HALE SCHOOL
PHYSICS
Electromagnetism
YEAR 12 Unit 3A Test 2012

Test Score:

Name: solutions	Set:	Teacher: JAA MV

INSTRUCTIONS:

- ☐ Time Allowed = 40 minutes
- ☐ Total Marks = 38 marks
- ☐ Answer all questions in the space provided.
- ☐ Rough working is permitted on the question paper.
- ☐ Show all relevant working details in order to acquire full marks.
- ☐ Graphic Calculators are Not permitted for this paper.
- ☐ ***Do Not write in pencil. (Note: a 1 mark penalty will be incurred)**
- ☐ ***Do Not borrow materials. (Note: a 1 mark penalty will be incurred)**

POST ASSESSMENT REVIEW (to be completed upon return of your marked paper)

SELF-ASSESSMENT:

Relative Weaknesses –Objective No.	**Relative Strengths** –Objective No.

Major Concerns: (be specific)

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Action Plan: (be specific)

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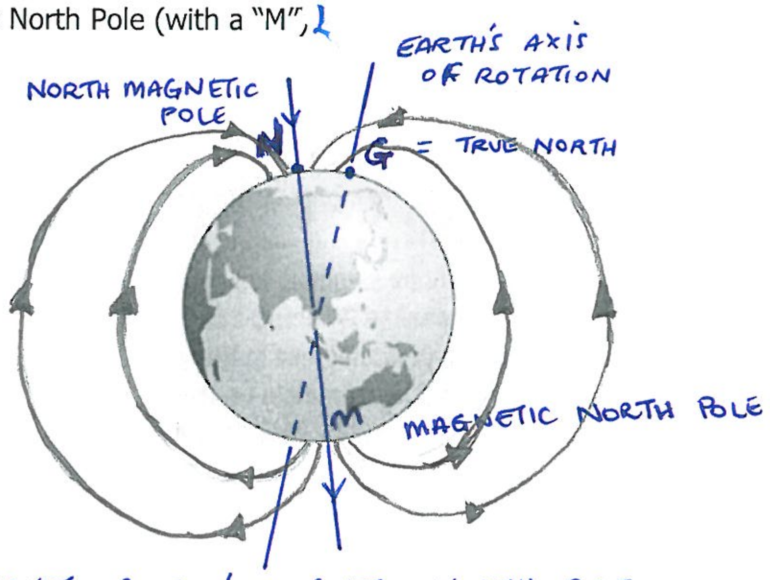
Q1 [4 marks]

On the diagram of the Earth provided:

1a) Sketch the shape and direction of the Earth's magnetic field.

1b) Label the Geographical North Pole (with a "G")

1c) Label the Magnetic North Pole (with a "M")



NOTE: NORTH MAGNETIC POLE ≠ MAGNETIC NORTH POLE
N ≠ M

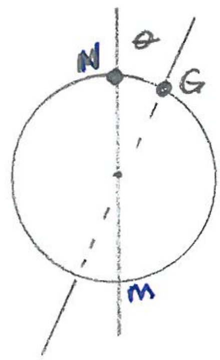
(4 marks)

Q2 [4 marks]

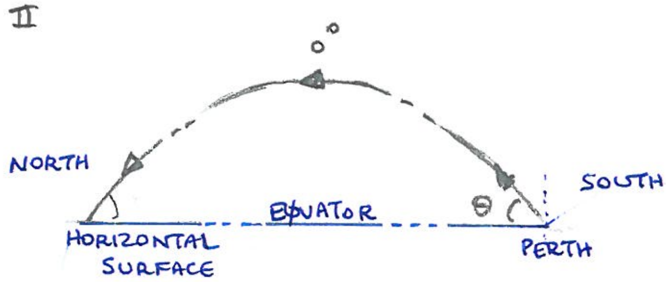
Perth is known to have a angle of declination of -1.6° and an angle of inclination of 70°.

Carefully discern and explain what these angles measure in relation to the Earth's magnetic field at Perth's geographical location. Simple, clearly labeled diagrams may assist your answer.

I



II



THE ANGLE OF DECLINATION IS THE ANGLE BETWEEN TRUE NORTH (GEOGRAPHICAL) AND THE NORTH MAGNETIC POLE. PERTH'S NAVIGATIONAL BEARING IS ADJUSTED BY 1.6° (WEST OF NORTH).

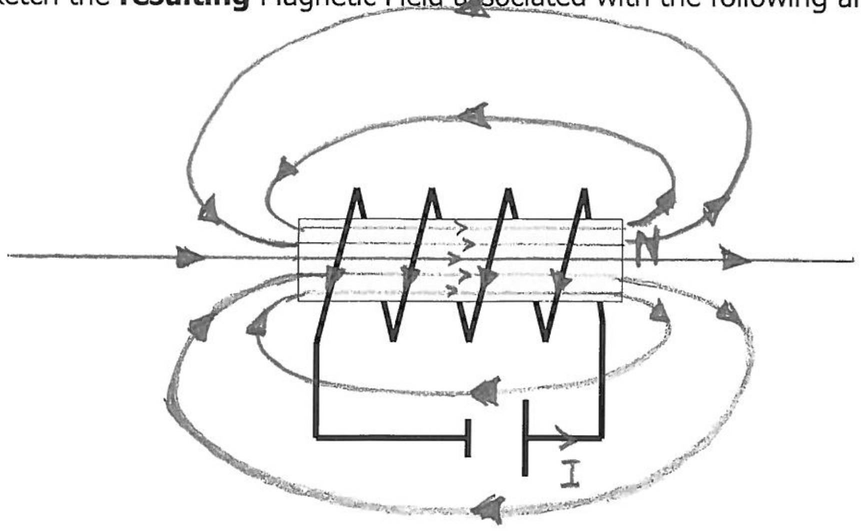
THE ANGLE OF INCLINATION IS THE ANGLE THE EARTH'S MAGNETIC FIELD MAKES WITH THE HORIZONTAL AT THE EARTH'S SURFACE AT A LOCATION. (PERTH HAS A SIGNIFICANT VERTICAL COMPONENT)

(4marks)

Q3 [6 marks]

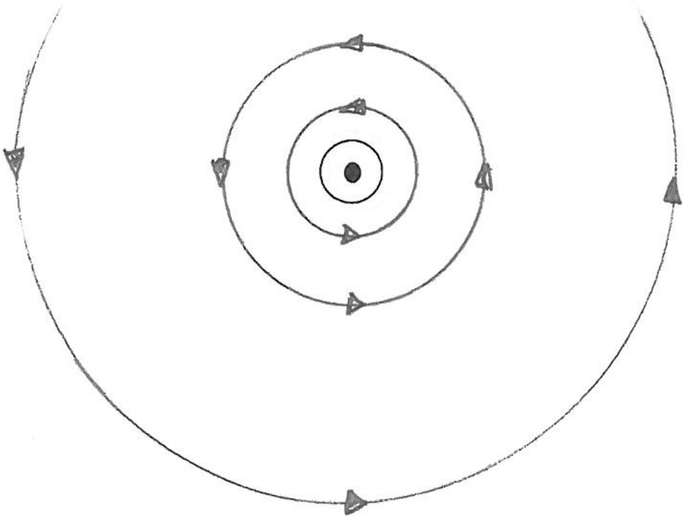
Carefully sketch the **resulting** Magnetic Field associated with the following arrangements:

3a)



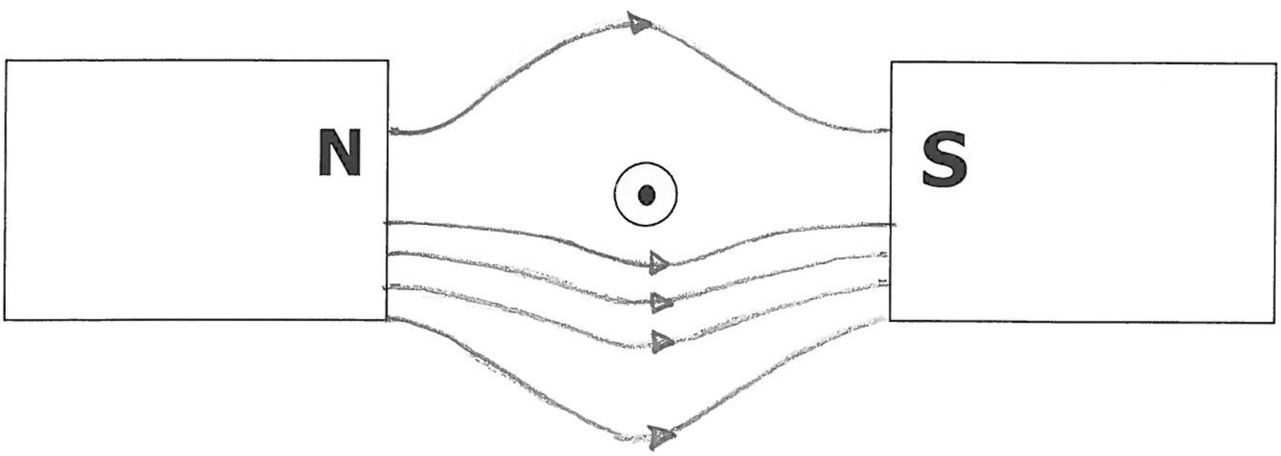
(2 marks)

3b)



(2 marks)

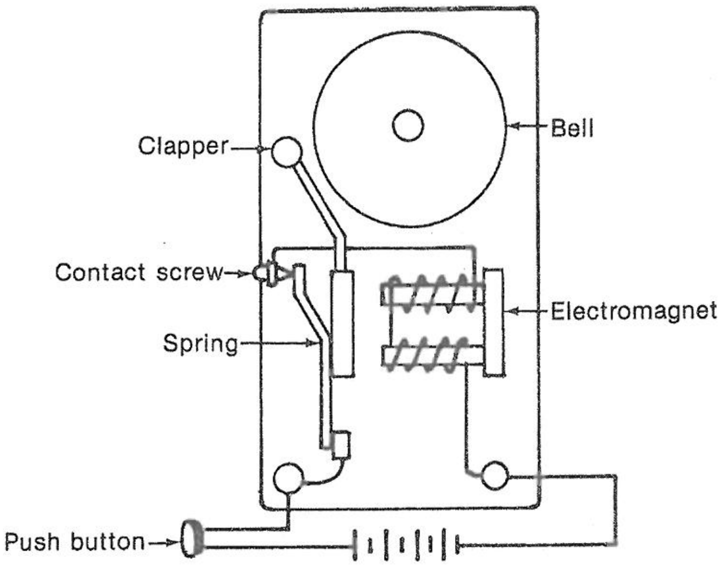
3c)



(2 marks)

Q4 [4 marks]

The diagram below shows a doorbell that has an electromagnet as its main component. Carefully explain (in detail) what causes the rapid repetitive movement that will result in the bell "ringing".



1. WHEN THE PUSH BUTTON IS DEPRESSED, THE CIRCUIT IS COMPLETED.
2. CURRENT FLOWING IN THE COILS OF THE ELECTROMAGNET PRODUCES A STRONG MAGNETIC FIELD / FORCE
3. THIS MAGNETIC FORCE ATTRACTS THE CLAPPER BASE WHICH MOVES IN RESPONSE
4. THIS MOMENTARILY BREAKS THE CIRCUIT AT THE CONTACT SCREW
5. THE INERTIA OF THE CLAPPER KEEPS IT MOVING UNTIL IT HITS THE BELL
6. THE SPRING PULLS THE CLAPPER BACK TO ITS ORIGINAL POSITION.
7. THIS COMPLETES THE CIRCUIT WHICH ACTIVATES THE ELECTROMAGNET AGAIN
8 THE ENTIRE SERIES OF EVENTS IS REPEATED UNTIL THE PUSH BUTTON IS RELEASED AND THE CIRCUIT IS BROKEN

(4marks)

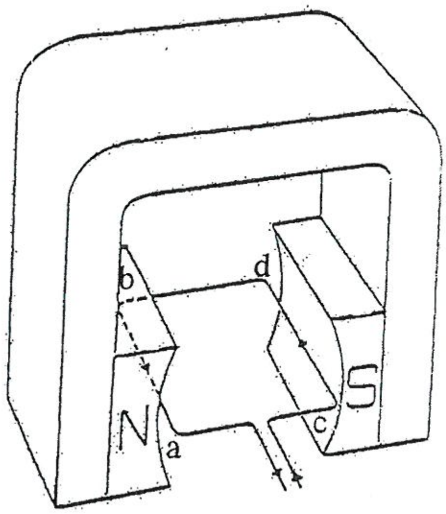
Q4 [20 marks]

A simplified diagram is provided for a coil abcd, which is free to rotate about an axis within a magnetic field of 155 mT.

The coil consists of 64 turns and a current of 250 mA is passed through it.

The coil is rectangular with ab = 72 mm and bd = 58 mm.

Note: All values must be given to the correct number of significant figures. (1 mark)



4a) Determine the maximum force (magnitude and direction) exerted on side ab

USING $F = N.B.I.l.\sin\theta$

$F = 64 \times 155\times10^{-3} \times 250\times10^{-3} \times 72\times10^{-3} \times \sin 90°$

$= 0.179$ N UPWARDS

$\therefore F = 0.18$ N UPWARDS (2 S.F)

(3marks)

4b) Determine the maximum torque (magnitude and direction) developed by this coil .

USING $\tau = N.B.I.A.$

$= 64 \times 155\times10^{-3} \times 250\times10^{-3} \times (72\times10^{-3} \times 58\times10^{-3})$

$= 0.0104$ Nm CLOCKWISE

$\therefore \tau = 1.0\times10^{-2}$ N m CLOCKWISE (2 SF)

(3marks)

4c) Determine the maximum flux threading the coil when it rotates.

USING $\phi = B.A(\sin\theta)$

$= 155\times10^{-3} \times (72\times10^{-3} \times 58\times10^{-3})$

$= 6.473\times10^{-4}$ Wb

$\therefore \phi = 6.5\times10^{-4}$ Wb (2SF)

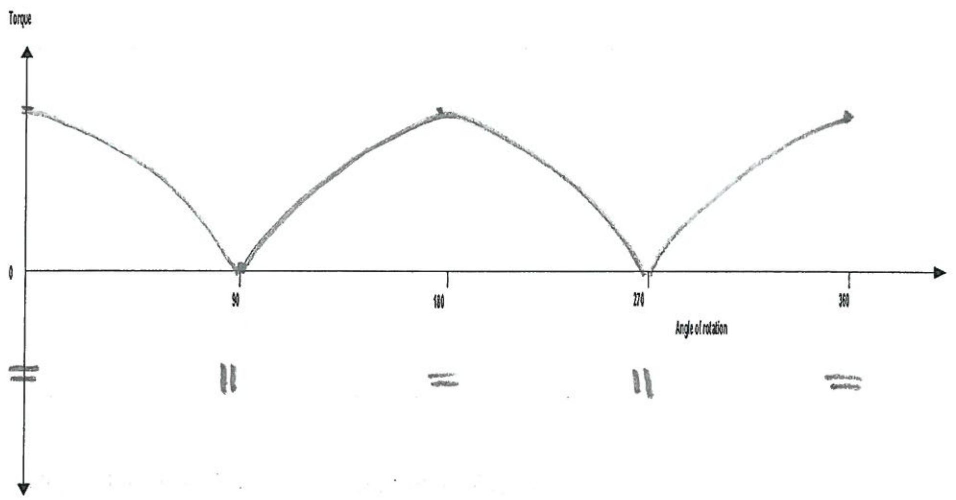
(3marks)

5d) Carefully describe what needs to be added in order to make the arrangement a DC motor. Briefly explain why it is required and how it works with reference to the original diagram.

- ADD A SPLIT RING COMMUTATOR
- THE COMMUTATOR ENABLES THE COIL TO CONTINUE TURNING IN A PARTICULAR DIRECTION BY REVERSING THE DIRECTION OF THE CURRENT IN THE COIL EACH HALF TURN. $(I \Rightarrow F \Rightarrow \tau)$
- SLIDING CONTACTS CALLED "BRUSHES" ALLOW FOR THE SWITCHING OF THE CURRENT DIRECTION BY CHANGING CONTACT WITH THE COIL VIA SEGMENTED RINGS ON THE COMMUTATOR AT THE REQUIRED STAGE OF ROTATION.
- CURRENT DIRECTION DETERMINES THE FORCE DIRECTION AND HENCE TORQUE.

(4 marks)

5e) Using the modifications described (in part d), sketch a graph the torque on the coil as it rotated through 360°. (assume 0° is when the sides bd, is parallel to the magnetic field)



(3marks)

5f) Describe two practical changes that will make the torque produced more consistent.

- SEVERAL COILS, SET AT DIFFERENT ANGLES / PLANES, EACH CONNECTED TO PAIRS OF COMMUTATOR SEGMENTS.
- CURVED MAGNETIC POLE PIECES PRODUCE A NEAR-RADIAL MAGNETIC FIELD WHICH PROVIDE A NEAR PARALLEL INTERACTION BETWEEN THE COIL PLANES AND THE MAGNETIC FIELD ⇒ EVEN FORCE ⇒ EVEN TORQUE.

(3marks)