M1.C

[1]

M2.A

[1]

M3.C

[1]

M4.A

[1]

M5.(a) $t = \sqrt{\frac{2s}{g}}$ or $4.5 = \frac{1}{2} \times 9.81 \times t^2$ ✓

$t = 0.96$ s✓

2

(b) Field strength = 186000V m^{-1}✓

Acceleration = *Eq / m*

or $186\,000 \times 1.2 \times 10^{-6}$ ✓

0.22 m s^{-2} ✓

3

(c) 0.10(3)m (allow ecf from (i))✓

1

(d) Force on a particle = mg and

acceleration = F / m so always = g ✓

Time to fall (given distance) depends (only) on the distance and acceleration ✓

OR:

$g = GM / r^2$ ✓

Time to fall = $\sqrt{2s / g}$

so no m in equations to determine time to fall ✓

2

(e) Mass is not constant since particle mass will vary ✓

Charge on a particle is not constant ✓

Acceleration = Eq / m or $(V / d)(q / m)$ or Vq / dm ✓

E or V / d constant but charge and mass are 'random' variables so q / m will vary (or unlikely to be the same) ✓

4

[12]

M6. D

[1]

M7. B

[1]

M8. D

[1]

M9.D

[1]

M10.A

[1]

M11.C

[1]

M12.B

[1]

M13.C

[1]

M14.A

[1]

M15.(a) (i) force acts towards left or in opposite direction to field lines ✓

because ion (or electron) has negative charge

(∴ experiences force in opposite direction to field) ✓

Mark sequentially.

Essential to refer to negative charge (or force on + charge is to right) for 2nd mark.

2

(ii) (use of $W = Fs$ gives) force $F = \frac{4.0\times10^{-16}}{63\times10^{-3}}$ ✓

= $6.3(5) \times 10^{-15}$ (N) ✓

If mass of ion m is used correctly ***using algebra*** *with F = ma, allow both marks (since m will cancel). If numerical value for m is used, max 1.*

2

(iii) electric field strength $E\left(=\frac{F}{Q}\right)=\frac{6.35\times10^{-15}}{3\times1.6\times10^{-19}}$ = 1.3(2) ✓ 10^{4} (N C^{-1}) ✓

[**or** $\Delta V\left(=\frac{\Delta W}{Q}\right)=\frac{4.0\times10^{-16}}{3\times1.60\times10^{-19}}$ (833 V)

$E\left(=\frac{\Delta V}{d}\right)=\frac{833}{63\times10^{-3}}$ = 1.3(2) ✓ 10^{4} (V m^{-1}) ✓]

Allow ECF from wrong F value in (ii).

1

(b) (i) (vertically) downwards on diagram ✓

reference to Fleming's LH rule **or** equivalent statement ✓

Mark sequentially.

1st point: allow "into the page".

2

(ii) number of free electrons in wire = $A \times l \times$ number density

= $5.1 \times 10^{-6} \times 95 \times 10^{-3} \times 8.4 \times 10^{28} = 4.1\ (4.07) \times 10^{22}$ ✓

Provided it is shown correctly to at least 2SF, final answer alone is sufficient for the mark. (Otherwise working is mandatory).

1

(iii) $B\left(=\frac{F}{Qv}\right)=\frac{1.4\times10^{-25}}{1.60\times10^{-19}\times5.5\times10^{-6}}$ ✓ = 0.16 (0.159) (T) ✓

[or $B\left(=\frac{F}{Il}\right)=\frac{1.4\times10^{-25}\times4.07\times10^{22}}{0.38\times95\times10^{-3}}$ ✓ = 0.16 (0.158) (T) ✓]

In 2nd method allow ECF from wrong number value in (ii).

2

[10]

M16.B

[1]

M17.A

[1]

M18.D

[1]

M19.(a) (i) required pd (= 2.5 × 10^6 × 12 × 10^{-3}) = 3.0(0) × 10^4 (V) ✓

1

(ii) charge required Q *(= CV)* = 3.7 × 10^{-12} × 3.00 × 10^4 ✓

(= 1.11 × 10^{-7} C)

Allow ECF from incorrect V from (a)(i).

time taken $t\left(=\frac{Q}{I}\right)=\frac{1.11\times10^{-7}}{3.2\times10^{-8}}$ = 3.5 (3.47) (s) ✓

2

(b) (i) time increases ✓

(larger *C* means) more charge required (to reach breakdown pd)

Mark sequentially *i.e. no explanation mark if effect is* *wrong.*

or $t = \frac{CV}{I}$ **or** time ∝ capacitance ✓

2

(ii) spark is brighter (**or** lasts for a longer time) ✓

more energy (**or** charge) is stored **or** current is larger

Mark sequentially.

or spark has more energy ✓

2

(Total 7 marks)