



Candidate Code No.	
For Board Use Only	
Result	Result
Date	Date
Int	Int

ELECTRICIAN'S THEORY EXAMINATION

21 November 2009

QUESTION AND ANSWER BOOKLET

Time Allowed: Three hours

INSTRUCTIONS – READ CAREFULLY

You have 10 minutes to read this paper but do not start writing until you are told to do so by the supervisor.

Write your Candidate Code Number in the box provided above. Your name must NOT appear anywhere on this paper.

Answer all questions.

The pass mark for this examination is 60 marks.

Use a pen for written answers. **Do not** use a pencil or a red pen.

Drawing instruments and pencils may be used when diagrams are required. Marks are allocated on the basis of correctness.

Do not use correcting fluid or correcting tape.

For calculation questions all workings, including formulae, must be shown to gain full marks.

Non-programmable calculators may be used.

Warning – You could get 0 marks for any question, or part of a question, if you show anything hazardous or dangerous in your answer.

Candidates are not permitted to use any Act, Regulation, Standard, Code of Practice, Handbook or other reference text in this examination.

PLEASE HAND THIS PAPER TO THE SUPERVISOR BEFORE LEAVING THE ROOM.

(turn over)

Question 1

- (a) State the main reason why the low voltage windings in large power transformers are placed closest to the iron core?

(2 marks)

- (b) State **TWO** reasons, other than cost, for balancing the load over three phases.

(2 marks)

(1) _____

(2) _____

- (c) State **TWO** reasons why an industrial electrical installation is likely to have a larger prospective short circuit current than a domestic electrical installation.

(2 marks)

(1) _____

(2) _____

- (d) List **TWO** types of single-phase induction motors, other than a capacitor start induction motor.

(2 marks)

(1) _____

(2) _____

(turn over)

Question 1 continued

(e) AS/NZS 3760 permits two methods of verifying that the insulation of a Class 1 electrical appliance is in sound condition. One method is an insulation resistance test using an insulation resistance tester. For the other test state:

(i) The name of the test.

(1 mark)

(ii) The maximum permitted value of that test.

(1 mark)

(f) An RCD is used for personal protection. What is the maximum time permitted for the RCD to trip at 5 times its residual current rating?

(2 marks)

(g) A heater draws 2000W at 230V. What power will the heater draw if the voltage drops 5%?

(2 marks)

(turn over)

Question 1 continued

- (h) State the reason why you would carry out an earth fault loop impedance test at the switchboard of a low voltage electrical installation.

(2 marks)

- (i) A CT metering circuit is measuring the consumption of an installation at near to full load.

- (i) State the precaution that must be taken before disconnecting the meters from the CT.

(1 mark)

- (ii) State **ONE** reason why this precaution is taken.

(1 mark)

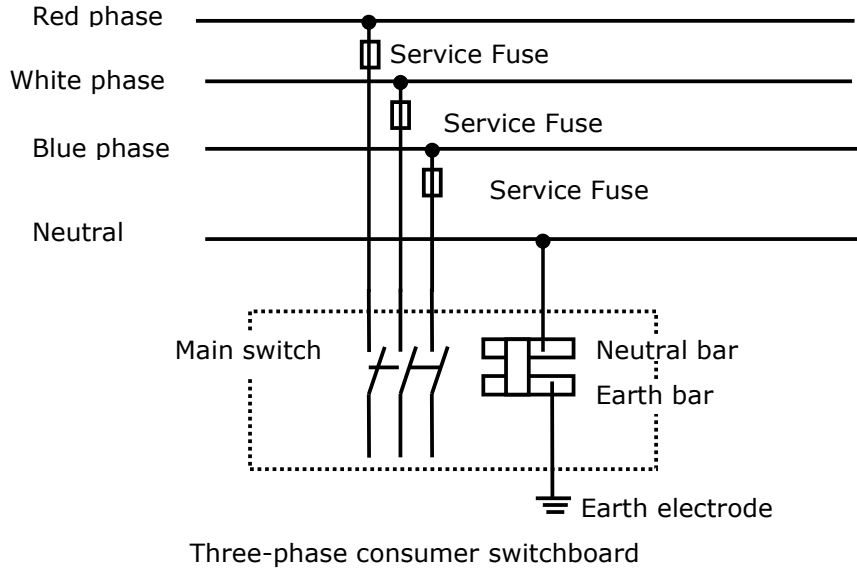
- (j) A three-phase motor has the term "230V/400V" on its nameplate. What method of connection would you use to connect the motor to a three-phase supply?

(2 marks)

(turn over)

Question 2

The figure below represents a low voltage, three-phase 400V supply to an electrical installation. **The installation is live.**



This figure is relevant to both questions (a) and (b).

- (a) State **THREE** hazards that will occur if any one of the three phases and the neutral are transposed at a point between the distribution line and the switchboard.

(3 marks)

(1) _____

(2) _____

(3) _____

(turn over)

Question 3

(a) A three-phase squirrel cage induction motor is running on full-load. It is controlled by a DOL starter.

(i) A small mechanical overload over a long period of time has occurred. What effect does this fault have on:

(A) The motor

(½ mark)

(B) The motor protection.

(½ mark)

(ii) A mechanical overload has occurred that caused the motor to exceed its pull-out torque (break-down torque). What effect does this fault have on:

(A) The motor

(½ mark)

(B) The motor protection.

(½ mark)

(turn over)

Question 3 continued

(b) A three-phase squirrel cage induction motor is running on full-load. It is controlled by a DOL starter.

(i) Under-voltage has occurred on the supply to the motor and starter. What effect does this fault have on:

(A) The motor

(1/2 mark)

(B) The motor protection.

(1/2 mark)

(ii) An open circuit has occurred in one winding of the motor. What effect does this fault have on:

(A) The motor

(1/2 mark)

(B) The motor protection.

(1/2 mark)

(turn over)

Question 4

The two figures on the following page represent a three-phase MEN switchboard and a three-phase distribution switchboard in a three-phase electrical installation

The supply comes into the MEN switchboard and the three-phase distribution switchboard is supplied from the MEN switchboard. The distribution switchboard is protected by an RCBO.

On the figures, draw and label the circuit diagram that shows:

- The supply to the MEN switchboard.
- The wiring between the MEN switchboard and the distribution switchboard.
- The distribution board protection on the MEN switchboard.
- The main switches on both boards.
- The earthing and neutral arrangements on both boards
- The neutral and earthing fittings on both boards (bars, link, electrode, tags).

There are other final subcircuits, MCBs, RCDs on both switchboards that do not need to be drawn.

(10 marks)

(turn over)

Question 4 continued



(turn over)

Question 5

(a) Danger tags and out-of-service tags are designed to promote safety in the workplace.

(i) Give a brief description of circumstances when a Danger Tag is used. (1 mark)

(ii) Give a brief description of circumstances when an Out-of-Service Tag is used. (1 mark)

(iii) List **THREE** precautions to be taken when attaching a danger tag to an isolating switch. (3 marks)

(1) _____

(2) _____

(3) _____

(turn over)

Question 5 continued

(b) Explain the difference between:

- A 10 kW pump motor that has been "isolated".
- and
- A 10 kW pump motor that has been "switched off".

(3 marks)

(c) Describe how the prove-test-prove method of testing is carried out.

(1½ marks)

(d) You are using the prove-test prove method at the supply side of a three-phase main switch to see if the switchboard is isolated. What tests would you make to clearly establish that isolation (or otherwise) has taken place.

(½ mark)

(turn over)

Question 6 continued

- (b) State **TWO** uses for the information gained from an earth fault loop impedance test carried out in (a) above.

(2 marks)

(1) _____

(2) _____

- (c) Why is the earth fault loop path between the earth and neutral bars and MEN link and the star point via the main neutral considered more important than the path between the earth and neutral bars and MEN link and the star point via the mass of earth

(½ mark)

- (d) State the main reason why an installation supplied by a 35 mm² copper mains cable requires a larger main earthing lead than an installation supplied by a 16 mm² copper mains cable.

(2 marks)

(turn over)

Question 7

- (a) Draw and label a circuit diagram of a three-phase RCD used for personal protection that protects a 5-pin socket outlet in a workshop.

(5 marks)

(turn over)

Question 7 continued

- (b) Describe the operation of an RCD when there is an active (phase) to earth fault occurs on the circuit the RCD protects.

(4 marks)

- (c) Define the term "RCBO"

(1 mark)

(turn over)

Question 8

- (a) You have done an earth fault loop impedance test on a domestic installation and, from the test results, have calculated that the fault level is 1.2 kA.

On the switchboard there are three rewirable fuses. State **TWO** reasons relating to the fault level why you would replace the rewirable fuses with MCBs.

(2 marks)

(1) _____

(2) _____

- (b) MCBs with both thermal and magnetic functions are installed on a switchboard in a factory.

- (i) Briefly describe the internal operation of the MCB when its thermal function operates.

(2 marks)

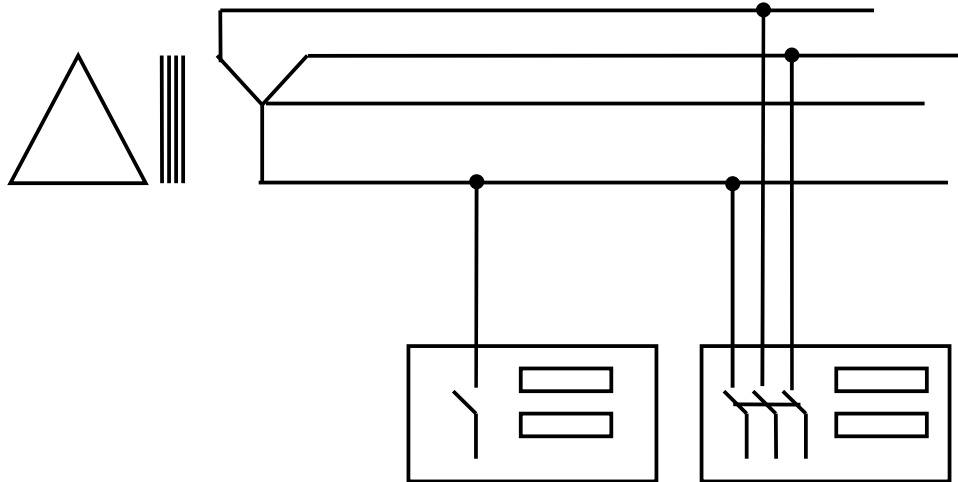
- (ii) Briefly describe the internal operation of the MCB when its magnetic function operates.

(2 marks)

(turn over)

Question 8 continued

- (c) The following is a diagram of a 400V/230V MEN distribution system supplying a single-phase MEN switchboard and a three-phase MEN switchboard.



Complete the diagram by drawing the components of the MEN system that are missing.

(4 marks)

(turn over)

Question 9

A low voltage, three-phase, five-pin, socket outlet and final subcircuit wiring has been installed in a bakery.

- (a) State the Standard that specifies the tests and checks that need to be carried out on the socket outlet and final subcircuit wiring.

(1 mark)

- (b) State the document that must be completed once all the testing and checking has been completed.

(1 mark)

- (c) State the **THREE** tests, using test instruments you would carry out prior to connecting the final subcircuit cable at the switchboard to ensure the socket outlet and final subcircuit wiring is electrically safe.

For each test:

- Describe how you would carry it out.
- State the test instrument used.
- State the permitted test result (if applicable).

(6 marks)

(1) _____

(2) _____

(3) _____

(turn over)

Question 9 continued

- (d) The socket outlet is protected by an RCCB. State the test, using a test instrument that you would carry out after connecting and livening the final subcircuit cable at the switchboard to ensure the socket outlet and final subcircuit wiring is electrically safe.

(2 marks)

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In the box, write the number of **EXTRA** sheets you have used. Write **NIL** if you have not used any

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Questions Answered	Marks	
1		
2		
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TOTAL		