

5(a)	work done per unit charge
	work (done) moving positive charge from infinity (to the point)
5(b)(i)	potential (due to proton) = $(1.60 \times 10^{-19}) / (4\pi \times 8.85 \times 10^{-12} \times 10 \times 10^{-12})$
	or
	potential (due to electron) = $(-1.60 \times 10^{-19}) / (4\pi \times 8.85 \times 10^{-12} \times 110 \times 10^{-12})$
	$V = [(1.60 \times 10^{-19}) / (4\pi \times 8.85 \times 10^{-12})] \times [(10^{-1} - 110^{-1}) \times 10^{12}] = 130 \text{ V}$
5(b)(ii)	$V = [(1.60 \times 10^{-19}) / (4\pi \times 8.85 \times 10^{-12})] \times [(30^{-1} - 90^{-1}) \times 10^{12}]$
	= (+) 32 V
5(b)(iii)	cross drawn midway between the electron and the proton
5(b)(iv)	line from (10, +130) to (110, -130)
	curve getting shallower until $x = 60 \text{ pm}$, crossing $V = 0$ at (60, 0) and then getting steeper after $x = 60 \text{ pm}$
	curve passing through (30, ± 32) and (90, ± 32)

2(a)	(electric) force is (directly) proportional to product of charges
	force (between point charges) is inversely proportional to the square of their separation
2(b)(i)	charge = (+)2e
2(b)(ii)	$F = 2 \times (1.60 \times 10^{-19})^2 / [4\pi \times 8.85 \times 10^{-12} \times (170 \times 10^{-12})^2] = 1.6 \times 10^{-8} \text{ N}$
2(c)(i)	$F = mv^2 / r$
	$v = [(1.6 \times 10^{-8} \times 170 \times 10^{-12}) / (9.11 \times 10^{-31})]^{1/2}$ $= 1.7 \times 10^6 \text{ m s}^{-1}$
2(c)(ii)	$F = mr\omega^2$ and $\omega = 2\pi / T$
	$F = 4\pi^2 mr / T^2$
	$T = [(4\pi^2 \times 9.11 \times 10^{-31} \times 170 \times 10^{-12}) / (1.6 \times 10^{-8})]^{1/2}$ $= 6.2 \times 10^{-16} \text{ s}$
	or
	$v = 2\pi r / T$
	$T = (2\pi \times 170 \times 10^{-12}) / (1.73 \times 10^6)$ $= 6.2 \times 10^{-16} \text{ s}$

2(d)(i)	$E \propto Q / r^2$
	$\text{ratio} = [1.60 \times 10^{-19} \times (170 \times 10^{-12})^2] / [3.2 \times 10^{-19} \times (340 \times 10^{-12})^2]$ $= 0.13$
2(d)(ii)	resultant force slightly less (than $1.6 \times 10^{-8} \text{ N}$) so speed lower or resultant force slightly less (than $1.6 \times 10^{-8} \text{ N}$) so period greater

6(a)	plate X marked as negative and plate Y marked as positive
6(b)(i)	$E = V / x$
	$= (58 \times 10^3) / 0.041$ $= 1.4 \times 10^6 \text{ N C}^{-1}$
6(b)(ii)	$ma = eE$
	$a = (1.60 \times 10^{-19} \times 1.41 \times 10^6) / (9.11 \times 10^{-31})$ $= 2.5 \times 10^{17} \text{ m s}^{-2}$
6(c)(i)	$eV = hc / \lambda$ or $eV = hf$ and $f = c / \lambda$
	$(1.60 \times 10^{-19} \times 58 \times 10^3) = (6.63 \times 10^{-34} \times 3.00 \times 10^8) / \lambda$
	clear conversion from m to pm leading to $\lambda = 21 \text{ pm}$
6(c)(ii)	X-rays
6(c)(iii)	Any two points from: • waves are passed into structure and transmitted waves detected • different parts of the structure absorb different fractions of energy • difference in detected / transmitted <u>intensities</u> used (to form image)