Name of the Student:_____
Max. Marks : 26 Marks **Time : 26 Minutes**

Mark Schemes

Q1.

(a) (i) *Two examples (any order)*:

- when charged particle is at rest **or** not moving relative to field ✓
- when charged particle moves parallel to magnetic field ✓

2

(ii) $BQv = \frac{mv^2}{r}$ ✓ (gives $BQr = mv$)

Acceptable answers must include correct force equation (1st point).

B and *Q* are constant so $r \propto$ momentum (mv) ✓

Insist on a reference to B and Q constant for 2nd mark.

2

(b) (i) upwards (perpendicular to plane of diagram) ✓

Accept "out of the page" etc.

1

(ii) $v \left(= \frac{BQr}{m}\right) = \frac{0.48 \times 1.60 \times 10^{-19} \times 0.19}{1.67 \times 10^{-27}}$ ✓ $= 8.7(4) \times 10^6 \, (\text{m s}^{-1})$

2

(iii) length of path followed (= length of semi-circle) = πr ✓

time taken $t \left(= \frac{\pi r}{v}\right) = \frac{\pi \times 0.19}{8.74 \times 10^6} = 6.8(3) \times 10^{-8} \, (\text{s})$ ✓

Allow ECF from incorrect v from (b)(ii).

[**or** $\frac{v}{r} = \frac{BQ}{m}$ gives $t = \frac{\pi r}{v} = \frac{\pi m}{BQ}$ ✓

$= \frac{\pi \times 1.67 \times 10^{-27}}{0.48 \times 1.60 \times 10^{-19}} = 6.8(3) \times 10^{-8} \, (\text{s})$ ✓]

Max 1 if path length is taken to be 2 πr (gives 1.37 × 10^{-7}s).

2

(iv) $v \propto r$ (and path length $\propto r$) ✓

t = (path length / v) **or** (πr / v)

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so r cancels (∴time doesn't depend on r)

[**or** $t\left(=\frac{\pi r}{v}\right)=\frac{\pi rm}{BQr}$ ✓ $=\frac{\pi m}{BQ}$ (because r cancels) ✓]

[**or** $BQv = m\omega^2 r$ gives $BQ\omega r = m\omega^2 r$ and $BQ = m\omega = 2\pi fm$ ✓

∴ frequency is independent of r ✓]

2

(c) $v_{max} = 8.74\times10^{6}\times\left(\frac{0.47}{0.19}\right) = 2.16\times10^{7}\ (\text{m s}^{-1})$ ✓

1st mark can be achieved by full substitution, as in (b)(ii), or by use of data from (b)(i) and / or (b)(ii).

$E_k\ (= ½\ mv_{max}^2) = ½ \times 1.67 \times 10^{-27} \times (2.16 \times 10^7)^2$ ✓
$(= 3.90 \times 10^{-13}\ \text{J})$

$=\frac{3.90\times10^{-13}}{1.60\times10^{-13}} = 2.4(4)\ (\text{MeV})$ ✓

Allow ECF from incorrect v from (b)(ii), or from incorrect t from (b)(iii).

3

(Total 14 marks)

Q2.

(a) (grav) potential energy → kinetic energy → (grav) potential energy → kinetic energy → gravitational potential energy **(1)**

energy lost to surroundings in overcoming air resistance **(1)**

2

(b) (i) period $T = \left(\frac{42}{15}\right)$ = 2.8 s **(1)**

use of $T = 2\pi\sqrt{\frac{l}{g}}$ gives length $l = \left(=\frac{T^2 g}{4\pi^2}\right)=\frac{2.8^2\times9.81}{4\pi^2}$ **(1)**

giving distance from pt of support to c of m, l = 1.9 (m) or 1.95 (m) **(1)**

answer must be to **2 or 3 sf** only **(1)**

4

(ii) $E_k = mg\Delta h$ stated or used **(1)**

gives E_k of girl at lowest point = 18 × 9.81 × 0.25 = 44 (J) **(1)**

2

(iii) $½\ mv^2 = 44.1$ gives max speed of girl $v = \sqrt{\frac{2\times44.1}{18}}$ = 2.2 (m s^{-1}) **(1)**

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[**alternatively**: $A^2 = (3.9 – 0.25) \times 0.25$ gives $A = 0.955$ (m)
and $v_{max} = 2\pi f A = (2\pi/2.8) \times 0.955 = 2.1$ (m s^{-1}) **(1)**]

1

(c) graph drawn on **Figure 2** which:

shows $E_k = 0$ at $t = 0$, $T/2$ and T **(1)**

has 2 maxima of similar size (some attenuation allowed)
at $T/4$ and $3T/4$ **(1)**

is of the correct general shape **(1)**

3

[12]

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