

VERSION 3 - ET 15 - Electrician Theory Examination Marking Schedule

- Notes:
- (1 mark) means that the preceding statement/answer earns 1 mark.
 - 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.
 - Symbols and terms - alternatives
Power W or P
Voltage V or E or U
Phase Active

QUESTION 1

- (a) **"Sensitivity" is the:**
- Current imbalance (earth leakage) required to trip the RCD** (1 mark)
 - For an RCD used for personnel protection the RCD must trip if the imbalance (earth leakage) is 30 mA or greater.** (1 mark)
- (b) Any ONE of:
- Because the protection device must be capable of safely clearing that level of prospective short-circuit current without damage.
 - Ensure protection has enough rupturing capacity to clear the prospective short-circuit current.
 - Makes sure protection can operate within 0.4 seconds or the minimum permitted time.
- (2 marks)
- (c) Any ONE of:
- To prevent the starter from switching motor windings to delta before run-up in star.
 - To prevent the start and run contactors from operating at the same time.
 - To prevent a short-circuit
- (2 marks)
- (d) Any TWO of:
- Select a meter setting that will ensure that the expected voltage value will read mid-range.
 - Keep clearance between instrument clips, leads and probes
 - Avoid contact with live conductors or earth or earthed metal when the circuit is live
 - All equipment (leads, meter, and probes) is in good condition.
 - Prove-test-prove the meter.
 - Select a meter with a fault duty comparable to that of the circuit being tested.
 - Personal protective equipment (PPE)**
- (2 marks)

(e) As current through the protective device increases, the time taken to operate decreases. (2 marks)

(f) (i) Any ONE of:
• Solid state current relay
• External relay
• Timer (1 mark)

Note: Apply discretion when marking. The use of the term “switch” in the question may confuse some candidates.

(ii) One (1 mark)

(g) (i) No effect (1 mark)

(ii) 110 V (1 mark)

(h) (i) A thermistor is a device which changes resistance with temperature
Note: They can either be n.t.c. or p.t.c (1 mark)

(ii) Any ONE of:
• Sensing overheating of a.c. machines.
• Measuring temperature
(or any other reasonable answer) (1 mark)

(i) Any ONE of:
• Because an auto transformer can fail in such a way as to have the primary voltage across the secondary.
• The primary and secondary are not isolated.
• The output is not safety extra-low voltage. (2 marks)

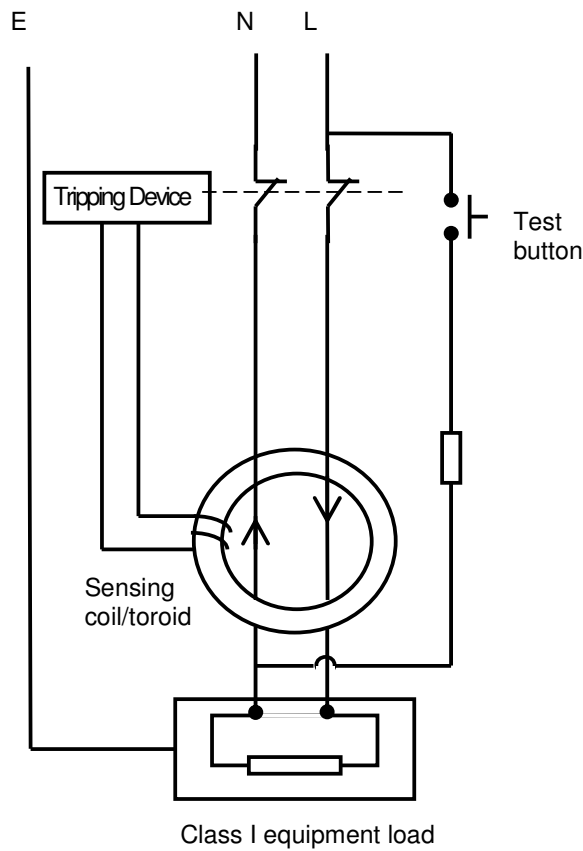
(j) Any TWO of:
• Thermal or bi-metal strips
• Magnetic
• Combined thermal/magnetic (2 marks)

QUESTION 2

- (a) (i) It protects the whole of the circuit. (1 mark)
(ii) Short-circuit and overload protection to the circuit. (1 mark)
- (b) (i) It protects Fitting A (1 mark)
(ii) Short-circuit and overload protection to Fitting A. (1 mark)
- (c) (i) It protects the whole of the circuit. (1 mark)
(ii) Any earth fault on the circuit. (1 mark)
- (d) By fusing each fitting with a 1 amp fuse, compared to the 16A MCB protecting the circuit. (2 marks)
- (e) Any TWO of:
• the main circuit breaker would operate disconnecting all the lights in the circuit.
• the wiring and components in the light fittings may have a much lower current rating.
• The MCB may not trip and cause a shock hazard due to a faulty fitting. (2 marks)

QUESTION 3

(a)



- Correctly connected test circuit and resistance (1 mark)
 - Correctly connected sensing coil/toroid (1 mark)
 - Correctly connected phase, neutral and earth. (1 mark)
 - Correctly connected tripping circuit (1 mark)
- (b)
- Neutral current out of balance with the phase current. (1 mark)
 - A magnetic field is induced into the iron core. (1 mark)
 - The induced magnetic field induces a current in the sensing coil (1 mark)
 - The tripping coil is energised, opening the RCD contacts (1 mark)
- (c)
- PRCD **P**ortable **R**esidual **C**urrent **D**evice. (1 mark)
- RCBO **R**esidual **C**urrent-**O**perated **C**ircuit **B**reaker with **O**vercurrent **P**rotection (1 mark)

QUESTION 4

(a) (i) Any THREE of:

- **Any metal not normally live could be live at up to 230V.**
- **If the earth fault path is of high impedance the main fuse may not blow**
- **Shock hazard could occur**
- **Fire hazard could occur**
- **Parts of an electrical appliance could be live with the control switch in the “OFF” position.**
- **Parts of the installation could be live with the main switch in the “OFF” position.**
- **The earth bar/neutral bar/MEN link could be live at up to 230V.**
- **The neutral is being switched .**

(3 marks)

(b) (i) • Use a voltmeter, remote earth and trailing lead.

(1 mark)

- Take a voltage test between the supply side of the main switch and the remote earth.

(1 mark)

- Take a voltage test between the earth/neutral bar and the remote earth.

(1 mark)

(ii) If no transposition has taken place:

- The reading at the main switch should be about 230 V

(1 mark)

- The reading at the neutral/earth bar should be about 0 V.

(1 mark)

(iii) If a transposition has taken place:

- The reading at the main switch should be about 0 V

(1 mark)

- The reading at the neutral/earth bar should be about 230 V.

(1 mark)

Note: 1. Alternative methods that can cover (b)(i), (ii) and (iii) are:

(a) Disconnect the installation and do the polarity test with an ohmmeter.

(b) Disconnect the installation and remove the MEN link. Reliven the installation and test with a voltmeter.

2. The removal of the MEN link with the installation live is hazardous.

QUESTION 5

(a) (i) $I_{\text{fault}} = \frac{230}{(7 + 0.5)}$ (1/2 mark)
 $= 30.66\text{A}$ (1/2 mark)

$I_{\text{total}} = I_{\text{fault}} + I_{\text{load}} = 30.66 + 25$ (1/2 mark)
 $= 55.66\text{A}$ (1 mark)

- (ii) The 30A fuses have a fusing factor (gG Utilisation Category) of 1.5
Fusing current = $1.5 \times 30 = 45\text{ A}$ (1/2 mark)

Total current is 55.66A, which is more than the fusing current of 45A (1/2 mark)

The fuse will operate. (1 mark)

(b) (i) $I_{\text{fault}} = \frac{230}{(7 + 12)}$ (1/2 mark)
 $= 12.1\text{A}$ (1/2 mark)

$I_{\text{total}} = I_{\text{fault}} + I_{\text{load}} = 12.1 + 25$ (1/2 mark)
 $= 37.1\text{A}$ (1 mark)

- (ii) Total current is 37.1A, which is less than the fusing current of 45A (1/2 mark)

***The fuse will not operate
or
The fuse may take a long time to operate.*** (1/2 mark)

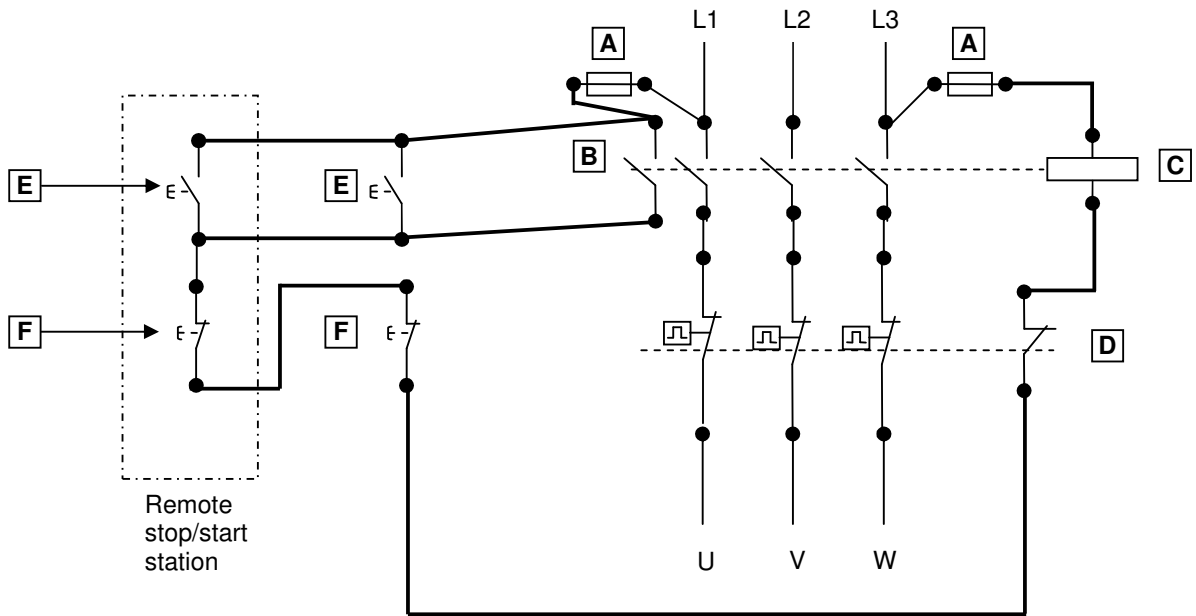
- (iii) V_d across Earth conductor equals shock voltage

$V_{dE} = I \times R$
 $= 12.1 \times 12$ (1/2 mark)
 $= 145.2\text{ V}$ (1/2 mark)

Electric shock hazard of 145.2V frame to earth exists (1 mark)

QUESTION 6

(a)



- *1/2 mark for each of the 9 wires added.*
- *4 1/2 marks for an operation (and safe) circuit.*

(9 marks)

(b) Any ONE of:

- Less mechanical strain put on motor shaft and bearings.
- **Reduced starting current**
- **Reduce voltage drop**

(1 mark)

QUESTION 7

- (a) • Ensure main switch is turned off and a danger tag attached. (1 mark)
- Use prove-test-prove method to ensure load side of the switch is isolated. (1 mark)
- (b) The test method described for the installation has to show:
- ***The MEN link and main neutral disconnected.*** (1 mark)
 - ***All switches and circuit breakers in the “ON” position*** (1 mark)
 - ***Testing between phase and earth.*** (1 mark)
 - ***Testing between neutral and earth.*** (1 mark)
 - ***A minimum reading for the installation of 1 Megohm*** (1 mark)
- (c) The test method described for either the water heater or the range has to show:
- ***Testing between phase and earth.*** (½ mark)
 - ***Testing between neutral and earth.*** (½ mark)
 - ***A minimum reading for the installation of 10,000 Ohm*** (1 mark)
- (d) (i) Insulation resistance tester (½ mark)
- (ii) 500V d.c. (½ mark)

QUESTION 8

- (a) (i) A. Load
B. Current transformer
C. Ammeter
D. Wattmeter
E. Voltmeter
F. Voltage transformer

(3 marks)

- (ii) • The CT secondary must be shorted.
or
• **Ensure the CT secondary is not open-circuited**

(2 marks)

(b) (i)
$$\frac{N_s}{N_p} = \frac{V_s}{V_p}$$
$$V_s = \frac{N_s \times V_p}{N_p}$$

(1/2 mark)

$$= \frac{1 \times 11000}{47.8}$$

(1/2 mark)

$$= 230.13\text{V or }230\text{V}$$

(1 mark)

(ii) $V_1 = V_{ph} \times \sqrt{3}$

(1/2 mark)

$$= 230.13 \times \sqrt{3}$$

(1/2 mark)

$$= 398.6\text{V or }400\text{V}$$

(1 mark)

- (c) Any ONE of:

- When under load due to current flow there is an internal volt drop due to the impedance of the windings.
- Under no-load conditions no current flows, no volt drop.
- Therefore, no-load voltage is higher than the full load voltage.

(1 mark)

QUESTION 9

(a) The isolation method has to show:

- Identification of the correct fuses. (1 mark)
- Prove-test-prove to ensure circuit is isolated. (2 marks)
- No live terminals exposed (1 mark)
- Steps taken to prevent reconnection
 - Danger tag for personal protection
 - Locking off isolator or disconnecting conductors from load side of isolator. (2 marks)

(b) The method used to ensure a safe work area has to show:

- Ensuring no access to live parts, (1 mark)
- Ensure cables are protected against damage. (1 mark)
- Danger tag removed and/or Out-of-service tag attached. (1 mark)

(c) Ensure the circuit is still isolated by using the prove-test-prove method.

(1 mark)