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

ELECTRICAL WORKERS REGISTRATION BOARD

ELECTRICIAN'S THEORY EXAMINATION

17 June 2006

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. Show answers to TWO decimal places.

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) Explain the term sensitivity in relation to using an RCD for personal protection.
(2 marks)

_____

_____

_____

_____

(b) State **ONE** reason why it is important to consider prospective-short-circuit current when choosing a protection device?
(2 marks)

_____

_____

_____

_____

(c) State **ONE** reason why interlocks are used in a star/delta starter.
(2 marks)

_____

_____

(d) When connecting test instruments to confirm the isolation of a 230V circuit (that may or may not be live), it is important to follow set procedures to ensure personal safety. Briefly describe **TWO** important precautions which will promote personal safety.
(2 marks)

(1) _____

_____

(2) _____

_____

(turn over)

Question 1 continued

(e) What is meant by the term "inverse time-current characteristic" in relation to protective devices?

(2 marks)

_____

_____

_____

(f) (i) What type of switch can be used instead of the centrifugal switch in single-phase capacitor start motors?

(1 mark)

_____

(ii) How many capacitors are there in the circuit of a single-phase permanently-split capacitor motor?

(1 mark)

_____

(g) (i) If the burden on a current transformer is increased, what practical effect does this have on the primary current?

(1 mark)

_____

_____

(ii) What is the normal maximum secondary voltage of an instrument voltage transformer?

(1 mark)

_____

(turn over)

Question 1 continued

(h) (i) Describe the characteristics of a thermistor.

(1 mark)

_____

_____

(ii) Give **ONE** practical application of this device.

(1 mark)

_____

_____

(i) State **ONE** reason why auto transformers are **not** used to supply electric toys?

(2 marks)

_____

_____

(j) State **TWO** types of operation employed by most miniature circuit-breakers.

(2 marks)

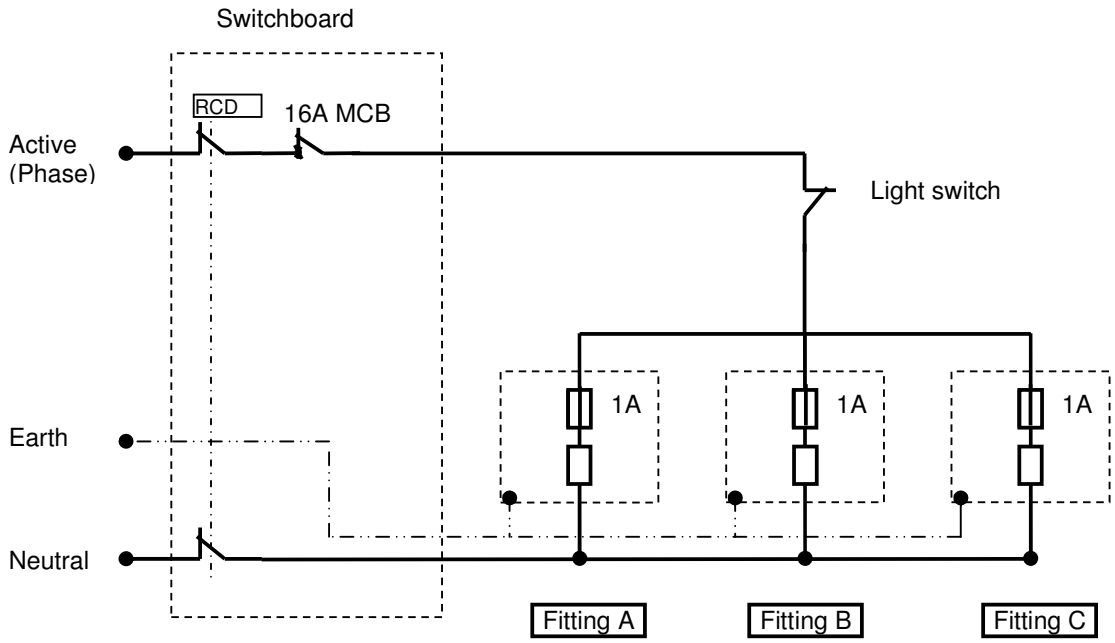
(1) _____

(2) _____

(turn over)

Question 2

The figure below represents 3 fluorescent lights supplied from a 230V MEN supply.



The fuses in the light fittings are HRC fuses.

(a) (i) Which parts of the circuit are protected by the MCB.

(1 mark)

_____

(ii) What types of fault does the MCB provide protection for?

(1 mark)

_____

_____

(b) (i) Which parts of the circuit are protected by the HRC fuse in Fitting A?

(1 mark)

_____

(ii) What types of fault does this fuse provide protection for?

(1 mark)

_____

_____

(turn over)

Question 2 continued

(c) (i) Which parts of the circuit are protected by the RCD.

(1 mark)

_____

(ii) What type of fault does the RCD provide protection for?

(1 mark)

_____

_____

(d) How are they seeking to achieve discrimination in the figure above?

(2 marks)

_____

_____

(e) State **TWO** reasons why the fuses in the fittings must not be shorted out or increased in current rating.

(2 marks)

(1) _____

_____

(2) _____

_____

(turn over)

Question 3

(a) Sketch and label a circuit diagram of an RCD used for personal protection that includes the following components:

- Sensing coil/toroid
- Tripping device
- Test circuit (push button and resistor)
- Active, neutral and earth conductors.
- Class I equipment load

(4 marks)

(turn over)

Question 3 continued

(b) Describe the operation of the RCD circuit when there is a phase to earth fault

(4 marks)

(1) _____

_____

(2) _____

_____

(3) _____

_____

(4) _____

_____

(c) Explain the following terms:

(2 marks)

PRCD _____

_____

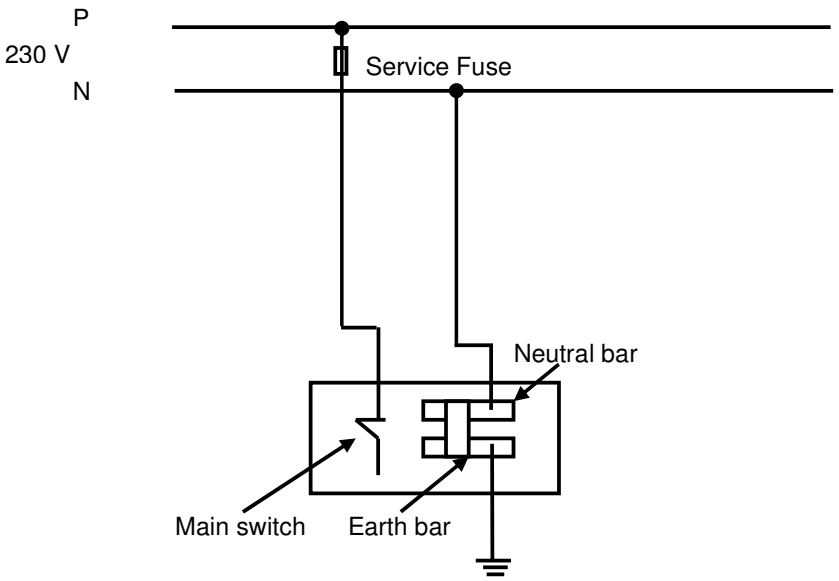
RCBO _____

_____

(turn over)

Question 4

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



Single-phase consumer

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

(3 marks)

(1) _____

_____

_____

(2) _____

_____

_____

(3) _____

_____

_____

(turn over)

Question 4 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 no transposition has taken place.

(2 marks)

_____

_____

_____

_____

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

(2 marks)

_____

_____

_____

_____

(turn over)

Question 5

A three-phase star-connected pottery kiln draws 25A from a 400V supply and is protected by 30A HRC fuses. A fault of 7Ω has developed between one line and the kiln frame while the kiln is operating and the protective earth conductor resistance to the kiln is 0.5Ω.

Assume that the fuse has a fusing factor (gG Utilisation Category) of 1.5.

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

(2½ marks)

(ii) Explain, using calculations, the effect on the operation of the fuse.

(2 marks)

(b) (i) Calculate the total current in the faulty line if the protective earthing conductor resistance was 12Ω.

(2½ marks)

(turn over)

Question 5 continued

(ii) Explain, using calculations, the effect on the operation of the fuse.

(1 mark)

(iii) Explain, using calculations, what electrical hazard the protective earthing conductor resistance of 12Ω presents to the user of the kiln.

(2 marks)

(turn over)

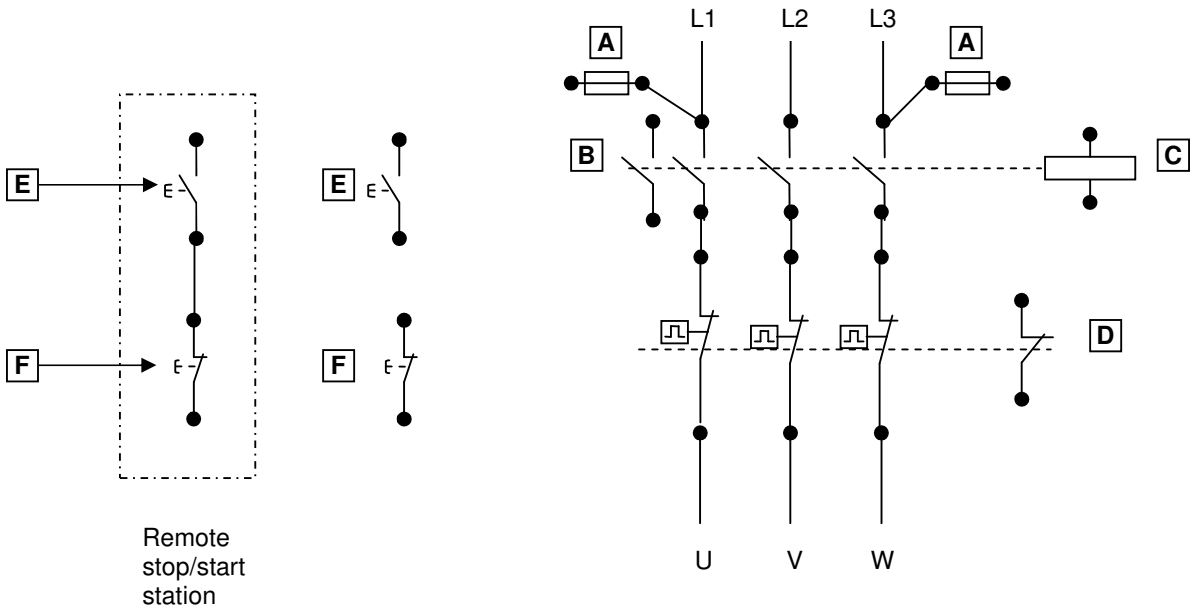
Question 6

(a) The figure below represents the components of a direct-on-line (DOL) starter with a 400V control circuit and a remote stop/start station:

- L1, L2, and L3 represent the three-phases connected to the main contacts.
- U, V and W represent the three conductors from the thermal overloads to the motor
- A are the control circuit fuses
- B is the hold-in contact
- C is the 400V coil
- D is the maintaining contact
- E are the start buttons
- F are the stop buttons

Draw the conductors on the figure to complete a working 400V control circuit

(9 marks)



(b) List **ONE** reason for using reduced voltage starters with squirrel-cage induction motors when a DOL starter may accelerate the load up to speed more quickly.

(1 mark)

_____

_____

(turn over)

Question 7

Note: Read the entire question before answering (a), (b), (c) and (d).

You have completely rewired a single-phase domestic residence. The work included a new switchboard and all sub-circuits including a 2 kW water heater and a 6 kW range. There was no change to the mains and main earthing system **and the installation is live**.

You now need to carry out an insulation resistance test on the installation, but not the mains or main earthing system.

(a) Describe the actions you will take to ensure that the electrical installation is safe to carry out an insulation resistance test.

(2 marks)

(b) Describe how you will carry out the insulation resistance test on the installation with the water heater and range disconnected. Include the permitted minimum test result.

(5 marks)

(turn over)

Question 7 continued

(c) Describe how you will carry out the insulation resistance test on water heater **or** the range. Include the permitted minimum test result.

(2 marks)

_____

_____

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_____

(d) (i) State the type of instrument used for the insulation resistance test.

(½ mark)

_____

(ii) State the prescribed voltage that is to be used for the insulation resistance test.

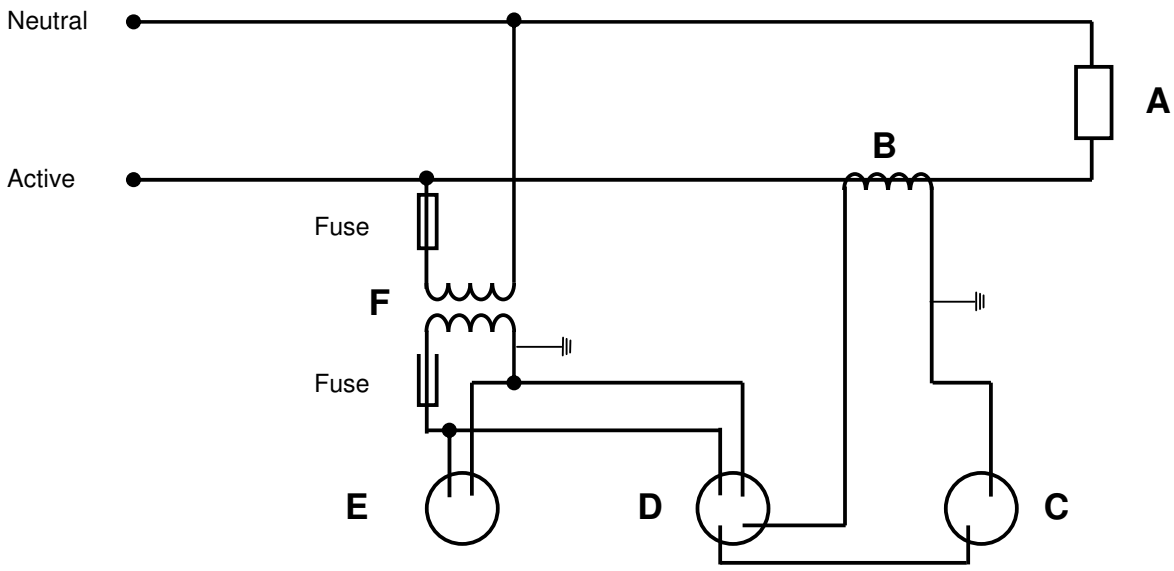
(½ mark)

_____

(turn over)

Question 8

(a) The circuit below represents an arrangement to measure the voltage, total current, and the power of a load.



(i) Name the components indicated.

(3 marks)

A _____

B _____

C _____

D _____

E _____

F _____

(ii) What main precaution needs to be taken when working on that part of the circuit containing components "B" and "C".

(2 marks)

_____

_____

(turn over)

Question 8 continued

(b) A 250 kVA three phase, delta-star connected transformer has a phase ratio of 47.8 to 1. The primary is connected to an 11kV three phase supply and the transformer is fully loaded.

(i) Calculate the secondary phase voltage.

(2 marks)

(ii) Calculate the secondary line voltage.

(2 marks)

(c) State **ONE** reason why the secondary terminal voltage of a transformer is less at full load than it is with no load.

(1 mark)

_____

_____

(turn over)

Question 9

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

Alterations are being carried out in a milking shed. An old three-phase electric hot water cylinder is to be removed and you have been requested to disconnect it. The cylinder is protected by HRC fuses on a three-phase switchboard and a lockable isolating switch is located adjacent to the cylinder.

At a later date a new cylinder will be installed in the same position and reconnected to the existing wiring by another electrician.

You have been requested to:

- Disconnect the wiring from the existing cylinder, but leave the wiring in place.
- Ensure that another electrician can safely connect the new cylinder.

You need to carry out the work in such a manner that ensures your own safety, the safety of others in the factory and the electrical service technician who is to connect the new cylinder.

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

(a) Describe how you will isolate the cylinder and wiring to ensure it is safe to disconnect. (6 marks)

_____

_____

_____

_____

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_____

(turn over)

Question 9 continued

(b) After you have done the isolation, what would you do to ensure that the work area is safe to be left unattended?

(3 marks)

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_____

(c) State the first action the other electrician should take before attempting to install the replacement hot water cylinder.

(1 mark)

_____

_____

For Candidate's Use

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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7		
8		
9		
TOTAL		