1)

Question			Expected Answers	Marks	Additional guidance
	(a)		Down(wards)	B1	**Note:** Can be on Fig. 5.1
	(b)		(Fleming's) left-hand rule	B1	**Allow:** Thumb in direction of force, first finger in direction of (magnetic) field and second finger in direction of (conventional) current
	(c)	(i)	force = *BIL* = 0.080 × 4.0 × 5.0 × 10^{-2} force = 0.016 (N)	B1	
		(ii)	reading = 2.500 – 0.016 reading = 2.484 (N)	B1	
			The force on core/magnets is up(wards)	B1	
			(According to Newton's third law) the forces (on the rod and steel core/magnets) are equal and opposite	B1	**Allow:** 'up and down' as equivalent to 'opposite'
	(d)		Resistance increases by a factor of 4	C1	
			Current decreases by a factor of 4	C1	
			The force decreases by a factor of 4		
			force = 0.004 (N)	A1	Possible e.c.f. from **(c)(i)** **Note:** force = **(c)(i)**/4 can score full marks **Special case:** Allow 1 mark for (resistance doubles, current is halved, hence) force = 0.008 (N)
			Total	**9**	

2)

Question			Expected Answers	Marks	Additional Guidance
	a	(i)	uniformly spaced, vertical parallel lines must begin and end on the plates with a minimum of three lines	**B1**	ignore any edge effects
			arrow in the correct direction down	**B1**	
		(ii)	E = V / d E = 60 / 5 x 10^{-3} = 12000 (V m^{-1})	**A1**	
	b	(i)	Use of energy qV and kinetic energy = ½ mv^2	**M1**	
			v = $[(2qV)/m]^{1/2}$		
			v = $[(2 \times 3.2 \times 10^{-19} \times 400)/6.6 \times 10^{-27}]^{1/2}$	**M1**	
			v = 1.97 x 10^5 (m s^{-1})	**A0**	
		(ii)	a = F / m a = Eq / m	**C1**	Both required for the mark
			a = (12000 x 3.2 x 10^{-19}) / 6.6 x 10^{-27})		
			= 5.82 x 10^{11} (m s^{-2})	**A1**	
		(iii)	**1** t = (16 x10^{-3}) / 2 x 10^5	**M1**	Answer will depend on number of sf used by candidate.
			= 8 x 10^{-8} (s)	**A0**	
			2 s = ½ a x t^2 = ½ [5.82 x10^{11} x (8 x 10^{-8})^2]	**C1**	Using u = 2 x 10^5 scores 0/2
			= 1.86 x 10^{-3} (m)	**A1**	Allow slight variation in answers that follow from the candidates working

	c		Eq = Bqv B = E / v = 12000 / 2 x 10^5 = 0.060 (T)	**C1** **C1** **A1**	 Allow one sf unless answer is 0.061 when using v =1.97 x 10^5
	d		velocity (produced by p.d / 400 V) is less force due the magnetic field is reduced / Bqv is less / force due to the electric field is unchanged hence beam deflects down	**B1** **B1**	 Allow the resultant force is downward Allow towards the lower plate
			Total	**[15]**	

3)

Question			Answer	Marks	Guidance
	(a)		Arrow to the left	B1	
	(b)	**(i)**	1500 (eV)	B1	**Note**: 2.4 × 10^{-16} (J) on the answer line scores zero
		(ii)	(KE =) 1500 × 1.6 × 10^{-19} (= 2.4 × 10^{-16} J) $2.4\times10^{-16} = \frac{1}{2}\times9.11\times10^{-31}\times v^2$ (Allow any subject) v = 2.3 × 10^7 (m s^{-1})	C1 C1 A1	Possible ecf from **(b)(i)** **Allow**: 2 marks for 5.3 × 10^{14} (answer not square-rooted) **Note**: $v=\sqrt{\frac{2\times1500}{9.11\times10^{-31}}}=5.74\times10^{16}$ (m s^{-1}) does not score
	(c)	**(i)**	$F_{(E)} = Eq$ and $F_{(M)} = Bqv$ $Eq = Bqv$ (This mark is for equating the two equations) (Hence) $v=\frac{E}{B}$	 M1 A1	 **Allow** an equivalent approach **Allow** any subject
		(ii)	Force due to magnetic field > force due to electric field Electrons drift 'downwards'	B1 B1	**Allow**: magnetic force > electric force or $F_M > F_E$ or $Bqv > Eq$ or magnetic force is bigger and electric force is the same **Note**: This mark can be scored on Fig. 3.2
			Total	**9**	

Also see questions OCR A Magnetism and Circular motion @theonlinephysicstutor.com