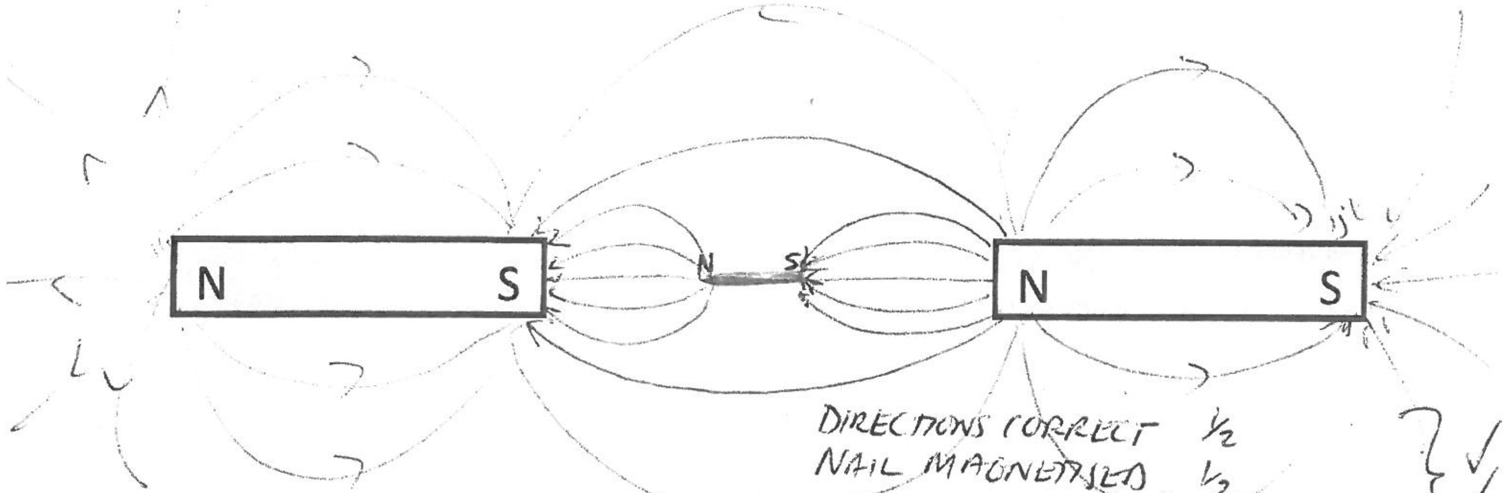
STAWA VALIDATION TEST – ELECTROMAGNETISM, SETS 6, 7 & 9

NAME: SOLUTIONS

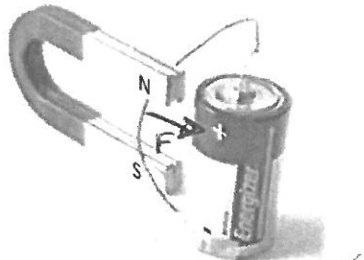
1. Draw the magnetic field for the following configuration. The shape in the middle is an iron nail: (2)



DIRECTIONS CORRECT ½
NAIL MAGNETISED ½
NAIL EFFECTS FIELD CORRECTLY ½
REST OF SHAPE OK ½
✓✓

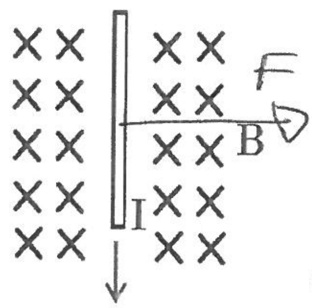
2. Draw an arrow to show the direction of the force in each of the following situations Directions – (3)

a)



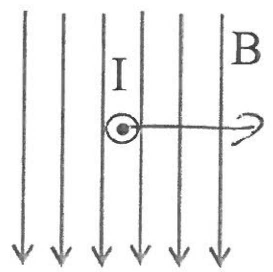
✓

b)



✓

c)



✓

3. A 50-m wire is suspended between two electricity towers in a region where the Earth's magnetic field is 5 x 10^{-5} T. Calculate the magnitude of the force on the wire is it carries a current of 30 A. (2)

$F = BIl$ ✓

$= 5 \times 10^{-5} \times 30 \times 50$

$= 0.0750\ N$

$= \underline{7.50 \times 10^{-2}\ N}$ ✓

4. A Ford Falcon has a roof rack which is 1200 mm wide. The roof rack consists of two steel bars which run across the roof (i.e. from door to door). They are insulated from the roof of the car. The car is moving in a northerly direction at 80 km h^{-1}. The vertical component of the Earth's magnetic field is 3.2×10^{-5} T upward.

a) Calculate the emf induced in one bar of the roof rack. (3)

$l = 1200$ mm
$= 1.2$ m
$v = 80$ km h^{-1}
$= 80 \div 3.6$
$= 22.222$ m s^{-1} ✓

$\varepsilon = Blv$ ✓
$= 3.2\times10^{-5} \times 1.2 \times 22.222$
$= 8.53\times10^{-4}$ V ✓

b) Which end of the bar is at a positive potential? (1) RH RULE $\rightarrow$ EAST ✓

c) Does the emf remain the same if the car now travels in a westerly direction? Explain. (1)

YES, (½) Because only the vertical component of field induces the EMF and so the same amount of flux is cut regardless of which direction the car points. (½)

5. An AC generator is turning at 480 rpm and produces a peak voltage of 185 V. The coil has an area of 120 cm^2 and rotates in a field of 0.4 T. Calculate the number of turns required to produce this maximum voltage. (3)

$f = 480$ rpm
$= 480 \div 60$
$= 8$ rps / 8 Hz
$A = 120 \text{ cm}^2$
$= 120 \times 10^{-4} \text{ m}^2$ ✓

$\varepsilon_{peak} = 2\pi NBAf$

$N = \dfrac{\varepsilon_{peak}}{2\pi BAf}$ ✓

$= \dfrac{185}{2\pi \times 0.4 \times 120 \times 10^{-4} \times 8}$

$= \underline{767 \text{ turns}}$ ✓

6. A proton is accelerated through a potential difference of 100 V. Calculate the speed of the electron. (3)

$q = \cancel{1.9} \; 1.6 \times 10^{-19}\,C$

$m = 1.67 \times 10^{-27}\,kg$

$V = 100\,V$

$v = ?$

$KE = PE$ ✓

$\frac{1}{2}mv^2 = qV$

$v = \sqrt{\frac{2qV}{m}}$

$= \sqrt{\frac{2 \times \cancel{1.9} \; 1.6 \times 10^{-19} \times 100}{1.67 \times 10^{-27}}}$ ✓

$= \cancel{1.51} \; 1.38 \times 10^{5}\,ms^{-1}$ ✓

7. A cathode ray tube contains parallel plates which are 400 mm long separated by 80 mm. There is a potential difference of 20 V between the plates

   a. Calculate the electric field strength between the plates (1)

$E = \frac{V}{d} = \frac{20}{0.08} = 250\,NC^{-1}$ ✓

   b. An electron travelling at 8×10^{6} m s^{-1} enters the field at right angles. Calculate the force on the electron (2)

$F = Eq$

$= 250 \times 1.6 \times 10^{-19}$ ✓

$= 4.00 \times 10^{-17}\,N$ ✓

   c. Calculate the final *speed* of the electron when it leaves the region between the plates.(4)

x direction

$V_x = 8 \times 10^{6}\,ms^{-1}$

$t = \frac{s}{v} = \frac{0.4\,m}{8 \times 10^{6}}$

$= 5 \times 10^{-8}\,s$ ✓

y direction

$a_y = \frac{F_y}{m} = \frac{4 \times 10^{-17}}{9.11 \times 10^{-31}}$

$= 4.39078 \times 10^{13}\,ms^{-2}$ ✓

$V_y = \cancel{u_y}^{\,0} + a_y t$

$= 4.39078 \times 10^{13} \times 5 \times 10^{-8}$

$= 2195390\,ms^{-1}$ ✓

$V_{tot} = \sqrt{V_x^2 + V_y^2}$

$= \sqrt{(8 \times 10^{6})^2 + (2195390)^2}$

$= 8.30 \times 10^{6}\,ms^{-1}$ ✓