ET 22 - Electrician Theory Examination
Marking Schedule

Notes:1. (1 mark) means that the preceding statement/answer earns 1 mark.

2. This schedule sets out the accepted answers to the examination questions. A 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

4. Key to abbreviated terms:

EA	Electricity Act 1992
ER	Electricity Regulations 1997
AS/NZS	Australia and New Zealand Joint Standard
NZS	New Zealand Standard
AS	Australian Standard
ECP	New Zealand Electrical Code of Practice
GK	General Knowledge

5. Those parts of an answer that are under-lined indicate the parts required to be covered by a candidate.

QUESTION 1

(a) Any ONE of:

- An earth electrode.
- An earthing conductor or terminal, provided by the electricity distributor
- The electricity distributor neutral bar or link within the electrical installation (e.g. at meter panel), if required by the electricity distributor.

(2 marks)

(b) In Star

(2 marks)

(c) For protecting people against electric shock when using portable equipment

(2 marks)

(d) To raise or lower the voltage to maintain a constant voltage under full load.

(2 marks)

(e) (i) 1 MΩ

(ii) 10, 000Ω

(2 marks)

(f) Any TWO of:

- Attach a safety warning tag
- Lock open the isolating switch.
- Lock open the circuit breaker controlling the circuit supplying the appliance.
- Move the fuse carriers of the fuses controlling the circuit supplying the appliance to a safe location.
- Use an access permit or "hold card" system.
- Disconnect the circuit supplying the appliance at source.

(2 marks)

(g) $P = \frac{V^2}{R}$

(½ mark)

$= \frac{240 \times 240}{26.45}$

(½ mark)

$= 2180W$

(1 mark)

(h) It disconnects the start winding when the motor approaches full speed.

(2 marks)

(i) Any **TWO** of:

- Avoid damage to metal sheath
- Maintain loop or "S" bend in cable.
- Do not disturb pot seal
- Do not flex the solid conductors
- Ensure all conductor connections tight
- Ensure gland is clean and tight

(2 marks)

(j) Any ONE of:

Thermal	A bi-metal strip bends when heated and trips the circuit breaker out the heating of the strip is caused by the current flowing through it – or through a heater coil.
Electromagnetic	As the current increases, the magnetic field increases, and at a predetermined point, it attracts an armature that trips out the circuit breaker.

(2 marks)

QUESTION 2

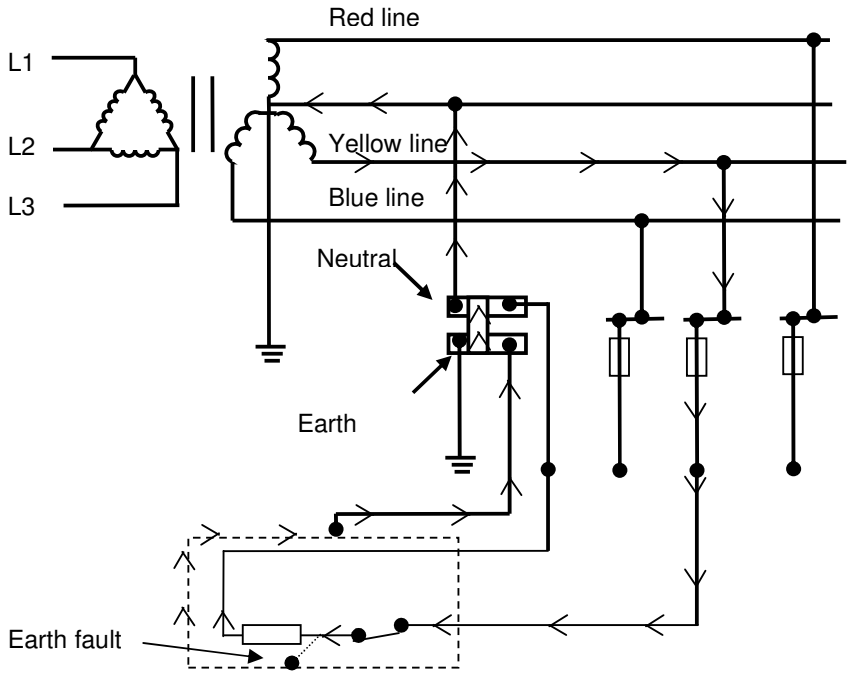
(a)
- The final subcircuit neutral conductor provides the return path from the loads back to the distribution transformer for the resultant "out-of-balance" current from the three phases

(2 marks)

- The neutral conductor is required to ensure that the phase voltage is maintained at its nominal value with respect to earth.

(2 marks)

(b)



The path showing:

- From the fault through the protective earthing conductor, (PE), main earthing terminal bar and MEN link.

(1 mark)

- The neutral-return path, consisting of the neutral conductor, (N), between the main neutral terminal or bar and the neutral point at the transformer.

(1 mark)

- The path through the neutral point of the transformer and the transformer winding.

(1 mark)

- The active conductor as far as the point of the fault.

(1 mark)

(c) Any TWO of:

- The neutral ensures a low impedance fault loop on an earth fault.
- The lower the resistance of the fault circuit, the higher the fault current and the more reliable the operation of protection equipment (fuses and circuit breakers).
- Limits the voltage to the nominal phase voltage.
- Mass of earth provides an alternative return path for the current if neutral is lost.

Note: Award a ½ mark for the answer "0 voltage between neutral and earth"

(2 marks)

QUESTION 3

(a)
- 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, isolating the circuit

(1 mark)

(b) 30 milliamps

(1 mark)

(c) Because the RCD trips in milliseconds

(2 marks)

(d) Any ONE of:

- The RCCB operates only on an earth fault.
- The RCCB does not provide overcurrent or short-circuit protection.
- The RCCB is not intended to provide electrical protection for the circuit.
- The RCCB primary purpose is to provide protection for the person using the circuit

(1 mark)

(e)
- In the event of failure of the supply the PRCD will trip.
- The PRCD will not reliven when supply is restored.

(2 marks)

QUESTION 4

(a) (i) Input power = $\sqrt{3} \times V_L \times I_L \times pf$

= $\sqrt{3} \times 415 \times 8.52 \times 0.82$

(½ mark)

= 5020 watts

(½ mark)

Efficiency = $\frac{\text{Output} \times 100}{\text{Input} \times 1}$

(½ mark)

= $\frac{4000 \times 100}{5020 \times 1}$

(½ mark)

= 79.7%

(1 mark)

(ii) %Slip = $\frac{(Ns - Nr) \times 100}{Ns \times 1}$

(½ mark)

= $\frac{(1500 - 1440) \times 100}{1500 \times 1}$

(½ mark)

= 4%

(1 mark)

or

Slip speed = Ns – Nr

= 1500 – 1440

= 60 rpm

(b) (i) One third. 33.33%

(1 mark)

(ii) Any TWO of:

- Overcurrent
- No-voltage
- Phase failure

(2 marks)

(iii) To prevent the Star and Delta contactors operating at the same time.

(2 marks)

QUESTION 5

(a) The isolation method has to show:

- Identification and removal of the correct fuses.
  (1 mark)
- Prove-test-prove to ensure circuit is isolated.
  (2 marks)
- No live terminals are left exposed
  (1 mark)
- Steps taken to prevent reconnection
  - Danger tag
  - Locking off isolator or disconnecting conductors.

  (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)

QUESTION 6

(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 volts.

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

QUESTION 7

(a) (i) Primary I_L = Primary I_{PH} x $\sqrt{3}$

= 13.8 x $\sqrt{3}$

(½ mark)

= 23.9 Amps

(½ mark)

(ii) Se. V_{PH} = $\frac{\text{Sec } V_L}{\sqrt{3}}$

(½ mark)

= $\frac{11000}{\sqrt{3}}$

(½ mark)

= 6350 volts

(1 mark)

Turns ratio = $\frac{33000}{6350}$

(½ mark)

= 5.2 to 1

(1 mark)

Sec I_L = 13.8 x 5.2

(½ mark)

= 71.8 Amps

(1 mark)

(iii) kVA = $\frac{\sqrt{3} \times PV_L \times PI_L}{1000}$

(½ mark)

= $\frac{\sqrt{3} \times 33000 \times 23.9}{1000}$

(½ mark)

= 1366 kVA

(1 mark)

Note: Alternative solutions are acceptable

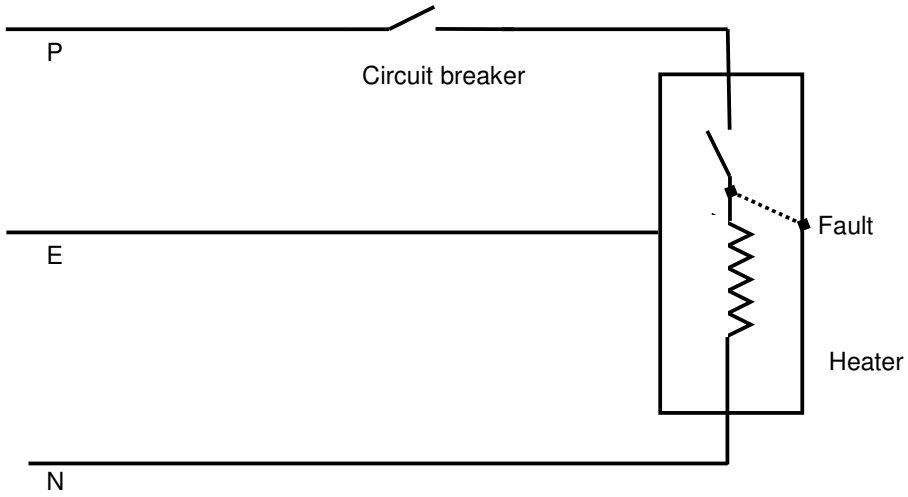
(b) Any ONE of:

- To prevent the CT from being open circuited.
- Withdrawing the fuse and opening the CT circuit could damage to the CT windings.
- Withdrawing the fuse and opening the CT circuit could cause high voltages to be present causing hazard of electric shock

(2 marks)

QUESTION 8

(a)



Phase, neutral and earth correct (½ mark)

Circuit-breaker in phase (½ mark)

Heater switch in phase (½ mark)

Fault in correct place (½ mark)

(b)
- No potential difference can develop across the protective earthing conductor.
- Therefore the appliance frame is held at 0 V and no shock hazard exists.
- Ensure protection will operate.

(3 marks)

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

(3 marks)

(d) $P = \frac{V^2}{R}$

(½ mark)

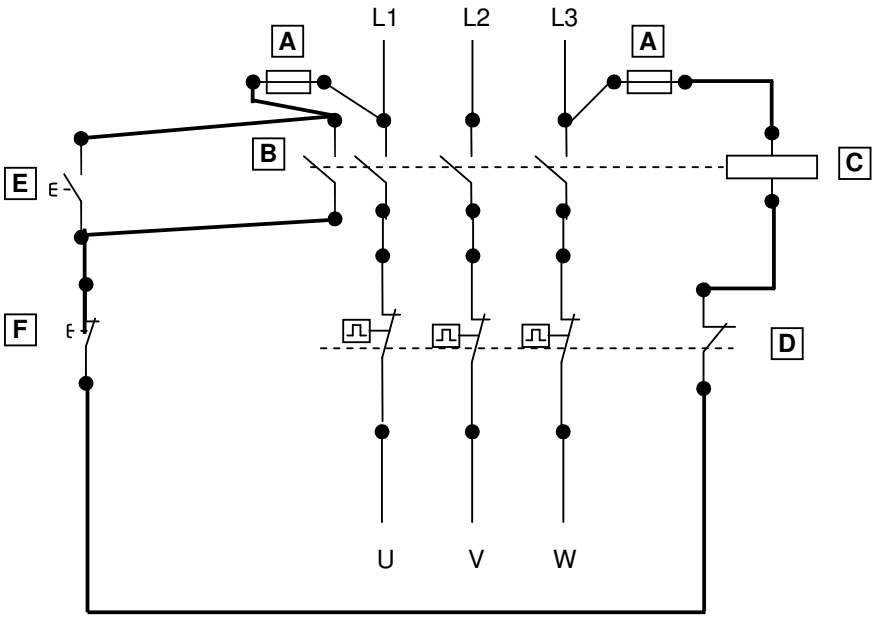
$= \frac{230 \times 230}{101}$

(½ mark)

$= 524W$

(1 mark)

QUESTION 9



- ½ mark for each of the 6 wires added.
- 1 mark for an operational (and safe) circuit.

(4 marks)

(b) A variable speed controller varies frequency and voltage to vary the speed.
(1 mark)

The electronic soft start varies voltage on starting to limit starting current.
(1 mark)

(c) (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)