



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

ELECTRICIAN'S THEORY EXAMINATION

20 June 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) 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)

(b) State the **TWO** technical factors that will determine the size of a cable used to supply a three-phase induction motor.

(2 marks)

(1) _____

(2) _____

(c) (i) State **ONE** precaution that could be taken when carrying out an insulation resistance test on equipment containing semi-conductor devices?

(1 mark)

(ii) State **ONE** reason why you would take the precaution stated in (c)(i).

(1 mark)

(turn over)

Question 1 continued

(d) AS/NZS 3000 requires that a test voltage of 500V d.c. is used for an insulation resistance test of a low voltage electrical installation.

(i) Briefly explain why a voltage of 500V is applied.

(1 mark)

(ii) Briefly explain why the voltage is a d.c. voltage.

(1 mark)

(e) Calculate the power factor of a small three-phase printing factory with mainly motor loading. Metering instruments have recorded the following information:

- Watts = 30000W
- Volts = 406V
- Amps = 57A per phase

(2 marks)

(f) Some fittings in an electrical installation have a fault duty lower than the prospective short circuit rating of the installation. State **TWO** hazards that could occur when a high prospective short-circuit fault current occurs in the electrical installation.

(2 marks)

(1) _____

(2) _____

(turn over)

Question 1 continued

- (g) A three-phase cable was run between a distribution pillar and a building and connected only in the pillar. Three months after the cable was connected to the pillar an electrician received an electric shock from the cable while attempting to terminate the cable at the main switchboard of the building.

No other person worked on the cable in the time between it being connected to the pillar and the electrician receiving the shock

The electrician had tested the end of the cable with a multimeter and found no voltage present. The meter was proved to be working before and after the test. She then proceeded to strip the cable and received the shock.

- (i) State the reason why the electrician received a shock. (1 mark)

- (ii) State the action the electrician failed to take when testing. (1 mark)

- (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)

(turn over)

Question 1 continued

- (i) For what reason would you connect a resistor across a circuit after the electricity supply to that circuit has been isolated.

(2 marks)

- (j) 100 metres of three-phase mains cable gave an insulation test result of $100\text{M}\Omega$. Calculate the insulation resistance of 500m of the same type of cable.

(2 marks)

(turn over)

Question 2

Note: Read the entire question before answering it.

You have completely rewired a three-phase shop that is metered on a remote panel. The work included all final subcircuits including a fixed wired, single-phase 2 kW water heater. There was no change to the mains, main earthing system or switchboard.

To complete the work you need to carry out an insulation resistance test of the work you have done and the installation is live.

- (a) Describe the actions you will take to ensure that the electrical installation is isolated so it is safe to carry out the insulation resistance test. (1½ marks)

- (b) For the insulation resistance test state:

- The type of instrument you will use.
- The test voltage – if applicable

(1 mark)

(turn over)

Question 2 continued

- (c) Describe how you will carry out the insulation resistance test on the shop.

Include in your description the permitted minimum value of any test results.

(3½ marks)

- (d) When you tested the installation the test result was 0.2 MΩ. You proceeded to certify the installation on a Certificate of Compliance as it complied with AS/NZS 3000.

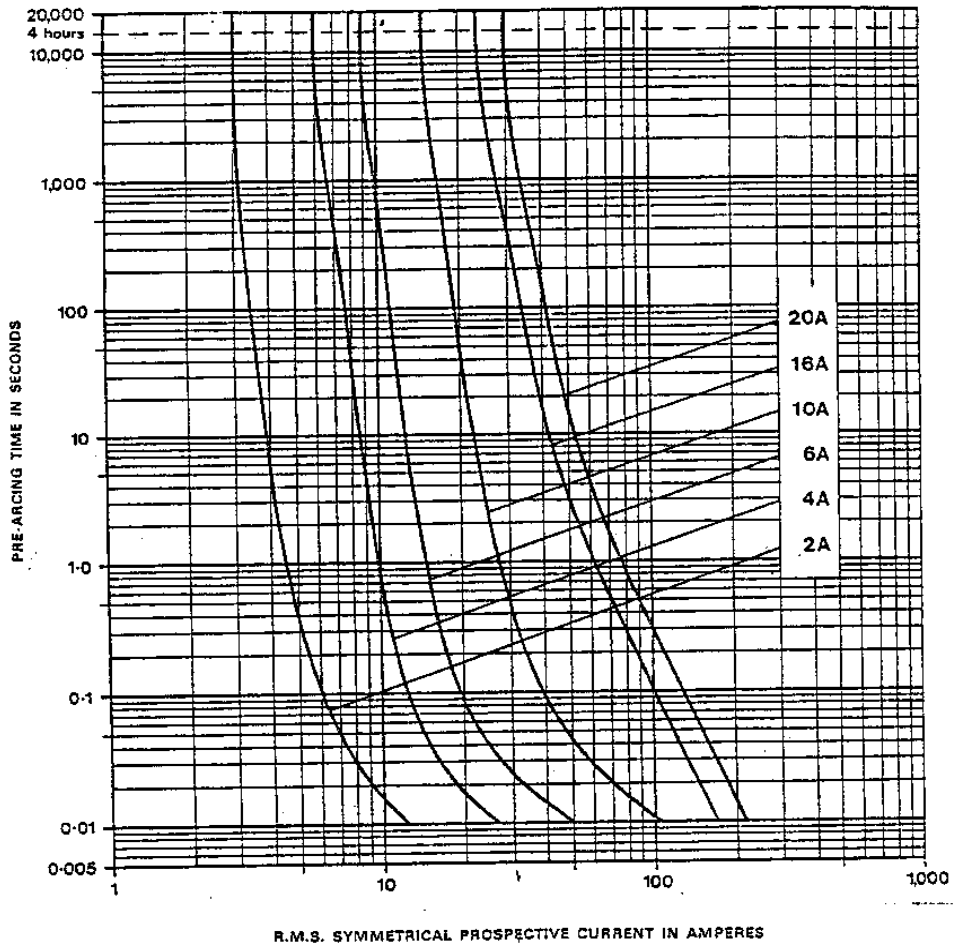
Describe the actions and further tests you took to verify that the installation complied with AS/NZS 3000. Include in your description the permitted minimum value of any test results.

(4 marks)

(turn over)

Question 3

- (a) The following graph shows the time/current characteristics of six HRC fuses.



- (i) Which one of these fuses would blow (with a pre-arcing time of 0.1 seconds) when a current of 100A flows? Give a reason for your answer

(2 marks)

(turn over)

Question 3 continued

- (ii) Why is the graph referred to as an inverse-time current characteristic graph? Provide an example from the graph to support your answer. (4 marks)

- (b) (i) What is the fusing current of a 20A gG rated HRC fuse? (½ mark)

- (ii) What is the fusing current of a 20A gM rated HRC fuse? (½ mark)

- (c) Give a brief description of what "discrimination" means when applied to protective devices. (1 mark)

- (d) Under what circumstances must back-up protection be installed in a motor circuit? (2 marks)

(turn over)

Question 4

(a) A 400V, three-phase, four-wire installation has the following resistive loads on each phase:

- Red 60kW
- White 40kW
- Blue 82kW

Determine the neutral current. A scaled diagram may be used.

(8 marks)

(turn over)

Question 4 continued

- (b) State **TWO** technical reasons why it is important to balance single-phase loads on a star-connected three phase installation.

(2 marks)

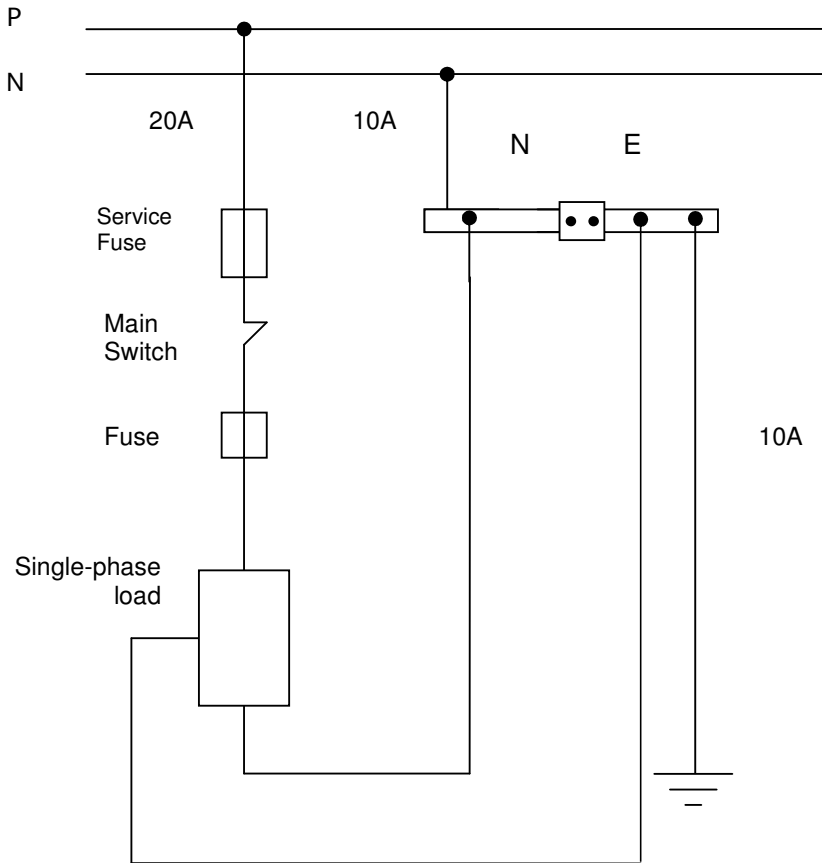
(1) _____

(2) _____

(turn over)

Question 5

- (a) This diagram represents a single phase domestic installation. The current in the phase is 20A, the neutral 10A and the main earth is 10A.



- (i) Give **TWO** reasons why the neutral and earth of the installation carry the same current?

(2 marks)

- (1) _____

- (2) _____

(turn over)

Question 5 continued

- (ii) Explain why the main earth in the installation is effective. (1 mark)

- (b) State **THREE** main features that distinguish an MEN switchboard from a distribution switchboard? (3 marks)

(1) _____

(2) _____

(3) _____

- (c) State **TWO** factors that limit the prospective short-circuit current in an electrical installation. (2 marks)

(1) _____

(2) _____

(turn over)

Question 5 continued

- (d) In the New Zealand low voltage MEN distribution system the neutral is earthed. State **TWO** points on the MEN distribution system where the neutral is earthed.

(2 marks)

(1) _____

(2) _____

(turn over)

Question 6

A 11kV/415V, three-phase, delta-star transformer has a 5% impedance. When fully loaded a phase current of 3.03A flows in its primary windings. Assume there are no internal losses.

(a) Calculate the full-load secondary line current.

(4½ marks)

(turn over)

Question 6 continued

(b) Calculate the **kVA** rating of the transformer

(2½ marks)

(c) (i) Calculate the fault level in kVA which would be produced at the transformer secondary terminals.

(1½ marks)


(ii) Calculate the prospective short circuit current that would flow if a short circuit of negligible impedance occurs across the transformer output terminals.

(1½ marks)

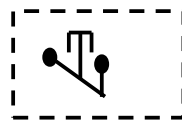
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Question 7

(a) The diagram below is a control circuit for a star delta starter. The remote start/stop station and remote emergency stop are to be added to the circuit. Draw the conductors that connect the remote start/stop station and remote emergency stop to the existing circuit.

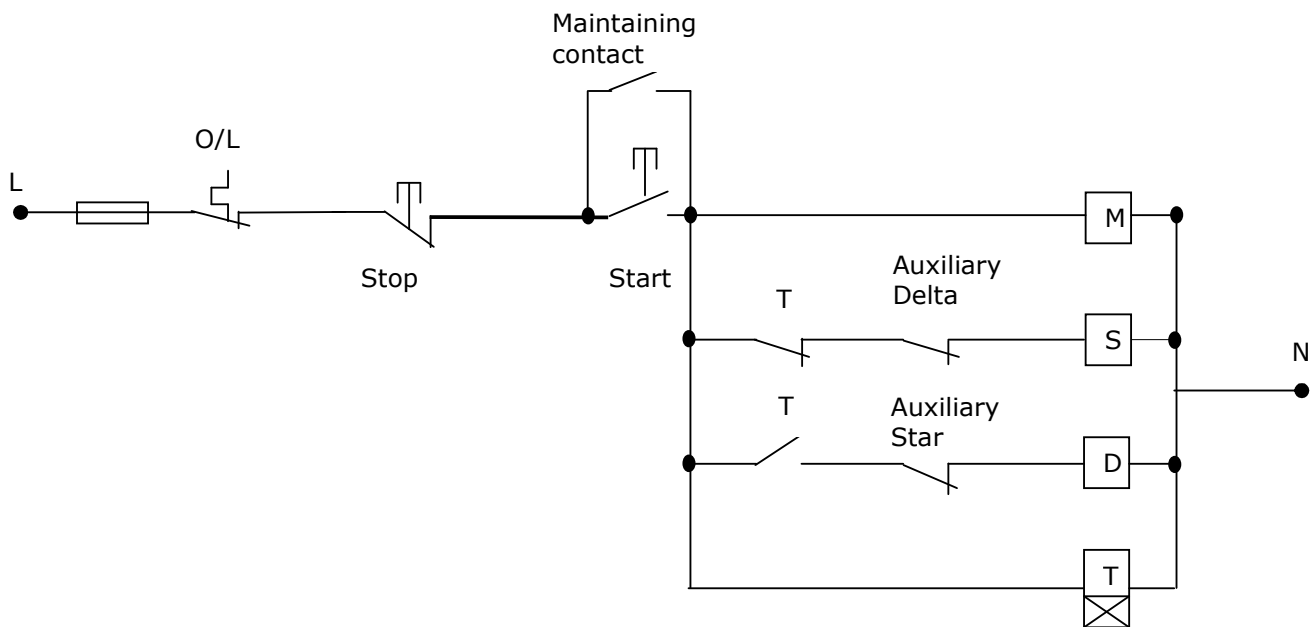
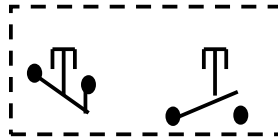
- You can use only use **FIVE** conductors to connect the remote start/stop station and remote emergency stop:
- You must remove **ONE** conductor from the existing circuit - show this by crossing the conductor out like this 

(4 marks)



Remote emergency stop

Remote start/stop



(turn over)

Question 7 continued

- (b) You have been requested to wire the power circuit for a single phase forward and reverse motor to control a roller door.

Draw and label the 230V power circuit for the single phase 550W capacitor-start induction motor showing all control components to enable it to run correctly and safely.

(6 marks)

(turn over)

Question 8

(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 8 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 9

- (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 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)

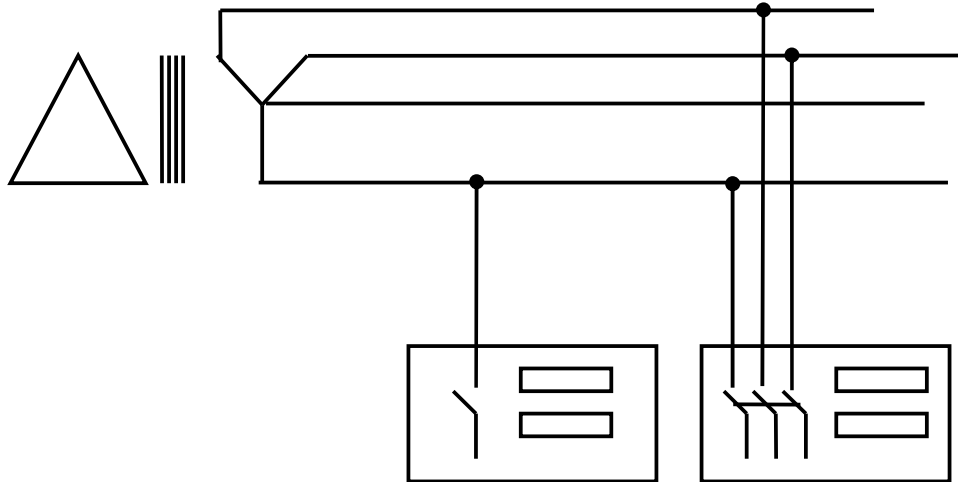
- (ii) Briefly describe the internal operation of the MCB when its magnetic function operates.

(2 marks)

(turn over)

Question 9 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)

For Candidate's Use

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

For Examiner's Use Only		
Questions Answered	Marks	
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