$R = mv/qB$

PART B

The questions in this part of the assignment concern Unit 10.

Q6 [*The motion of particles in electric and magnetic fields*] The key contains six statements about the effects of electric and magnetic fields. Two of these statements are true and the others are false. Select the *two* true statements. Pencil across *two* cells in row 6.

KEY for Q6

A The magnetic force on a positively charged particle acts in the same direction as the magnetic field at the position of the particle.

B The electric force on a negatively charged particle acts in the same direction as the electric field at the position of the particle.

C The speed of a non-magnetic charged particle is unchanged by the magnetic force due to a time-independent magnetic field.

D The speed of a non-magnetic charged particle is unchanged by the electric force due to a time-independent electric field.

E A uniform magnetic field exerts no force on a stationary electron.

F A moving electron experiences no magnetic force if it moves in a direction perpendicular to the magnetic field lines.

C E

Q7 [*Lorentz force law*] A particle carrying a positive charge of 2.7×10^{-6} C travels horizontally at the Earth's equator at $1.5 \times 10^{6}\,\mathrm{m\,s^{-1}}$. The particle travels on a heading of 30° (i.e. at an angle of 30° measured clockwise from due north, as viewed from above). The Earth's magnetic field at the equator has magnitude 4.1 $\times 10^{-6}$ T and, of course, points horizontally and to the north. Calculate the magnitude and direction of the magnetic force on the particle due to the Earth's magnetic field. Pencil across *one* cell in row 7.

KEY for Q7

? A 8.3×10^{-6} N, horizontally, 30° east of north
? B 8.3×10^{-6} N, horizontally, 60° west of north
? C 8.3×10^{-6} N, upwards
? D 8.3×10^{-6} N, downwards
E 1.4×10^{-5} N, horizontally, 30° east of north
F 1.4×10^{-5} N, horizontally, 60° west of north
G 1.4×10^{-5} N, vertically upwards
H 1.4×10^{-5} N, vertically downwards

Q8 [*Magnetic force on charged particles*] Figure 32 in Unit 10 is a photograph of the tracks of charged particles in a bubble chamber. Suppose that the particle on the right-hand side, spiralling anticlockwise, is a positron of charge 1.6×10^{-19} C moving in the plane of the page, with a magnetic field of magnitude 0.2 T applied into the plane of the page. Assuming that the photograph has been magnified by a factor of 100, take measurements from the photo to estimate the magnitude of the momentum of the positron immediately after it has been created. Choose the option from the key that is closest to your estimate. Pencil across *one* cell in row 8.

KEY for Q8

A $5 \times 10^{-24}\,\mathrm{kg\,m\,s^{-1}}$	D $4 \times 10^{-22}\,\mathrm{kg\,m\,s^{-1}}$
B $7 \times 10^{-23}\,\mathrm{kg\,m\,s^{-1}}$	E $3 \times 10^{-22}\,\mathrm{kg\,m\,s^{-1}}$
C $3 \times 10^{-23}\,\mathrm{kg\,m\,s^{-1}}$	F $2 \times 10^{-21}\,\mathrm{kg\,m\,s^{-1}}$

Q9 [*Magnetic field due to a current*] Two long straight parallel wires A and B are fixed a distance 40 cm apart. Wire A carries a steady current of 3.0 A and wire B carries a steady current of 9.0 A; these currents are in the same direction. A third current-carrying wire C is placed between A and B, with all three wires in the same plane. Where must wire C be placed in order for the total magnetic force on it due to the other two wires to be zero? Select one option from the key. Pencil across *one* cell in row 9.

KEY for Q9

A 4 cm from wire A, 36 cm from wire B
B 36 cm from wire A, 4 cm from wire B
C 10 cm from wire A, 30 cm from wire B
D 30 cm from wire A, 10 cm from wire B
E 16 cm from wire A, 24 cm from wire B
F 24 cm from wire A, 16 cm from wire B
G 20 cm from wire A, 20 cm from wire B

Q10 [*Thompson's e/m$_e$ experiment*] A physicist observes that a proton beam travelling in a horizonal direction is undeflected when it passes through a region where there is a vertical electric field of magnitude $1000\,\mathrm{V\,m^{-1}}$ and a horizontal magnetic field of magnitude 3.0×10^{-3} T perpendicular to the direction of the beam. Before entering the region, the protons have been accelerated from rest by a potential difference. Calculate the magnitude of this potential difference and select the option from the key that is closest to your answer. (You may ignore any effects due to gravity.) Pencil across *one* cell in row 10.

KEY for Q10

A 0.2 V	E 580 V
B 5.4 V	F 1160 V
C 50 V	G 2300 V
D 220 V	

PART C

The questions in this part of the assignment concern Unit 11.

Q11 [*Faraday's law*] An ohmic circular loop of radius 1.8 cm and resistance 12 Ω is placed in a magnetic field $\boldsymbol{B}$ whose direction is at 90° to the plane of the loop and whose magnitude is given by $B = Ct^2$, where the constant C is $15\,\mathrm{T\,s^{-2}}$. Calculate the magnitude of the current in the loop at time $t = 4$ s and select from the key the option that is closest to your answer. Pencil across *one* cell in row 11.

KEY for Q11

A 10^{-3} A	E 10 A
B 10^{-2} A	F 10^{2} A
C 10^{-1} A	G 10^{3} A
D 1 A	

$$I = \frac{1}{R} \times \frac{d\Phi}{dt} = \frac{1}{R} \times \pi r^2 \times \frac{d(Ct^2)}{dt} = \frac{\pi r^2}{R} \times 2Ct = \frac{2\pi r^2 Ct}{R}$$