SAFETY | COMPETENCY | COMPLIANCE

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

ELECTRICAL INSTALLER THEORY EXAMINATION

15 November 2014

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.

Question 1

(a) State **TWO** reasons for balancing a load over three phases.

(2 marks)

(1) _____

_____

(2) _____

_____

(b) AS/NZS 3760 permits two methods of verifying that the insulation of a Class I electrical appliance is in sound condition.

For each method state:
- The name of the test.
- The minimum or maximum permitted test result.

(i) Test 1

(1 mark)

_____

_____

(ii) Test 2

(1 mark)

_____

_____

(c) A heater is rated at 2 kW when operating at 230V.

(i) What effect will a voltage drop of 5% have on the resistance of the heater elements?

(1 mark)

_____

(ii) By how much will the power dissipated by the heater change if the voltage drops 5%.

(1 mark)

_____

(turn over)

Question 1 continued

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

(2 marks)

(1) _____

(2) _____

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

Describe the internal operation of the MCB when its magnetic function operates.

(2 marks)

_____

_____

_____

_____

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

(2 marks)

(1) _____

(2) _____

(turn over)

Question 1 continued

(g) Electrical equipment incorporates semi-conductor devices.

(i) State **ONE** precaution that can be taken when carrying out an insulation resistance test on the equipment using a test voltage of 500V d.c.

(1 mark)

_____

_____

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

(1 mark)

_____

_____

(h) 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) Explain why a voltage of 500V is applied.

(1 mark)

_____

_____

(ii) Explain why the voltage is a d.c. voltage.

(1 mark)

_____

_____

(turn over)

Question 1 continued

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

(1 mark)

_____

_____

(ii) Where in a motor circuit would a thermistor be located?

(1 mark)

_____

_____

(j) When taking measurements in a single phase a.c. inductive circuit, the following readings were obtained

- 235V
- 12A
- 2115W

Calculate the power factor of the circuit.

(2 marks)

(turn over)

Question 2

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

(i) Describe the circumstances when a **danger tag** is used.

(1 mark)

_____

_____

_____

(ii) List **THREE** associated requirements for attaching a **danger tag** to an isolating switch after isolation has occurred.

(3 marks)

(1) _____

_____

(2) _____

_____

(3) _____

_____

(iii) Describe the circumstances when an **out-of-service tag** is used.

(1 mark)

_____

_____

_____

(turn over)

Question 2 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 for isolation is carried out.

(1½ marks)

(d) You are testing for voltage at the load side of an isolator to see if a motor is isolated. What tests would you make to clearly establish that isolation (or otherwise) has taken place.

(½ mark)

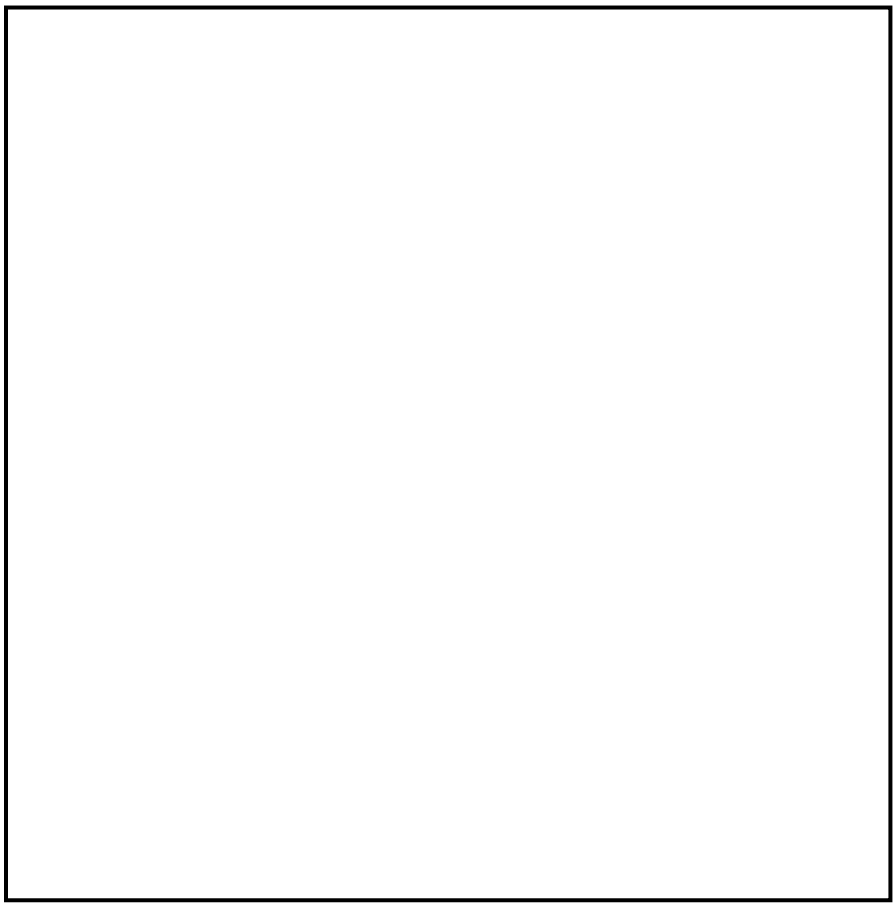
(turn over)

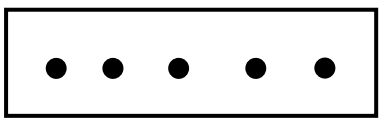
Question 3

(a) The figure below shows a **three-phase** RCD used for personal protection that protects a 5-pin socket outlet in a workshop.

- Draw and label the internal components of the three-phase RCD
- The three-phase supply to the RCD
- The supply to the three-phase socket outlet

(5 marks)





Three-phase socket outlet

(turn over)

Question 3 continued

(b) Explain the term **sensitivity** in relation to an RCD.

(1 mark)

_____

_____

(c) A RCCB protects a 230V final subcircuit and a Class I, fixed-wired electrical appliance. The RCCB has operated (tripped).

State what has occurred that has caused the RCCB to operate (trip).

(2 marks)

_____

_____

_____

(d) State the full names for the following terms:

(2 marks)

RCBO _____

_____

SRCD _____

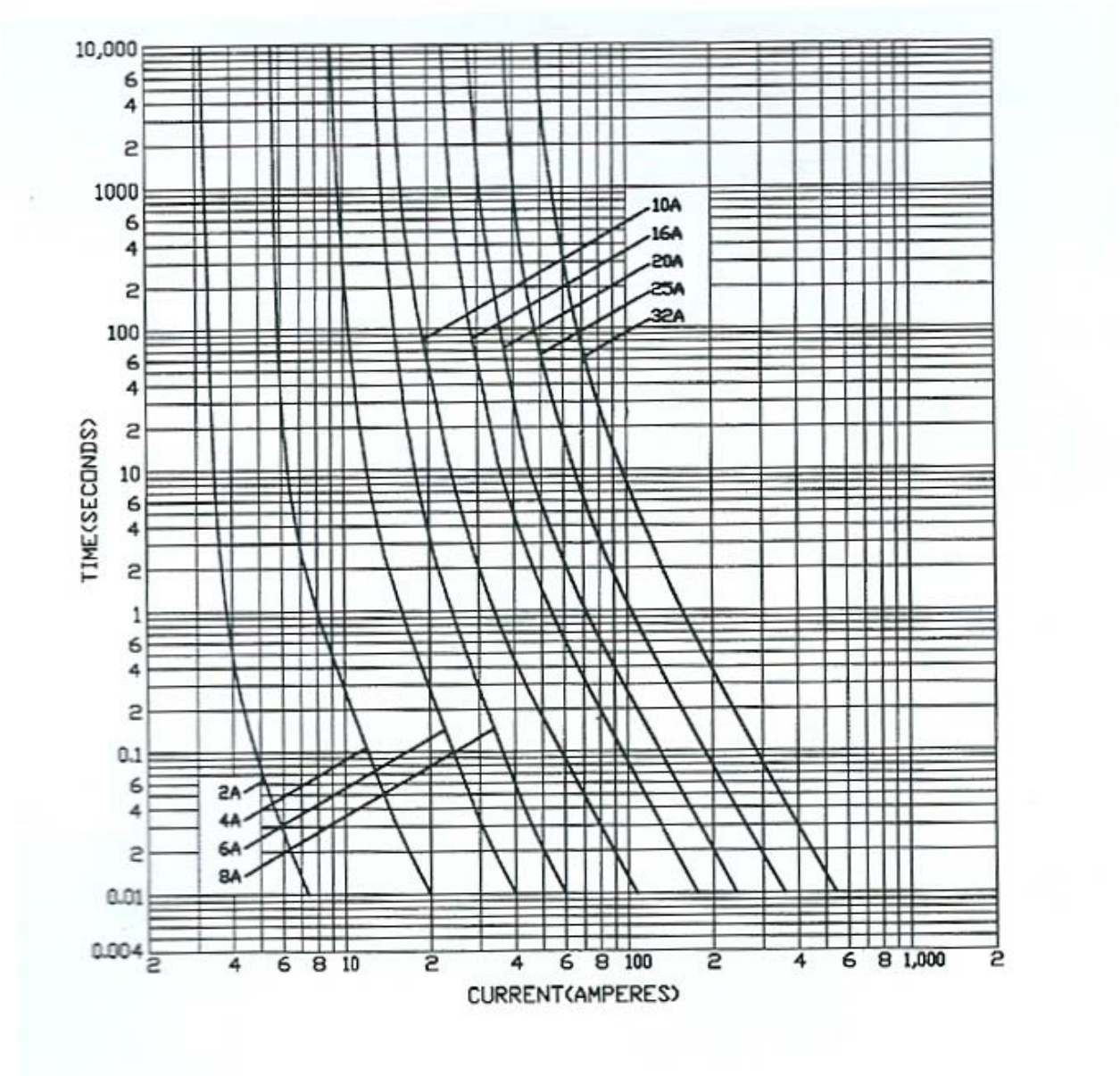
_____

(turn over)

Question 4

(a) **Introduction**

The following graph shows the time/current characteristics of various HRC fuses.



Use the information in the graph to answer part 4(a)(i), 4(a)(ii), 4(a)(iii), 4(a)(iv) and 4(a)(v).

(turn over)

Question 4 continued

(i) Explain why the graph is referred to as an inverse-time current characteristic graph?

(2 marks)

_____

_____

_____

_____

(ii) Use a 25A HRC fuse with fault currents of 50A and 200A to demonstrate an inverse-time current characteristic.

(2 marks)

_____

_____

_____

_____

(iii) Calculate the fusing current of a 20A gG rated HRC fuse with a utilisation category of 1.5.

(1 mark)

(iv) Refer to the graph and determine how long it will take the 20A HRC fuse to operate with the fusing current calculated in (a)(iii) flowing.

(1 mark)

_____

(v) A 20A HRC fuse protects a socket outlet final subcircuit. Refer to the graph and determine the minimum fault current that must flow under fault conditions so the fuse will operate in the maximum time required by AS/NZS 3000.

(1 mark)

_____

(turn over)

Question 4 continued

(b) Define the term **breaking (or rupturing) capacity** as it applies to an HRC fuse

(1 mark)

_____

_____

_____

(c) Define the term **total clearing time** as it applies an HRC fuse.

(1 mark)

_____

_____

_____

(d) Define the term **current rating** as it applies to an HRC fuse?

(1 mark)

_____

_____

_____

(turn over)

Question 5

An 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 5 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 secondary terminals.

(1½ marks)

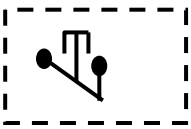
(turn over)

Question 6

(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.

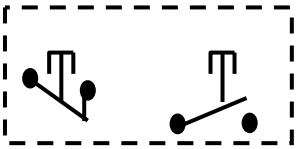
- You can use only **FIVE** conductors to connect the remote start/stop station and remote emergency stop:
- You must remove **ONE** conductor from the existing circuit - show this by crossing the conductor out like this ~~XX~~

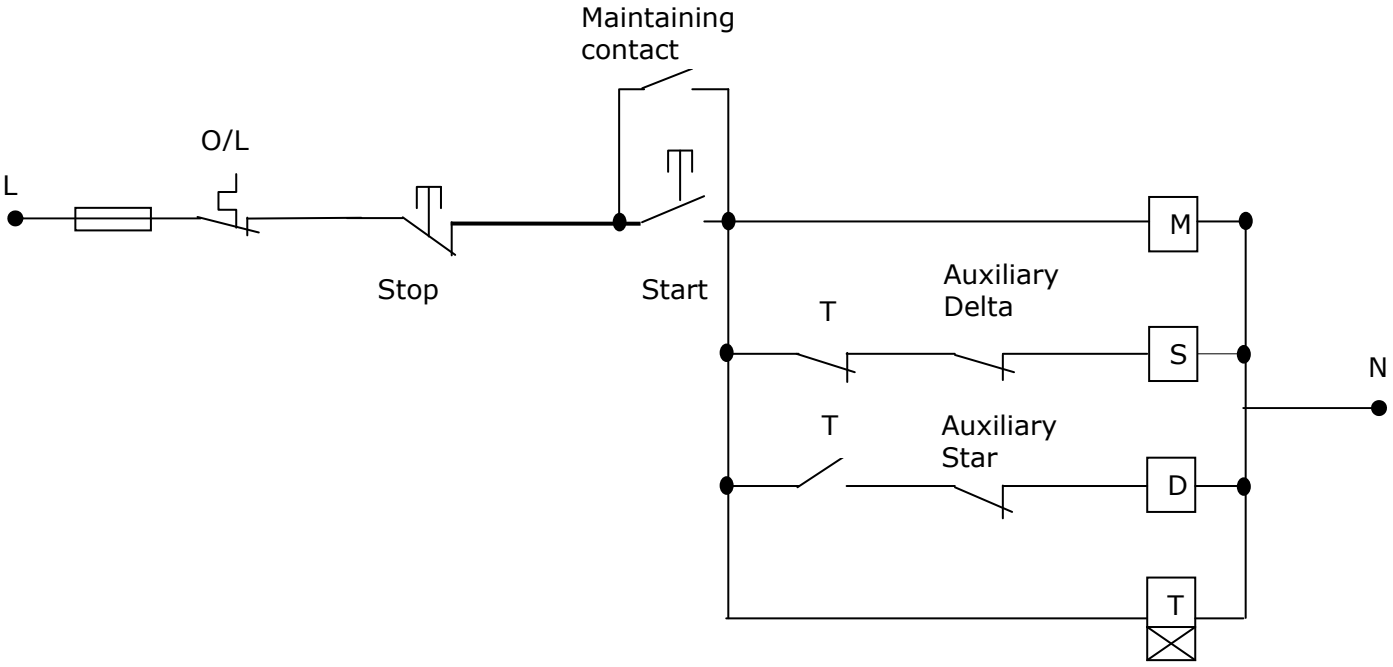
(4 marks)



Remote emergency stop

Remote start/stop





(turn over)

Question 6 continued

(b) Draw and label the **power circuit** for a single-phase 550W, capacitor-start induction motor for a garage roller door. The motor is required to operate in forward and reverse directions.

The fuse or the isolator or control circuit **do not** need to be shown.

(6 marks)

(turn over)

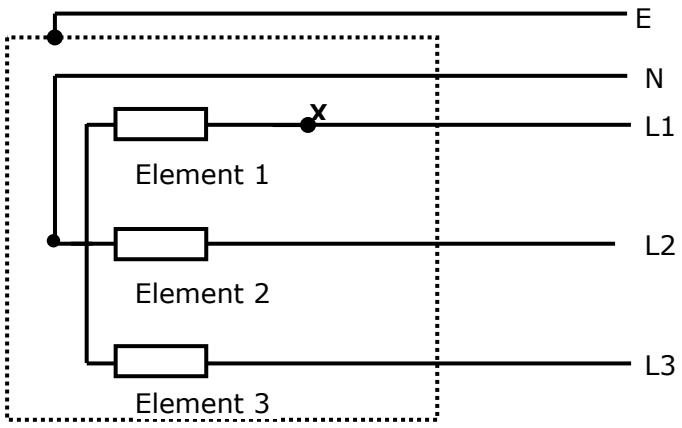
Question 7

Introduction

The figure below represents a three-phase, star-connected 400V, 18 kW commercial oven. The oven is protected by 40A HRC fuses with a fusing factor (gG Utilisation Category) of 1.5.

An earth fault of 6Ω has developed between L1 and the oven frame while the oven is operating. The fault occurred at point X.

The protective earthing conductor resistance is 0.25Ω.



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

(a) Calculate the total current that will flow in L1 under the fault conditions.
(5 marks)

(turn over)

Question 7 continued

(b) Explain by calculations whether the fuse protecting L1 will operate.

(2½ marks)

(c) Explain by calculations whether any hazard exists to the operator of the oven.

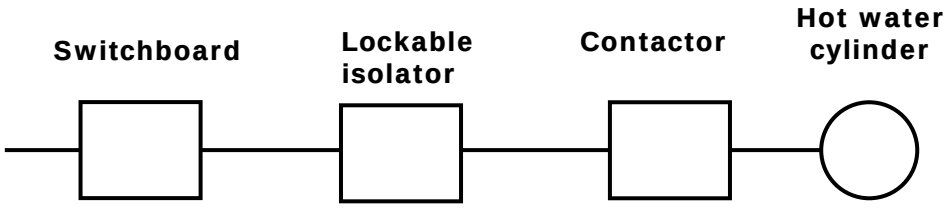
(2½ marks)

(turn over)

Question 8

Introduction

The following figure is a block diagram of a three-phase circuit to a three-phase **star-connected** hot water cylinder in a factory. There are no other connections to the circuit.



The cylinder circuit is protected by HRC fuses on a three-phase switchboard and the lockable isolator and contactor are adjacent to the cylinder.

The existing hot water cylinder is to be replaced. The new cylinder will be installed at a later date

Use the information in the introduction to this question to answer parts 8(a) and 8(b).

(a) (i) Describe the procedure you will use to isolate the old hot water cylinder so it can be safely disconnected and removed.

(3½ marks)

Question 8 continued

(ii) The cables between the contactor and the cylinder are to be left connected to the contactor. State the action you will take to ensure the cables can be connected to the new cylinder

(1 mark)

_____

_____

_____

(iii) You have to remove the lock and danger tag at the completion of the work.

State the actions that need to be taken to ensure the work area is safe to be left unattended.

(2 marks)

_____

_____

_____

_____

_____

_____

(turn over)

Question 8 continued

(b) Sometime later, another electrician is engaged to connect the new cylinder.

State the safety actions that electrician needs to take to ensure it is safe to connect the new hot water cylinder.

(3½ marks)

_____

_____

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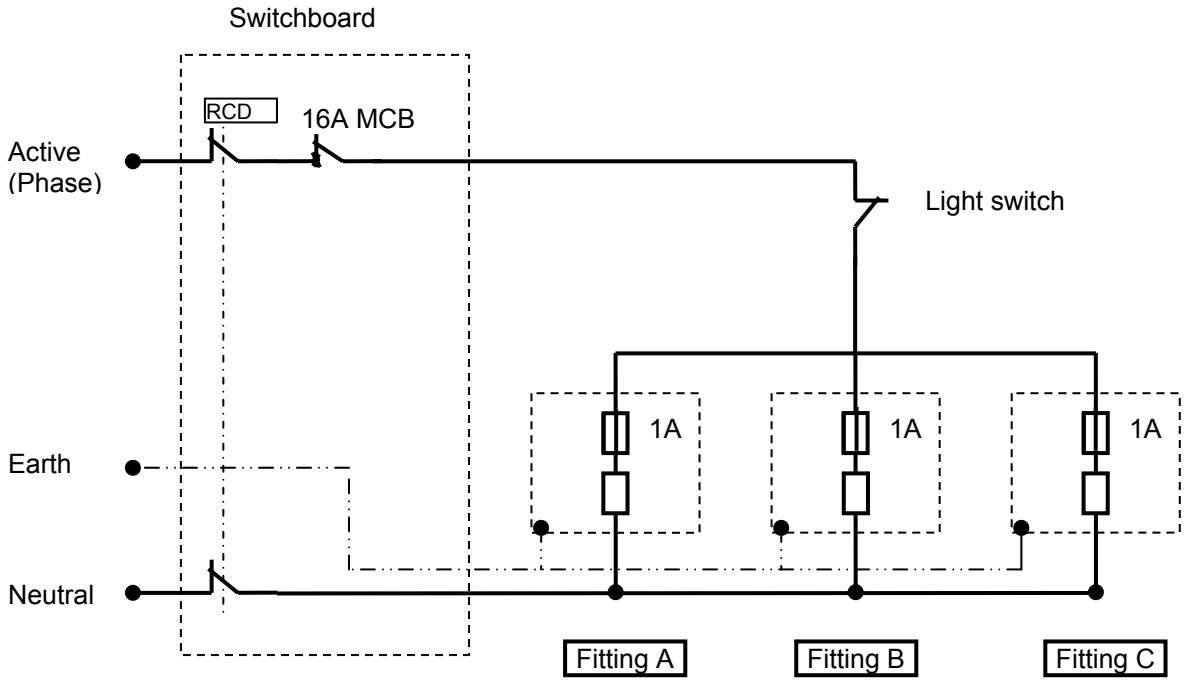
_____

(turn over)

Question 9

Introduction

The figure below represents 3, 230V single fluorescent lights in one section of a factory. This circuit is supplied from a three-phase switchboard



The fuses in the light fittings are HRC fuses.

Use the information in the introduction to this question to answer parts 9(a), 9(b) and 9(c)

(a) The section of the factory incorporates rotating machinery.

The main reason why the fluorescent lighting is not suitable is **stroboscopic effect.**

(i) Explain how a fluorescent light produces a **stroboscopic effect.**

(2 marks)

_____

_____

_____

_____

_____

(turn over)

Question 9

(ii) Describe the dangers produced by **stroboscopic effect**.

(2 marks)

_____

_____

_____

_____

_____

(iii) State **TWO** methods of eliminating **stroboscopic effect**.

(2 marks)

(1) _____

_____

(1) _____

_____

(b) How is discrimination achieved in the lighting final subcircuit?

(2 marks)

_____

_____

_____

(c) State the **main reason** why the fuses in the light fittings must not be shorted out or increased in current rating.

(2 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**	
1		
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