E and M Assessed Problem Sheet for handout on 2nd March

1. (i) A collimated beam of alpha-particles (i.e. helium nuclei, mass = 6.64×10^{-27} kg, charge = 3.2×10^{-19} C) is to be deflected through 90° by applying a uniform magnetic field (of suitably limited extent) of strength 0.05 T perpendicular to the beam. For how long is each alpha particle in the magnetic field region?

(a) 0.65 μs
(b) 5.3 μs
(c) 0.61 ms
(d) 4.7 ps

[3 marks]

(ii) A charged particle gyrates with constant *speed* perpendicular to a uniform magnetic field. The field is slowly increased to twice its initial value. Which statement of the following is correct:

(a) The period of the motion halves, and the radius of the motion doubles.
(b) The period of the motion halves, and the radius of the motion halves.
(c) The period of the motion stays the same, and the speed doubles.
(d) The period of the motion doubles, and the speed doubles.

[2 marks]

(iii) A current of 20A passes along a strip of copper (conduction charge number density $n = 8.4\times10^{28}$ m^{-3}) which is 2mm thick. The Hall voltage, produced when a uniform magnetic field of 2.0T is applied perpendicularly to the plane of the strip, is

(a) 20.0 mV
(b) 15.3 μV
(c) 1.5 μV
(d) 28 V

[3 marks]

(iv) An electron moves at a velocity v = (20$\hat{\mathbf{x}}$+15$\hat{\mathbf{y}}$) ms^{-1} in a magnetic field $\mathbf{B}$ = 5$\hat{\mathbf{x}}$ T. The force on the electron is:

(a) $-1.2\times10^{-17}\hat{\mathbf{z}}$ N
(b) $1.2\times10^{-17}\hat{\mathbf{z}}$ N
(c) $(1.6\times10^{-17}\hat{\mathbf{y}} + 1.2\times10^{-17}\hat{\mathbf{z}})$ N
(d) $2.8\times10^{-17}\hat{\mathbf{z}}$ N

[2 marks]

[Total 10 marks]