basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 10

ELECTRICAL TECHNOLOGY

EXEMPLAR 2016

MEMORANDUM

MARKS: 200

This memorandum consists of 13 pages.

INSTRUCTIONS TO MARKERS

1. All questions with multiple options assume that any relevant, acceptable answer should be considered.

2. Calculations:

   2.1 All calculations should include formulae.

   2.2 Substitution of values should be done correctly.

   2.3 All answers MUST contain the correct unit in order to be considered.

   2.4 Alternative methods should be considered, on the condition that the correct answer is arrived at.

   2.5 When a wrong answer is used in a subsequent calculation, the initial answer will be considered wrong. If, however, the wrong answer is applied correctly thereafter, the marker should determine the answer with the incorrect values. If the candidate uses the answer (that was incorrect initially) correctly, the candidate should be awarded full marks for any correct calculations that follow.

3. This memorandum is only a guide with exemplar answers. Alternative interpretations should be considered and marked on merit. This principle should be applied consistently.

SECTION A: GENERIC SECTION (COMPULSORY)

QUESTION 1: OCCUPATIONAL HEALTH AND SAFETY

1.1 An accident is an unplanned and uncontrolled event✓ caused by unsafe acts and/or unsafe conditions✓ performed by a person that could cause injury to him-/herself or his/her workmates. (2)

1.2 Good housekeeping in a workshop means the orderly arrangement/management✓ of tools✓, equipment, operations, storage facilities and materials to their respective places✓. **OR**
Good housekeeping can also be defined as 'everything in its place and a place for everything'. (3)

1.3 1.3.1 Smoking prohibited✓ (1)

1.3.2 Fire extinguisher✓ (1)

1.3.3 Eye protection must be worn✓ (1)

1.4 Inadequate supports or guards✓
Congestion in the workplace✓ (2)

1.5 An unsafe action is the performance of a task or other activity that is conducted in a manner that may threaten✓ the health and safety of workers.✓ (2)
[12]

QUESTION 2: TOOLS AND MEASURING INSTRUMENTS

2.1 2.1.1 For gripping, twisting, cutting, bending wires✓ or cables and crimping lugs✓ (2)

2.1.2 To remove solder✓ so that components may be removed✓, replaced or salvaged
To remove the molten solder from the joint (2)

2.2 2.2.1 Frame✓ (1)

2.2.2 Handle✓ (1)

2.2.3 Cutting blade✓ (1)

2.2.4 Blade-adjusting nut✓ (1)

2.3 To prevent electric shock✓ or other injuries that may result from direct or indirect✓ contact with energised electrical conductors. (2)

2.4 To ensure successful cutting with minimal effort✓ and to prevent the blade from breaking, bending or wearing through. ✓ (2)

2.5 Use the screw driver for the intended job.✓
Use the correct size and type of screw driver to loosen or tighten screws. ✓
Clean the screw driver tips with a brush or sponge regularly. (2)

2.6 An ammeter must be connected in series✓ with the components under test. ✓
An ammeter has a low resistance and if connected in parallel a high fault current will flow. (2)

2.7 The voltmeter must be connected in parallel✓ with components under test✓ and the voltage must be set to the highest practically readable scale. (2)

2.8 To ensure that the measurements taken are as consistent and accurate✓ as possible and are within the acceptable range.✓ (2)
[20]

QUESTION 3: BASIC PRINCIPLES OF ELECTRICITY

3.1 3.1.1 An insulator is a material that does not allow current✓ to flow through it✓ (2)

3.1.2 When the temperature of a material is increased, its resistance decreases✓ When the temperature of a material is decreased, its resistance increases. ✓ (2)

3.2 A good conductor✓
Durable
Corrosion/Rust/Oxidation resistant
Ductile
Malleable (1)

3.3 The tolerance of a resistor is the percentage error of its resistance value or by how much (more or less) one can expect a resistor's actual measured value✓ to differ from the stated value.✓ (2)

3.4 15 kΩ ✓± 5%✓ (2)

3.5 Ohm's law states that the current in a circuit is directly proportional to the voltage across the circuit✓and inversely proportional to the resistance of the circuit ✓, provided the temperature remains constant. ✓ (3)

3.6 $R = \frac{V}{I}$ ✓
$R = \frac{220}{2}$ ✓
$R = 110\,\Omega$ ✓ (3)

3.7 3.7.1 $V_3 = IR_3$ ✓

$= 21,2 \times 10^{-3} \times 470$ ✓

$= 9,96\ V$ ✓ (3)

3.7.2 $V_{R1} = V_T - V_{R3}$ ✓

$= 12 - 9,96$ ✓

$= 2,04\ V$ ✓ (3)

3.7.3 $I_{R1} = \frac{V_{R1}}{R_1}$ ✓

$= \frac{2,04}{220}$ ✓

$= 9,25\ mA$ ✓ (3)

3.7.4 $I_{R2} = I_T - I_{R1}$ ✓

$= 21,2 - 9,25$ ✓

$11,95\ mA$ ✓ (3)

3.7.5 $R_2 = \frac{V_{R2}}{I_{R2}}$ ✓

$= \frac{2,04}{11,95 \times 10^{-3}}$ ✓

$= 170\ \Omega$ ✓ (3)

3.8 The current will increase✓ because the resistance of the circuit has decreased.✓ (2)

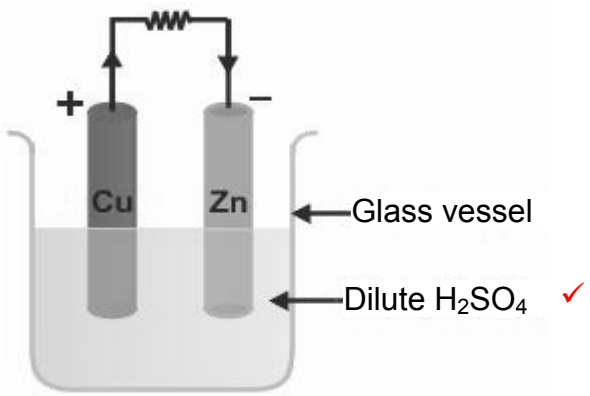
[32]

QUESTION 4: POWER SOURCES

4.1 Energy is the ability✓ to do work✓ such as the capacity to move an object by the application of force. ✓ (3)

4.2 Nuclear energy✓
Hydro energy
Geothermal energy
Solar energy
Wind energy
Fossil energy (Any one) (1)

4.3



Voltaic cell (5)

4.4 Primary cells are power sources that are not easily recharged after use✓, while secondary cells are power sources that can be recharged.✓ (2)

4.5 Potential difference is the electrical pressure measured across a power source✓ when it is connected to a load✓. Emf is the electrical pressure measured across a power source ✓when it is not connected to a load.✓ (4)

4.6 $E = I(R + r)$ ✓

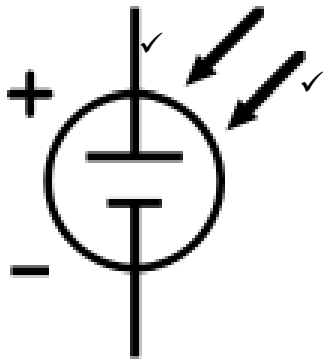
$$r = \frac{E}{I} - R$$

$$= \frac{1,5}{14,9 \times 10^{-3}} - 100 \quad ✓$$

$$= 0,67\ \Omega \quad ✓$$

(3)

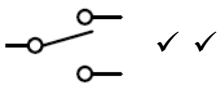
4.7



(2)
[20]

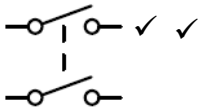
QUESTION 5: ELECTRONIC COMPONENTS

5.1 5.1.1



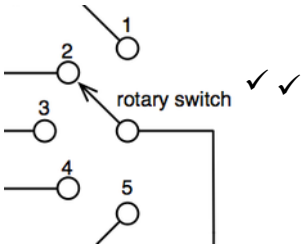
✓ ✓ (2)

5.1.2



✓ ✓ (2)

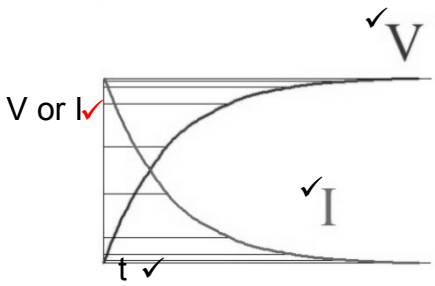
5.1.3



✓ ✓ (2)

5.2 A capacitor stores charge and dissipates it in a controlled manner. (2)

5.3



(4)

5.4 5.4.1

$$C_T = C_1 + C_2 \quad ✓$$
$$= 2200\times10^{-6} + 2200\times10^{-6} \quad ✓$$
$$= 4400\ \mu F \quad ✓$$

(3)

5.4.2

$$\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} \quad ✓$$
$$= \frac{1}{2200\times10^{-6}} + \frac{1}{2200\times10^{-6}} \quad ✓$$
$$C_T = 1100\ \mu F \quad ✓$$

(3)

5.5

$$T = 5\tau \quad ✓$$
$$\tau = RC \quad ✓$$
$$= 50000\times100\times10^{-6}$$
$$= 5\,s \quad ✓$$
$$T = 5\times5 \quad ✓$$
$$= 25\,s \quad ✓$$

(5)

5.6 When the anode is connected to positive✓ and the cathode is connected to negative (1)

5.7 The purpose of the resistor connected with an LED is to protect the LED✓ against excessive current.✓ (2)
[26]

QUESTION 6: MAGNETISM

6.1 6.1.1 An electromagnet is a type of magnet in which the magnetic field is produced by an electric current flowing through a conductor✓, and this magnetic field will collapse once the current ceases to flow. ✓ (2)

6.1.2 Induction takes place as a result of the expansion and contraction of the magnetic field due to changes in polarity.✓ When a second coil is brought closer to the first coil, the magnetic field of the first coil will link✓ with the second coil, thus inducing an emf of self-inductance. ✓ (3)

6.2 Magnetic flux consists of the invisible magnetic flux lines produced around a magnet✓ and is measured in weber (Wb).✓
Flux density is the concentration of magnetic flux lines per unit area✓ and is measured in weber per square metre Wb/m^2 or tesla (T).✓ (4)

6.3 Air core ✓
Ferrite core ✓
Laminated iron core
Toroid core (Any 2) (2)

6.4 An inductor is formed when an insulated conductor✓ is wound into a number of turns to form a coil.✓ (2)

6.5 $L_T = L_1 + L_2 + L_3$ ✓
$= 120 + 100 + 90$ ✓
$= 310$ mH ✓ (3)

6.6 When current passes through a coil it creates a magnetic field around it. ✓ This magnetic field will attract the armature.✓ The armature will rotate slightly around the pivot, which presses against the movable contact.✓ This moves the contact into an alternate position.✓ (4)

6.7 6.7.1 Field coils✓ (1)

6.7.2 Stator✓ (1)

6.7.3 Poles✓ (1)

6.7.4 Armature✓ (1)

6.8 To transfer the current✓ from the supply to the commutator.✓ (2)
[26]

TOTAL SECTION A: 136

SECTION B: ELECTRICAL

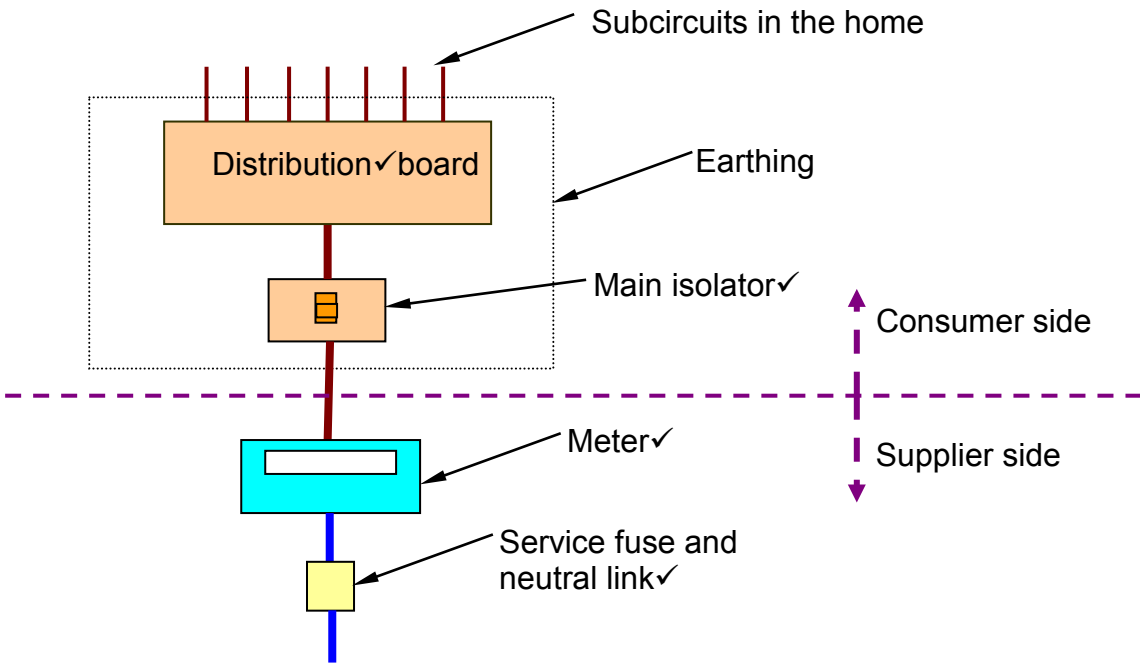
QUESTION 7: DOMESTIC INSTALLATIONS

7.1 A domestic installation is the electrical installation in a house✓, also called the wiring system.✓ (2)

7.2 7.2.1 50 Hz✓ (1)

7.2.2 220 V–240 V✓ (1)

7.3



(4)

7.4 South✓ African✓ National✓ Standards✓ (4)

7.5 To ensure that people, animals and property✓are protected from hazards✓ that may arise from the operation of an electrical installation✓ under normal as well as faulty conditions.✓ (4)

7.6 Overcurrent ✓
Fault current ✓
Overvoltage
Undervoltage (Any 2) (2)

7.7 7.7.1 It must not be possible to touch any live parts✓ of an installation✓ unless a cover has been removed with the use of a tool or key✓ (3)

7.7.2 Electrical equipment should be designed, positioned or protected✓ such that accessible parts under normal operating conditions✓do not reach a temperature that exceeds 70 °C for metal parts and 90 °C for non-metal parts ✓ (3)

7.8 7.8.1 A distribution board is a panel board✓ that may be used in a domestic environment, which distributes electricity into different subcircuits✓ and provides protection to the subcircuits.✓ (3)

7.8.2 Bathroom ✓
Above or below cooking appliances (1)

7.8.3 The busbar must be appropriate for a possible short current✓ that may occur at the supply terminals of the distribution board.✓ (2)

7.9 7.9.1 The function of a miniature circuit breaker is to protect an electrical circuit✓ and appliances✓ on that circuit from damage caused by overload or a short circuit.✓ (3)

7.9.2 The contacts that keep the circuit closed are held in by a latch.✓
If the current exceeds the rated current of the MCB, the magnetic field set up in the solenoid will be strong enough to pull and release the latch.✓
This will open the contacts, disconnecting the current flow through the MCB.✓
Once the current has been disconnected, the magnetic field will fall away, which will allow the latch to be reset.✓
This will then close the contact again.✓ (5)

7.9.3 10 A ✓ (1)

7.9.4 The overload current that it will open✓ under overload conditions ✓.
The fault current that it must be able to contain safely under fault conditions.✓ (4)

7.9.5 The bimetal strip has two different types of metal bonded together.✓
When a current exceeds the rated current the strips heat up.✓
The strips are made of different materials, and thus expand at different rates.✓ This causes the strip to bend, opening a set of contacts that in turn opens the circuit.✓ (4)

7.10 7.10.1 Opens under overload conditions✓
Opens under earth-fault conditions✓
Opens and closes under normal conditions✓ (3)

7.10.2 A fault may occur with a toaster if the insulation has worn off the live or neutral✓ and they may come into contact with a conducting part of the toaster.✓ This will create an earth fault.✓ (3)

7.11 7.11.1 Earthing may be described as a system of electrical connections✓ to the general mass of the earth✓ (2)

7.11.2 To provide protection to persons or animals against electric shock.✓ To maintain proper functioning of an electrical system.✓ (2)

7.11.3 The earthing system must have a low resistance.✓ In the event of an earth fault✓ the current will take the path of least resistance✓ and discharge down to earth.✓ (4)

7.11.4 The earth spike is the final part of the earthing system✓ that is driven into the mass of the earth to make good contact with the earth.✓ (3)

TOTAL SECTION B: 64

SECTION C: ELECTRONICS AND DIGITAL ELECTRONICS

QUESTION 8: LOGIC

8.1 8.1.1 Analogue system✓ (1)

8.1.2 Digital system.✓ (1)

8.2 Decimal number system✓, binary number system✓, octal number system, hexadecimal number system. (Any two) (2)

8.3

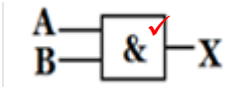
2 19	Remainder	
2 9 →	1 ✓	← LSB
2 4 →	1✓	
2 2 →	0✓	
2 1 →	0✓	
2 0 →	1 ✓	← MSB

Therefore $19_{10} = 10011_2$ (5)

8.4 $1\,0\,0\,1_2 = (1 \times 8) + (0 \times 4) + (0 \times 2) + (1 \times 1)$ ✓
$1\,0\,0\,1_2 = 8 + 0 + 0 + 1$✓
$1\,0\,0\,1_2 = 9_{10}$✓✓ (4)

8.5
$$\begin{array}{r} 0\,1\,1_2 \\ +1\,0\,0_2 \\ \hline 1\,1\,1_2 \end{array}$$ ✓✓✓ (3)

8.6
$$\begin{array}{r} 1100 \\ -0111 \\ \hline 0101 \end{array}$$ ✓✓✓ (3)

8.7 8.7.1 

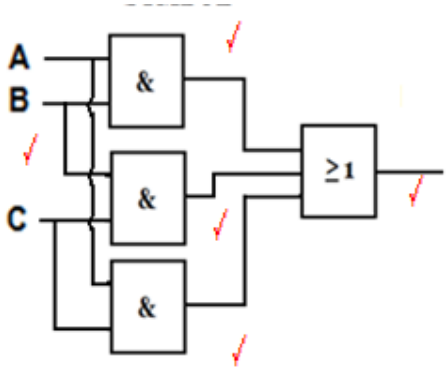
✓ Correct Gate Symbol = ✓ (2)

8.7.2 **X = A.B**✓✓ (2)

8.7.3

A	B	X	
0	0	0	✓
0	1	0	✓
1	0	0	✓
1	1	1	✓

(4)

8.8 

(5)
[32]

QUESTION 9: COMMUNICATION

9.1 They are used to transmit✓ signs, signals, writing, images, sounds, data or intelligence of any nature, as a whole✓ or in part by wire, radio, electromagnetic, photo-electronic or optical system to a receiver.✓ (3)

9.2 Radio-wave propagation is the transmission of signals✓ by modulation of electromagnetic waves✓ with frequencies below those of visible light.✓ (3)

9.3 Ground-wave propagation✓
Sky-wave propagation✓
Line-of-sight propagation✓ (3)

9.4 Frequency is the number of cycles✓ an AC wave or signal is able to deliver✓ in one second.✓ It is measured in hertz (Hz). (3)

9.5 9.5.1 Amplitude✓ (1)

9.5.2 One cycle✓ (1)

9.6 A radio antenna is a device designed to do two things: It captures radio-frequency signals✓ that are then converted to electrical signals by the receiver,✓ and it takes electrical signals from the transmitter and converts them into radio-frequency signals. ✓ (3)

9.7 Monopole antenna✓
Dipole antenna 1/2 λ✓ (2)

9.8 Commercial broadcasting can be described as one-way communication.✓ In other words, no communication is received back from the receiver✓ or transmitter.✓ These signals are normally transmitted via microwaves✓ (4)

9.9. 9.9.1 Plastic jacket✓ (1)

9.9.2 Dielectric insulator✓ (1)

9.9.3 Centre core✓ (1)

9.9.4 Metallic shield✓ (1)

9.10 Light and easy to carry around✓
Have multiple functions✓
Are affordable for most people✓
Are physically attractive✓
Gives one the ability to communicate to the four corners of the earth✓ (5)
[32]

TOTAL SECTION C: 64
GRAND TOTAL: 200