = 2.70 \times 10^{-23} \text{ kg m s}^{-1}$ $B = 2.70 \times 10^{-23} \text{ kg m s}^{-1} / 0.061 \text{ m} \times 1.60 \times 10^{-19} \text{ C}$ $B = 0.0028 \text{ T}$	4
	Total for question 18	14