



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

ELECTRICIAN'S THEORY EXAMINATION

17 November 2007

QUESTION AND ANSWER BOOKLET

Time Allowed: 3 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) Briefly describe how earthing the metal frame of a Class I electrical appliance prevents electric shock hazards under fault conditions. (2 marks)

- (b) State **TWO** reasons for using reduced voltage starting for a three-phase induction motor. (2 marks)

(1) _____

(2) _____

- (c) (i) What type of three-phase a.c. motor is most likely to have a wound rotor and an external resistance bank? (1 mark)

- (ii) How is the rotation of a three phase slip ring motor reversed? (1 mark)

- (d) A residual current device (RCD) has operated. The RCD protects a circuit and a fixed-wired Class I electrical appliance. What has the RCD detected that would cause it to operate? (2 marks)

(turn over)

Question 1 continued

(e) What is the purpose of the capacitor in starting a single-phase a.c. capacitor-start induction motor?

(2 marks)

(f) State the main reason why it is important to consider prospective-short-circuit current when choosing a protection device?

(2 marks)

(g) What is the main consequence of opening the secondary circuit of a CT?

(2 marks)

(h) State **TWO** advantages that HRC fuses have when compared to rewirable fuses.

(2 marks)

(1) _____

(2) _____

(turn over)

Question 1 continued

(i) An ohmmeter gives a reading of 24 ohms when used to measure the resistance of a plug-in heater designed for use on 230V/240V a.c. supply. If the heater draws 10 amps when plugged into a 240 V supply:

(i) Will the current increase or decrease when the heater is plugged into a 230 V supply?

(1 mark)

(ii) Will the power dissipated increase or decrease when the heater is plugged into a 230 V supply?

(1 mark)

(j) In a three-phase standard low voltage MEN electrical installation, one end of the main earthing conductor is connected to an earth electrode. To where must the other end of the main earthing conductor be connected.

(2 marks)

(turn over)

Question 2

- (a) Describe what happens in an electrical installation when a fault occurs and there is "discrimination" between protective devices.

(2 marks)

- (b) An HRC fuse is marked with the terms "60A", "440V" and "AC40". What is the meaning of each of these terms?

60A

(1 mark)

440V

(1 mark)

AC40

(2 marks)

- (c) Under what circumstances must back-up protection be installed in a circuit?
(1 mark)

(turn over)

Question 2 continued

- (d) What is meant by the term inverse time-current characteristic in relation to fuses and circuit breakers?

(2 marks)

- (e) Sketch a typical inverse time-current characteristic as applied to fuses.

(1 mark)

(turn over)

Question 3

(a) An old three-phase induction motor has been repaired and there are no markings on the terminal block to indicate which pair of terminals are the ends of a winding. Both the protective earthing conductor test and the insulation resistance test of the motor are satisfactory.

(i) List the tests you would carry out to enable the motor to be connected.

(2 marks)

(ii) The motor nameplate shows the following term:

400V 

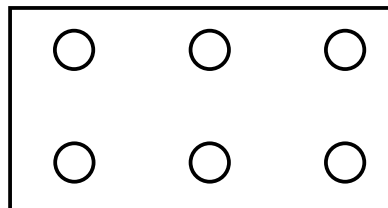
What does this term mean?

(1 mark)

(iii) On the terminal block below:

- Draw the windings across the terminals
- Label the terminals
- Draw the links
- Draw the supply lines to achieve the connection you have stated in (ii) above.

(4 marks)



(turn over)

Question 3 continued

- (b) A three-phase induction motor hums on starting but fails to rotate. List **TWO** possible causes for this fault.

(2 marks)

(1) _____

(2) _____

- (c) A three-phase induction motor overheats while running on load. List **ONE** possible cause for this fault.

(1 mark)

(turn over)

Question 4

Note: Read the entire question before attempting to answer (a), (b) and (c).

Another electrician has isolated, disconnected and repaired a 400V three-phase wood planer in joinery. You are required to:

- Reconnect the machine by connecting the flexible cord to the DOL (direct-on-line) starter mounted on an adjacent pillar, and
- Recommission the planer.

There are no danger tags or lock attached to the isolator controlling the DOL starter. The isolator has a locking facility.

Warning: If any part of your answer is dangerous or hazardous, you will get no marks for this question.

(a) You need to carry out **TWO** tests using test instruments to ensure the planer is safe to connect to the supply.

(i) State the order in which the tests are carried out.

(1 mark)

(ii) For each of the two tests state:

- The type of test
- The type of instrument used.
- How the test is carried out.
- The expected test result.
- Whether the test result is a minimum or maximum value.

(4½ marks)

Test 1

(turn over)

Question 4 continued

Test 2

- (b) Briefly describe the sequence of actions you should take to ensure your own safety before recommissioning the planer.

(1½ marks)

- (c) State **THREE** main actions you will need to take after you have connected the planer.

(3 marks)

(1) _____

(2) _____

(3) _____

(turn over)

Question 5

A three-phase star connected pottery kiln draws 20A from a 400V supply and is protected by 32A fuses.

(a) A fault of 8Ω has developed between one line and the kiln frame while the kiln is operating. Assume that the protective earthing conductor resistance is 0Ω and the fuse has a fusing factor (gG Utilisation Category) of 1.5.

(i) Calculate the total current in the faulty line.

(3 marks)

(ii) Determine by calculation and state the effect if any, that this fault will have on the circuit protection.

(2 marks)

(turn over)

Question 5 continued

(b) A fault of 8Ω has developed between one line and the kiln frame while the kiln is operating and the protective earth conductor resistance to the kiln was 12Ω .

(i) Calculate the total current in the faulty line

(2 marks)

(ii) Explain by calculations, what electrical hazard this presents to the user.

(3 marks)

(turn over)

Question 6

(a) Draw and label a circuit diagram of a 230V control circuit of a three-phase DOL motor starter. Only the items listed below are to be included.

- The polarity
- A fuse that protects the entire circuit
- A stop button that controls the circuit
- A start button that controls the circuit
- A hold in contact (maintaining contact)
- A thermal overload relay contact
- A 230V coil

You do not need to show the main contacts or the motor

(6 marks)

turn over)

Question 6 continued

- (b) Redraw the stop and start buttons you have drawn in (a) above and show how a remote stop-start station may be connected into the circuit by the use of a three-core cable.

(3 marks)

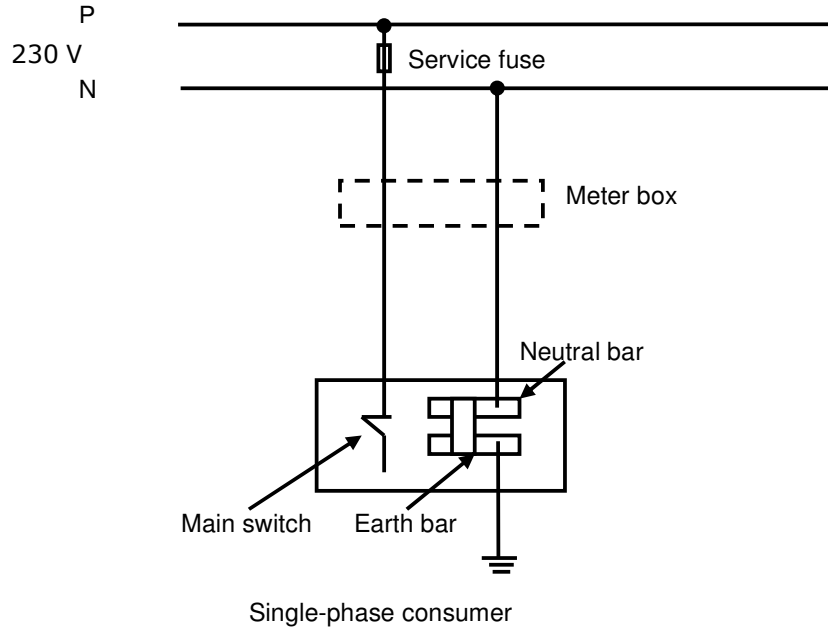
- (c) State **ONE** other type of protective device that could be used in place of a thermal overload.

(1 mark)

(turn over)

Question 7

- (a) The figure below represents a new low voltage single-phase supply to a domestic installation. **The installation is live.**



State **THREE** hazards that will occur if the phase and neutral are transposed.

(3 marks)

- (1) _____

- (2) _____

- (3) _____

(turn over)

Question 7 continued

(b) From the figure in (a) above:

- (i) Describe how you would carry out an instrument test to establish whether a phase/neutral transposition has taken place. Include in your description the type of instrument and equipment used.

(3 marks)

- (ii) State the expected instrument readings when a transposition has taken place.

(2 marks)

- (c) An existing low voltage single phase electrical installation has been operating satisfactorily for the 10 years since it was new. No electrical work has been carried out on the installation or on the surrounding distribution network since the house was built.

The occupants have begun to receive electric shocks off their washing machine you have been called to investigate and make repairs for some No transposition has occurred to the mains of the house.

State **TWO** likely causes of the problem.

(2 marks)

(1) _____

(2) _____

(turn over)

Question 8

- (a) The three phase low voltage supply to a factory is required to be at a voltage that is not commonly used.

The factory is supplied by a 150 kVA, three-phase, delta-star-connected step-down transformer has a phase- turns ratio of 43.3 to 1. The primary is connected to an 11 kV, three-phase supply, and the transformer is fully loaded.

- (i) Draw a diagram of the circuit, showing primary and secondary windings.

(1½ marks)

- (ii) Calculate the secondary phase voltage.

(1½ marks)

- (iii) Calculate the secondary line voltage.

(1½ marks)

(turn over)

Question 8 continued

(iv) Calculate the primary line current.

(2 marks)

(v) Calculate the maximum secondary line current the transformer can deliver under full load conditions.

(1½ marks)

(b) Explain **ONE** practical method of reducing the iron loss of a transformer.

(2 marks)

(turn over)

Question 9

(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. (2 marks)

(ii) Give a brief description of circumstances when an Out-of-Service Tag is used. (2 marks)

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

(1) _____

(2) _____

(3) _____

(turn over)

Question 9 continued

- (b) Describe how the prove-test-prove method of testing is carried out. (3 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		
3		
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7		
8		
9		
TOTAL		