



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

ELECTRICAL INSTALLER THEORY EXAMINATION

22 June 2013

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 plug-in electric heater is rated for use on 230V/240V supply. It is rated at 2kW on a 230V supply. An ohmmeter measures the resistance of the heater as 26.45Ω .

Calculate the power the heater dissipates when operating at 240V.

(2 marks)

- (b) Describe **ONE** acceptable method of discharging a **large** capacitor before disconnection from a circuit that has already been isolated.

(2 marks)

- (c) (i) If a three-phase motor has six terminals and windings rated at 230V how should it be connected to a 400V, three-phase supply?

(1 mark)

- (ii) Why do three-phase induction motors run smoother and quieter than single-phase induction motors?

(1 mark)

(turn over)

Question 1 continued

- (d) State **TWO** types of operation employed by most MCBs. (2 marks)

(1) _____

(2) _____

- (e) State **TWO** components that are usually used to smooth the DC output of a rectifier. (2 marks)

(1) _____

(2) _____

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

(1) _____

(2) _____

- (g) An RCD is a safeguard designed to operate if current from a faulty appliance flows through a person's body to earth.

Why, then, doesn't that person receive a severe shock from the faulty appliance?

(2 marks)

(turn over)

Question 1 continued

- (h) (i) How many capacitors are there in the circuit of a permanently split capacitor motor?

(1 mark)

- (ii) What is the purpose of a centrifugal switch in a single-phase split-phase motor?

(1 mark)

- (i) State the reason why a PRCD is designed to open if the electricity supply to the PRCD is interrupted and **not** automatically reset when supply is restored.

(2 marks)

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

(1 mark)

- (ii) State the circumstances where a capacitor-start induction motor would be the preferred choice.

(1 mark)

(turn over)

Question 2

A new three-phase water heater has been installed in an industrial installation to replace an existing water heater. It has three elements rated at 400V, each with a resistance of 30Ω . The elements can be connected either in star or delta.

No changes will be made to the circuit supplying the new water heater.

- (a) (i) Calculate the line current drawn when the **elements are connected in star.**

(2 marks)

- (ii) Calculate the line current drawn when the **elements are connected in delta.**

(3½ marks)

- (iii) The circuit is protected by 10A rewirable fuses. In relation to the electrical protection, state which connection arrangement is most suitable for this installation?

(½ mark)

(turn over)

Question 2 continued

- (b) Calculate the difference in the power consumed by the water heater when the elements are connected in star and when the elements are connected in delta

(4 marks)

(turn over)

Question 3

- (a) State **TWO** reasons why a neutral conductor is required in the cable supplying a three-phase final subcircuit that has heating loads that draw different values of current on each of the phases.

(4 marks)

(1) _____

(2) _____

- (b) State **TWO** reasons why the neutral conductor is earthed in an MEN system.

(4 marks)

(1) _____

(2) _____

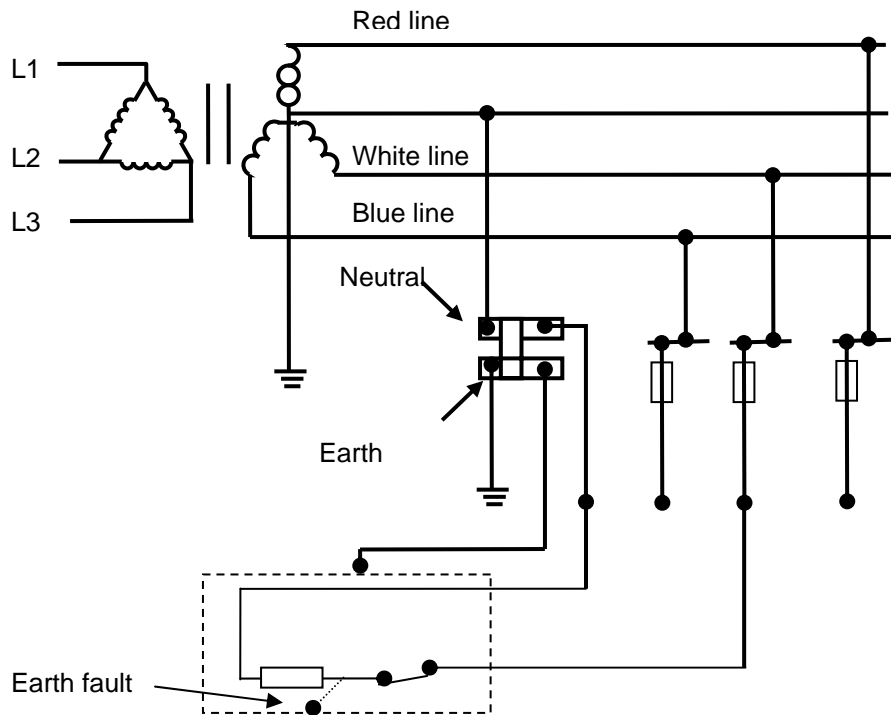
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Question 3 continued

- (c) The figure below shows a three-phase supply, consumers' neutral and earth bars, and protective fuses. It also shows a single-phase Class I appliance with a phase - to - frame fault on the load side of the appliance switch.

Clearly draw on the figure the fault loop impedance path for this circuit.

(2 marks)



(turn over)

Question 4

Introduction

A 20A MCB protects a circuit consisting of multiple plug sockets supplying various electrical appliances in an office. The MCB has tripped. When the MCB is reset, it trips again when the supply is restored to the circuit.

You have established that the MCB is not faulty and is correctly rated for the circuit.

Use the information in the introduction to this question to answer parts 4(a), 4(b), 4(c) and 4(d).

- (a) State the **THREE** possible faults that would cause the MCB to trip for a second time.

(1½ marks)

Fault No.1

Fault No.2

Fault No.3

(turn over)

Question 5

Introduction

A three-phase motor is controlled by DOL starter that contains thermal overloads. The starter control circuit operates at 230V. The motor circuit is protected by HRC fuses.

Use the information in the introduction to this question to answer parts 5(a), 5(b) and 5(c).

- (a) (i) Draw and label the circuit diagram of the 230V DOL starter control circuit. The control circuit incorporates electrical protection.

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

(4 marks)

(turn over)

Question 5 continued

- (ii) The 230V coil in the control circuit has burnt out. The only replacement you have is a 400V coil. State the modifications you would make to the 230V control circuit so the 400V coil can be used. (2 marks)

- (b) The thermal overload protection is replaced with thermistor protection.

Describe how the thermistor would provide protection to the motor (2 marks)

- (c) When the start button is pushed on the DOL starter the contactor closes, but as soon as the start button is released the contactor drops out.

State the main reason why this situation would occur. (2 marks)

(turn over)

Question 6 continued

(b) The circuit has been correctly isolated. You have removed the motor and replaced the isolator with a new lockable isolator.

(i) State **TWO** methods, either of which can be used to ensure the **continued** isolation of the motor cables.

(2 marks)

(1) _____

(2) _____

(ii) State what needs to occur to ensure that the equipment is safe to be left unattended?

(2 marks)

(c) Describe the circumstances when a **Danger Tag** is used.

(2 marks)

(turn over)

Question 7

Introduction

A three-phase, 400 V, star-connected lathe draws 27A per phase from the supply. The circuit is protected by 32A motor-rated fuses that have a utilisation category (fusing factor) of 2.

A fault of 14Ω has occurred between blue phase and the machine frame while the machine was operating.

The earth fault loop impedance of the circuit is 13.7Ω . This **includes** a protective earthing conductor resistance of 10.3Ω .

Use the information in the introduction to this question to answer parts 7(a), 7(b) 7(c) and 7(d).

- (a) Calculate the total current that would flow in the blue phase when the fault occurred.

(4 marks)

- (b) Use calculations to show whether the HRC fuse will operate (blow) when this fault occurs on the blue phase.

(2 marks)

(turn over)

Question 7 continued

- (c) Use calculations to show the touch voltage that would develop on the machine frame when the fault occurred on the blue phase. (2 marks)

- (d) Explain whether or not the fault on the blue phase causes a danger to the operator of the lathe. (2 marks)

(turn over)

Question 8

(a) A three-phase induction motor is started by a star/delta starter.

- (i) State the percentage of the direct-on-line starting torque developed by the motor in the start (star) position.

(1 mark)

- (ii) State **TWO** forms of protection incorporated in the star/delta starter – other than interlocks.

(2 marks)

(1) _____

(2) _____

- (iii) Explain the purpose of the interlocks in the star/delta starter.

(2 marks)

(turn over)

Question 8 continued

- (b) State **THREE technical** advantages an electronic soft starter has when compared to an auto-transformer starter when **starting** a three-phase induction motor.

(3 marks)

(1) _____

(2) _____

(3) _____

- (c) State the effect on the operation of a three-phase induction motor if the **load-torque** exceeds the **pull-out torque**.

(2 marks)

(turn over)

Question 9

(a) You are testing the integrity of the insulation of a 230V, Class I, electrical appliance that has been repaired. The appliance has semi-conductor devices used in its internal circuitry. It is impractical to disconnect the semi-conductors.

(i) To test the integrity of the insulation you have an **insulation resistance tester with 100V d.c. and 250V d.c ranges.**

Describe how you would test the integrity of the insulation of the appliance using **this** test instrument. Include:

- Whether the appliance needs to be live.
- A test result that permits the appliance to be returned to service. (2½ marks)

(ii) To test the integrity of the insulation you have an **insulation resistance tester with 500V d.c. and 1000V d.c ranges.**

Describe how you would test the integrity of the insulation of the appliance using **this** test instrument. Include:

- Whether the appliance needs to be live.
- A test result that permits the appliance to be returned to service. (3 marks)

(turn over)

Question 9 continued

- (iii) To test the integrity of the insulation you have a **clip-on (clamp) ammeter with mA ranges**.

Describe how you would test the integrity of the insulation of the appliance using **this** test instrument. Include:

- Whether the appliance needs to be live.
- A test result that permits the appliance to be returned to service. (2 marks)

- (b) You have repaired the electric motor and flexible supply cord of a 230V, Class I, plug-in dishwasher. You need to carry out an earth continuity (protective earthing conductor) test.

- (i) What instrument should be used to make the earth continuity test? (½ mark)

- (ii) Briefly describe how you would carry out this test. (1 mark)

- (iii) State test result that permits the dishwasher to be returned to service. (1 mark)

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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		