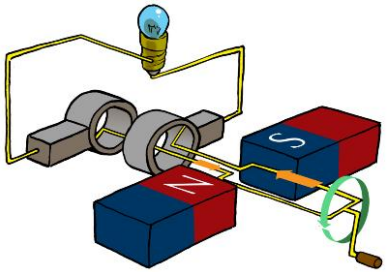
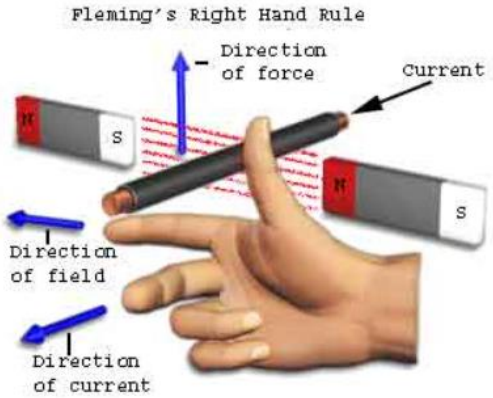
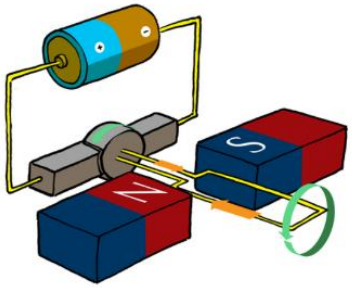
SUBJECT and GRADE	**Physical Sciences Grade 12**	
TERM 3	*Week 2*	
TOPIC	Electrodynamics	
AIMS OF LESSON	This lesson will focus on: • Operations of motors and generators. • Faraday's law of electromagnetic induction • Differences between direct current (DC) and alternating current (AC) in the cases of both motors and generators. • The graphs of AC and DC. • The use of motors in everyday life. • Calculations of the Root Mean Square (*rms*)	
RESOURCES	***Paper based resources***	***Digital resources***
	You are referred to the: • *Electrodynamics topic in the textbook or study guides (e.g. Answer Series) that learners will have on hand.* • *Examination Guideline (page 12)* • *Mind the Gap Chemistry book (pages 116 - 133)* • *Past NSC Examination papers (refer to question 9 in paper 1)*	*Refer to the relevant digital resources:* • *WCED ePortal* https://wcedeportal.co.za • *Past NSC Examination papers (refer to question 9 in paper 1)* https://wcedonline.westerncape.gov.za/grade-12-question-papers • *Telematics* https://wcedonline.westercape.gov.za/edumedia/revision-dvds-telematics • *Mind the Gap* https://wcedonline.westercape.gov.za/mind-gap • *HeyScience App for Physical Sciences on Play Store* • https://itsi.intelligentpractice.co.za/read/science/grade-12/electrodynamics/11-electrodynamics-02 • https://www.youtube.com/watch?v=gQyamjPrw-U AC Generator

INTRODUCTION	• Electrodynamics is the study of the relationship between electricity, magnetism and mechanical phenomena. • Concepts such as current, voltage, resistance and power should already be familiar to learners from previous grades 10 and 11 from the topic Electric Circuits. In grade 10 the magnetic field around a bar magnet was discussed. Electromagnetism was taught in grade 11 where learners were taught about electromagnetic induction. • Without electrical machines such as generators and motors life as we know it would have been very different. You will learn how these electrical machines work and what the functions of the different components of the electrical machines are. • In this topic you will also be looking at the difference between alternating current (AC) and direct current (DC) and the advantages of AC over DC.
CONCEPTS AND SKILLS	**Electrical machines (generators, motors)** *Generators* • State the energy conversion in generators: *mechanical to electrical energy* • Use the principle of electromagnetic induction to explain how a generator works. (Mind the Gap (MTG) page 116) • Use Fleming's Right Hand Rule to determine the direction of the induced current in the conductor.  AC generator (with split ring commutator) 

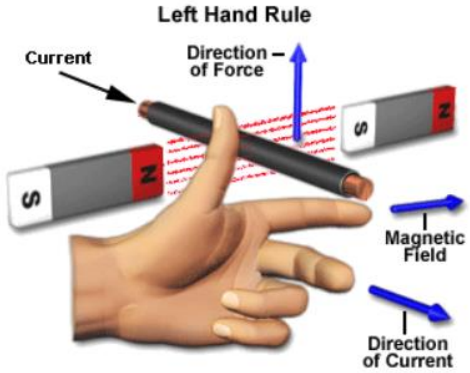
- Explain the functions of the components of an AC generator. (MTG page 117)
- Explain the functions of the components of a DC generator. (MTG page 120)
- State examples of the uses of AC and DC generators.

Motors

- State the energy conversion in motors: *electrical to mechanical energy*
- Use the motor effect to explain how a motor works. (MTG page 123)
- Use the Left-Hand Rule to determine the direction of the force on the conductor – the direction in which the coil turns.



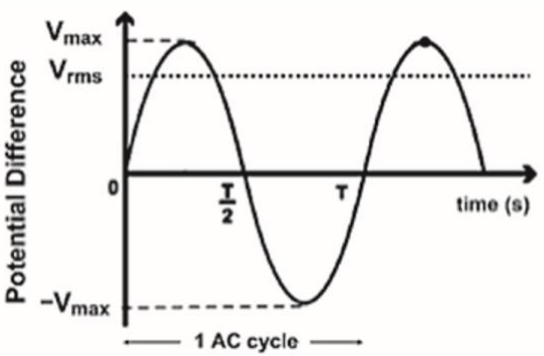
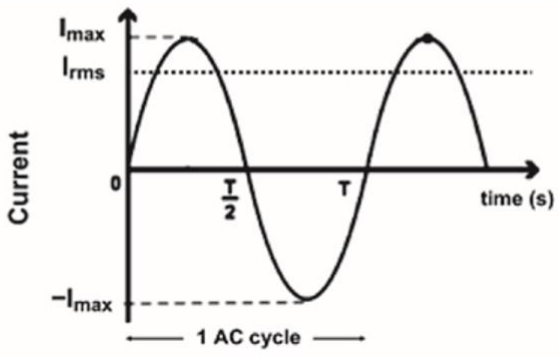
DC motor (with slip ring)



- Explain the functions of the components of a motor. (MTG page 123)
- State examples of the use of motors. (MTG page 124 - 125)

Alternating current

- State the advantages of alternating current (AC) over direct current (DC). (MTG page 128)
- Sketch graphs of *voltage versus time* and *current versus time* for an AC circuit. (MTG page 126)

emf induced by an AC generator	Current induced by an AC generator
	

- Define the term *rms* for an alternating voltage or an alternating current. *The rms value of AC is the DC potential difference/current which dissipates the same amount of energy as AC.*
- Solve problems using $I_{rms} = \frac{I_{max}}{\sqrt{2}}, V_{rms} = \frac{V_{max}}{\sqrt{2}}$. (MTG page 126)
- Solve problems using $P_{ave} = I_{rms}V_{rms} = {}^{1}/_{2}\, I_{max}V_{max}$ (for a purely resistive circuit), $P_{ave} = I_{rms}^2 R \text{ and } P_{ave} = \frac{V_{rms}^2}{R}$. (MTG page 127)

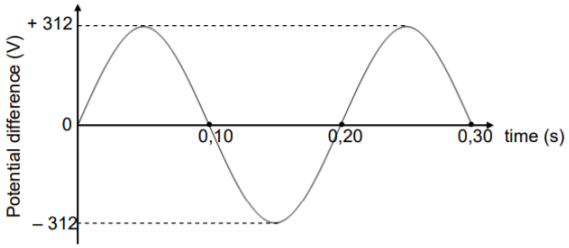
Key points to consider when studying this topic:

- Know the energy conversions in generators and motors.
- Sometimes learners become confused with which hand rule to use to determine the direction of the induced current in generators and the direction of the force on the conductor (coil) in the motor.
- Perform calculations based on rms values.
- When performing rms calculations, it is important to first write the formulae from the datasheet. Show your substitutions and write a unit with your answers.
- Highlight and study definitions from the examination guidelines (page 13).
- Common mistakes made: Learners do not state definitions as per examination guidelines. When calculations are performed, you do not write the formulae as is from the datasheet and forget to include units with the answers.

	• You are expected to be able to sketch and interpret graphs of *voltage versus time* and *current versus time* for an AC circuit.
ACTIVITIES/ ASSESSMENT	You are referred to *Electrodynamics activities/assessment* that they can complete/do in their *Physical Sciences textbooks or Study guides.* *Informal assessment activities in Mind the Gap:* • Activities 1 - 5 (page 129-133)
CONSOLIDATION	In this topic you have studied how generators and motors operate and how the principle of electromagnetic induction is applied to generators. You have also looked at the differences between direct current (DC) and alternating current (AC) in the cases of both motors and generators. Alternating current (AC) has many advantages over direct current (DC). An AC generator is also called an alternator. You should be able to sketch the graphs of AC and DC and know the difference between the types of graphs when it is given. By now you should be able to provide examples of the use of generators and motors in everyday life and to solve problems based on the Root Mean Square (rms) values.
VALUE	Without generators and motors life as we know it would not be possible. We are surrounded by many examples of the uses of generators and motors in our daily lives. One such example is the generators that we use at our homes and at stores when we experience loadshedding. A very important example of an electric motor is the starter motor of a car, which turns the car engine over in order to start it.

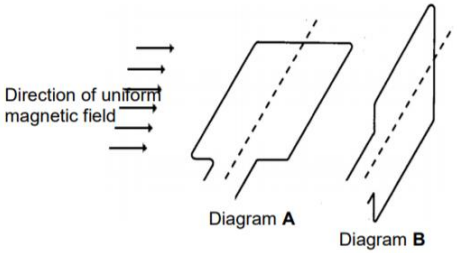
CONSOLIDATION QUESTION **[DBE NSC EXAMINATION 2019 MAY/JUNE]**

The diagram below shows the voltage output of a generator.



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

1.2 Which ONE of the diagrams below, A or B, shows the position of the generator's coil at time = 0,10 s? (1)



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

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

Calculate the:

1.4.1 Average power delivered by the generator to the device. (3)

1.4.2 Maximum current delivered by the generator to the device. (4)

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CONSOLIDATION QUESTION MEMORANDUM

1.1 Slip rings/Sleep ringe ✓ (1)

1.2 B✓ (1)

1.3 $V_{rms/wgk} = \frac{V_{max/maks}}{\sqrt{2}}$✓

$= \frac{312}{\sqrt{2}}$✓

$= 220{,}62\ V$✓ (3)

1.4.1 **OPTION 1/OPSIE 1**

$P_{ave/gem} = \frac{V_{rms/wgk}^2}{R}$ ✓

$= \frac{(220{,}62)^2}{40}$ ✓

$= 1216{,}83\ W$ ✓ (3)

OPTION 2/OPSIE 2

$I_{rms/wgk} = \frac{V_{rms/wgk}}{R}$ ✓

$= \frac{(220{,}62)}{40}$

$= 5{,}515$

$P_{ave/gem} = I_{rms/wgk}^2 R$

$= (5{,}515)^2(40)$ ✓

$= 1216{,}61\ W$ ✓

OR/OF

$P_{ave/gem} = V_{rms/wgk} I_{rms/wgk}$

$= (220{,}62)(5{,}515)$ ✓

$= 1216{,}72\ W$ ✓

OPTION 3/OPSIE 3

$I_{max/maks} = \frac{V_{max/maks}}{R}$ ✓

$= \frac{312}{40}$

$= 7{,}80\ A$

$P_{ave/gem} = \frac{I_{max/maks} V_{max/maks}}{2}$

$= \frac{(7{,}8)(312)}{2}$ ✓

$= 1216{,}80\ W$ ✓

1.4.2 **OPTION 1/OPSIE 1**

$I_{max/maks} = \frac{V_{max/maks}}{R}$ ✓

$= \frac{312}{40}$ ✓✓

$= 7{,}8\ A$✓ (4)

OPTION 2/OPSIE 2

$P_{ave/gem} = V_{rms/wgk} I_{rms/wgk}$ ✓

$1216{,}83 = 220\ I_{rms/wgk}$ ✓

$I_{rms/wgk} = 5{,}515\ A$

$I_{rms/wgk} = \frac{I_{max/maks}}{\sqrt{2}}$

$5{,}515 = \frac{I_{max/maks}}{\sqrt{2}}$ ✓

$I_{max/maks} = 7{,}8\ A$ ✓

OPTION 3/OPSIE 3

$P_{ave/gem} = I^2_{rms/wgk} R$ ✓

$1216{,}83 = I^2_{rms/wgk}(40)$ ✓

$I_{rms/wgk} = 5{,}515\ A$

$I_{rms/wgk} = \frac{I_{max/maks}}{\sqrt{2}}$

$5{,}515 = \frac{I_{max/maks}}{\sqrt{2}}$ ✓

$I_{max/maks} = 7{,}8\ A$ ✓

[12]