

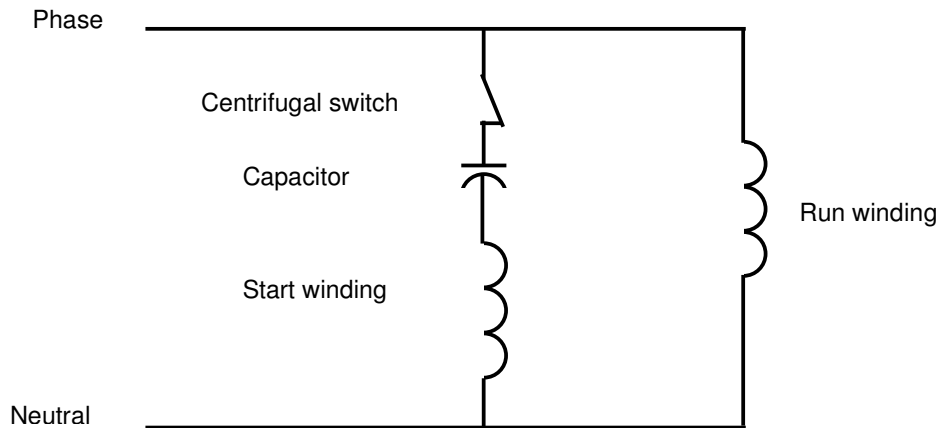
## Version 2 - ET 19 - Electrician Theory Examination Marking Schedule

- Notes: 1. (1 mark) means that the preceding statement/answer earns 1 mark.
2. This schedule sets out the expected answers to the examination questions. The marker can exercise their discretion and decide on the overall accuracy of any answer that is presented in the candidate's own words.
3. Symbols and terms - alternatives
- |         |             |
|---------|-------------|
| Power   | W or P      |
| Voltage | V or E or U |
| Phase   | Active      |

### QUESTION 1

- (a) To the main earthing terminal on the earth bar at the main switchboard. (2 marks)

(b)



(2 marks)

(c) Any TWO of:

- An MEN switchboard has an MEN link between the neutral and earth busbars  
Or  
A distribution switchboard has no MEN link between the neutral and earth bars
- An MEN switch board is connected to earth via an earth electrode  
Or  
A distribution switchboard is connected to earth via an MEN switchboard
- An MEN switchboard can be the closest switchboard to the point of supply  
Or  
A distribution switchboard cannot be the closest switchboard to the point of supply

- A MEN can supply a distribution switchboard but a distribution switchboard cannot supply a MEN switchboard (2 marks)

(d) Any ONE of:

- An auto transformer can fail in such a way as to have the primary voltage across the secondary
- Therefore the output must be insulated for the highest voltage present. (2 marks)

(e) Any TWO of:

- The wiring is damaged, faulty or wrongly installed.
- The wrong isolating switch has been operated.
- The isolating switch is damaged or faulty
- The appliance is supplied from two sources
- There is a conductive path still present owing to humidity, dust, dirt allowing "tracking" across contacts.
- There is an energised capacitor in the circuit (2 marks)

(f) Any TWO of:

- Voltage applied.
- Current level .
- Contact duration.
- Skin dryness.
- Current path.
- The frequency of the voltage (2 marks)

(g) Any ONE of:

- Six terminals
- Three terminals (2 marks)

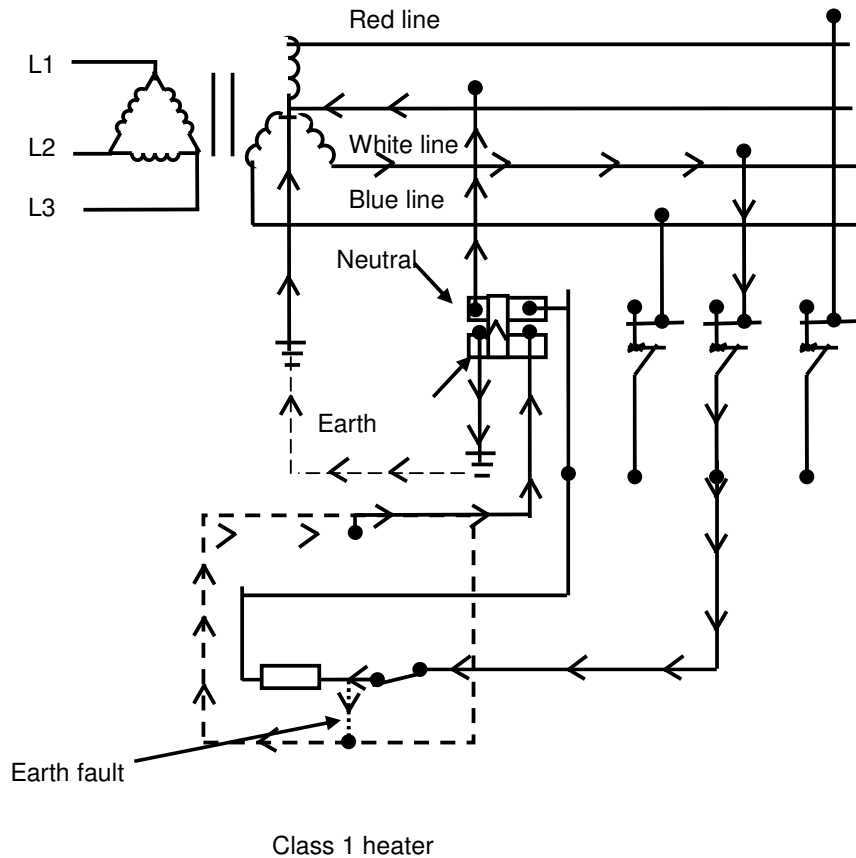
(h) Any TWO of:

- Capacity of the supply source
- Transformer impedance.
- Circuit impedance
- Length of cable run or distance from the transformer to the switchboard
- Current limiting reactors (2 marks)

- (i) (i) By reversing any two phase connections
- (ii) By reversing the connections to the start winding or the run winding.  
(2 marks)
  
- (j) (i) Decrease
- (ii) Decrease  
(2 marks)

## QUESTION 2

(a)



- Earth fault shown on the load side of the appliance switch (½ mark)
- Accurate fault loop drawn (1½ marks)

Note: The path between the star-point and the installation earth need not be shown. The path via the neutral must be shown.

(b) (i)  $I_{\text{load}} = \frac{W}{V}$  (½ mark)

$= \frac{2000}{230}$  (½ mark)

$= 8.7 \text{ A}$  (1 mark)

$$I_F = \frac{230}{(0.5 + 0.67 + 60)}$$

(½ mark)

$$= 3.76A$$

(1 mark)

$$I_T = I_L + I_F$$

(½ mark)

$$= 8.7 + 3.76$$

(1 mark)

$$= 12.46A$$

(ii) Fusing current of MCB is  $20 \times 1.5 = 30A$  (½ mark)

As the total current is 12.46A, the MCB will not operate (½ mark)

- (c)
- There will be a voltage difference between the frame of the appliance and earth presenting a shock hazard.
  - The protection will not operate.
- (2 marks)

### QUESTION 3

(a) (i) Any ONE of:

- Ensures adequate earthing connections
  - To test the impedance of the fault circuit
  - Determine if the protection will operate within the required time.
- (1 mark)

(ii) Any ONE of:

- A single-phase plug from the tester is plugged into a socket outlet.
- Phase is connected to phase, neutral is connected to neutral and earth is connected to earth.
- Phase is connected to phase and earth is connected to earth.

(1 mark)

(b) (i) To prove the RCD operates within the specified current and time limits.

(1 mark)

(ii) Plug the RCD into a socket outlet and the RCD tester into the RCD being tested.

(1 mark)

(c) Both tests are carried out on live circuits

(1 mark)

(d) (i) Prove the meter works on a known source

(1 mark)

Test the circuit for isolation

(1 mark)

Prove the meter works on a known source

(1 mark)

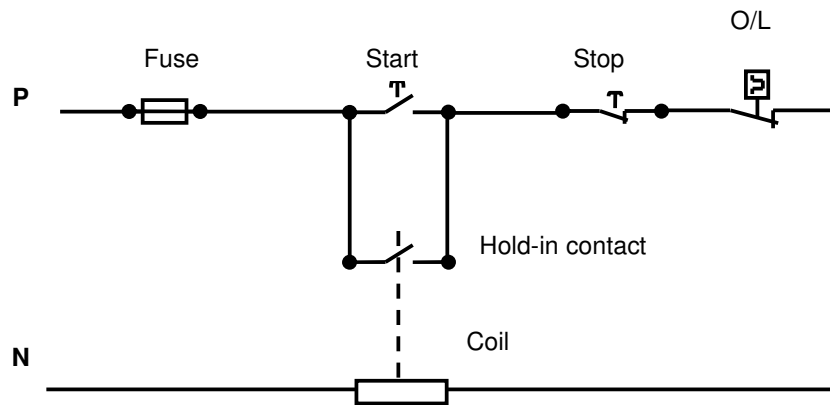
(ii) Any ONE of:

- Because it proves the meter works before and after testing
- To ensure the circuit is isolated

(2 marks)

#### QUESTION 4

(a)



- Correct supply (phase and neutral) (1/2 mark)
- Fuse protecting circuit (1/2 mark)
- Stop/start station correctly connected (1/2 mark)
- Hold-in contacts and coil correctly connected (2 marks)
- Thermal overload contacts correctly connected (1/2 mark)

(b) (i) Thermal overloads

Any ONE of:

- To protect the motor against a small sustained overload or over current.
  - To protect against the phase imbalance of single-phasing
- (2 marks)

(ii) HRC fuses

The HRC fuses operate fast under short circuit conditions, and will disconnect the circuit before any damage occurs.

(2 marks)

(c) The thermistor detects a rise in temperature in the motor windings and opens the control circuit when the temperature exceeds a pre-set level  
(2 marks)

## QUESTION 5

(a) (i) Secondary phase voltage

$$= \frac{66000}{287}$$

(1/2 mark)

$$= 230 \text{ V}$$

(1 mark)

(ii) Secondary line voltage

$$= 230 \times \sqrt{3}$$

(1/2 mark)

$$= 398.36 \text{ V}$$

(1 mark)

(iii) Primary line current

$$= \frac{\text{kVA}}{\sqrt{3} \times V_L}$$

(1/2 mark)

$$= \frac{150000}{\sqrt{3} \times 66000}$$

(1/2 mark)

$$= 1.31 \text{ A}$$

(1 mark)

(iv) Secondary line current

$$= \frac{150000}{\sqrt{3} \times 398.36}$$

(1/2 mark)

$$= 217.4 \text{ A}$$

(1/2 mark)

(b) A high voltage can be present at the secondary terminals.

(2 marks)

(c) Any ONE of:

- Laminating the iron core.
- Specially constructed core material (e.g., "stalloy", "grain-oriented silicon steel")
- Pitting the laminations to reduce iron losses

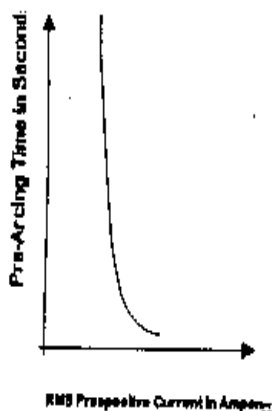
(2 marks)

## QUESTION 6

- (a) (i) As current through the protective device increase, the time taken to operate decreases.

(1 mark)

(ii)



(1 mark)

- (b) When a protective device cannot withstand the prospective short circuit current, it must be backed-up by a device which can.

(2 marks)

- (c) Discrimination means that:

- When short circuit or overcurrent occurs on the circuit, (1 mark)
- The protective device nearest the fault operates, (2 marks)
- Before any other protective device begins to clear the fault. (1 mark)

- (d) (i) The current rating is too low for the circuit, and could blow for no apparent reason well below the circuit full-load current.

(1 mark)

- (ii) The current rating is too large, and the circuit current could increase to a high level causing damage, before the fuse blows.

(1 mark)

## QUESTION 7

(a) The isolation method has to show:

- Identification of the correct MCB. (1 mark)
- Securing of the isolation (tag, lock etc.). (1 mark)
- Proving the isolation (prove-test-prove method etc.). (2 marks)

Note: Repeated use of a protective device to locate a fault is hazardous.

(b) The test method has to show:

- An insulation resistance test on each appliance to locate the fault.
- An insulation resistance test on the circuit to locate the fault (3 marks)

(c) 1. If the fault is in the socket outlet circuit, repair or replace the cable or socket outlet. (1 mark)

2. If the fault is in an appliance, repair the appliance and retest to ensure it is operationally safe. (2 marks)

## QUESTION 8

- (a) • The kiln will operate normally (1 mark)
- The neutral would be switched (1 mark)
- The kiln circuitry would be live when the isolating switch is in the "off" position. (1 mark)
- (b) The RCCB will trip. (1 mark)
- (c) Any ONE of:
- - The MCB would not operate (1 mark)
  - The kiln will not operate (1 mark)
  - Its framework will be alive at 230V to earth. (If the response is "an immediate and serious shock hazard exists" then award only 1 mark) (2 marks)
- The MCB would trip only if there was a fortuitous connection between the frame of the kiln and earth. (4 marks)
- (d) Any TWO of:
- Earth continuity test
  - Polarity test
  - Insulation resistance test between the phase conductor and the motor frame. (2 marks)

## QUESTION 9

- (a)
- Use a 500V d.c insulation resistance tester (1 mark)
  - Test between each of the three windings. (1 mark)
  - Test between each of the three windings and the motor framework (1 mark)
  - Each test result must be not less than 1 Megohm. (1 mark)
- (b)
- Use an ohmmeter or any other instrument with a low reading ohms scale. (1 mark)
  - Test the resistance of each winding. (1 mark)
  - Each winding must have the same resistance. (1 mark)
- (c) Any THREE of:
- Protective earthing conductor continuity test.
  - Visual test.
  - Polarity test.
  - Mechanical check (vibration, bearings etc.)
  - Check the integrity of the terminations
- (3 marks)