Physics 3A B

Stage 3 Written Paper Semester One 2011

Question/Answer Booklet

Student name: _____

Teacher name: _____

Time allowed for this paper

Reading time before commencing work: ten minutes
Working time for paper: two and a half hours

Materials required/recommended for this paper

To be provided by the supervisor

This Question/Answer Booklet
Formulae and Constants Sheet

To be provided by the candidate

Standard items: pens, pencils, eraser, correction fluid, ruler, highlighters

Special items: non-programmable calculators satisfying the conditions set by the Curriculum Council for this course

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.

Student Marks

Section	Percentage of paper	Maximum mark	Student Raw Mark	Student Scaled mark
Section One: Short response	30%	53		out of 30
Section Two: Problem-solving	50%	76		out of 50
Section Three: Comprehension	20%	31		out of 20
			Student Mark	out of 100

Structure of this paper

Section	Number of questions available	Number of questions to be answered	Suggested working time (minutes)	Marks available	Percentage of exam
Section One: Short response	13	13	45	53	32
Section Two: Problem-solving	7	7	75	76	48
Section Three: Comprehension	2	2	30	31	20
				157	100

Instructions to candidates

1. The rules for the conduct of Western Australian external examinations are detailed in the *Year 12 Information Handbook 2010.* Sitting this examination implies that you agree to abide by these rules.

2. Write answers in this Question/Answer Booklet.

3. You must be careful to confine your responses to the specific questions asked and to follow any instructions that are specific to a particular question.

4. Working or reasoning should be clearly shown when calculating or estimating answers. Answers should be given to the appropriate number of significant figures. Answers not given to the appropriate number of significant figures may result in marks being deducted.

5. Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.

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- Continuing an answer: If you need to use the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.

Section One: Short response 30% (50 Marks)

This section has **13** questions. Answer **all** questions. Write your answers in the space provided.

Suggested working time for this section is 50 minutes.

Question 1 (4 marks)

A bar magnet is glued to a piece of polystyrene so it floats in the middle of a plastic bowl filled with water.

Describe in detail the motion of the magnet until it comes to rest. Explain your answer.

Question 2 (5 marks)

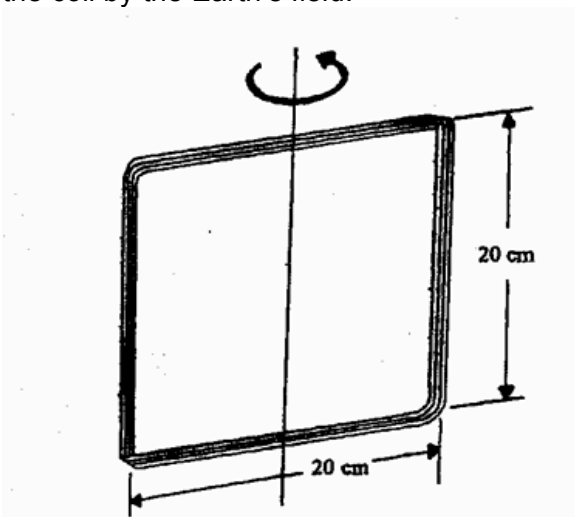
Geoffrey has thought of a way to determine the mass of a 4.80 m long plank. He placed a 2.0 kg mass on one end of the plank and a 25 kg mass at the other so that the plank balanced. The point at which the plank balanced was at the 3.10 m mark.

a) Draw a diagram of the situation. (1 mark)

b) Find the mass of the plank. (4 marks)

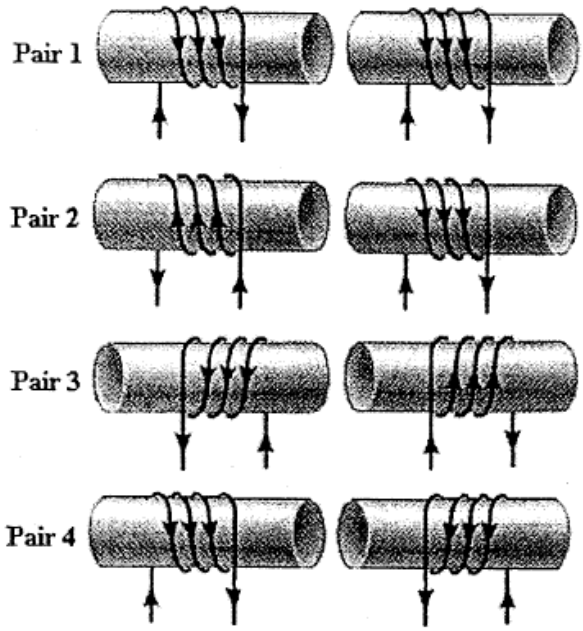
Question 3 (4 marks)

A square coil (20.0 cm x 20.0 cm) that consists of 100 loops of wire rotates in the Earth's magnetic field about a vertical axis at 1500 rpm (revolutions per minute). If the horizontal component of the Earth's magnetic field is 2.0×10^{-5} T, calculate the maximum emf induced by the coil by the Earth's field.



Question 4 (2 marks)

Jenny was given four pairs of coiled wires. Each coil was linked to its own DC source.



Which two pairs of coils did Jenny correctly predict would attract each other?

A Pairs 2 and 3
B Pairs 1 and 4
C Pairs 3 and 4
D Pairs 1 and 2

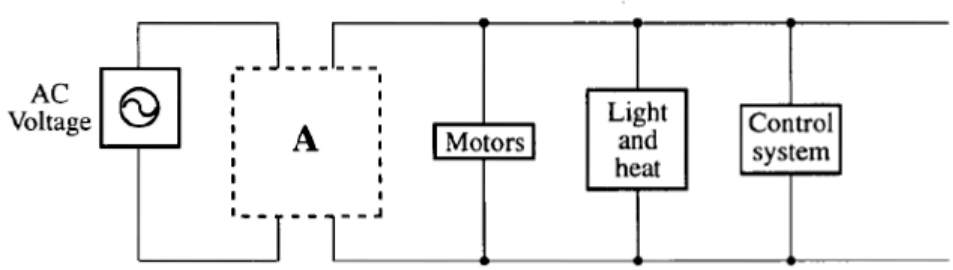
Question 5 (5 marks)

In many electrically powered passenger trains the input voltage V_I from the power supply is not the same as the operating voltage V_O of the electrical circuitry of the train.

Examples

	V_I	V_O
England	750	1500
English Channel	25000	1500
Belgium	3000	1500
France	50000	1500

The diagram below is a partial schematic of the electrical circuitry of an electric train.



a) What kind of transformer is most likely used in England? (1 mark)

b) Calculate the turns ratio for a transformer used in France. (2 marks)

c) If the supply voltage was DC would the transformer work? Explain your answer.
(2 marks)

Question 6 (5 marks)

A mass attached to a string is moving at constant speed of 2.0 ms^{-1} in a horizontal circle of radius 0.50 m.

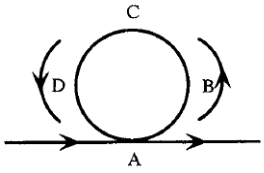
a) What is the magnitude and direction of the centripetal acceleration? (3 marks)

b) What is the tension in the string? (2 marks)

Question 7 (4 marks)

At an airshow a pilot takes his aircraft through a complete vertical loop.

a) At which point will the pilot **feel** the heaviest? (1 mark)



b) Justify your answer in part a). (3 marks)

Question 8 (3 marks)

The following symbols refer to the Earth orbiting the sun and a comet orbiting the sun.

r_E = radius of Earth orbit

T_E = period of Earth orbit

r_C = radius of comet orbit

T_C = period of comet orbit

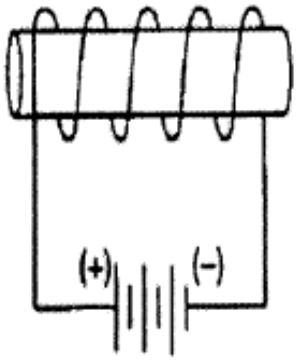
How does the value of $\frac{r_C^3}{T_C^2}$ compare to $\frac{r_E^3}{T_E^2}$?

A larger
B larger or smaller, depending on the mass of the comet
C smaller
D the same.

Question 9 (3 marks)

a) What is the direction of the magnetic field in the solenoid below? (1 mark)

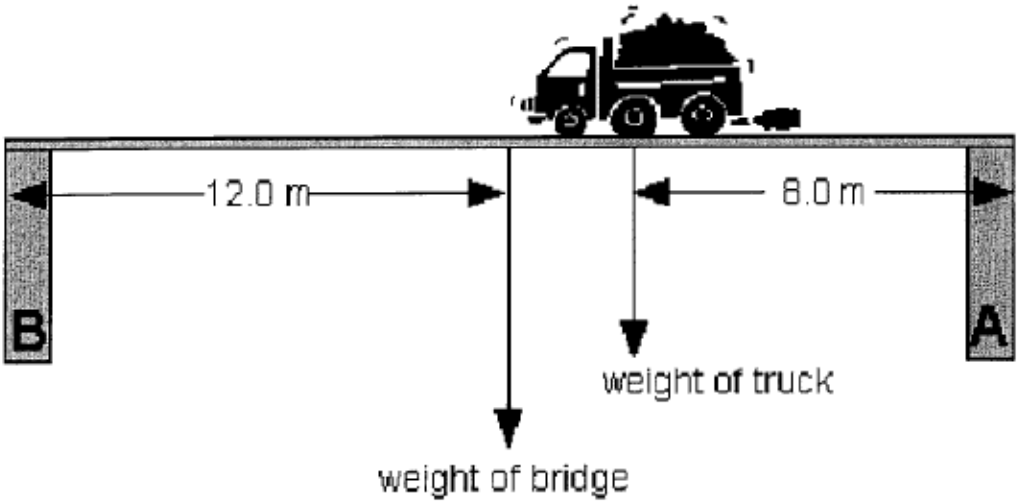
A up
B down
C left
D right



b) Draw the magnetic field produced when **electrons** are flowing in a straight conductor out of the page. (2 marks)

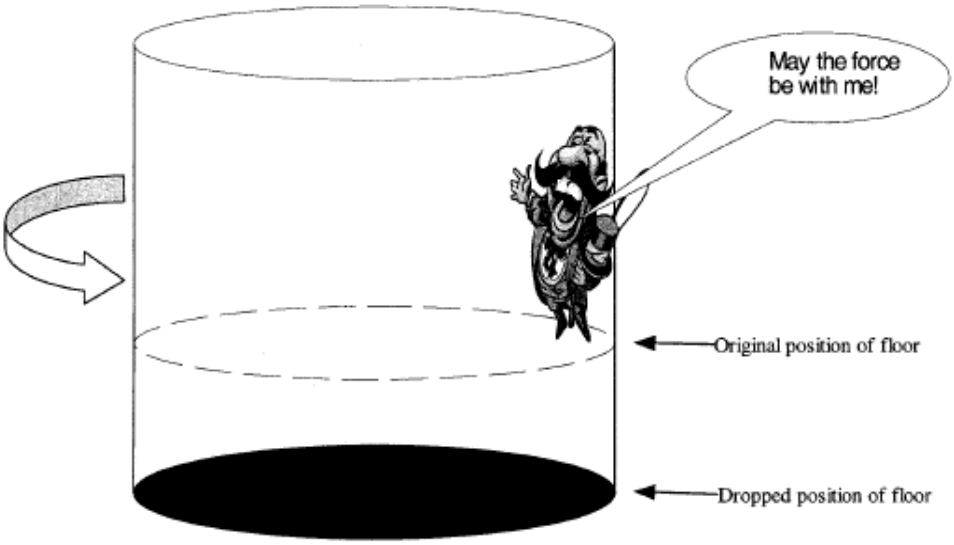
Question 10 (5 marks)

A 2.00x 10^4 kg dump truck is stopped one third of the way across a 24.0 m long bridge that is supported at each end by a concrete pillar. If the bridge is of uniform construction and has a mass of 1.25 x 10^5 kg what are the supporting forces that both pillars must provide?



Question 11 (6 marks)

The Gravitron is an amusement park ride that consists of a large rotating cylinder around a vertical axis much the same way as a awashing machine drum spins. A certain Gravitron of radius 7.00 m is spinning so that the rider has a speed of 17.6 ms^{-1} and remains "stuck" to the wall when the floor in the ride is lowered. The diagram below is an illustration of the way this works. The mass of the rider is 75.0 kg.



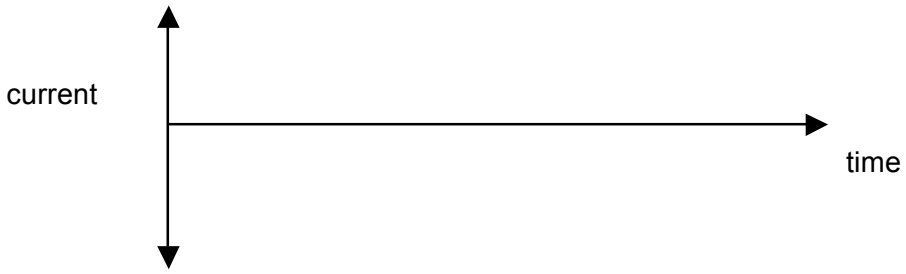
a) Draw a free body diagram for the force acting on the rider once the floor has been lowered. (2 marks)

b) What force(s) contribute to the centripetal force? (2 marks)

c) Calculate the magnitude of the frictional force needed to prevent the rider from sliding down the wall. (2 marks)

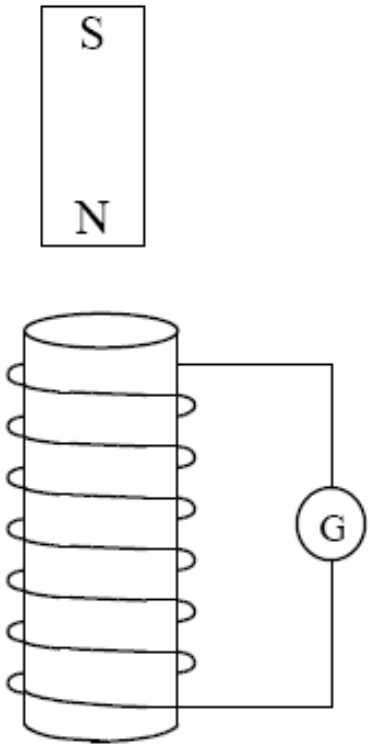
Question 12 (3 marks)

A bar magnet is dropped South pole first through a small coil. A current sensor was connected to the coil. On the axes provided, sketch a representation of the current from the time the South pole of the magnet enters the coil to the time the North pole of the magnet enters the coil.



Question 13 (4 marks)

A bar magnet moves **downwards** into a conducting coil as shown in the diagram causing an induced current to flow in the coil. The coil is connected to a galvanometer, G, a meter that detects current.



On the diagram sketch:

- The lines of magnetic force around the bar magnet.

- The lines of magnetic force produced by the induced current in the coil.

- The direction of the induced current in the coil and external circuit.

Be sure to label clearly your additions to the diagram.

End of Section One
Go on to Section Two

Section Two: Problem-solving 50% (81 Marks)

This section has **six (6)** questions. You must answer **all** questions. Write your answers in the space provided.

Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.

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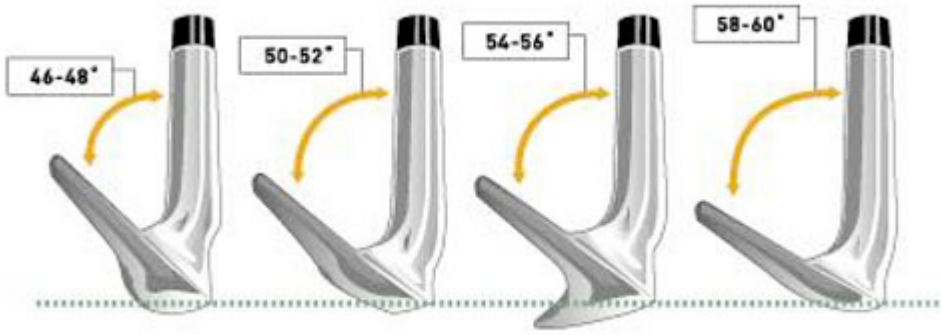
Suggested working time for this section is 90 minutes.

Question 14: (16 marks)

Chipping

Chipping is a technique used by golfers to hit golf ball accurately over short distances. The club used when chipping is called a wedge. It is designed so that when the ball is correctly hit the ball does not roll when it arrives at its destination, the green. To do this the club face is lofted. This means that the club face is inclined to the vertical as shown in the diagram.

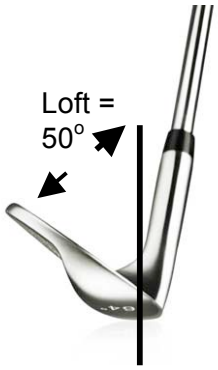
Different wedges have different uses and different loft angles. The most common wedges have loft angles of around 46 to 60^{o}. The first of the wedges shown below shows the most common of wedges known as pitching wedges with loft angles between 46 and 48^{o} that are designed to hit a golf ball 90 to 100 metres.

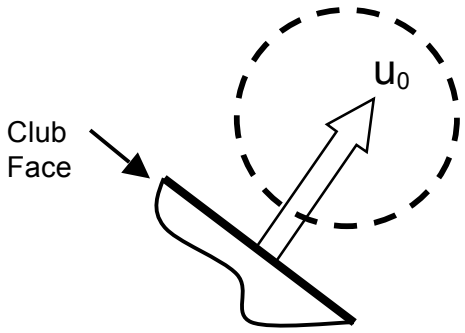


Question 14: (contd)

The second wedge is called a gap wedge pitching a golf ball 60 to 90 metres. The third wedge is a sand wedge designed to loft a golf ball out of a sand trap or bunker. The fourth wedge is called a lob wedge which is designed to hit the golf ball extremely high into the air over short distances, dropping the ball softly on the green with little or no roll.

The initial velocity of the ball is denoted as u_o. It is assumed that when hit the ball leaves the surface of the club at right angles to its face.





a) Write expressions giving the horizontal and vertical components of the golf ball's initial velocity u_o. (2 marks)

b) If you were given the value of u_0, explain how you would calculate each of the following given appropriate equations.

(i) the horizontal distance travelled by the golf ball in time *t*. (2 marks)

(ii) the height of the ball at any time *t*. (2 marks)

Question 14: (contd)

d) Using your knowledge of physics explain why the pitching wedge has the greatest range. (2 marks)

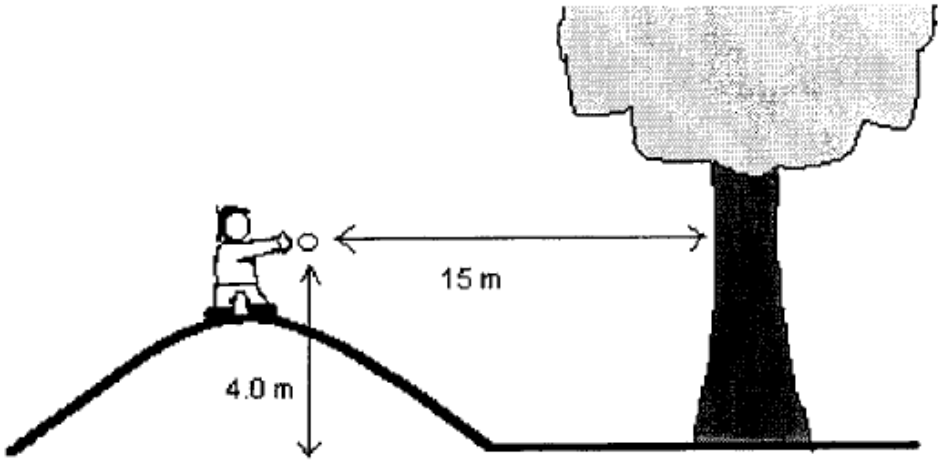
c) Which wedge would you use to approach a hole 100 m away? What is its loft angle? (2 marks)

d) With the help of appropriate equations with what **speed** would you hit the ball with the wedge chosen in part c) above and what **time** would the ball be in the air? (4 marks)

e) What **two** assumptions did you use in your calculation in part d) above? (2 marks)

Question 15: (11 marks)

A child standing on a small hill throws a snowball horizontally at a tree that is 15m away. When the snowball is released it is 4.0m above the ground on which the tree stands. The snowball hits the tree 0.60 seconds after it has been released.



a) What is the horizontal velocity at which the snowball was thrown? (3 marks)

b) Approximately how far above the level ground does the snowball hit the tree? (3 marks)

Question 15: (contd)

c) At what **velocity** does the snowball hit the tree? (5 marks)

Question 16: (9 marks)

Spiderman has a mass of 80.0 kg. He swings in a vertical, circular arc on a web that is 4.00 m long.

a) Draw a free body diagram of the force acting on Spiderman at the bottom of the swing. (2 marks)

b) If his speed is 3.20 ms^{-1} at the bottom of the swing, what is the tension in the web? (4 marks)

c) If the maximum tension the web can withstand is 1800 N, what is the minimum speed Spiderman would have to have at the bottom in order to break the web? (3 marks)

Question 17: (11 marks)

a) Two spheres, each having a mass of 40.0 kg are positioned so that their centres are 8.00 m apart. What is the gravitational force of attraction between the two spheres? (4 marks)

b) If the mass of one of the spheres in part a) was doubled, how far apart would the spheres have to be placed to maintain the same force of gravity? (3 marks)

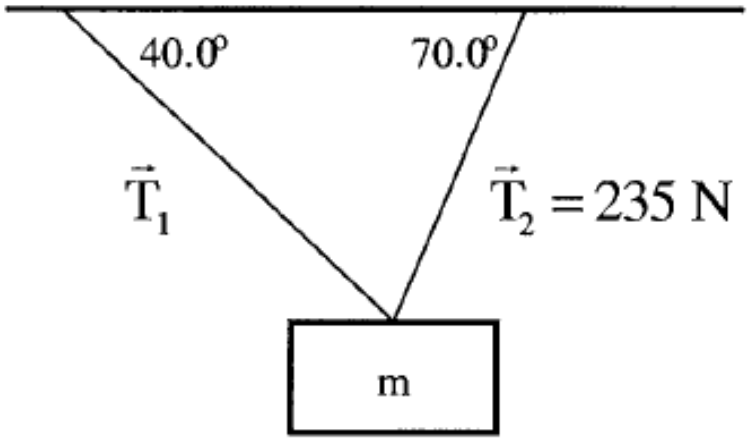
c) On a popular science TV show, the host described the orbiting space shuttle astronauts as being "weightless" because they were in a "zero gravity" environment.

(i) Using field concepts, explain why the phrase "zero gravity" **should not** be used. (2marks)

(ii) Explain why the astronauts **feel** weightless. (2 marks)

Question 18: (5 marks)

The accompanying diagram shows a mass suspended in equilibrium by two ropes. Calculate the mass m.



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Question 19: (13 marks)

Over the past year or so astronomers have discovered many planets orbiting distant stars. The following data gives the planetary orbital period **T** as a function of distance **r** from the central star.

T (seconds)	2.43 x 10^5	4.47 x 10^5	6.91 x 10^5
r (10^9m)	10.0	15.0	20.0

This data is related to the Kepler's Law equation:

$$T^2 = \frac{4\pi^2 r^3}{GM}$$

T = orbital period (seconds)
r = orbital radius (m)
G = gravitational constant (N m^2kg^{-2})
M = mass of central star (kg)

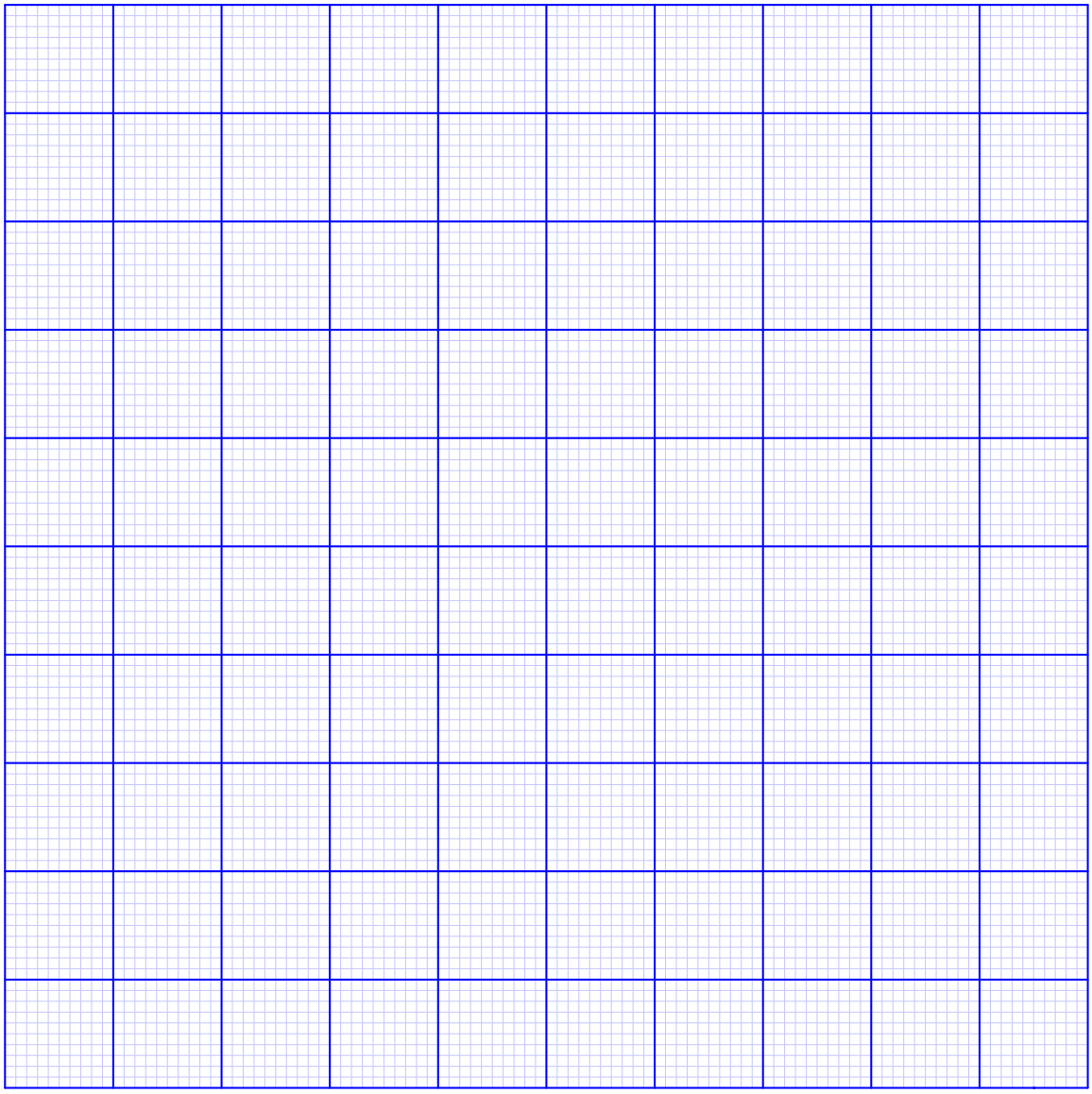
(a) Modify the above data to enable you to plot a straight-line graph relating period to orbital radius. Write your modified data in the **blank spaces in the table above**, including the units that you are using. (4 marks)

(b) Plot the modified data on the graph on the **opposite page**. (4 marks)

(c) **Describe** how this graph can be used to determine the **mass** of the central star. (3 marks)

(d) Using the graph, determine the value of the **mass** of the central star. (2 marks)

Question 19: (contd)



Question 20: (11 marks)

A 6.4 m ladder which has a mass of 30.0 kg leans against a frictionless wall at an angle of 60^{o}. A 65.0 kg workman is standing on the ladder 4.0 m along the ladder from its foot.

a) Draw a sketch of the ladder and any forces applied to it. (3 marks)

b) Find the horizontal reaction force between the ladder and the frictionless wall. (3 marks)

Question 20: (contd)

c) Determine the magnitude and direction of the reaction force at the foot of the ladder.
(5 marks)

Section Three: Comprehension 20% (31 Marks)

This section contains **two (2)** questions. You must answer both questions. Write your answers in the space provided.

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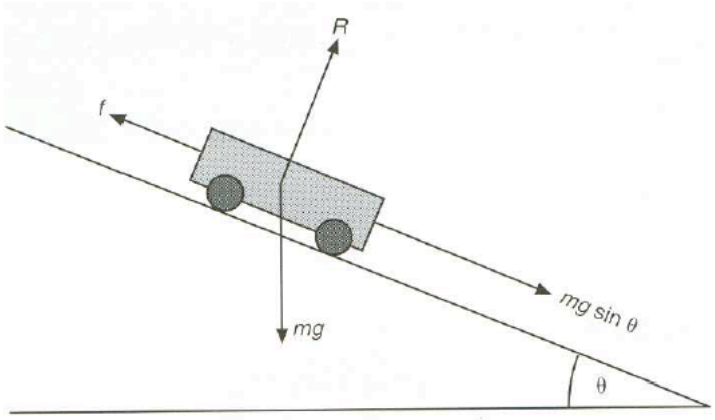
Suggested working time for this section is 40 minutes.

Question 21: (18 marks)

The diagram below shows a method of investigating how the resultant force acting on a trolley varies with the angle that the slope makes with the horizontal.



The equation for the resultant force ***F*** acting on the trolley is

$$\boldsymbol{F} = mg \sin\theta - \boldsymbol{f}$$

where:

mg is the weight of the trolley,
R is the normal reaction to the slope,
mg sin θ is the force acting parallel to the plane,
f is the net effect of friction and air resistance.

The readings of force ***F*** (N) and angle of incline θ (°) were recorded in the table shown below:

F (N)	1.1	2.8	4.4	6.1	7.6	9.1
θ (°)	10	15	20	25	30	35

Question 21: (contd)

(a) Explain how you would manipulate the data in the table on page 26 to get a **straight line**. (3 marks)

(b) Manipulate the data in the table below. (3 marks)

F(N)	1.1	2.8	4.4	6.1	7.6	9.1
θ°	10	15	20	25	30	35

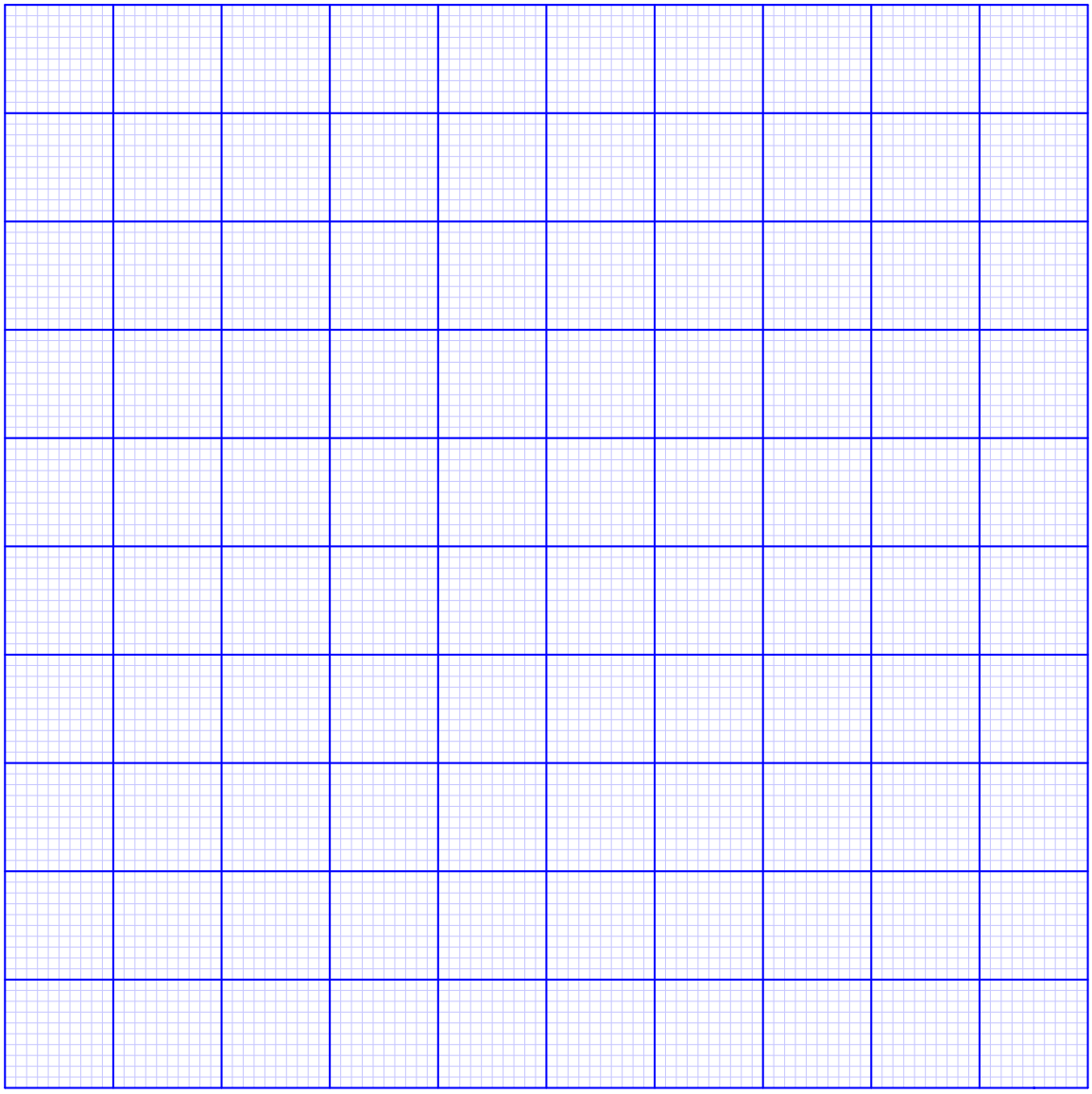
(b) Plot (on page 28) a graph of your manipulated data. (5marks)

(c) Determine a value for the **mass** of the trolley from the graph. (3 marks)

(d) Use the graph to find a value for the frictional force and the air resistance. (2marks)

(e) How would the graph change if the value of the frictional force increases? (2marks)

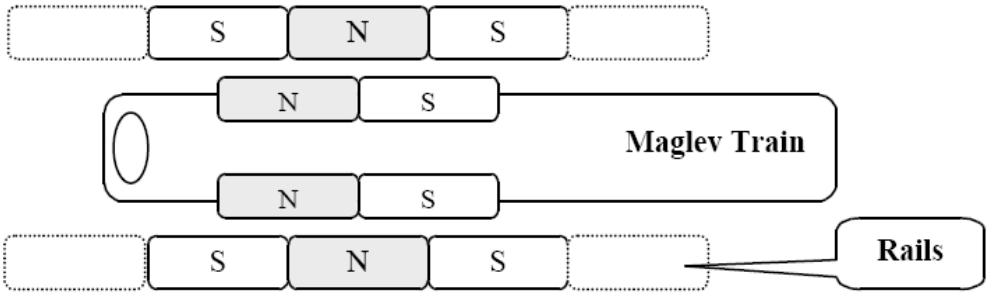
Question 21: (contd)



Question 22: (13 marks)

Over the past few years there has been increasing interest in magnetic levitation trains (maglev trains) which are supported by magnetic forces.

The diagram below, which shows a top view of a maglev train travelling between stationary rails on either side, illustrates the propulsive force accelerating the train along its tracks. While the train is passing, the rails become magnetised as shown.

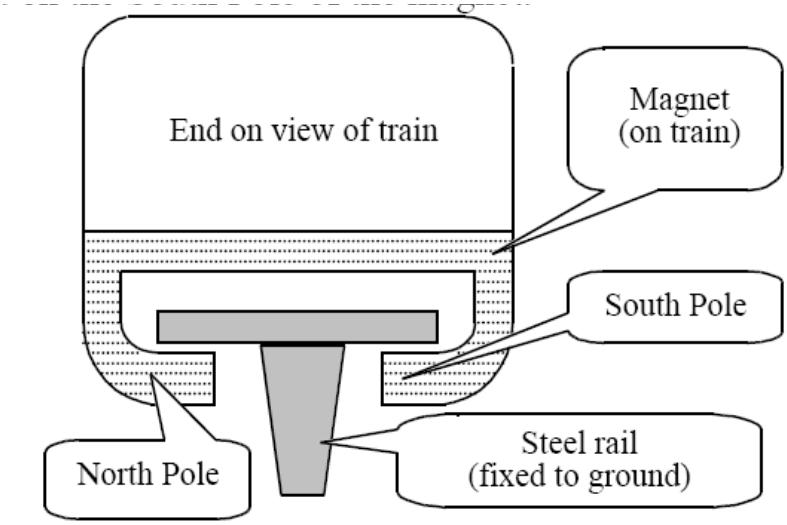


a) On the diagram above, draw vectors illustrating the two main magnetic forces acting on each of the magnet poles of the maglev train. (2 marks)

b) What is the direction of the total force acting on the train? (1 mark)

c) The diagram below shows the electromagnetic suspension (EMS) system for providing a levitation force which holds the train above a steel track. The North Pole and the South Pole of the magnet are each attracted towards the steel rail.

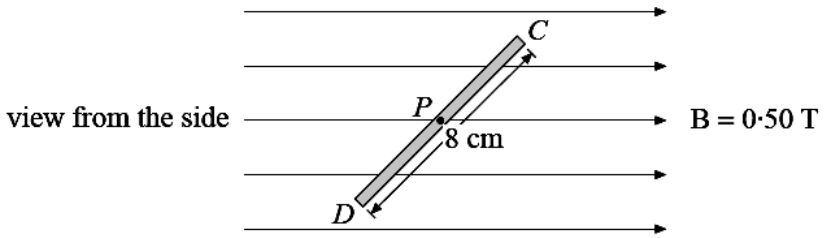
(i) **On the diagram below**, sketch vectors representing the magnetic forces acting on the North Pole and on the South Pole of the magnet. (2 marks)

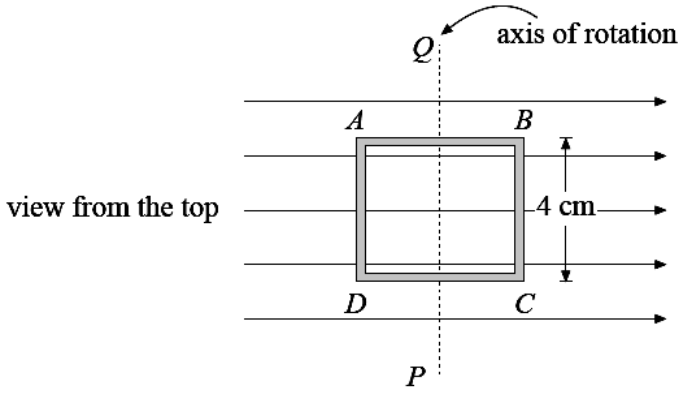


Question 22: (contd)

(ii) How would you convert the permanent magnet shown on the diagram to an electromagnet? Illustrate your answer with a sketch diagram. (3 marks)

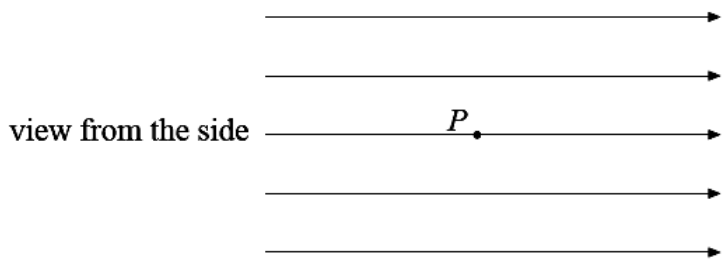
d) A rectangular coil *ABCD* of dimensions 8·0 cm by 4·0 cm is made up of 250 turns of copper wire. It is placed in a uniform magnetic field with a flux density of 0·50 T. It is free to rotate about an axis, *PQ*, as shown in the diagrams below. A current of 9·0 mA flows through the coil.





Question 22: (contd)

i) Complete the diagram below by drawing a sketch **from the side** showing the angle of the coil in the field when the torque is maximum. (1 mark)



ii) The coil is then rotated 180° around axis *PQ* from the position of maximum torque. Compare the torque in this position with that described in part (a). (2 marks)

iii) What is the **magnitude** of the maximum torque? (2 marks)

End of Examination

Spare Page