SA-STUDENT

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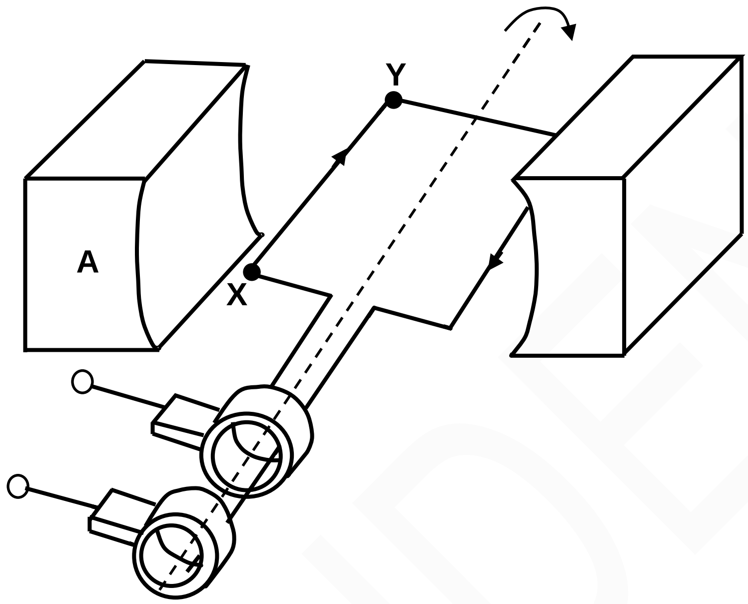
QUESTION 9 (Start on a new page.)

9.1 The simplified sketch below represents an AC generator with the coil initially horizontal between the poles of a magnet. **X** and **Y** are two points on the coil, while **A** is one of the poles of the magnet.



When the coil of the generator rotates clockwise between the two poles of the magnet, the direction of the induced current is from **X** to **Y**, as shown above.

9.1.1 Is **A** the NORTH POLE or the SOUTH POLE of the magnet? (1)

9.1.2 The coil is now rotated through 180°.

Will the direction of the current be from **X** to **Y** or from **Y** to **X**? (1)

9.1.3 Sketch an emf-time graph for TWO complete rotations of the coil, starting from the position of the coil as shown in the diagram above. (3)

9.2 An electrical device is connected to an AC generator. The rms potential difference across the device is 200 V and the maximum current passing through the device is 6 A.

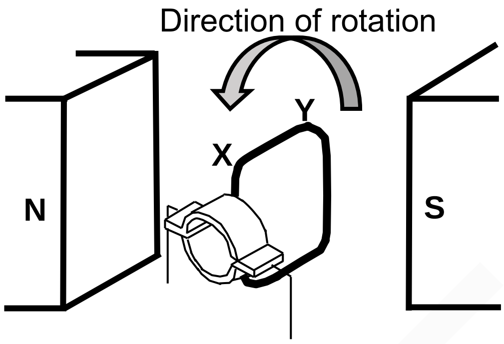
Calculate the:

9.2.1 Resistance of the device (4)

9.2.2 Energy consumed by the device in two hours (4)
[13]

QUESTION 9 (Start on a new page.)

9.1 The diagram below shows the initial position of the coil in a simple DC generator. The coil is rotated in an anticlockwise direction, as shown.



9.1.1 Name the component in this generator that ensures that the induced current in the external circuit is in one direction only. (1)

9.1.2 Is the direction of the induced current from **X to Y** or from **Y to X**? (1)

A maximum voltage of 90 V is generated when the coil is rotating at a frequency of 20 Hz.

9.1.3 Write down the time taken for the coil to complete ONE rotation. (1)

9.1.4 The coil starts rotating from the initial position, as shown in the diagram above.

Sketch a graph of output voltage versus time for one complete rotation of the coil. Indicate the maximum voltage and the relevant time values on the graph. (4)

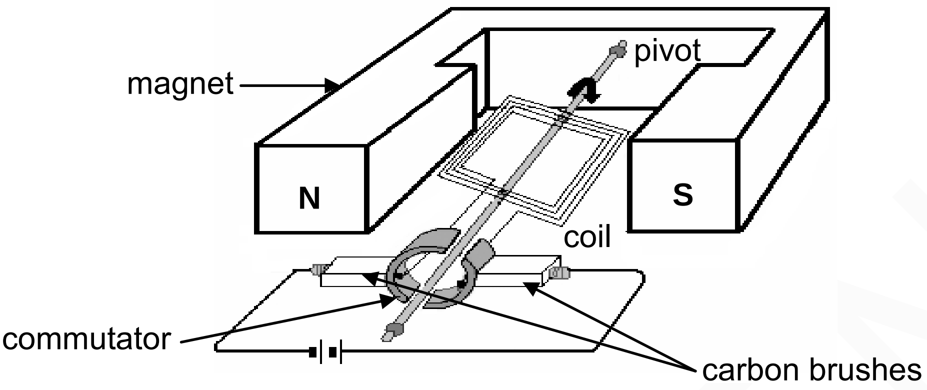
9.2 Wall sockets supply rms voltage and current.

A 220 V AC voltage is supplied from a wall socket to an electric kettle having a resistance of 32 Ω.

Calculate the average energy dissipated by the kettle in TWO minutes. (4)
[11]

QUESTION 9 (Start on a new page.)

9.1 The simplified sketch of an electric motor is shown below.

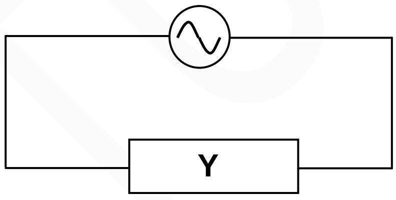


9.1.1 Write down the energy conversion that takes place in this motor. (1)

9.1.2 Is the motor above an AC motor or a DC motor? (1)

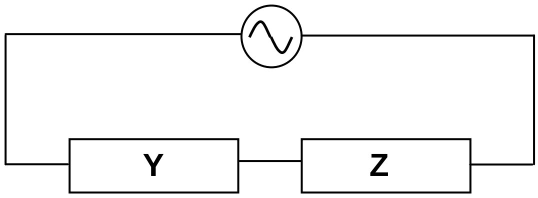
9.1.3 What is the function of the commutator in this motor? (1)

9.2 A resistor **Y** is rated 220 V, 100 W and is connected to a 220 V AC source, as shown in the circuit below.



9.2.1 Calculate the resistance of resistor **Y**. (3)

Another resistor **Z** with a rating 220 V, *X* W, is now connected in series to resistor **Y** and to the same AC source. See the diagram below.

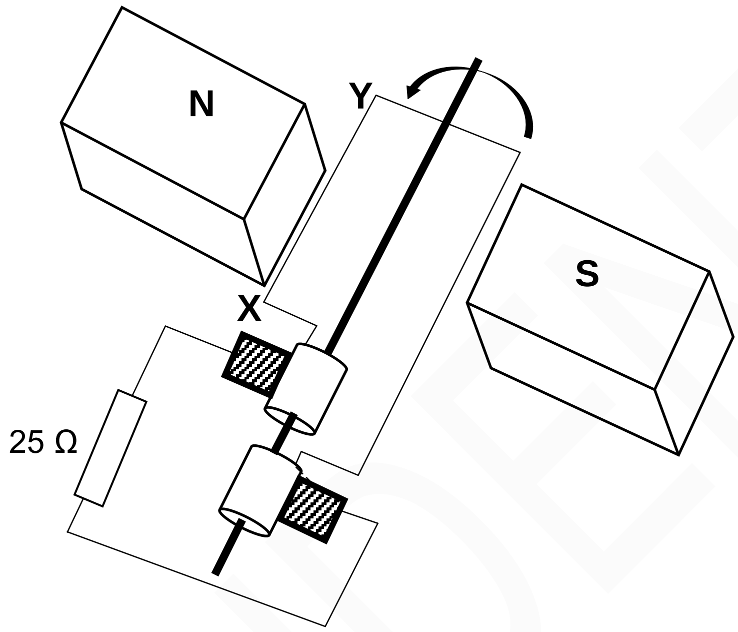


The power dissipated by resistor **Y** changes to 80 W, while its resistance remains constant.

9.2.2 Calculate the power rating *X* of resistor **Z**, assuming that resistor **Z** has constant resistance. (6)
[12]

QUESTION 9 (Start on a new page.)

A simplified diagram of an AC generator connected to a 25 Ω resistor is shown below. The coil rotates anticlockwise.

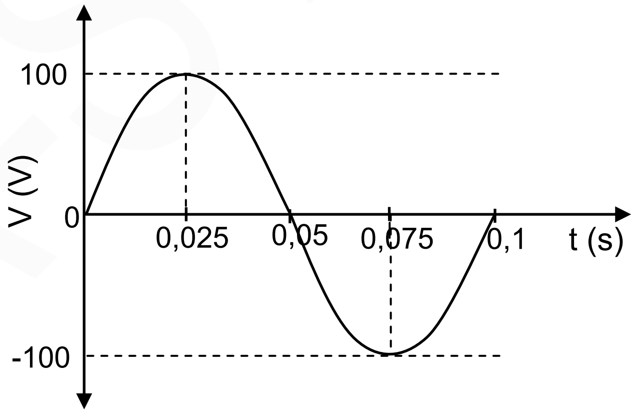


9.1 Name the component that distinguishes this generator from a DC generator. (1)

9.2 In which direction will the induced current flow in section **XY** of the coil?

Choose from **X to Y** OR **Y to X**. (2)

The graph below shows the output voltage of the generator for one cycle of rotation of the coil.



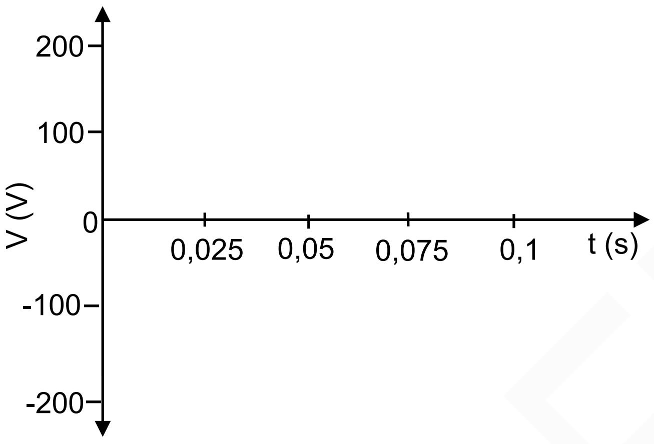
9.3 Define the term *rms potential difference*. (2)

9.4 Calculate the rms current in the circuit. (4)

9.5 Calculate the average power dissipated in the 25 Ω resistor. (3)

The speed of rotation of the coil in the generator is now DOUBLED.

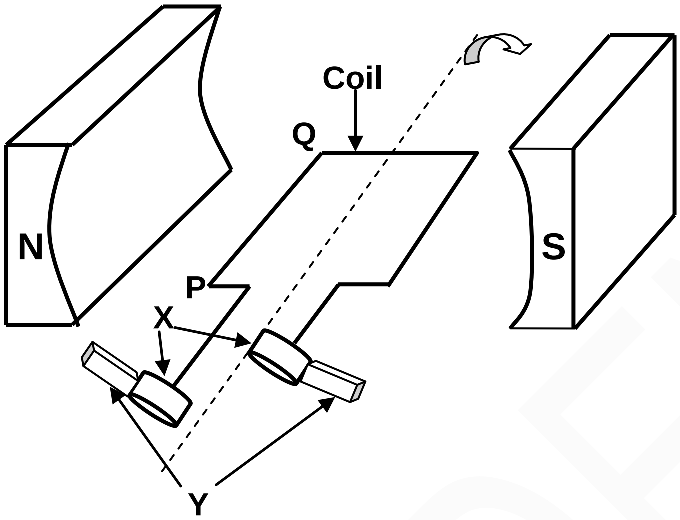
9.6 Copy the set of axes below in your ANSWER BOOK and sketch the graph of output voltage versus time for 0,1 s.



(3)
[15]

QUESTION 9 (Start on a new page.)

The diagram below is a simplified representation of an AC generator. The coil is rotated in a clockwise direction in the magnetic field.



9.1 Write down the name of component **X**. (1)

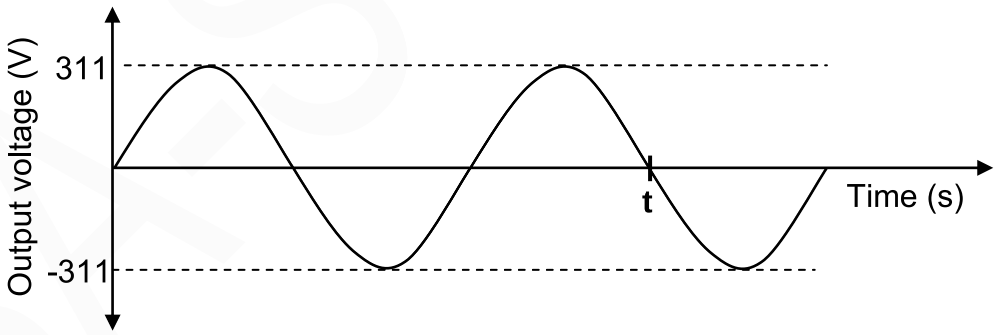
9.2 Write down the function of component **Y**. (1)

9.3 Use the relevant principle to explain why an emf is induced in the coil when the coil is rotated in the magnetic field. (2)

9.4 The coil rotates CLOCKWISE from the position shown in the diagram. In which direction will current be induced in segment **PQ** of the coil?

Choose from '**P to Q**' or '**Q to P**'. (2)

The output voltage versus time graph below was obtained for the above generator.



The output voltage is generated at a frequency of 50 Hz.

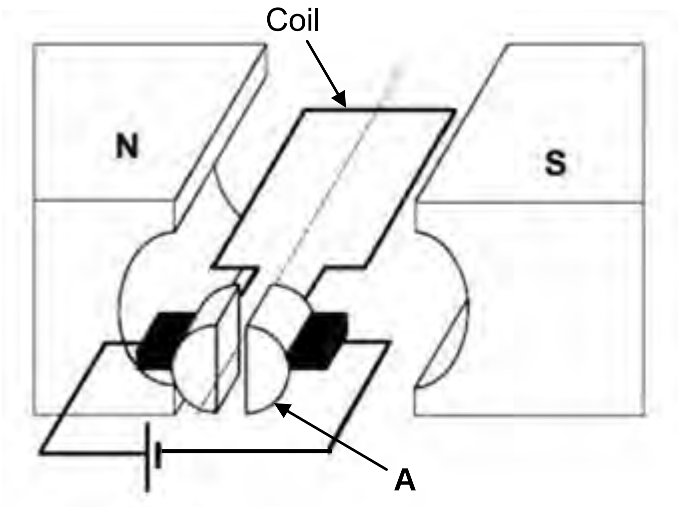
9.5 Calculate the time **t** indicated in the above graph. (3)

9.6 The generator is now connected to an appliance with a resistance of 100 Ω. Calculate the energy dissipated when the appliance is in operation for ONE minute. (5)

[14]

QUESTION 9 (Start on a new page.)

9.1 A simplified diagram of an electrical machine is shown below.



9.1.1 Is this machine a DC motor or a DC generator? (1)

9.1.2 Write down the energy conversion that takes place while this machine is in operation. (2)

9.1.3 Write down the name of component **A** in the diagram. (1)

9.1.4 In which direction will the coil, shown in the diagram above, rotate? Choose from CLOCKWISE or ANTICLOCKWISE. (2)

9.2 An electrical device is marked 200 W ; 220 V.

9.2.1 Define the term *rms voltage*. (2)

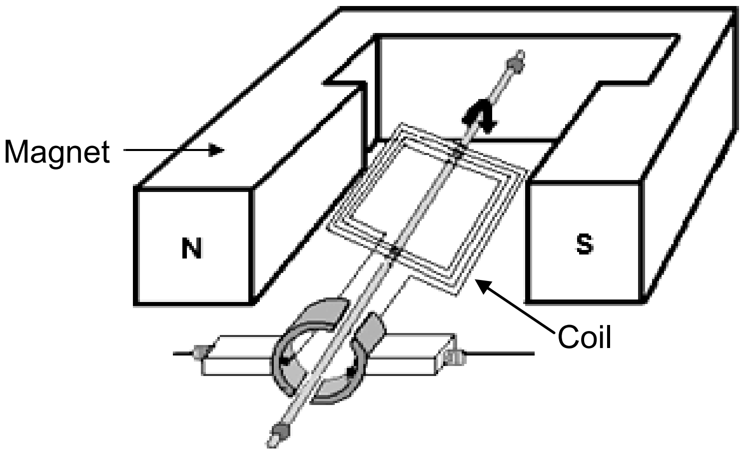
9.2.2 Calculate the resistance of the device. (3)

This device is now connected to a 150 V AC source.

9.2.3 Calculate the energy dissipated by the device in 10 minutes. (5)
[16]

QUESTION 9 (Start on a new page.)

9.1 A simplified diagram of an electric generator is shown below. When the coil is rotated with a constant speed, an emf is induced in the coil.



9.1.1 Is this an AC generator or a DC generator? (1)

9.1.2 Briefly explain how an emf is generated in the coil when the coil is rotated by referring to the principle of electromagnetic induction. (2)

9.1.3 Draw a sketch graph of the output voltage versus time for this generator. Show ONE complete cycle. (2)

9.2 A 200 Ω resistor is connected to a DC voltage supply, as shown in diagram **A**. The energy dissipated in the resistor in 10 s is 500 J.

The same resistor is now connected to an AC source (diagram **B**) and 500 J of energy is also dissipated in the resistor in 10 s.

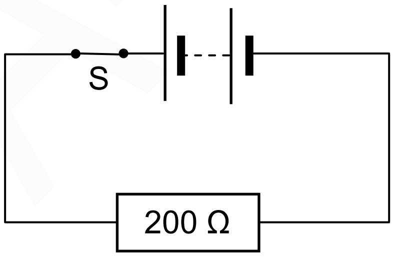


Diagram **A**

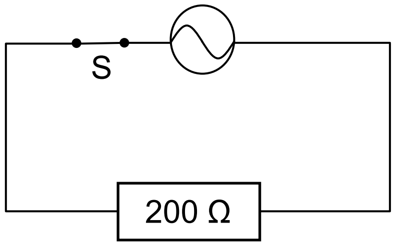


Diagram **B**

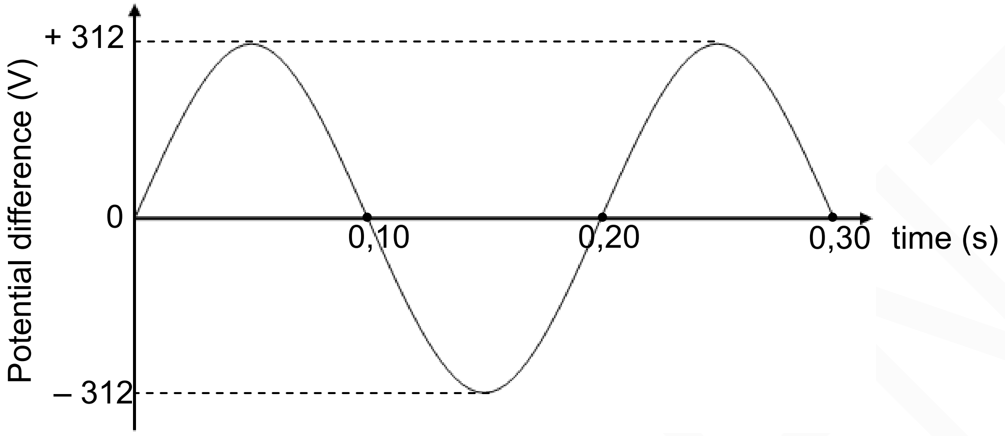
9.2.1 Define the term *rms voltage* of an AC source. (2)

9.2.2 Calculate the maximum (peak) voltage of the AC source. (5)

[12]

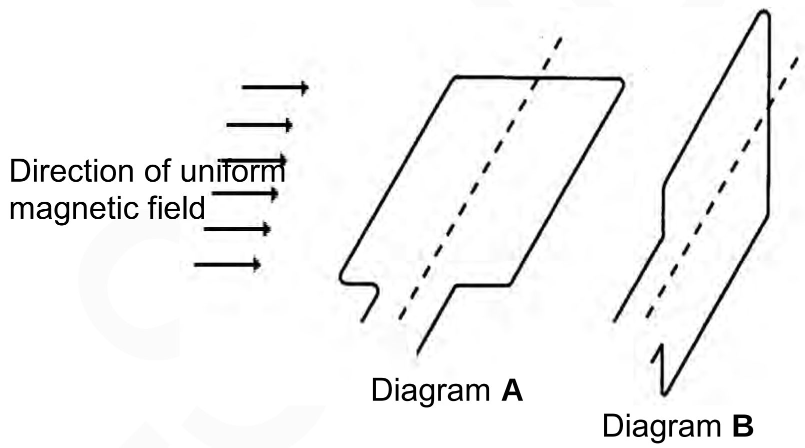
QUESTION 9 (Start on a new page.)

The diagram below shows the voltage output of a generator.



9.1 Does this generator have split rings or slip rings? (1)

9.2 Which ONE of the diagrams below, **A** or **B**, shows the position of the generator's coil at time = 0,10 s?



(1)

9.3 Calculate the root mean square (rms) voltage for this generator. (3)

9.4 A device with a resistance of 40 Ω is connected to this generator.

Calculate the:

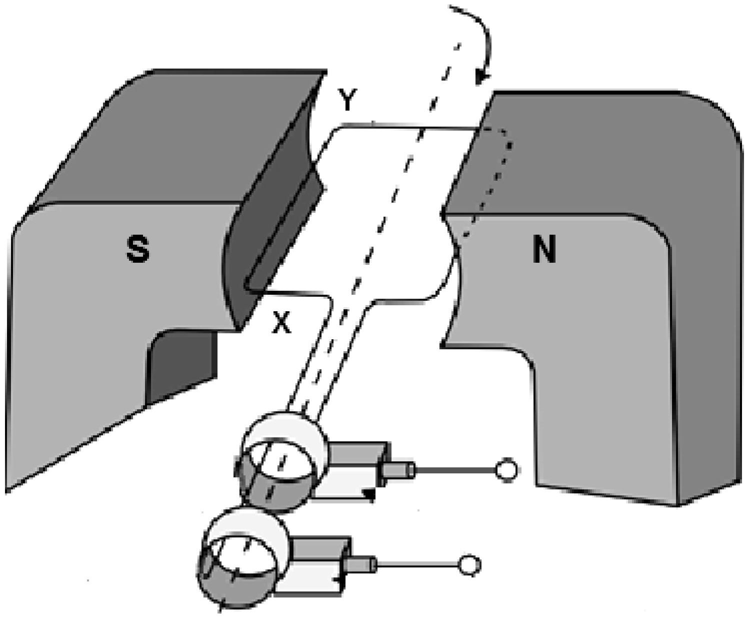
9.4.1 Average power delivered by the generator to the device (3)

9.4.2 Maximum current delivered by the generator to the device (4)

[12]

QUESTION 10 (Start on a new page.)

10.1 In the simplified AC generator below, the coil is rotated clockwise.



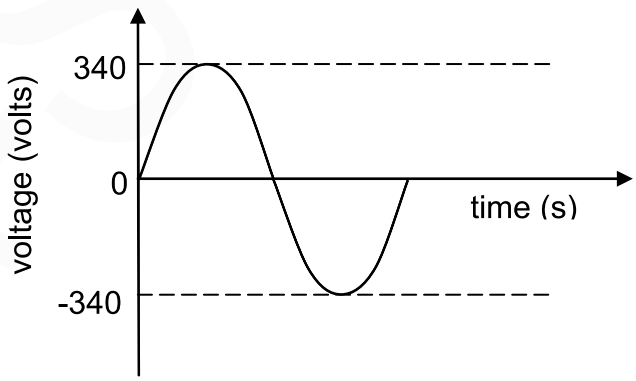
10.1.1 In which direction does the induced current flow in the coil?

Choose from: **X to Y** or **Y to X**. (1)

10.1.2 On which principle or law is the working of the generator based? (1)

10.1.3 State the energy conversion that takes place while the generator is in operation. (2)

10.2 The voltage output for an AC generator is shown below.



10.2.1 Write down the maximum (peak) output voltage of the generator. (1)

A stove is connected to the generator above, and delivers an average power of 1 600 W.

10.2.2 Calculate the rms voltage delivered to the stove. (3)

10.2.3 Calculate the resistance of the stove. (3)
[11]

The switch **S** is now open.

9.2.2 Will the ammeter reading in QUESTION 9.2.1 INCREASE, DECREASE or REMAIN THE SAME? Give a reason for the answer. (2)

9.2.3 How will the voltmeter reading now compare with the voltmeter reading when the switch is closed? Choose from INCREASE, DECREASE or REMAIN THE SAME. (1)

9.2.4 Explain the answer to QUESTION 9.2.3. (3)
[15]

QUESTION 10 (Start on a new page.)

10.1 Learners want to build a small **DC** motor as a project.

Write down THREE essential components that are needed for the building of the motor. (3)

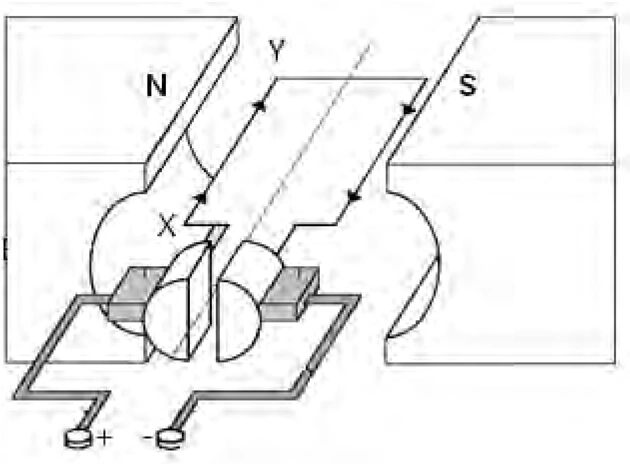
10.2 An electrical device with a resistance of 11 Ω is connected to an **AC** source with an rms voltage of 240 V.

10.2.1 Define the term *rms voltage*. (2)

10.2.2 Calculate the maximum (peak) current passing through the device. (4)
[9]

QUESTION 10 (Start on a new page.)

10.1 The diagram below is a simplified representation of a DC motor. The current in the coil is in the direction XY.



10.1.1 Name the component that ensures that the coil rotates continuously in ONE DIRECTION. (1)

10.1.2 In which direction will the coil rotate? Write down only CLOCKWISE or ANTICLOCKWISE. (2)

10.1.3 Write down the energy conversion which takes place while the motor is working. (2)

10.2 An AC generator, producing a maximum voltage of 320 V, is connected to a heater of resistance 35 Ω.

10.2.1 Write down the structural difference between an AC generator and a DC generator. (1)

Calculate the:

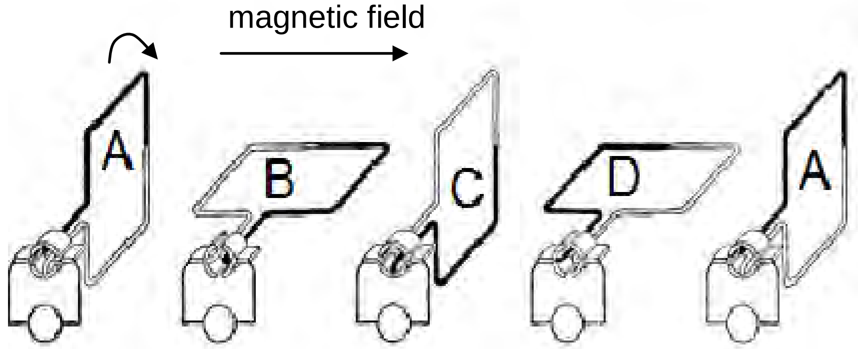
10.2.2 Root mean square (rms) value of the voltage (3)

10.2.3 Root mean square (rms) value of the current in the heater (4)
[13]

QUESTION 10 (Start on a new page.)

10.1 The diagram below shows different positions (**ABCDA**) of the coil in a **DC** generator for a complete revolution. The coil is rotated clockwise at a constant speed in a uniform magnetic field.

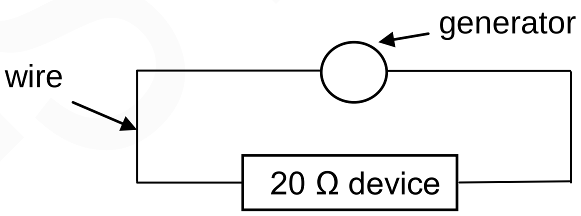
The direction of the magnetic field is shown in the diagram below.



10.1.1 Write down the energy conversion that takes place during the operation of the DC generator. (1)

10.1.2 Sketch a graph to show how the induced emf of the generator varies with time. Clearly indicate positions **A**, **B**, **C**, **D** and **A** on the graph. (2)

10.2 A small AC generator, providing an rms voltage of 25 V, is connected across a device with a resistance of 20 Ω. The wires connecting the generator to the device have a total resistance of 0,5 Ω. Refer to the diagram below.

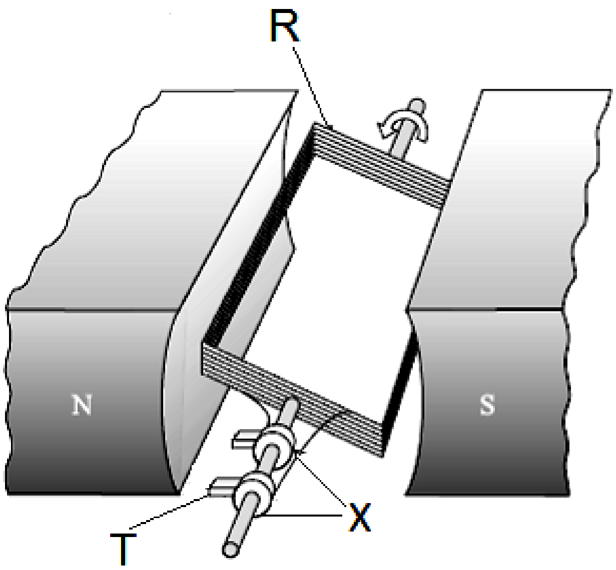


10.2.1 Write down the total resistance of the circuit. (1)

10.2.2 Calculate the average power delivered to the *device*. (5)
[9]

QUESTION 10 (Start on a new page.)

10.1 The diagram below shows a simplified version of a generator.



10.1.1 Write down the name of EACH part, **R**, **T** and **X**. (3)

10.1.2 Give the NAME of the law upon which the operation of the generator is based. (1)

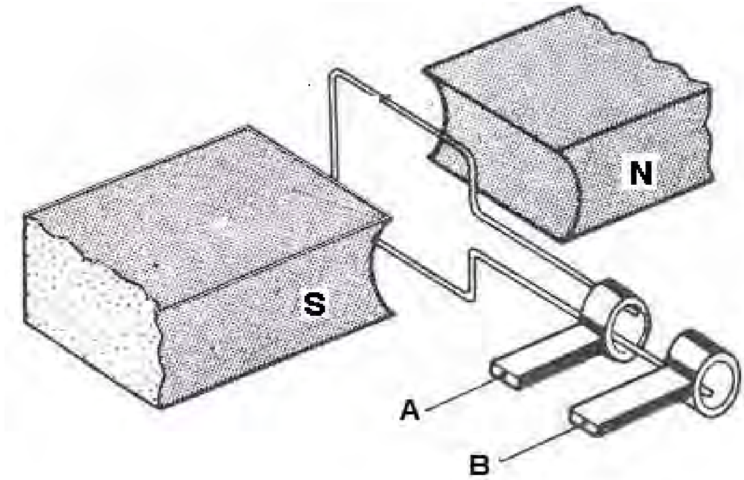
10.2 An AC supply is connected to a light bulb. The light bulb lights up with the same brightness as it does when connected to a 15 V battery.

10.2.1 Write down the rms value of the potential difference of the AC supply. (1)

10.2.2 If the resistance of the light bulb is 45 Ω, calculate the maximum current delivered to the light bulb. (4)
[9]

QUESTION 9 (Start on a new page.)

The diagram below shows a simplified version of an AC generator.



9.1 Name the component in this arrangement that makes it different from a DC generator. (1)

9.2 Sketch a graph of induced emf versus time for TWO complete rotations of the coil. (2)

A practical version of the generator above has a large number of turns of the coil and it produces an rms potential difference of 240 V.

9.3 State TWO ways in which the induced emf can be increased. (2)

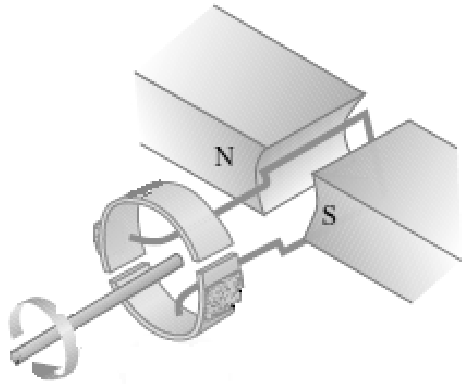
9.4 Define the term *root mean square (rms) value* of an AC potential difference. (2)

9.5 The practical version of the generator above is connected across an appliance rated at 1 500 W.

Calculate the rms current passing through the appliance. (3)
[10]

QUESTION 9 (Start on a new page.)

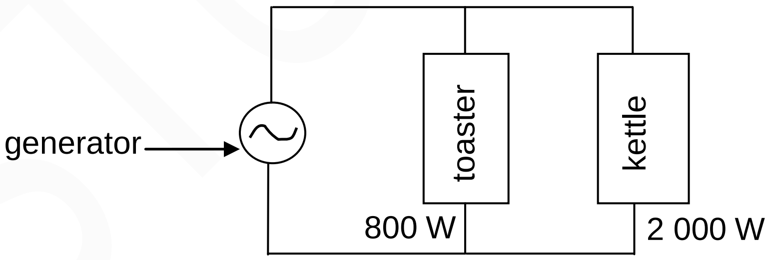
9.1 A generator is shown below. Assume that the coil is in a vertical position.



9.1.1 Is the generator above AC or DC? Give a reason for the answer. (2)

9.1.2 Sketch an induced emf versus time graph for ONE complete rotation of the coil. (The coil starts turning from the vertical position.) (2)

9.2 An AC generator is operating at a maximum emf of 340 V. It is connected across a toaster and a kettle, as shown in the diagram below.



The toaster is rated at 800 W, while the kettle is rated at 2 000 W. Both are working under optimal conditions.

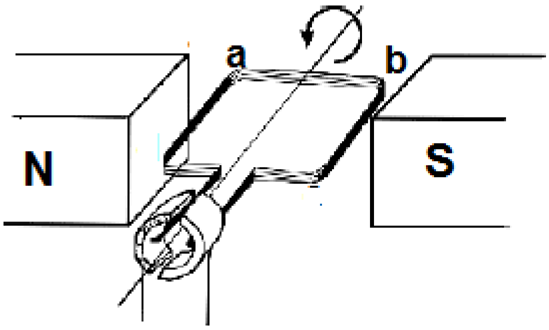
Calculate the:

9.2.1 rms current passing through the toaster (3)

9.2.2 Total rms current delivered by the generator (4)
[11]

QUESTION 10 (Start on a new page.)

10.1 A part of a simplified DC motor is shown in the sketch below.



10.1.1 In which direction (**a** to **b**, OR **b** to **a**) is the current flowing through the coil if the coil rotates anticlockwise as indicated in the diagram? (1)

10.1.2 Name the rule you used to answer QUESTION 10.1.1. (1)

10.1.3 Which component in the diagram must be replaced in order for the device to operate as an AC generator? (1)

10.2 An electrical device of resistance 400 Ω is connected across an AC generator that produces a maximum emf of 430 V. The resistance of the coils of the generator can be ignored.

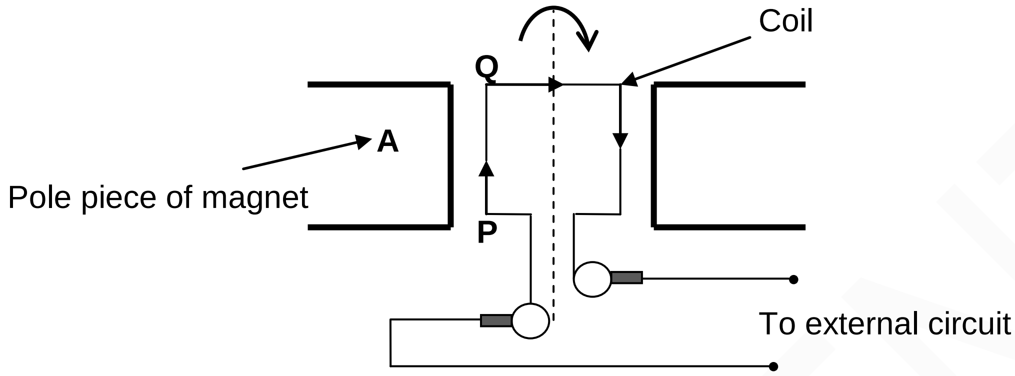
10.2.1 State the energy conversion that takes place when the AC generator is in operation. (2)

10.2.2 Calculate the root mean square value of the current passing through the resistor. (5)

[10]

QUESTION 10 (Start on a new page.)

10.1 A simplified sketch of an AC generator is shown below.



The coil of the generator rotates clockwise between the pole pieces of two magnets. At a particular instant, the current in the segment **PQ** has the direction shown above.

10.1.1 Identify the magnetic pole **A**.
Only write NORTH POLE or SOUTH POLE. (1)

10.1.2 The coil is rotated through 180^o.

Will the direction of the current in segment **PQ** be from **P** to **Q** or **Q** to **P**? (1)

10.2 An electrical device is connected to a generator which produces an rms potential difference of 220 V. The maximum current passing through the device is 8 A.

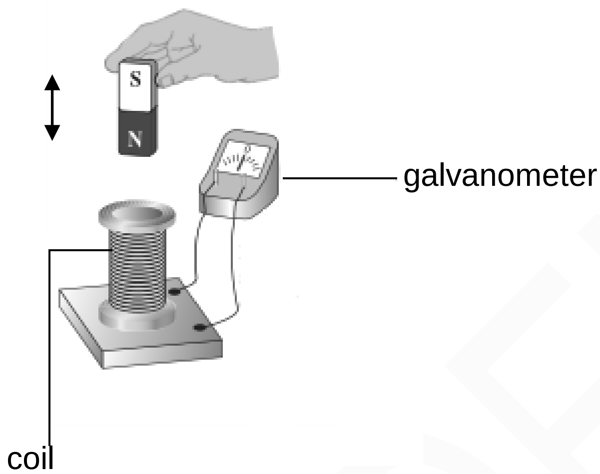
Calculate the:

10.2.1 Resistance of the device (5)

10.2.2 Energy the device consumes in two hours (5)
[12]

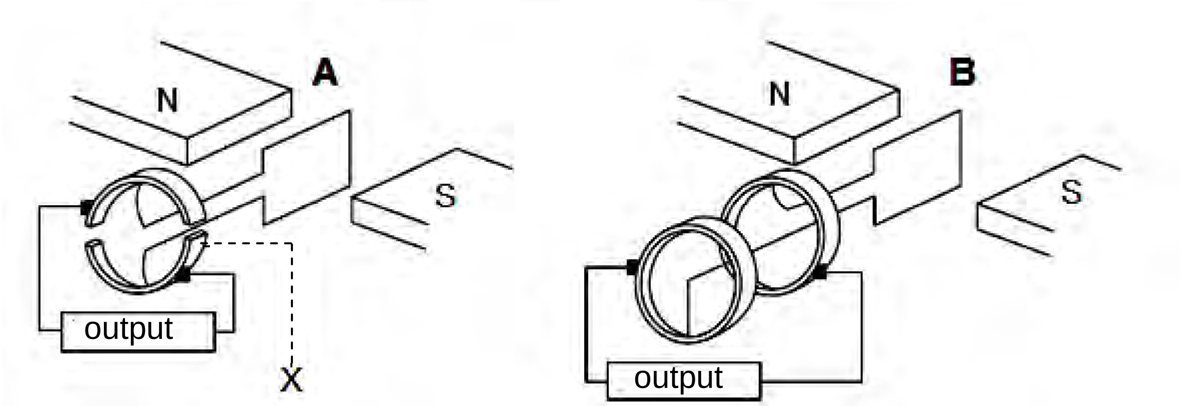
QUESTION 10 (Start on a new page.)

10.1 A teacher demonstrates how current can be obtained using a bar magnet, a coil and a galvanometer. The teacher moves the bar magnet up and down, as shown by the arrow in the diagram below.



10.1.1 Briefly describe how the magnet must be moved in order to obtain a LARGE deflection on the galvanometer. (2)

The two devices, **A** and **B**, below operate on the principle described in QUESTION 10.1.1 above.



10.1.2 Write down the name of the principle. (1)

10.1.3 Write down the name of part **X** in device **A.** (1)

10.2 A 220 V, AC voltage is supplied from a wall socket to an electric kettle of resistance 40,33 Ω. Wall sockets provide rms voltages and currents.

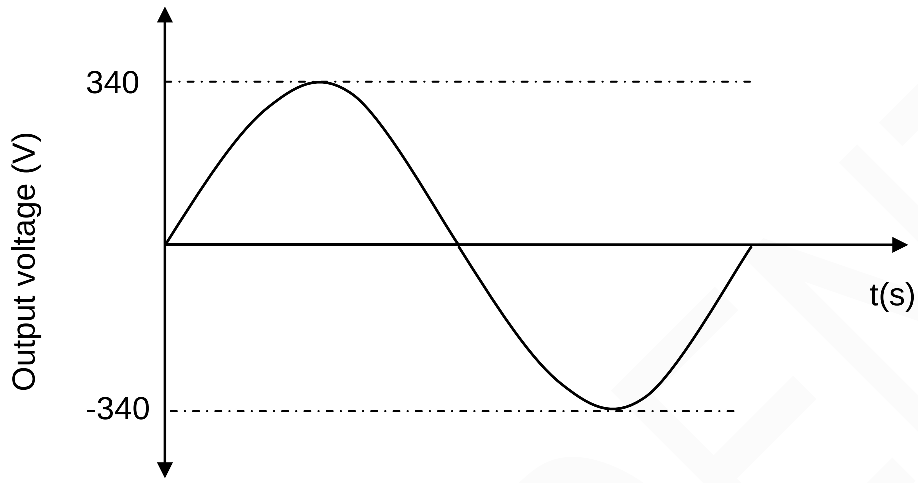
Calculate the:

10.2.1 Electrical energy consumed by the kettle per second (4)

10.2.2 Maximum (peak) current through the kettle (3)
[11]

QUESTION 9 (Start on a new page.)

The graph below shows the output voltage from a household AC generator for one cycle of rotation of the coils.



9.1 A 100 W light bulb is connected to this generator and it glows at its maximum brightness. Use the information from the graph to calculate the:

9.1.1 Resistance of the bulb (5)

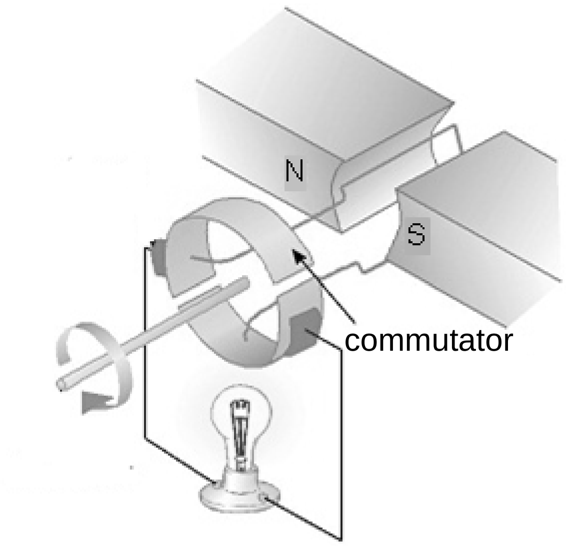
9.1.2 rms current through the bulb (3)

9.2 Give ONE reason why AC voltage is preferred to DC voltage for everyday use. (1)

[9]

QUESTION 9 (Start on a new page.)

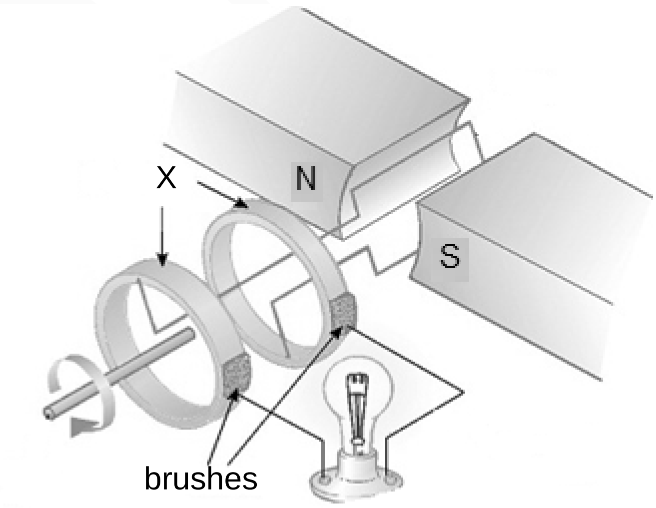
The diagram below represents a simplified version of an electrical machine used to light up a bulb.



9.1 Name the principle on which the machine operates. (1)

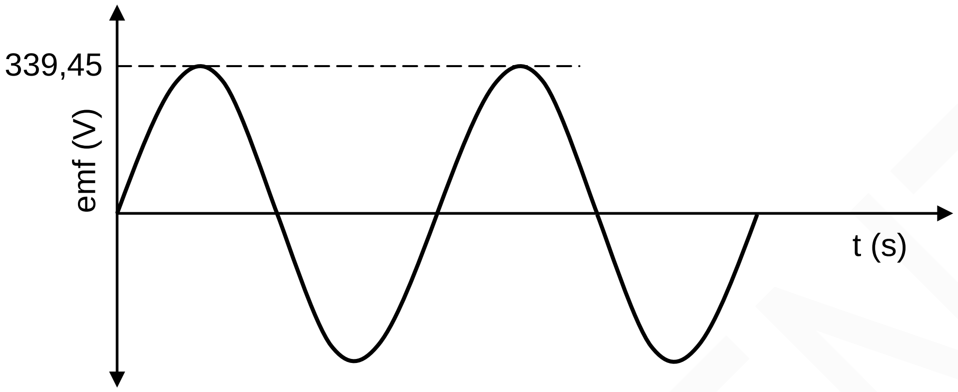
9.2 State ONE way in which to make this bulb burn brighter. (1)

Some changes have been made to the machine and a new device is obtained as shown below.



9.3 Name part **X** in the new device. (1)

9.4 The graph of output emf versus time obtained using the device in QUESTION 9.3 is shown below.

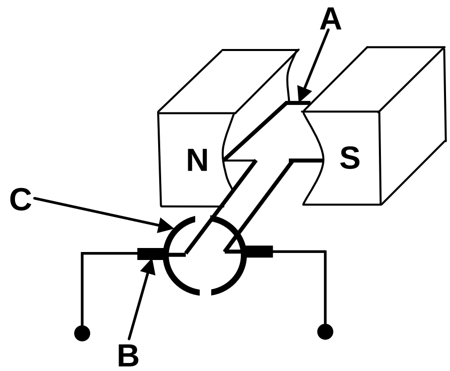


9.4.1 Define the term *root mean square value* of an AC voltage. (2)

9.4.2 Calculate the rms voltage. (3)
[8]

QUESTION 10 (Start on a new page.)

10.1 A simplified diagram of an electric motor is shown below.



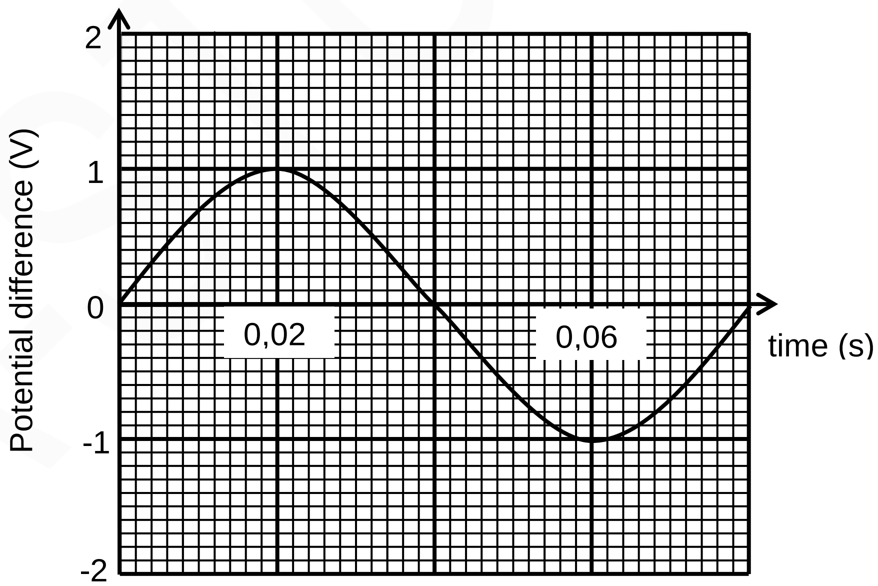
10.1.1 Name the components labelled **A**, **B** and **C**.
Write down only the name of the component next to the letter (A–C). (3)

10.1.2 Write down the function of the component labelled **B**. (1)

10.1.3 Is this motor an AC motor or a DC motor? (1)

10.1.4 Give a reason why component **A** experiences a magnetic force when a current passes through it. (2)

10.2 A coil is rotated in a magnetic field. The varying induced emf obtained is represented in the graph below.



10.2.1 Calculate the induced rms potential difference. (3)

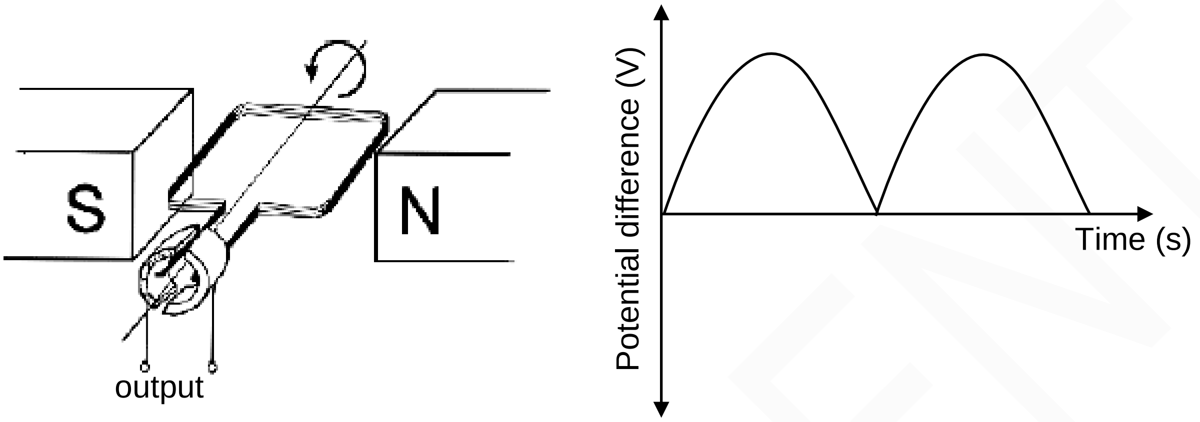
10.2.2 The coil is now rotated at TWICE the original speed.

Write down the period of the new wave. (2)

10.2.3 Calculate the average power generated if the generator produces a maximum current of 2 A. (4)
[16]

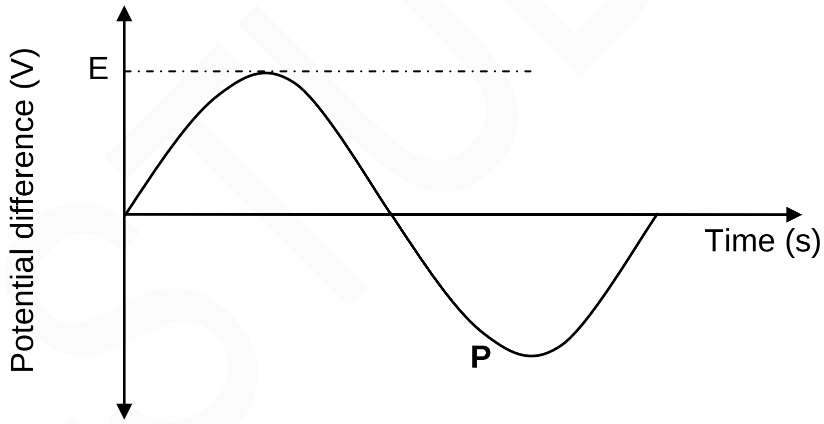
QUESTION 10 (Start on a new page.)

A simplified diagram of a DC generator and a graph of its output potential difference for one cycle is shown below.



10.1 Write down ONE way in which the output of this generator can be increased. (1)

A specific change is made to the structure of the DC generator in QUESTION 10.1. The output potential difference obtained as a result of this change is shown below.



10.2 Write down the change that was made to the DC generator. (1)

10.3 Copy graph **P** into your ANSWER BOOK.

On the same set of axes, sketch the graph of the output potential difference that will be obtained when the new generator is rotated at TWICE its original speed.

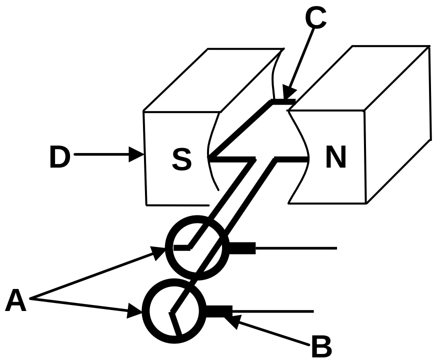
Label this graph as **Q**. (2)

10.4 A certain generator operates at a maximum voltage of 340 V. A 120 W appliance is connected to the generator. Calculate the resistance of the appliance. (4)

[8]

QUESTION 10 (Start on a new page.)

The simplified sketch represents an AC generator. The main components are labelled **A**, **B**, **C** and **D**.



10.1 Write down the name of component:

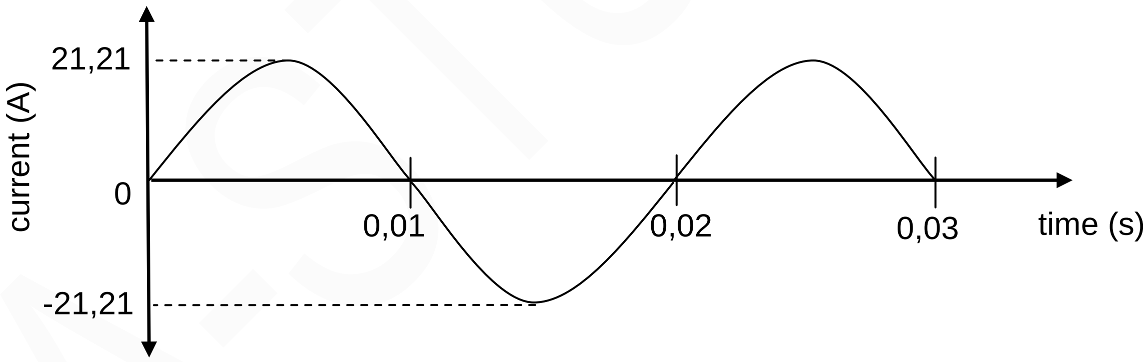
10.1.1 **A** (1)

10.1.2 **B** (1)

10.2 Write down the function of component **B**. (1)

10.3 State the energy conversion which takes place in an AC generator. (1)

A similar coil is rotated in a magnetic field. The graph below shows how the alternating current produced by the AC generator varies with time.



10.4 How many rotations are made by the coil in 0,03 seconds? (1)

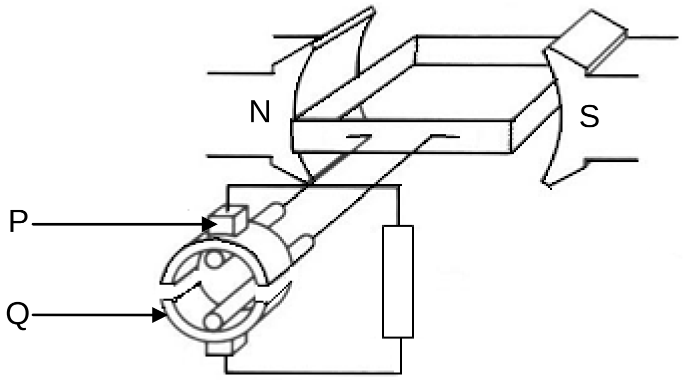
10.5 Calculate the frequency of the alternating current. (3)

10.6 Will the plane of the coil be PERPENDICULAR TO or PARALLEL TO the magnetic field at t = 0,015 s? (1)

10.7 If the generator produces a maximum potential difference of 311 V, calculate its average power output. (5)
[14]

QUESTION 10 (Start on a new page.)

AC generators and DC generators differ in their construction and the type of current they deliver. The simplified sketch below represents a DC generator.



10.1 Which component (**P** or **Q**) enables this generator to produce DC? (1)

10.2 What structural change must be made to this generator to change it to an AC generator? (1)

10.3 Briefly explain why Eskom prefers using AC instead of DC for the long-distance transmission of electricity. (2)

10.4 An AC generator delivers 240 V_{rms} to a 60 W light bulb. The peak current in the light bulb is 0,35 A.

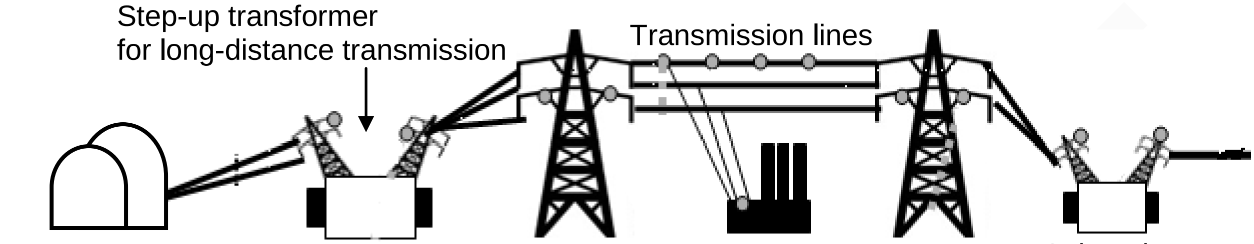
Calculate the:

10.4.1 rms current in the light bulb (3)

10.4.2 Resistance of the light bulb (3)
[10]

QUESTION 10 (Start on a new page.)

The diagram below illustrates how electricity generated at a power station is transmitted to a substation.



10.1 Does the power station use an AC or a DC generator? (1)

10.2 Sketch a graph of the potential difference generated at the power station versus time. (2)

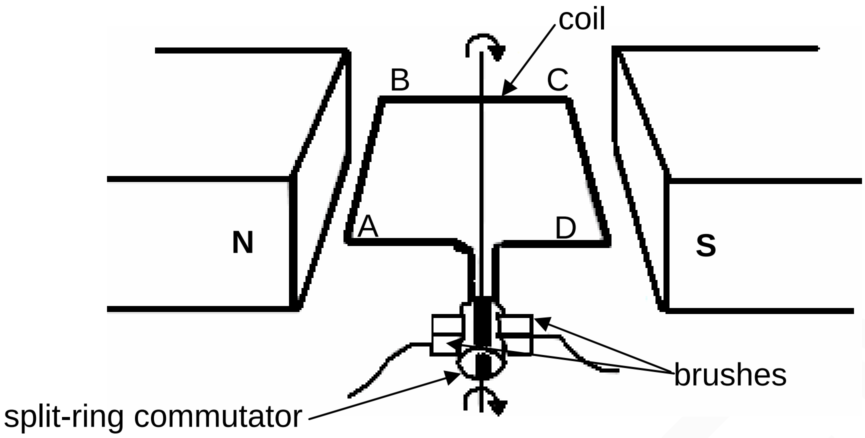
10.3 The average power produced at the power station is 4,45 x 10^9 W.

Calculate the rms current in the transmission lines if the power is transmitted at a maximum voltage of 30 000 V. (5)

10.4 Give a reason why electricity should be transmitted at high voltage and low current. (1)
[9]

QUESTION 10 (Start on a new page.)

10.1 The essential components of a simplified DC motor are shown in the diagram below.



When the motor is functioning, the coil rotates in a clockwise direction, as shown.

10.1.1 Write down the function of each of the following components:

(a) Split-ring commutator (1)

(b) Brushes (1)

10.1.2 What is the direction of the conventional current in the part of the coil labelled **AB**? Write down only FROM A TO B or FROM B TO A. (1)

10.1.3 Will the coil experience a maximum or minimum turning effect (torque) if the coil is in the position as shown in the diagram above? (1)

10.1.4 State ONE way in which this turning effect (torque) can be increased. (1)

10.2 Alternating current (AC) is used for the long-distance transmission of electricity.

10.2.1 Give a reason why AC is preferred over DC for long-distance transmission of electricity. (1)

10.2.2 An electric appliance with a power rating of 2 000 W is connected to a 230 V rms household mains supply.

Calculate the:

(a) Peak (maximum) voltage (3)

(b) rms current passing through the appliance (3)
[12]

QUESTION 11 (Start on a new page.)

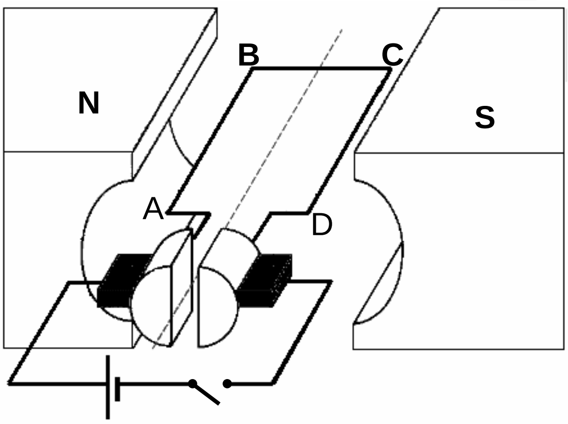
Diesel-electric trains make use of electric motors as well as generators.

11.1 The table below compares a motor and a generator in terms of the type of energy conversion and the underlying principle on which each operates. Complete the table by writing down only the question number (11.1.1–11.1.4) in the ANSWER BOOK and next to each number the answer.

	TYPE OF ENERGY CONVERSION	**PRINCIPLE OF OPERATION**
Motor	11.1.1	11.1.3
Generator	11.1.2	11.1.4

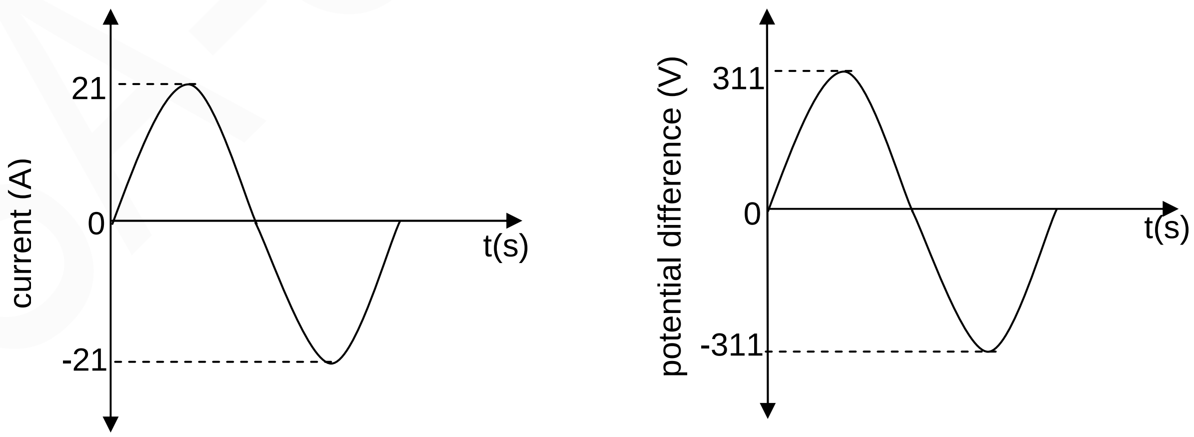
(4)

The simplified diagram below represents an electric motor.



11.2 Give a reason why the section of the coil labelled **BC** in the above diagram does not experience a magnetic force whilst the coil is in the position as shown. (2)

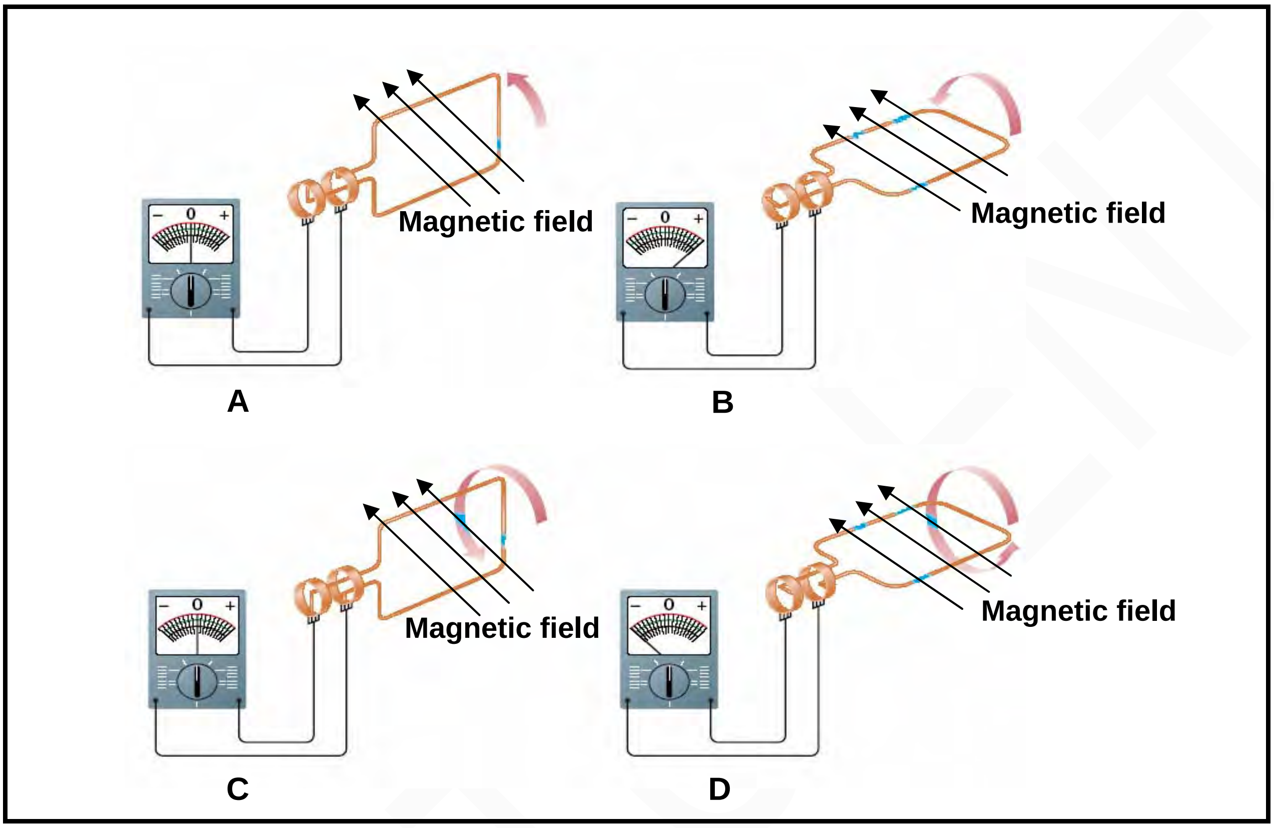
11.3 Graphs of the current and potential difference outputs of an AC generator are shown below.



Calculate the average power output of this generator. (6)
[12]

QUESTION 13 (Start on a new page.)

The diagrams A to D below show four positions in sequence during the anti-clockwise rotation of the coil of a simple AC generator.



13.1 Name the fundamental principle on which generators work. (1)

13.2 What is the purpose of the slip rings in an AC generator? (1)

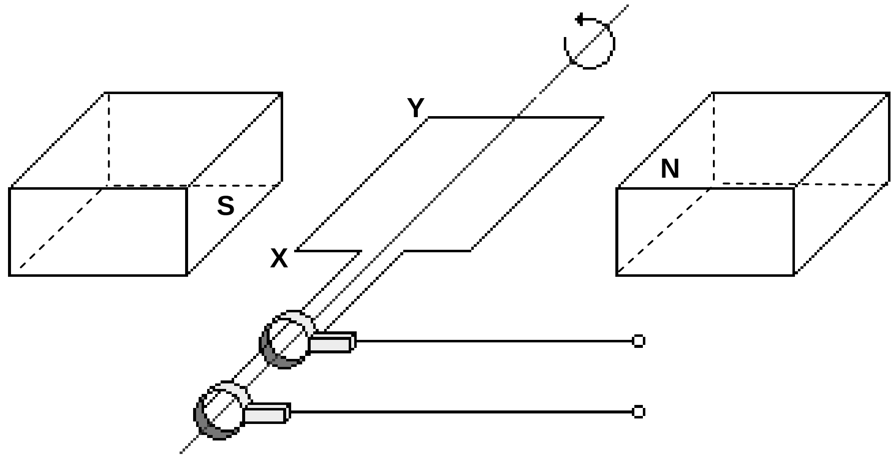
13.3 By referring to the relative positions of the coil in positions A to D, draw the corresponding graph of potential difference versus time for one full rotation (A to D to A). Indicate the positions of the coil (by using the letters A to D) on your graph. (3)

13.4 Name ONE way in which the induced emf of a specific generator can be increased. (1)

13.5 Which component in a DC generator makes it different from an AC generator? (1)
[7]

QUESTION 13

A coil is rotated anti-clockwise in a uniform magnetic field. The diagram below shows the position at the instant the coil lies parallel to the magnetic field.



13.1 What type of generator is illustrated in the diagram? Give a reason for your answer. (2)

13.2 Determine the direction of the current in segment XY when the coil is in the position shown above. Only write down X to Y OR Y to X. (2)

13.3 Assume that the speed and direction of rotation are constant. Draw a sketch graph of potential difference against time that represents the output of this device. (2)
[6]

QUESTION 14

The municipality of Dinaledin implements a power cutback in the town. As a result of the cutback the rms voltage drops from 220 V_{rms} to 200 V_{rms}.

14.1 Calculate the peak voltage during cutback. (3)

14.2 A certain electrical appliance dissipates 1 200 W when it is operated at 220 V_{rms}. Calculate the power at which it will operate during the cutback. (4)

14.3 It is common practice to connect many appliances to a multi-plug. Modern types of multi-plugs have a cut-off switch built in.

Using principles in Physics, explain clearly why this cut-off switch is important. (4)
[11]