



PHYSICS

Year 12, 2012

Semester One Examination

SECTION A

Question/Answer Booklet

Name: _____

Teacher:

JAA \ MV

TIME ALLOWED FOR THIS PAPER

Reading time before commencing work: Ten minutes

Working time for paper: Three hours

EXAMINERS USE ONLY

Section A	
Section B	
Section C	
Total	

MATERIAL REQUIRED/RECOMMENDED FOR THIS PAPER

TO BE PROVIDED BY THE SUPERVISOR

This Question/Answer Booklet comprising **12** pages

Data and Constants Sheet

TO BE PROVIDED BY THE CANDIDATE

Standard Items: Pens, pencils, eraser or correction fluid, ruler

Special Items: Drawing instruments, templates and calculators satisfying the conditions set by the Curriculum Council.

IMPORTANT NOTE TO CANDIDATES

No other items may be taken into the examination room.

It is your responsibility to ensure that you do not have any unauthorised notes or other items of a non-personal nature in the examination room. If you have any unauthorised material with you hand it to the supervisor BEFORE reading any further.

SECTION A : Short Answers

Marks Allotted: 54 marks out of 180 (30%). Attempt ALL 14 questions in this section. Answers are to be written in the spaces provided.

QA1. [6 Marks]

A person is flying a kite in a brisk wind.

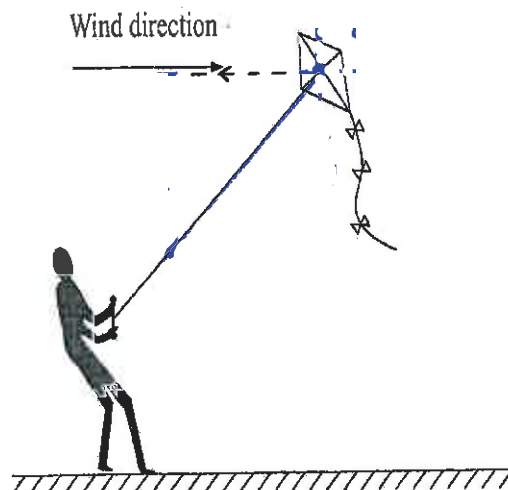
The kite is holding a steady (stationary) position as shown in the diagram.

The forces acting on the kite are resolved into four parts.

The horizontal drag (D), the weight (W), the vertical lift (L), and the force due to tension in the string (T).

The mass of the kite is 408 g

The magnitude of the drag equals that of the lift, and the magnitude of the lift is twice that of the weight.

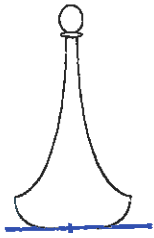


(2 marks)

- 1a) Draw a free-body diagram to illustrate the forces acting on the kite (use the diagram above).
- 1b) Carefully construct a scale diagram showing the vector addition of the forces, and hence graphically determine the tension in the string.

QA2. [4 Marks]

Antique decanters used for serving drinks on sailing vessels were often shaped with a broad thick glass base? Explain, with the aid of diagrams, how this ensures their stability when the ship rolls.



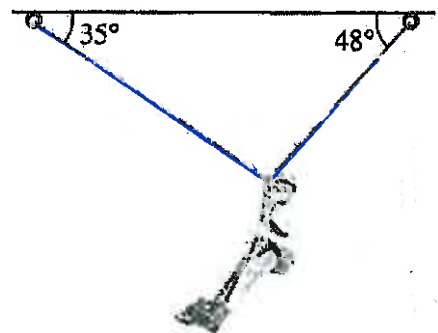
(4 marks)

QA3. [4 Marks]

In a rescue, a 73 kg policeman is suspended by two cables as shown.

Determine the tension in each cable.

(A vector diagram may be helpful)

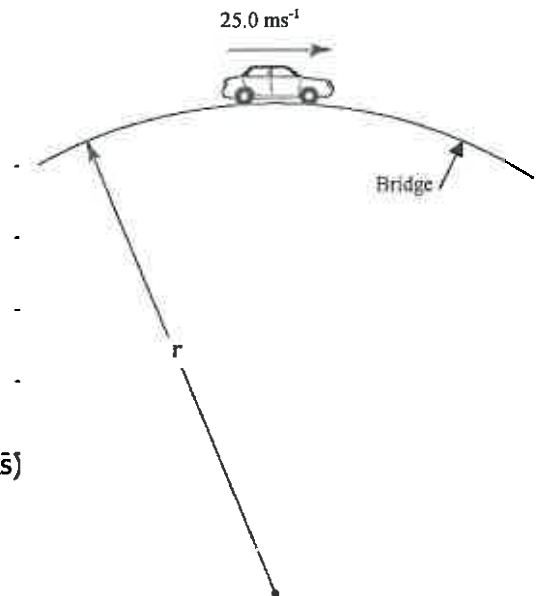


(4 marks)

QA4. [4 Marks]

A car of mass 935 kg is travelling at a constant speed of 25.0 ms^{-1} over a bridge. The bridge is shaped like an arc of a circle. At the top of the bridge the driver senses that the car is temporarily airborne at the instant he passes over the top of the curve.

4a) What is the centripetal force acting on the car at the top of the bridge?



(2 marks)

4b) What is the radius of the bridge?

(2 marks)

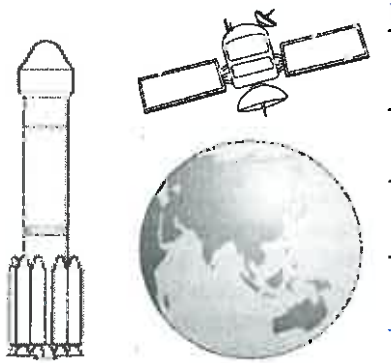
QA5. [4 Marks]

Estimate the force of gravitational attraction that you experience towards your favourite Physics teacher when he is presenting a lesson from the front of the classroom. Compare this force to that towards a student sitting next to you. Show all the relevant detail of your estimation.

(4 marks)

QA6. [2 Marks]

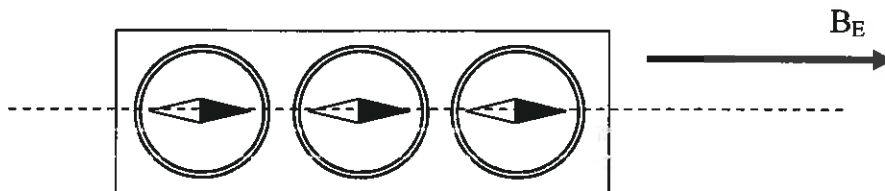
In which geographical direction are satellites launched? Explain why it is advantageous for satellites to be launched from the equator. (Hint: A diagram may assist your explanation.)



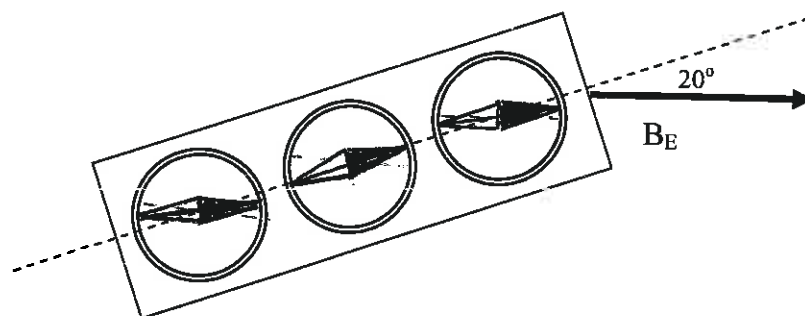
(2 marks)

QA7. [4 Marks]

Three compasses are placed on a card and aligned close together in Earth's magnetic field, B_E as shown.



The card is then rotated so that the line joining the compasses makes an angle of 20° with the Earth's magnetic field.



(2 marks)

7a) Clearly indicate on the diagram, the directions of the three compass needles in this new position.

7b) Briefly justify your choice of directions.

(2 marks)

QA8. [3 Marks]

A laboratory solenoid consists of 1050 turns. The length of such a solenoid is 16.3 cm with a radius of 2.25 cm. When it carries a current of 4.0 A it generates a magnetic field strength of 0.62 T.

Determine the magnetic flux passing through the coil well inside the solenoid.



(3marks)

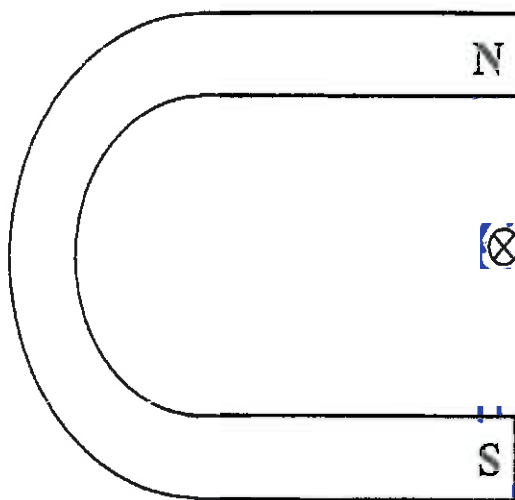
QA9. [4 Marks]

A wire carrying an electric current is placed between the poles of a horseshow magnet as shown.

The 6.35 cm long conductor carries a current of 4.8 A and the magnetic field between the poles of the magnet has a strength of 0.54 T.

- 9a) On the diagram, carefully illustrate the resulting magnetic field and the direction of the force experienced by the conductor.

(2marks)



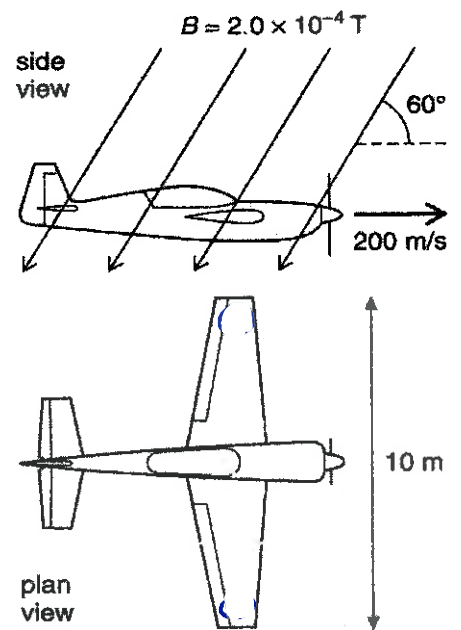
- 9b) Determine the magnitude of the force experienced by the conductor.

(2 marks)

QA10. [5 Marks]

An aero-plane with a wingspan of 10.0 m is flying horizontally at a velocity of 200 m s⁻¹. In the region the plane is flying, the Earth's magnetic field is 2.0 x 10⁻⁴ T, at an angle of 60° to the horizontal.

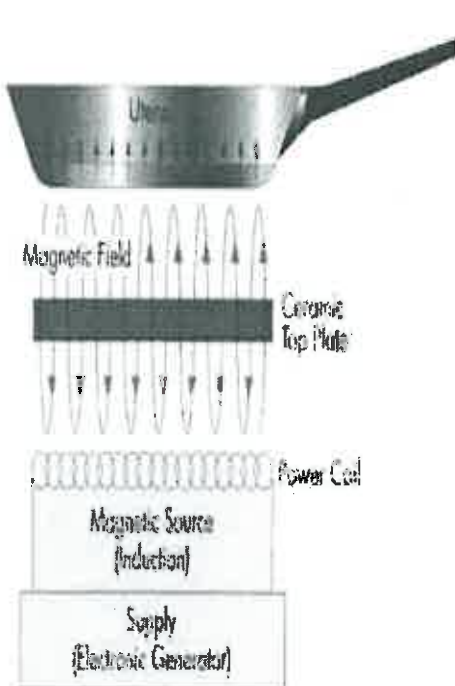
- 10 a) label the diagram to show the polarity of the induced EMF on each wing tip.
- 10 b) What is the magnitude of EMF induced across the wingtips of the aero-plane?



(4 marks)

QA11. [3 Marks]

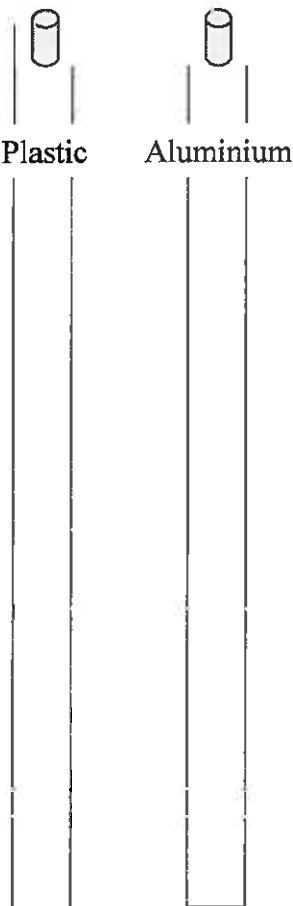
Carefully explain how an induction cooker produces the heat to cook the food.



(3 marks)

QA12. [4 Marks]

A Physics teacher set up the equipment shown below to present an important demonstration.



The time required for a cylindrical rare earth magnet to fall from the same height in both tubes was measured.

It was observed that the magnet falling through the plastic tube travelled much faster compared to falling through the aluminium tube.

Carefully explain this observation in terms of the Physics principles involved.

(4 marks)

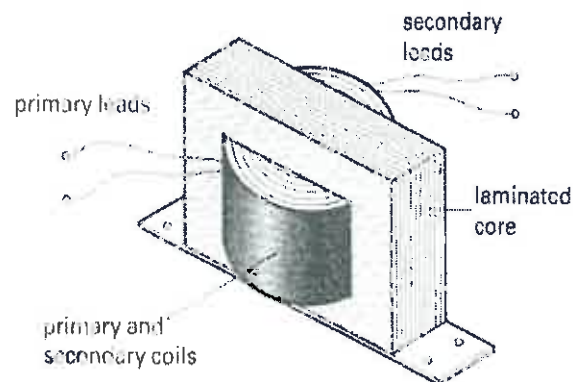
QA13. [3 Marks]

A transformer for a toy train set plugs into the 240 V mains supply and changes it to 12.0 V.

13a) Is this a step-up or step-down transformer ?

(1 mark)

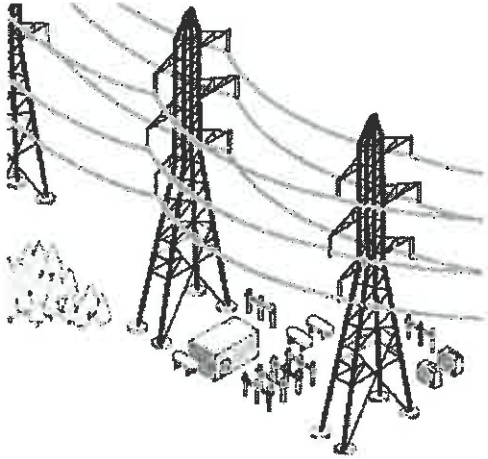
13 b) If the primary consists of 360 turns of wire, how many turns will the secondary have?



(2 marks)

QA14. [4 Marks]

Briefly explain why our electrical energy is an AC supply that is transmitted at very high voltages between the power stations and the cities where it is used.



(4 marks)

End of Section A

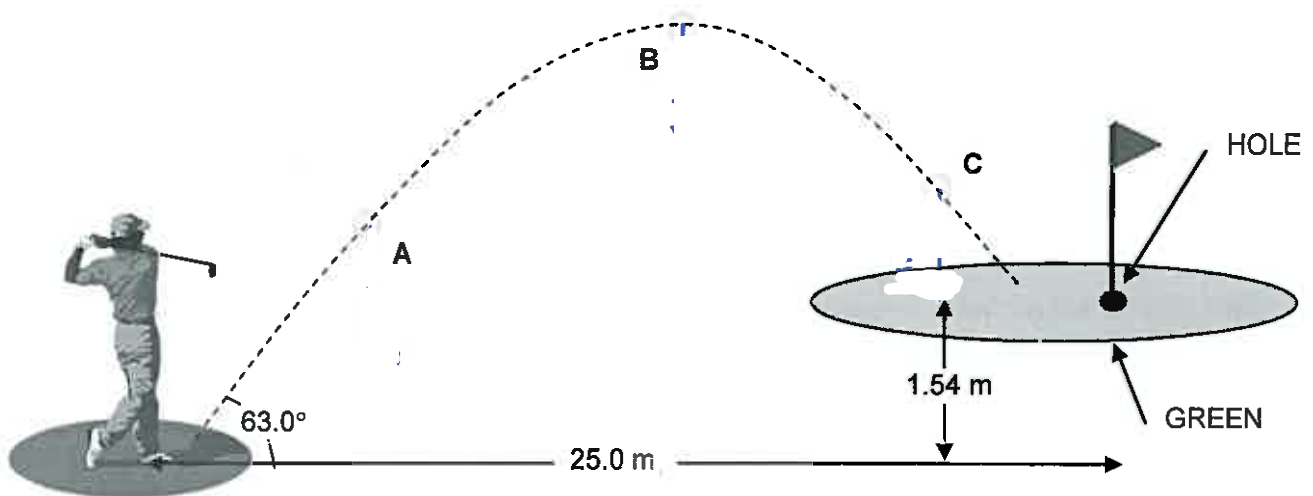
SECTION B : Problem Solving

Marks Allotted: 90 marks out of 180 (50%). Attempt ALL 6 questions in this section.

Answers are to be written in the spaces provided.

QB1. [16 Marks]

A golfer is approaching the green on the 18th hole in a round of golf as summarised in below.



The green is elevated 1.54 m above his position and the hole is located 25.0 m horizontally away.

Using a lofted club, he strikes the ball at an angle of 63° to the horizontal such that it is launched at 16.0 m s^{-1} and it flies directly toward the flag (hole).

- 1a) On the diagram above, carefully indicate with an arrow the relative net force on the ball at points A, B and C, as indicated. (Assume that air resistance is negligible) (2marks)
- 1b) Ignoring the effects of air resistance, determine the time of flight of the ball, i.e. how long is the ball in the air during its flight?

(4marks)

1c) Ignoring the effects of air resistance, determine how far from the hole the ball will land.

(4marks)

1d) Ignoring the effects of air resistance, determine the velocity of the ball when it hits the green.

(4marks)

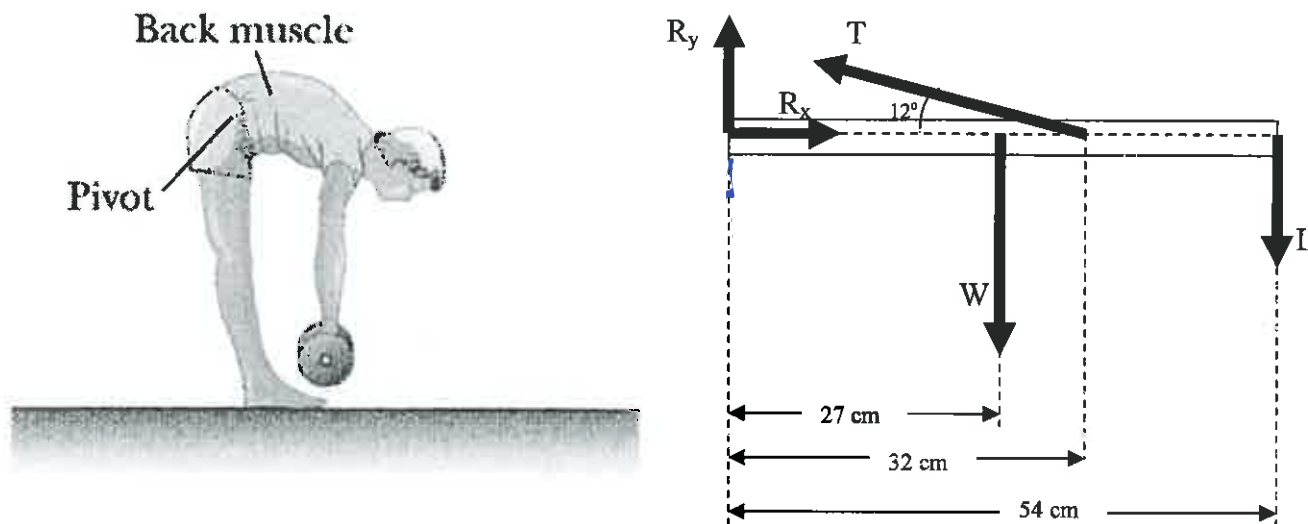
1e) Briefly describe how your answers to parts c) and d) would be different if the effects of air resistance are taken into account. (Hint: a simple sketch may assist your answer).

(2marks)

QB2. [14 Marks]

A person bending forward to lift a load "with his back" rather than "with his knees" can be injured by the large forces exerted on the back muscles and vertebrae.

To consider the magnitude of the forces involved in such poor lifting practices, consider the following simplified schematic diagram for a person lifting a 25.0 kg load (L).



The spine and upper body are represented as a uniform horizontal rod of 41.5 kg (W) pivoted at the base of the spine. The erector spinalis muscle acts at an angle of 12° to maintain the position of the back.

5a) Determine the tension (T) in the erector spinalis muscle while in this position.

(4 marks)

5b) Determine the "compressional" force on the spine (R_x) while in this position.

(3 marks)

5c) Determine the magnitude and direction of the vertical component (R_y) of the reaction on the base of the spine while in this position. Comment on this value.

(3 marks)

5d) Describe and carefully explain the recommended way to lift heavy objects.

(4 marks)

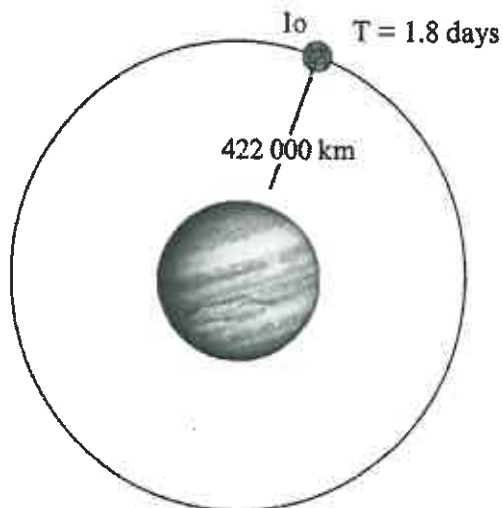
QB3. [16 Marks]

Io, the fifth of Jupiter's moons was first discovered by Galileo and Marius in 1610.

A spacecraft approaches Io;
when it is 9.00×10^6 m away,
the crew determines that Io has
a radius of 1.80×10^6 m.

The spacecraft eventually lands on Io.

To determine the mass of Io,
a crew member drops a stone
from a rocky ledge of height 19.0 m
and finds that it takes 4.60 s to fall
to the ground.



3a) Determine the acceleration of the falling stone due to the gravitational attraction of Io "near" its surface.

(3 marks)

3b) Calculate the mass of the moon Io.

(3 marks)

- 3c) Io has an orbital radius of 422 000 km with a period of 1.80 Earth days.
Determine the mass of Jupiter.

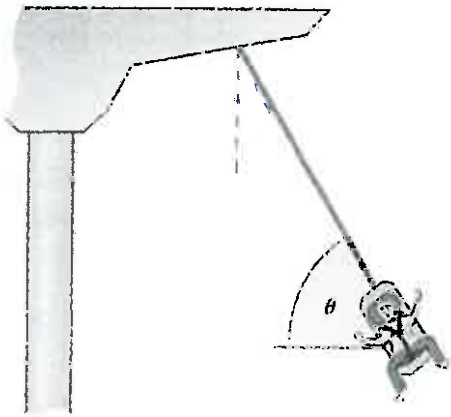
(4 marks)

- 3d) The spacecraft needs to remain in a "fixed" orbit in order to observe a massive storm on the surface of Jupiter. It is known that the period of Jupiter's rotation is equal to 10.2 Earth hours.
Determine the altitude required for the spacecraft to orbit directly over the same position.

(5 marks)

QB4. [13 Marks]

A popular side show ride consists of a carousel with chairs suspended from light chains around its circumference (as seen in the diagram). Assume that the circular path is only horizontal.



(2marks)

Once the carousel is turning at full speed the chain typically makes an angle of 50° with the vertical. You can assume that for this example the combined mass of the chair and passenger is 115 kg and that the radius of revolution is 15.2 m.

- 4a) In the space provided above, carefully sketch and label a Vector diagram to show all relevant forces acting on the passenger (and the relationship between them).
- 4b) The passengers "feel" as if they are being pushed outwards. Is this due to a "centrifugal force"? Carefully explain why the chains suspending the chairs are leaning outwards.

- 4c) Determine the tension in the light chain suspending the chair (plus passenger).

(3marks)

4d) Estimate the acceleration (in g's) experienced by the passenger.

(3marks)

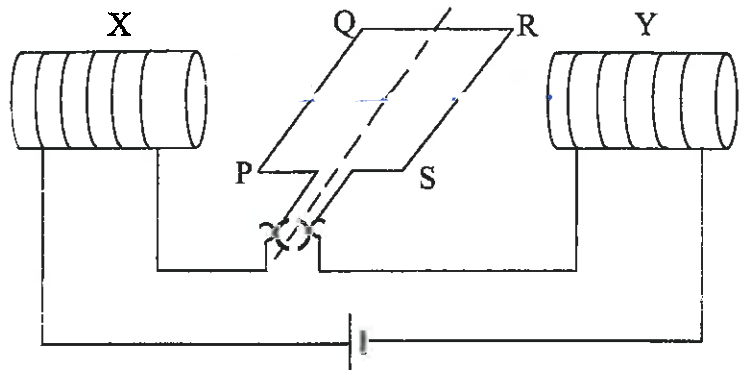
4e) Determine the frequency of revolution necessary for this ride.

(4marks)

QB5. [15 Marks]

The schematic diagram below shows an electric motor that produces its magnetic field from field coils either side of the armature coil. It is called a series wound motor because the field coils X and Y are wired in series with the armature coil. One advantage of this type of motor is that it works on either AC or DC electrical supplies.

- The armature coil of the motor has 150 turns.
- Side PQ is 5.0 cm long and side QR is 4.0 cm long.
- A 12 V supply provides a current of 0.75 A, and generates a 0.095 T magnetic field across the armature coil.

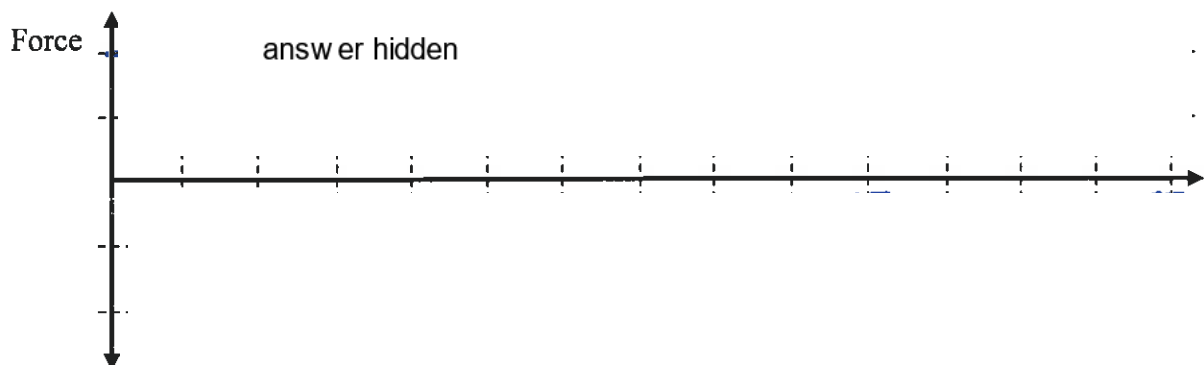


(2 marks)

- 5a) i) Draw one arrow on the diagram to show the direction of the magnetic field (label B)
- ii) Draw one arrow on the diagram to show the direction of the force of side PQ (label F)
- 5b) Calculate the force on the side RS of the armature.

(3 marks)

- 5c) Sketch the graph of the Force on the side PQ versus time for this simple motor.



(2 marks)

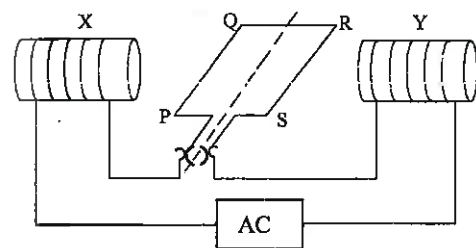
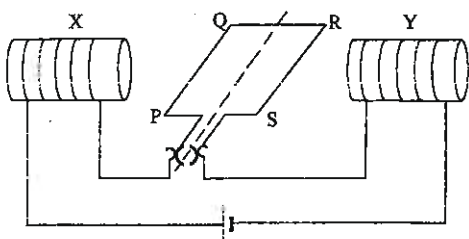
5d) Determine the torque produced when the plane of the armature coil at an angle of 30° to the magnetic field.

(3 marks)

5e) Describe and explain two practical ways in which the motor can be modified to produce a greater torque.

(2 marks)

5f) Using either or both of the diagrams below as part of your answer, explain why this motor will turn in the same direction, regardless of the type of electrical supply.



(3 marks)

QB6. [14 Marks]

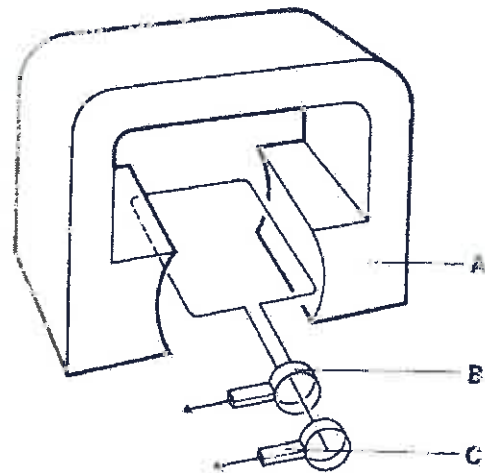
The diagram represents a simple generator.

6a) Is this an A.C or D.C generator?

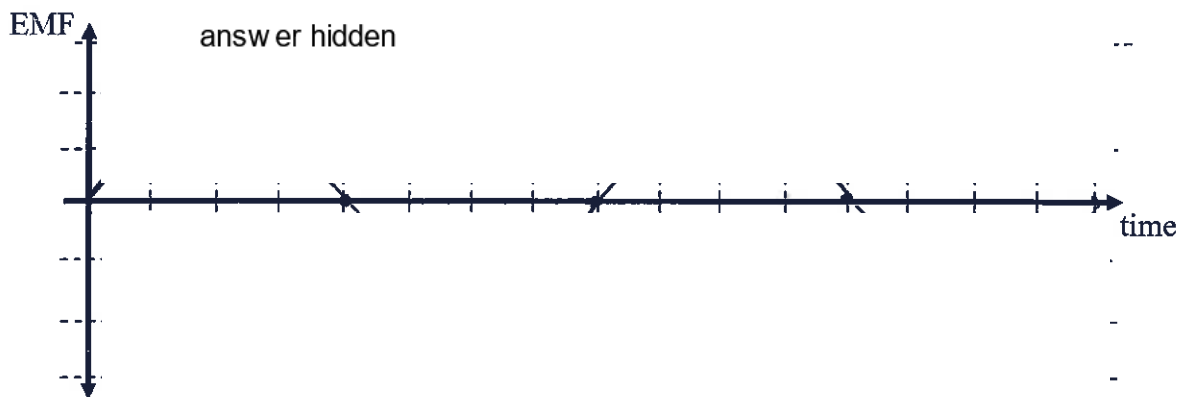
(1 mark)

6b) What is the component labelled B ?

(1 mark)



6c) Carefully construct a graph of the EMF versus time for two rotations of the coil for this generator commencing in a vertical position.



(3marks)

6d) Carefully describe and explain two practical improvements that can be made to the simple model generator shown that will increase the EMF that is generated.

(2marks)

Now consider an A.C generator consisting of 400 turns of square coil of length 4.50 cm is spinning at 50 Hz. The magnetic field strength of the magnet is 0.50 T and the coil's resistance of 15 Ω .

6d) Determine the **average** induced EMF generated.

(3 marks)

6e) Determine the **peak** value of the induced EMF generated.

(2 marks)

6f) Determine the (average) current generated.

(2 marks)

SECTION C : Comprehension and Interpretation

Marks Allotted: 36 marks out of 180 (20%). Attempt BOTH questions in this section.

Candidates are reminded of the need for clear and concise presentation of answers.

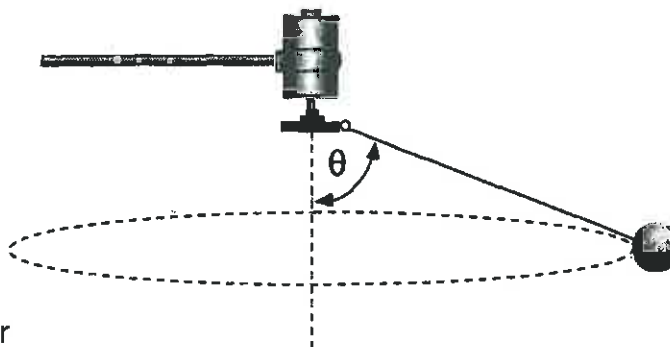
Diagrams, equations and/or numerical results should be included where appropriate.

QC1 [16 marks]

Experimental Analysis and Interpretation

The apparatus shown below is used to investigate the period of rotation of a conical pendulum.

The ball is set revolving and the motor is adjusted to give a stable orbit with the pendulum making an angle of 60° with the vertical.



The time taken for the ball to complete 10 revolutions is taken with a stopwatch and the period of revolution calculated.

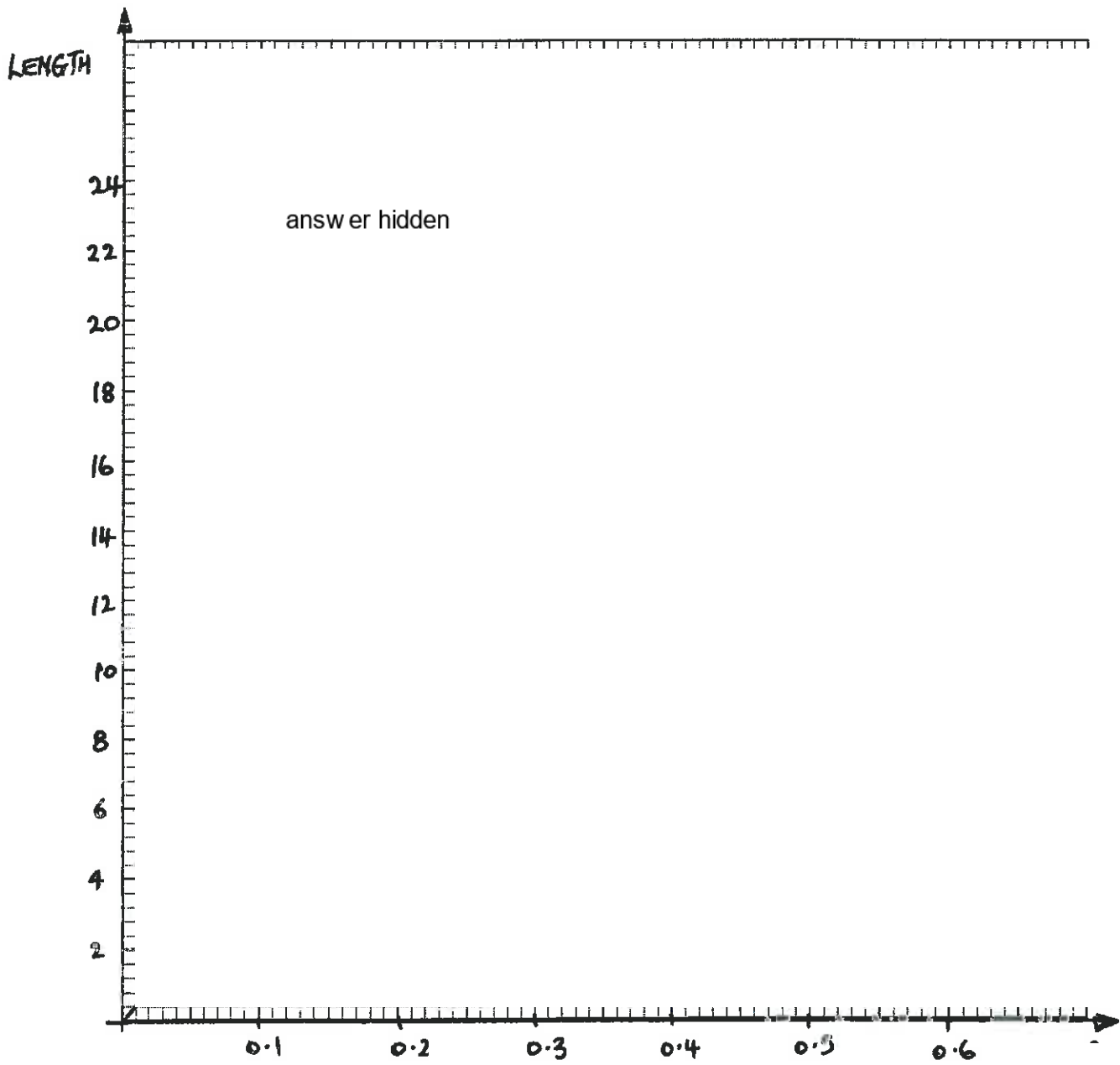
This technique is repeated using a number of strings of successively greater length.

The results are tabulated below.

Length ℓ (cm)	6.0	8.0	10.0	12.0	14.0	16.0	18.0	20.0
Period T (s)	0.348	0.432	0.449	0.492	0.500	0.568	0.602	0.635

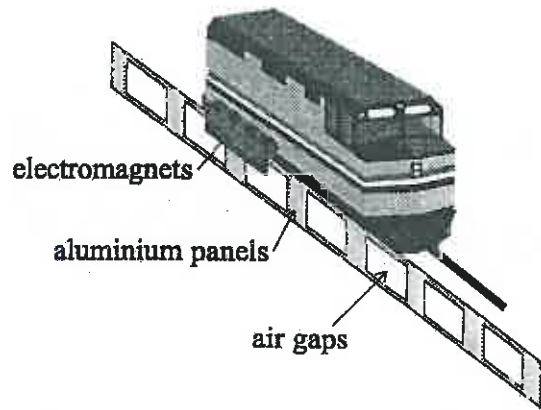
When period T is graphed against length of pendulum ℓ , a curve results suggesting a relationship of the form $\ell = kT^2$ where 'k' is a constant.

- 1a) You are to plot a second graph - **not ℓ against T** - which will test this relationship. Modify the data as necessary, recording the required values in the vacant row of the table. Include the heading and units. (4marks)
- 1b) Plot the points and clearly identify any which do not fit the trend. Draw a line of best fit through the others. (7marks)



- 1c) From the gradient of the graph determine the value of the constant 'k' expressed in SI units.

(5marks)



Paragraph 5

Test models have, so far, given encouraging results but full-sized operational trains pose some challenges to designers. Firstly, passengers would need to be shielded from the large magnetic fields of approximately two tesla. Without shielding passengers with metal shoes would stick to the floor! The shields can be built from iron which essentially contain the magnetic fields. Secondly, the noise made by switching magnets on and off will create acoustic waves in the middle range of human hearing making soundproofing essential. Finally, the cooling of the magnets would need to be addressed. At this stage water is favoured. However, the fast moving air created by the locomotive may be utilised for this purpose.

Questions

1. Paragraph 3 states "*a conductor is made to move through a changing magnetic field and a magnetic force is created that pushes the original magnet away*". Carefully explain how this may be achieved.

(4marks)

2. Why would the force propelling the train be reversed if the electromagnets were switched on before the centre of the aluminium plates had passed. (paragraph 4)

(4marks)

3. Carefully explain why people would "*stick to the floor*" if they were not shielded from the magnetic fields.(paragraph 5)

(4marks)

4. Why does iron "*contain*" the magnetic fields enabling the passengers to be shielded from the magnetic fields? (paragraph 5)

(4marks)

5. Calculate the current that would need to be induced in an aluminium conductor of resistance 0.15Ω and length of 0.65 m if it travels at 500 kmh^{-1} perpendicular to a 2.0 T field.

(4marks)