3	**C is the correct answer,** as $F = Bqv \sin\theta$ and $\sin\theta = 1$	1

2	**D is the only correct answer** because it shows the correct vector diagram A is not correct because this shows R – Q B is not correct because this shows the correct magnitude in the opposite direction C is not correct because this shows Q – R	1

3	**A is the only correct answer** because the force is down the page using FLHR B is not correct because it does not show the force down the page C is not correct because it does not show the force down the page D is not correct because it does not show the force down the page	1

4	The only correct answer is **A** because impulse has the units of mass × velocity **B** is not correct because this is not units of mass × velocity **C** is not correct because N is not a base unit **D** is not correct because N is not a base unit	1

8	**B is the correct answer** A is not correct because the poles at X and Y must be opposite C is not correct because this would not oppose the change in flux linkage D is not correct because the poles at X and Y must be opposite	1

2	**The only correct answer is D** (The inverse of the gradient of the line) A is not correct because this is energy B is not correct because this is energy C is not correct because this is the inverse of capacitance	1

7	**The only correct answer is B** (conserved , not conserved) A is not correct because total kinetic energy is not conserved C is not correct because total momentum is conserved and total kinetic energy is not conserved D is not correct because total momentum is conserved	1

8	**B is the correct answer** because $\omega = 2\pi \times$ (revolutions per second)	1

7	**B is the correct answer because** $r = \frac{mv}{BQ}$	1

6	**The only correct answer is D** $(\sqrt{2 \times 9.11 \times 10^{-31} \times 3.5 \times 10^{-28}})$ A is not correct because this is not $\sqrt{2 \times m \times E_k}$ B is not correct because this is not $\sqrt{2 \times m \times E_k}$ C is not correct because this is not $\sqrt{2 \times m \times E_k}$	1

15(a)(i)	States $T = 0.16$ s	(1)	
	Use of $\omega = 2\pi / T$	(1)	
	$\omega = 39$ (radian s^{-1})	(1)	3
	<u>Example of calculation</u> $T = 0.16$ s $\omega = 2\pi / 0.16$ s $\omega = 39.3$ radian s^{-1}		

15(a)(ii)	Maximum force read from graph (F = 0.63 N) (accept 0.62 N to 0.64 N) Use of $F = m\omega^2 r$ r = 0.044 (m) (e.c.f from (a)(i)) 86 mm is 2 × 0.043 m, so 0.086 m was the diameter in mm <u>Example of calculation</u> 0.63 N = 0.0095 g × (39 radian s^{-1})^2 × r r = 0.044 m (Show that value gives 0.041)	**(1)** **(1)** **(1)** **(1)**	 **4**

	Indicative content: IC1: Magnitude of centripetal force is constant since speed is constant IC2: Centripetal force on car at bottom is normal contact force minus weight ($F = N - W$ **or** $N = F + W$) IC3: When car is at bottom force is maximum IC4: Centripetal force on car at top is normal contact force plus weight ($F = N + W$ **or** $N = F - W$) IC5: When car is at top force is minimum IC6: At 0.04 s it is at the bottom and at 0.12 s it's at the top	**6**

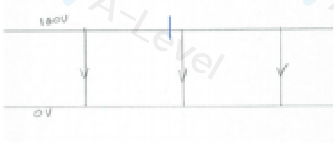
17(a)	At least 4 radial straight lines, from surface of sphere Equal spacing Arrows outward	**(1)** **(1)** **(1)**	 **3**

17(b)(i)	Use of $V = \frac{Q}{4\pi\varepsilon_0 r}$ $Q = 1.1 \times 10^{-8}$ (C) <u>Example of calculation</u> 5000 V = 8.99×10^9 Nm^2C^{-2} × $\frac{Q}{0.02 \text{ m}}$ $Q = 1.1 \times 10^{-8}$ C	**(1)** **(1)**	 **2**

17(b)(ii)	Use of $E = V/d$ Use of $F = EQ$ $F = 5.2 \times 10^{-4}$ N (e.c.f from (b)(i)) <u>Example of calculation</u> E = 5000 V ÷ 0.105 m = 47 600 V m^{-1} F = 47 600 V m^{-1} × 1.1 × 10^{-8} C $F = 5.24 \times 10^{-4}$ N	**(1)** **(1)** **(1)**	 **3**

17(b)(iii)	Use of $W = mg$ Use of suitable trigonometry, such as $\tan\theta = F/W$ $\theta = 1.1(°)$ (e.c.f from (b)(i) and (b)(ii)) <u>Example of calculation</u> $W = 0.0027 \text{ kg} \times 9.81 \text{ N kg}^{-1} = 0.0265 \text{ N}$ $\tan\theta = 5.24 \times 10^{-4} \text{ N} / 0.0265 \text{ N} = 0.0198$ $\theta = 1.13°$	**(1)** **(1)** **(1)**	**3**

17(c)	Use of $F = \frac{Q_1 Q_2}{4\pi\varepsilon_0 r^2}$ with $Q_1 = Q_2 = 1.2 \times 10^{-8}$ C $r = 0.051$ m <u>Example of calculation</u> 5.0×10^{-4} N $= \frac{8.99 \times 10^9 \text{ Nm}^2\text{C}^{-2} \times 1.2 \times 10^{-8} \text{ C} \times 1.2 \times 10^{-8} \text{ C}}{r^2}$ $r = 0.051$ m	**(1)** **(1)** **(1)**	**3**

16(a)	At least three equi-spaced vertical parallel lines touching the wires Arrows towards bottom plate [Ignore curved lines at edges of plates] <u>Example of diagram</u> 	**(1)** **(1)**	**2**

16(b)	Use of $\rho = \frac{m}{V}$ Use of $w = mg$ Use of $E = \frac{V}{d}$ Use of $E = \frac{F}{Q}$ $Q = 5e$, so the charge on the oil drop was a whole number multiple of the electronic charge. <u>Example of calculation</u> $m = \rho V = 920 \text{ kg m}^{-3} \times 5.00 \times 10^{-19} \text{ m}^3 = 4.60 \times 10^{-16} \text{ kg}$ $w = mg = 4.60 \times 10^{-16} \text{ kg} \times 9.81 \text{ N kg}^{-1} = 4.51 \times 10^{-15} \text{ N}$ $E = \frac{V}{d} = \frac{85 \text{ V}}{1.5 \times 10^{-2} \text{ m}} = 5.67 \times 10^3 \text{ V m}^{-1}$ $Q = \frac{F}{E} = \frac{4.51 \times 10^{-15} \text{ N}}{5.67 \times 10^3 \text{ N C}^{-1}} = 7.96 \times 10^{-19} \text{ C}$ $N = \frac{7.96 \times 10^{-19} \text{ C}}{1.6 \times 10^{-19} \, C} = 4.97$	**(1)** **(1)** **(1)** **(1)** **(1)**	**5**