Physics 3A B

Stage 3 Written Paper Semester One 2011

Question/Answer Booklet

Student name: DAVE

Teacher name: ANSWERS

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.

- Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
- 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.

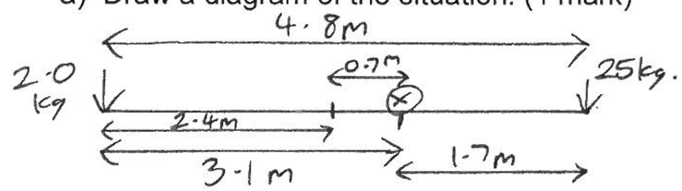
Describe in detail the motion of the magnet until it comes to rest. Explain your answer.

The bar magnet will spin until its aligned with the Earth's masnetic field.
ie the North pole of the magnet will point to geographic north.

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. (Assume plank uniform)

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



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

$W = Mg$

For mass, take moments about ⊗ :

$\tau_{CW} = (1.7 \times 25 \times 9.8) = \tau_{ACW} = (0.7 \times W) + (3.1 \times 2 \times 9.8)$

DIVIDE THROUGH BY 9.8 (ie g)

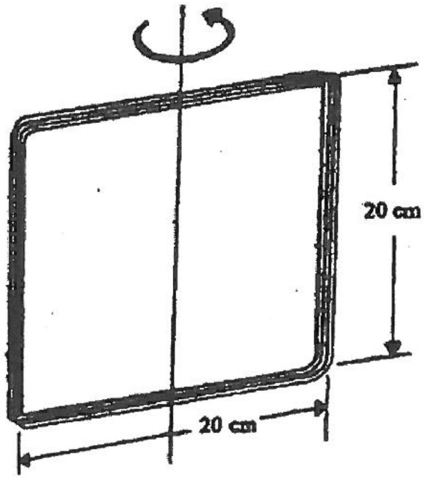
ie $(1.7 \times 25) = 0.7M + (3.1 \times 2)$

ie $0.7M = (1.7 \times 25) - (3.1 \times 2) = 42.5 - 6.2$
$= 36.3.$

$\therefore M = 36.3 \div 0.7 = 51.9\ kg = 52\ kg$ 2sf.

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 x 10^{-5} T, calculate the maximum emf induced by the coil by the Earth's field.



$EMF_{MAX} = EMF_{AVE} \times \sqrt{2}$.

$EMF_{AVE} = \frac{-N \times \Delta\phi}{\Delta t}$

$N = 100$

$\phi = BA$

$\Delta t \, (1/4) = \frac{1500}{(60)}$

$= 25 \text{ Hz}$.

$\Delta t = \frac{1}{(25 \times 4)}$

$= \frac{1}{100}$

$= 0.01 \text{ s}$

$EMF_{AVE} = \frac{-100 \times 2 \times 10^{-5} \times (0.2 \times 0.2)}{0.01}$

$= 0.008 \text{ V}$

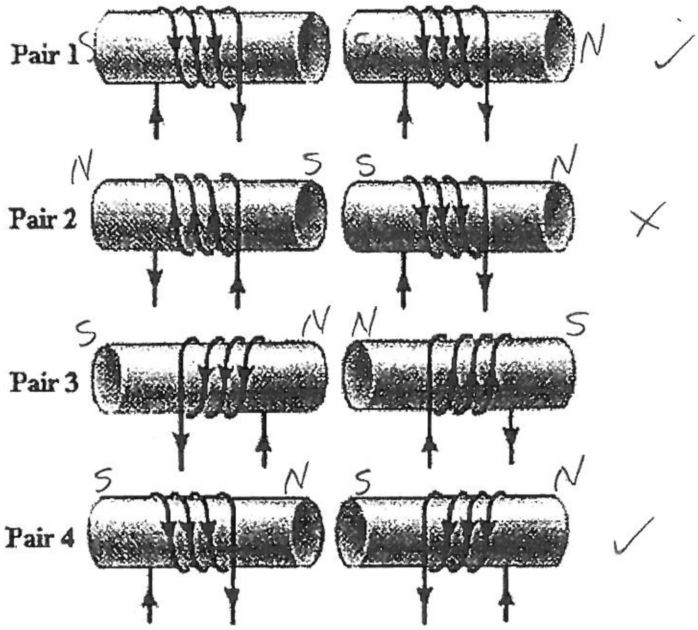
$EMF_{MAX} = 0.0113 \text{ V}$

$= 1.13 \times 10^{-2} \text{ V}$

$= 1 \times 10^{-2} \text{ V}$ 1 sf

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 ×

~~D~~ B.

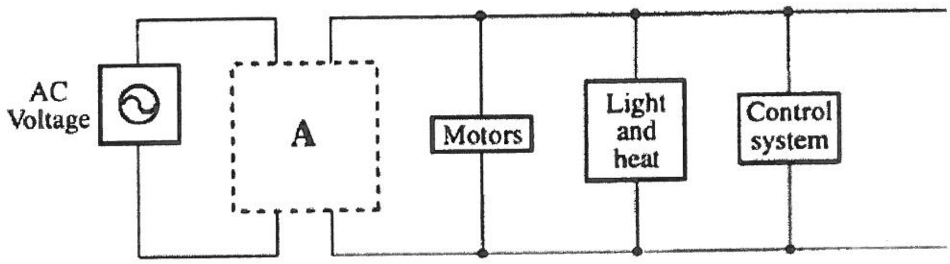
Question 5 (5 marks)

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)

STEP UP or STEP DOWN

STEP UP

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

$\frac{50\,000}{1\,500} = 33.3 : 1$

(or $1 : 0.030$)

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

No

Transformers required fluctuating ~~ac~~ current to create changing flux to induce voltage/current in the secondary

Question 6 (5 marks)

/ 5.00 kg

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)

$a = \frac{v^2}{r}$

$v = 2.0 ms^{-1}$

$r = 0.50 m$

$a = \frac{2^2}{0.5}$

$= 8.0 ms^{-2}$

TTC OTC

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

If $m = 5.0 kg$ $T = F_c = \frac{mv^2}{r}$

$= 5 \times 8 = 40 N$

$= 4.0 \times 10^1 N$

TTCOTC

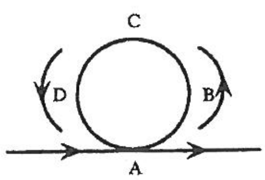
otherwise $T = 8 \times m$ N

TTCOTC

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)



A

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

At "A", Weight and Centripetal Force are in opposite directions, the effect of which is to create a maximum reaction force on the pilot.

via $W_{APP} = \frac{mv^2}{r} + mg\cos\theta$ ($\theta = 0°$ at A)

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.

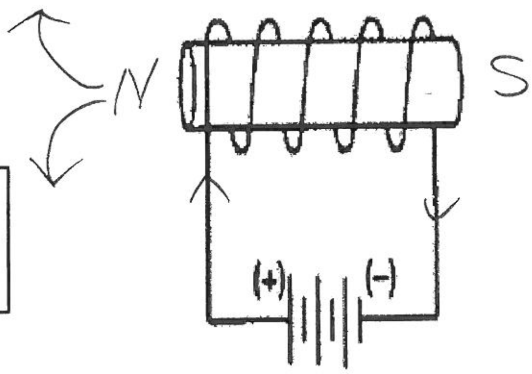
D

Question 9 (3 marks)

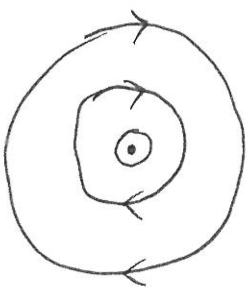
a) What is the direction of the magnetic field in the solenoid below? (1 mark)

A up
B down
C left
D right

C



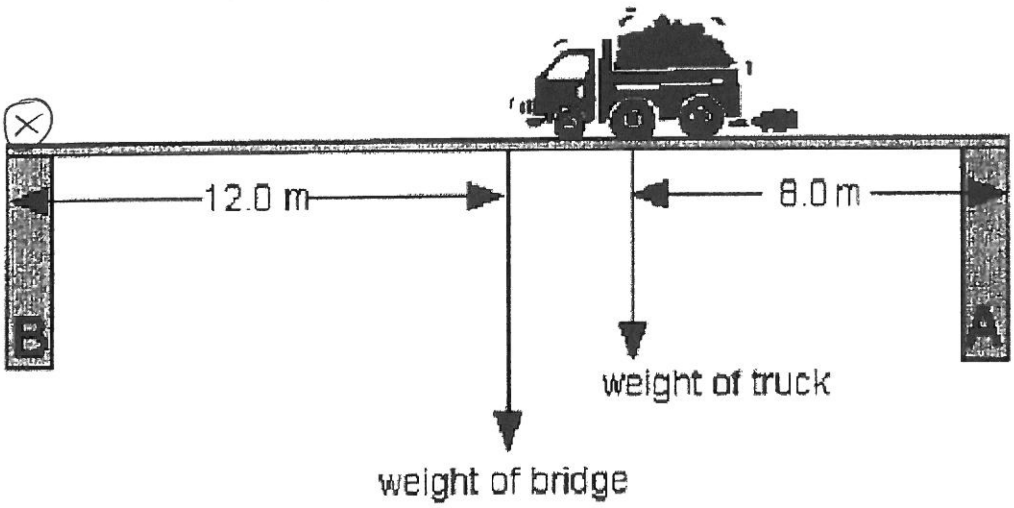
b) Draw the magnetic field produced when **electrons** are flowing in a straight conductor out of the page. (2 marks)



electrons - not conventional current - so opp. direction..

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?



$\Sigma\tau = 0$ and $\Sigma F = 0$

Find F_A using moments, then F_B using $\Sigma F = 0$

For F_A : take moments about ⊗ :

$\tau_{cw} = (12 \times 1.25 \times 10^5 \times 9.8) + (16 \times 2.00 \times 10^4 \times 9.8) = 24 \times F_A =$

ie $24 F_A = 14\,700\,000 + 3\,136\,000 = 17\,836\,000$

$F_A = 17\,836\,000 \div 24 = 743\,166$ N up

$\simeq 7.4 \times 10^5$ N up

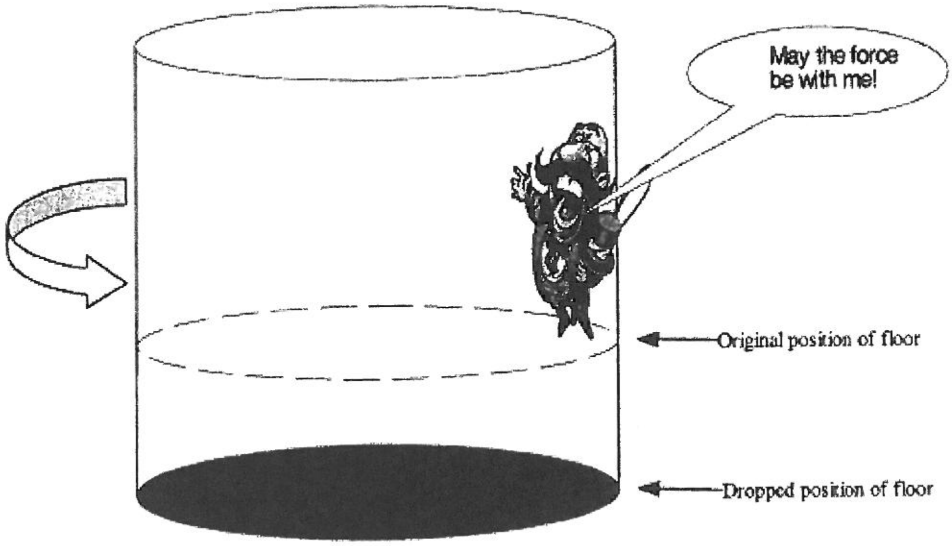
NOW $F_B = \Sigma F_{DOWN} - F_A$

$= (1.25 \times 10^5 + 2.00 \times 10^4) \times 9.8 - 743\,166$

$F_B = 677\,834 = 6.8 \times 10^5$ N up

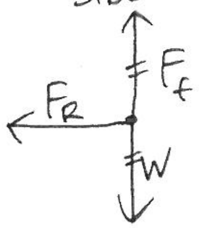
Question 11 (6 marks)

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 forces acting on the rider once the floor has been lowered. (2 marks)

SIDE VIEW



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

The reaction force of the inside of the drum

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

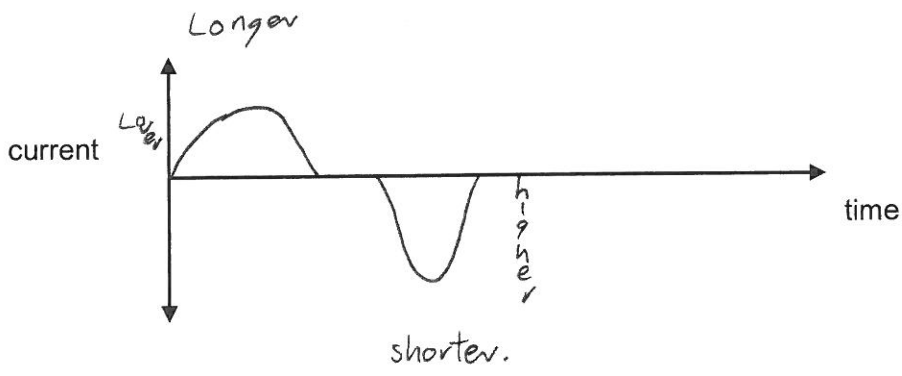
$F_f = W = mg = 75 \times 9.8$

$= 735\ N$ 3 sf

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.

exits



accelerating with gravity.

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.

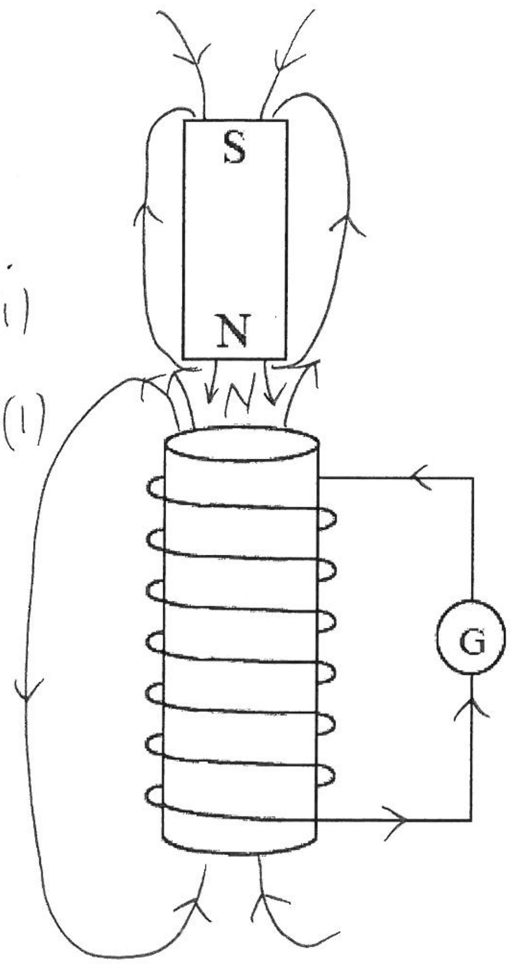
On the diagram sketch:

• The lines of magnetic force around the bar magnet. (1)

• The lines of magnetic force produced by the induced current in the coil. (1)

• The direction of the induced current in the coil and external circuit. (2)

Be sure to label clearly your additions to the diagram.



End of Section One
Go on to Section Two