Neap:

Trial Examination 2019

VCE Physics Unit 3

Written Examination

Question and Answer Booklet

Reading time: 15 minutes
Writing time: 1 hour 30 minutes

Student's Name: ______________________________

Teacher's Name: ______________________________

Structure of booklet

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*
A	10	10	10
B	13	13	80
			Total 90

Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers, pre-written notes (one folded A3 sheet or two A4 sheets bound together by tape) and one scientific calculator.

Students are NOT permitted to bring into the examination room: blank sheets of paper and/or correction fluid/tape.

Materials supplied

Question and answer booklet of 26 pages

Formula sheet

Answer sheet for multiple-choice questions

Instructions

Please ensure that you write your **name** and your **teacher's name** in the space provided on this booklet and on the answer sheet for multiple-choice questions.

Unless otherwise indicated, the diagrams in this booklet are **not** drawn to scale.

All written responses must be in English.

At the end of the examination

Place the answer sheet for multiple-choice questions inside the front cover of this booklet.

You may keep the formula sheet.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices into the examination room.

Students are advised that this is a trial examination only and cannot in any way guarantee the content or the format of the 2019 VCE Physics Units 3&4 Written Examination.

SECTION A – MULTIPLE-CHOICE QUESTIONS

Instructions for Section A

Answer **all** questions in pencil on the answer sheet provided for multiple-choice questions.

Choose the response that is **correct** or that **best answers** the question.

A correct answer scores 1; an incorrect answer scores 0.

Marks will **not** be deducted for incorrect answers.

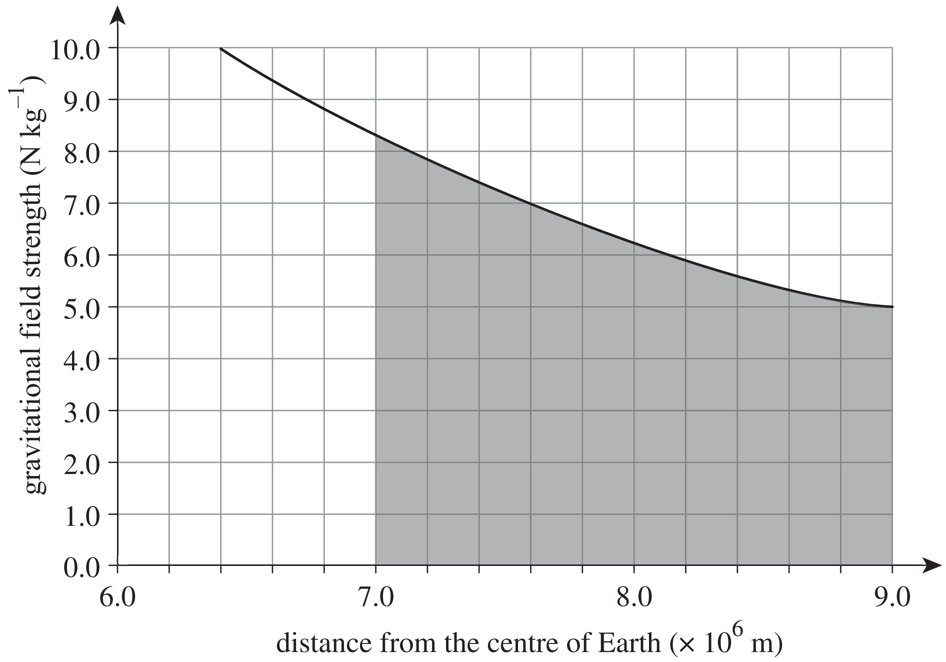
No marks will be given if more than one answer is completed for any question.

Unless otherwise indicated, the diagrams in this booklet are **not** drawn to scale.

Take the value of g to be 9.8 m s^{-2}.

Question 1

A decommissioned satellite is travelling in an elliptical orbit around Earth. At its closest point it is 7000 km from the centre of Earth and at its furthest point it is 9000 km from the centre of Earth.



Using the graph shown above, what is the estimated change in gravitational potential energy of the satellite as it moves from its closest point from the centre of Earth to its furthest point from the centre of Earth?

A. 1.4×10^{1} J

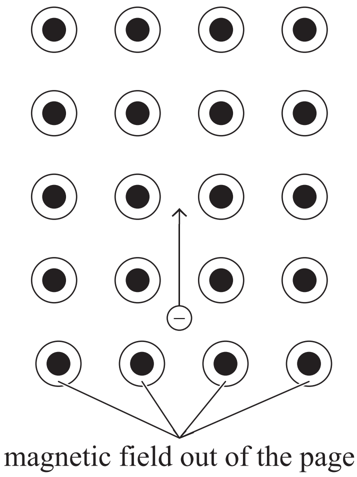
B. 1.4×10^{7} J

C. 2.8×10^{7} J

D. 2.8×10^{10} J

Question 2

A negatively charged particle is moving with velocity *v* in a magnetic field that is diverted out of the page, as shown in the diagram below.



At this moment, what is the direction of the force on the negatively charged particle?

A. to the right

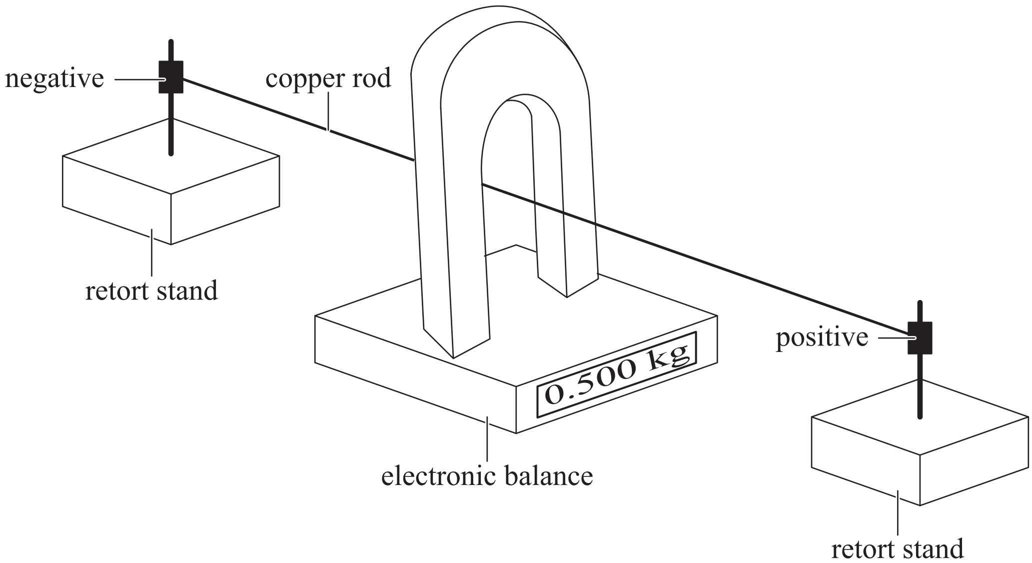
B. to the left

C. into the page

D. out of the page

Question 3

A student rests a horseshoe magnet on an electronic balance. A copper rod, which is fixed to two retort stands, runs horizontally through the magnet perpendicular to the magnetic field of the magnet. When the switch is open the reading on the electronic balance is 0.500 kg, as shown in the diagram below.



The student wishes to predict the reading on the electronic balance when the switch is closed.

Which expression can be used to calculate the reading on the balance when a current flows?

A. $0.500 - BIl$

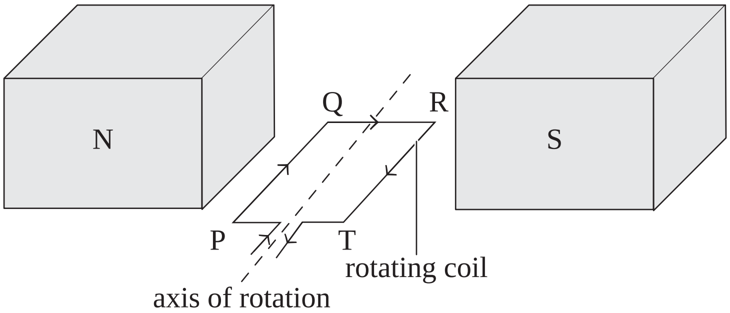
B. $0.500 + BIl$

C. $0.500 - \frac{BIl}{g}$

D. $0.500 + \frac{BIl}{g}$

Question 4

A square coil, PQRT, is rotated 90° in the field of a uniform permanent magnet of field strength, as shown in the diagram below. The coil is connected directly to a DC motor. There is no commutator. The arrows show the direction of the current.



Which one of the following best describes the force acting on side PQ during the rotation of the loop to a vertical position?

A. The force decreases in magnitude.

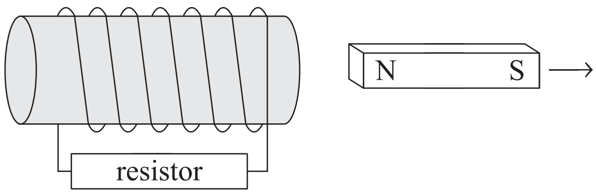
B. The force increases in magnitude.

C. The force maintains the same magnitude.

D. There is zero force on side PQ at all times through the rotation.

Question 5

Charlie is studying electromagnetic induction. He has a small bar magnet and a coil of wire wound around an iron core, as shown in the diagram below.



Charlie moves the magnet away from the coil at constant speed in the direction shown.

What is the direction of the induced current that flows in the resistor, and which law is used to verify this direction?

A. right; Faraday’s

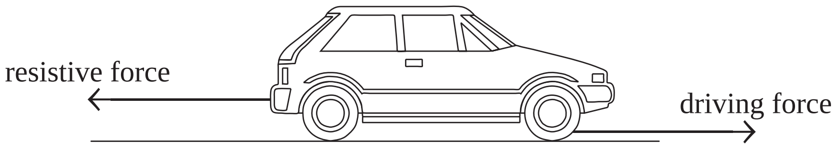
B. right; Lenz’s

C. left; Faraday’s

D. left; Lenz’s

Question 6

A car of mass 1200 kg has a resistive force of 1.5 kN acting horizontally. It has a forward horizontal acceleration of 2.0 m s^{-2}.

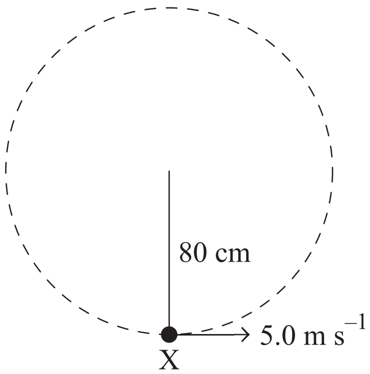


What is the horizontal driving force acting on the car?

A. 0.9 kN
B. 1.5 kN
C. 2.4 kN
D. 3.9 kN

Question 7

A mass of 1.0 kg is being swung by a light string in a vertical circle of radius 80.0 cm at a constant speed of 5.0 m s^{-1}, as shown in the diagram below.

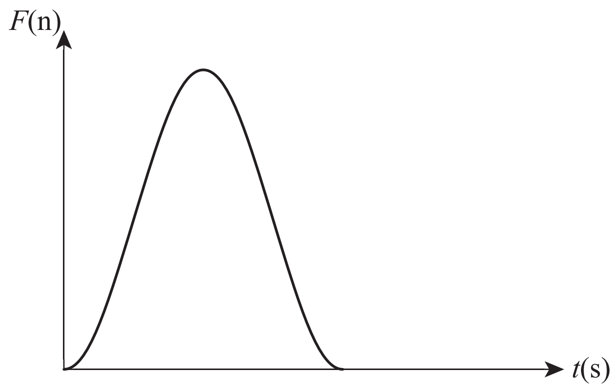


What is the magnitude of the tension in the string at point X?

A. 10.1 N
B. 21.5 N
C. 31.3 N
D. 41.1 N

Question 8

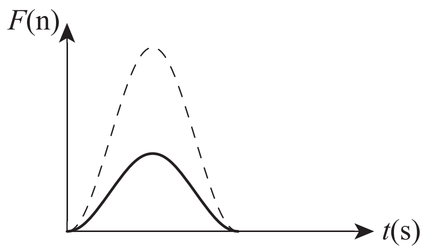
The graph below shows force versus time for a squash ball when it is hit by a racquet.



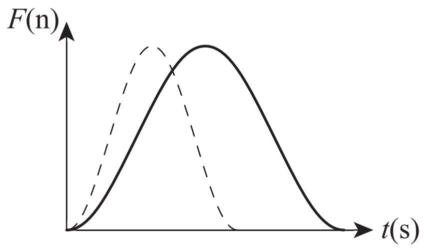
A similar but softer ball of the same mass is hit by the racquet. This collision produces the same change in momentum as that of the squash ball.

Which one of the following force versus time graphs would represent the softer ball? The dotted line shows the original curve.

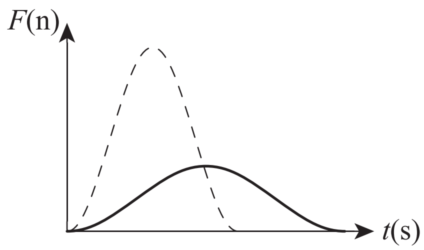
A.



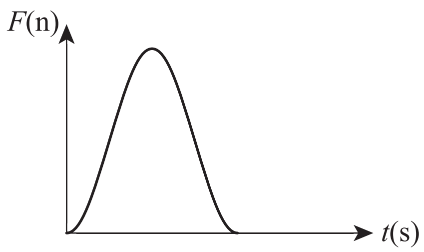
B.



C.



D.



Question 9

Harper is standing by the side of the road ($v = 0.0$ m s^{-1} relative to the kerb) while Kate skates past Harper at a constant velocity of 5.0 m s^{-1}.

Which one of the following statements about Harper and Kate is correct?

A. Harper must be in a non-inertial reference frame because she is moving relative to Kate.

B. Kate must be in a non-inertial reference frame because she is stationary at the moment.

C. Harper is stationary in her reference frame even though she is moving in Kate's reference frame.

D. Kate is not stationary in her reference frame because she is moving in Harper's reference frame.

Question 10

A nucleus in an excited energy state emits a gamma ray of energy 1.2 MeV as it decays to its ground state. The initial mass of the excited nucleus is *M*.

The final mass of the nucleus after decay is

A. $(M - 1.3 \times 10^{-11})$ kg

B. $(M + 2.1 \times 10^{-30})$ kg

C. M kg

D. $(M - 2.1 \times 10^{-30})$ kg

END OF SECTION A

SECTION B

Instructions for Section B

Answer **all** questions in the spaces provided. Write using blue or black pen.

Where an answer box is provided, write your final answer in the box.

If an answer box has a unit printed in it, give your answer in that unit.

In questions where more than one mark is available, appropriate working **must** be shown.

Unless otherwise indicated, the diagrams in this booklet are **not** drawn to scale.

Take the value of g to be 9.8 m s^{-2}.

Question 1 (3 marks)

A boat accelerates from rest across the water in the middle of Port Phillip Bay, as shown in Figure 1. The engine provides a constant force. After travelling 1.0 km, the boat is travelling at a constant speed. The mass of the boat is 5.0×10^3 kg.

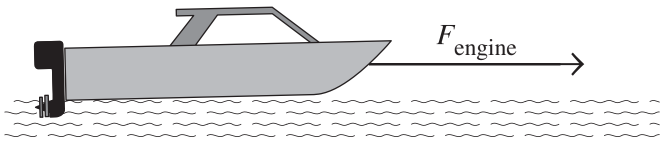


Figure 1

The graph in Figure 2 shows the opposing force acting on the boat versus distance.

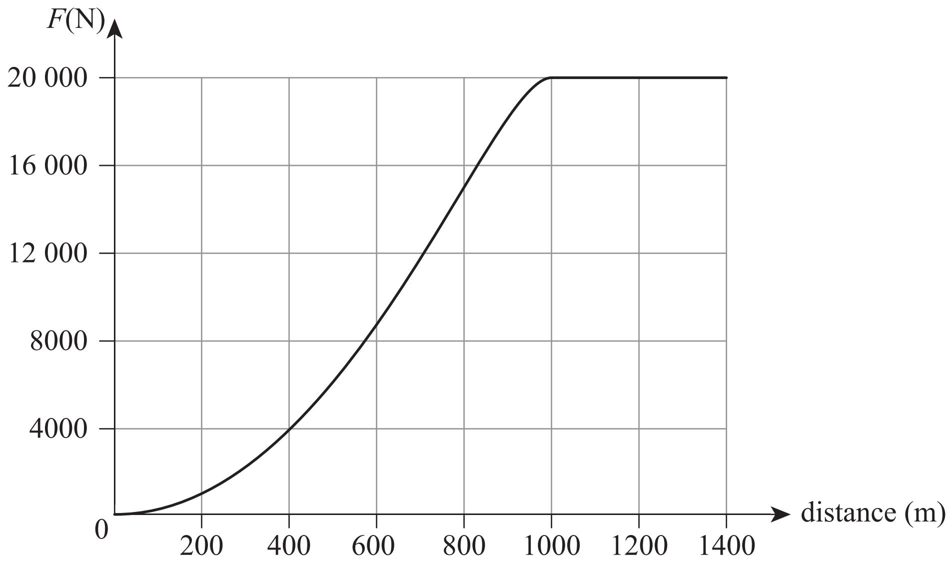


Figure 2

a. What is the driving force of the boat? 1 mark

N

b. What is the acceleration of the boat after it has travelled a distance of 800 m? 2 marks

$\boxed{\qquad\qquad \text{m s}^{-2}}$

Question 2 (8 marks)

A skier skis up a ramp as shown in Figure 3. The centre of mass of the skier and skis is 10.0 m above the ground when she projects into the air. The skier has an initial speed of 20.0 m s^{-1} at the end of the ramp, and at the top of her flight she has a speed of 17.3 m s^{-1}.

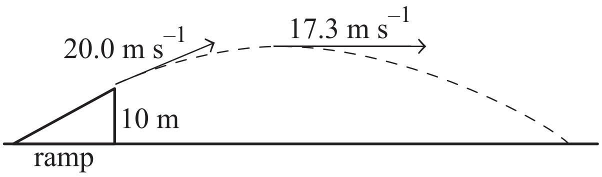


Figure 3

Assume that air resistance is negligible.

a. Calculate the height above the ground of the centre of mass of the skier at the highest point of her motion. 4 marks

m

b. What is the magnitude of the velocity as the skier hits the ground? 4 marks

m s^{-1}

Question 3 (4 marks)

A spaceship passes an observer with a velocity of 80% of the speed of light. The observer measures the length of the spaceship as 6.0 m

What velocity, as a percentage of the speed of light, would the spaceship be moving at relative to the observer if its measured length was instead 2.9 m as measured by the observer?

%

Question 4 (7 marks)

An experiment is conducted using a mass attached to a spring that has a spring constant of 10.0 N m^{-1}. The spring has an unstretched length of 50.0 cm. A 100 g mass is attached and held at the unstretched length. The mass is then released from its unstretched length and is allowed to oscillate freely, as shown in Figure 4.

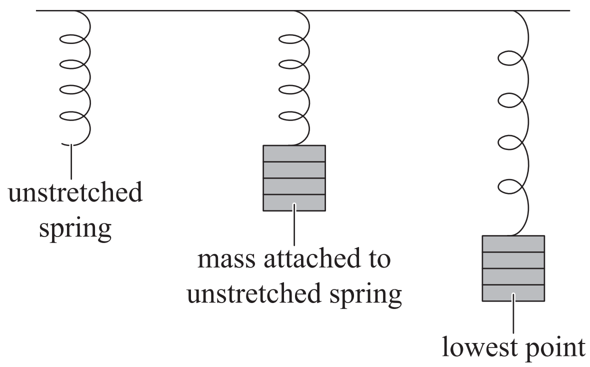


Figure 4

a. Find the extension of the spring at the **lowest point** of its oscillation, ignoring the effects of friction. Give your answer to three significant figures. 3 marks

cm

b. In the table below, describe the quantities listed at the **lowest point** in the mass' oscillation as measured from the unstretched length. Use only terms from the following list:

zero; maximum; minimum; unchanged; up; down; N/A

Note: Not all of the terms may be needed to complete the table. 4 marks

Quantity	Description	Direction
velocity		
net force		
kinetic energy		
elastic potential energy		
gravitational potential energy		

Question 5 (7 marks)

A ruckman of mass 100 kg runs to the left on a football field at 5.0 m s^{-1}. They collide with a midfielder of mass 90 kg who is travelling to the right at 4.0 m s^{-1}, as shown in Figure 5. After the collision they move off together before falling to the ground.

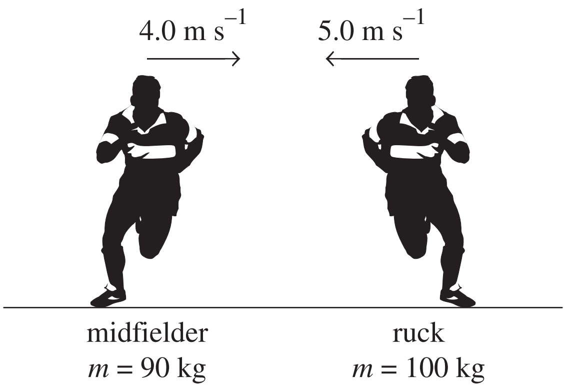


Figure 5

a. What is the magnitude of the velocity of the football players immediately after the collision? Assume that no external forces acted on the players during the collision. 2 marks

m s^{-1}

b. Calculate the magnitude of the change in momentum of the ruckman. 2 marks

kg m s^{-1}

c. Is this collision an elastic or inelastic collision? Use calculations to support your answer. 3 marks

Question 6 (7 marks)

A uniform electric field is produced between two vertical metal plates X and Y, as shown in Figure 6. The potential difference between the plates is 500 V and the separation of the plates is 10 mm.

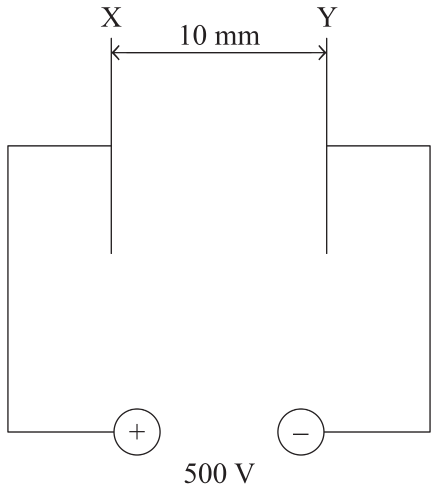


Figure 6

a. Explain what it meant by 'electric field'. 1 mark

____

____

b. Draw lines on Figure 6 to represent the electric field between the plates. 2 marks

c. Calculate the electric field strength between the plates. 2 marks

____

____

____

____

V m^{-1}

An electron is accelerated from plate Y to plate X.

d. Calculate the work done by the electric field on the electron as it moves from Y to X. 2 marks

____

____

____

____

J

Question 7 (4 marks)

Point A (+10.00 μC) and point B (+15.00 μC) are situated 1.00 m apart in a vacuum, as shown in Figure 7.

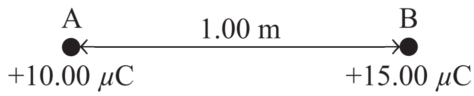


Figure 7

At what distance from point A is the electric field strength zero?

M

Question 8 (6 marks)

In an electron gun, electrons are accelerated from rest over a distance of 15 cm to reach a final speed of 3.0×10^7 m s^{-1}.

a. What is the accelerating voltage of the electron gun? Ignore any relativistic effects. 2 marks

kV

An electron then leaves the electron gun and enters a uniform magnetic field. It moves in a circular path of radius 10 cm, as shown in Figure 8.

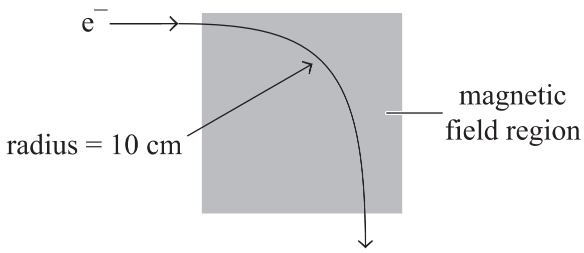


Figure 8

b. Which one of the following best describes the direction of the magnetic field? Explain how you determined this direction. 2 marks

A. up the page
B. down the page
C. into the page
D. out of the page
E. to the left of the page
F. to the right of the page

c. Calculate the force acting on the electron while in this magnetic field. 2 marks

N

Question 9 (7 marks)

A satellite is in a stable orbit at an altitude of 400 km above the surface of Earth. The total mass of the satellite is 50 tonnes.

Note: $G = 6.67 \times 10^{-11}$ N m^2 kg^{-2}, $M_{\text{Earth}} = 6.0 \times 10^{24}$ kg and $r_{\text{Earth}} = 6.4 \times 10^6$ m.

a. Calculate the period of the satellite's orbit in seconds. 3 marks

s

b. Calculate the speed of the satellite in orbit. 2 marks

m s^{-1}

c. If the mass of the satellite was increased to 100 tonnes and it was still in the same stable orbit, would this affect the speed? Explain your answer. 2 marks

Question 10 (8 marks)

Two Physics students build a simple DC motor, as shown in Figure 9. A single square coil, TUVW, with sides of 10.0 cm is rotated in the field of a uniform permanent magnet of field strength 20 mT. The motor is connected to a 12.0 V battery and the resistance of the coil is 6 Ω.

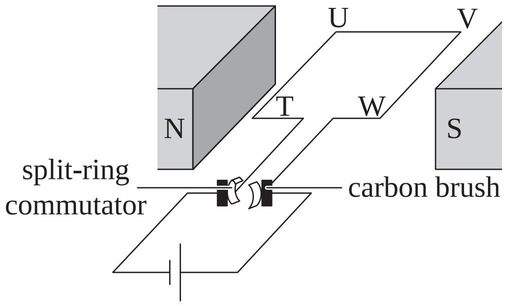


Figure 9

a. At what position(s) (A–C) of the rotating coil is the magnetic force on the side UV zero? Explain your answer. 2 marks

A. at all orientations of the coil

B. when the coil is in the horizontal position

C. when the coil is in the vertical position

b. Calculate the force acting on side TU when the coil is in the position shown in Figure 9. 4 marks

N

c. The students want to increase the speed of rotation of the motor.

State **two** ways the students could achieve this. 2 marks

Question 11 (4 marks)

A square coil is placed in a region of magnetic field such that the field passes through it. The strength of the field is gradually increased until it is doubled. As the field is increased, a current flows as shown in Figure 10.

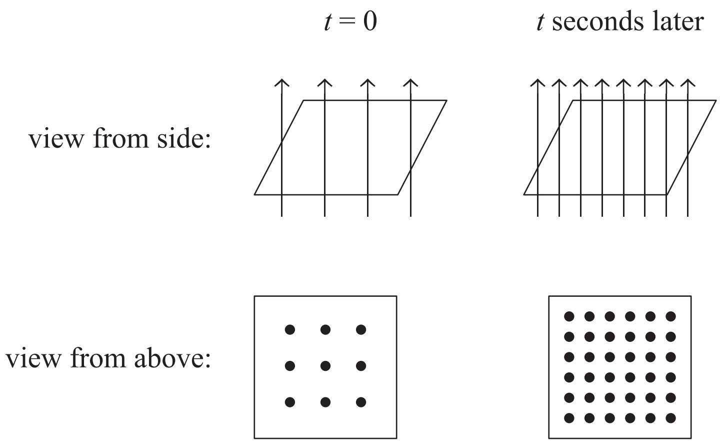


Figure 10

Does the current flow in a clockwise or anticlockwise direction, as viewed from above? Explain how you determined this in terms of Lenz's law.

Question 12 (8 marks)

Mickey and Millie are investigating the operation of an alternator. They have connected a coil ABCD so that it can rotate clockwise in a uniform magnetic field of 0.2 T. The area of the coil is 0.020 m^2 and it has 50 turns, as shown in Figure 11.

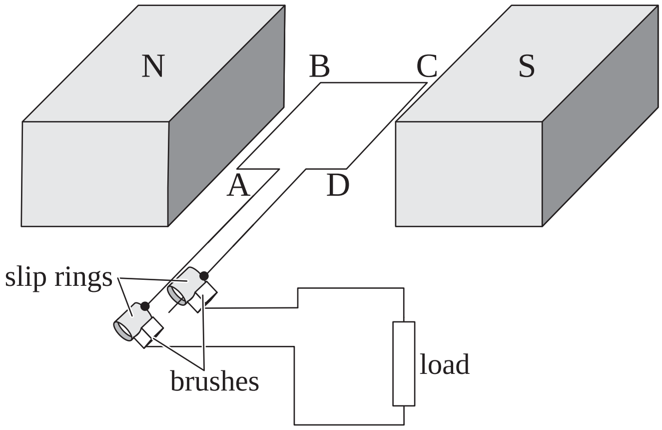


Figure 11

a. Explain the purpose of the slip rings in this circuit. 3 marks

b. The coil is now rotated at a constant rate of 50 Hz in a clockwise direction.

What is the average voltage developed across the load when the coil rotates from the position shown in Figure 11 through a quarter rotation? 3 marks

V

c. Sketch a graph of the variation of current through the coil as a function of time as it rotates through two revolutions. Take $t = 0$ to be the horizontal starting position of the coil as shown in Figure 11. 2 marks

Question 13 (7 marks)

A power station generates 300 MW of electric power, as shown in Figure 12. A transformer is located near the electric generating plant to step up the electricity voltage from 30 kV to 600 kV. After transformer T_1, electricity passes through transmission lines that carry power over long distances to step-down transformers. The total resistance of the transmission lines is 5.0 Ω.

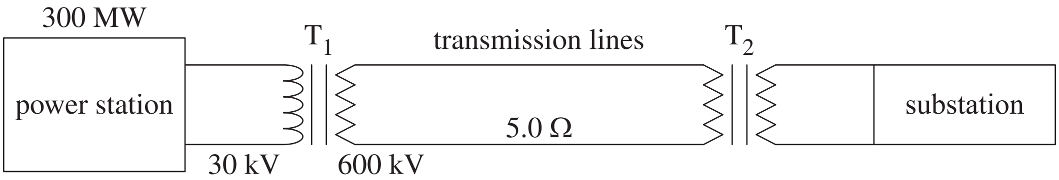


Figure 12

a. Calculate the current in the secondary windings of T_1. 2 marks

A

b. Calculate the value of the ratio $\dfrac{\text{number of turns in the secondary windings}}{\text{number of turns in the primary windings}}$ of T_1. 2 marks

c. Calculate the voltage of the secondary windings of T_1. 3 marks

kV

END OF QUESTION AND ANSWER BOOKLET