	Question		Answers	Notes	Total
4.	**a**		magnetic force is to the left «at the instant shown» **OR** explains a rule to determine the direction of the magnetic force ✔ force is perpendicular to velocity/«direction of» motion **OR** force is constant in magnitude ✔ force is centripetal/towards the centre ✔	*Accept reference to acceleration instead of force.*	**2 max**
4.	**b**	**i**	$qvB = \dfrac{mv^2}{R}$ ✔ $R = \dfrac{1.67 \times 10^{-27} \times 2.0 \times 10^{6}}{1.6 \times 10^{-19} \times 0.35}$ **OR** 0.060 «m»	*Award MP2 for full replacement or correct answer to at least 2 significant figures.*	**2**
4.	**b**	**ii**	$T = \dfrac{2\pi R}{v}$ ✔ Higher level only $T = «\dfrac{2\pi \times 0.06}{2.0 \times 10^{6}} =» 1.9 \times 10^{-7}$ «s» ✔	*Award [2] for bald correct answer*	**2**
4.	**c**		***ALTERNATIVE 1*** Higher level only work done by force is change in kinetic energy ✔ work done is zero/force perpendicular to velocity ✔ ***ALTERNATIVE 2*** proton moves at constant speed ✔ kinetic energy depends on speed ✔	*Award [2] for a reference to work done is zero hence E_k remains constant* *Accept mention of speed or velocity indistinctly in MP2*	**2**

5.	a		out of the page plane / ⊙ ✓	*Do not accept just "up" or "outwards".*	1
5.	b		$1.60 \times 10^{-19} \times 6.8 \times 10^{5} \times 8.5 = 9.2 \times 10^{-13}$ «N» ✓		1
5.	c	i	the magnetic force does not do work on the electron hence does not change the electron's kinetic energy **OR** the magnetic force/acceleration is at right angles to velocity ✓		1
5.	c	ii	the velocity of the electron is at right angles to the magnetic field ✓ (therefore) there is a centripetal acceleration / force acting on the charge ✓	*OWTTE*	2

(Question 2 continued)

	Question		Answers	Notes	Total
2.	b	ii	to stop Y from getting ahead ✓ to remain stationary with respect to X ✓ otherwise will add tension to cable/damage satellite/pull X out of its orbit ✓		**2 max**
2.	c			*Marks should be awarded from either one alternative or the other.*	**3**
			cable is a conductor and contains electrons ✓ electrons/charges experience a force when moving in a magnetic field ✓ use of a suitable hand rule to show that satellite Y becomes negative «so X becomes positive» ✓ ***Alternative 2*** cable is a conductor ✓ so current will flow by induction flow when it moves through a B field ✓ use of a suitable hand rule to show current to right so «X becomes positive» ✓	*Do not allow discussion of positive charges moving towards X*	
2.	d		electrons would build up at satellite Y/positive charge at X ✓ preventing further charge flow ✓ by electrostatic repulsion ✓ unless a complete circuit exists ✓		**3 max**
2.	e		«$\varepsilon = Blv =$» $31 \times 10^{-6} \times 7790 \times 15000$ ✓ 3600 «V» ✓	*Allow 3700 «V» from $v = 8000\ ms^{-1}$.*	**2**

(continued…)