M1. B

[1]

M2. C

[1]

M3. D

[1]

M4. (a)

quantity	SI unit	
(gravitational potential)	J kg^{-1} or N m kg^{-1}	scalar
(electric field strength)	N C^{-1} or V m^{-1}	vector
(magnetic flux density	T or Wb m^{-2} or N A^{-1} m^{-1}	vector

6 entries correct **(1) (1) (1)**
4 or 5 entries correct **(1) (1)**
2 or 3 entries correct **(1)**

3

(b) (i) $mg = EQ$ **(1)**

$$E\left(\frac{mg}{Q} = \frac{4.3\times10^{-9}\times9.81}{3.2\times10^{-12}}\right) = 1.32 \times 10^{4}\ (\text{V m}^{-1})$$ **(1)**

(ii) positive **(1)**

3

[6]

M5. (a) $T \cos 6^\circ = mg$ **(1)**

$T \sin 6^\circ = F$ **(1)**

hence $F = mg \tan 6^\circ$ **(1)**

[or by use of triangle: sides correct **(1)** 6º correct **(1)** tan 6º = F/mg **(1)**]

3

(b) (use of $E = \frac{V}{d}$ gives) $E = \frac{4200}{60 \times 10^{-3}} = 7.0 \times 10^4$ V m^{-1} **(1)**

(use of $Q = \frac{F}{E}$ gives) $Q \left(\frac{mg \tan 6^\circ}{E} \right) = \frac{2.1 \times 10^{-4} \times 9.81 \tan 6^\circ}{7.0 \times 10^{-4}}$ **(1)**

$= 3.1 \times 10^{-9}$C **(1)**

3

(allow ecf for value of E from (i))

[6]

M6. (a) (i) force per unit charge **(1)**
acting on a positive charge **(1)**

(ii) vector **(1)**

3

(b) (i) $F \left(= \frac{Q_1 Q_2}{4\pi\varepsilon_0 r^2} \right) = \frac{4.0 \times 10^{-9} \times 8.0 \times 10^{-9}}{4\pi \times 8.85 \times 10^{-12} \times (80 \times 10^{-3})^2}$ **(1)**

$=4.5(0) \times 10^{-5}$N **(1)**

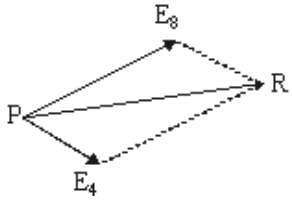
(ii) (use of $V = \frac{Q}{4\pi\varepsilon_0 x}$ gives) $0 = \left(\frac{4.0 \times 10^{-9}}{4\pi\varepsilon_0 x} \right) - \left(\frac{8.0 \times 10^{-9}}{4\pi\varepsilon_0 (80 \times 10^{-3} - x)} \right)$

or $\frac{4}{x} = \frac{8}{80 - x}$ **(1)**

$x = 26.7$mm **(1)**

4

(c) correct directions for E_4 and E_8 **(1)**
E_8 approx twice as long as E_4 **(1)**
correct direction of resultant R shown **(1)**



3

[10]

M7. (a) (i) $E\left(=\frac{V}{d}\right)=\frac{1400}{15\times10^{-3}}$ **(1)** $\left(=9.3\times10^{4}\,\text{Vm}^{-1}\right)$

(ii) $t\left(=\frac{l}{v}\right)=\frac{30\times10^{-3}}{3.2\times10^{7}}=9.38\times10^{-10}$ s **(1)**

(iii) $ma_y = Ee$ **(1)**

$ay = \frac{9.3\times10^{4}\times1.60\times10^{-19}}{9.11\times10^{31}}$ **(1)** (= 1.64×10^{16} m s^{-2})

acceleration is upwards [or towards + plate]**(1)**

5

(b) vy (= $a_y t$) = $1.64 \times 10^{16} \times 9.38 \times 10^{-10}$ **(1)** (= 1.54×10^{7} m s^{-1})

$v = \sqrt{(1.54\times10^{7})^2 + (3.2\times10^{7})^2}$ = 3.55×10^{7}m s^{-1}**(1)**

at $\tan^{-1}\left(\frac{1.54}{3.2}\right) = 26°$ above the horizontal **(1)**

3

[8]