ET 26 - 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) W = $\sqrt{3}$ x VL x IL

(½ mark)

IL = $\frac{15000}{1.732 \times 400}$

(½ mark)

= 21.65A

(1 mark)

(b) (i) 500 V dc (500 V ½ mark; dc ½ mark)

(1 mark)

(ii) 1MΩ

(1 mark)

(c) • To prevent the star and delta contactors closing simultaneously

(1 mark)

• Causing a short-circuit.

(1 mark)

(d) Any TWO of:

- Good discrimination
- Good back-up protection
- Fast operation
- Range of utilisation categories (fusing factor)
- Higher rupturing capacity

(2 marks)

(e) Any TWO of:

- Not very fast operating speeds
- Must wait to reset for thermal operation
- Fixed fusing factor
- Nuisance tripping in older models
- Mechanical mechanism could fail
- Lower breaking capacity

(2 marks)

(f) Any ONE of:

- To increase the phase displacement in the start winding to produce a rotating magnetic field.
- Increase the start-up torque

(2 marks)

(g) To discharge a large capacitor

(2 marks)

(h) (i) The maximum value of torque the motor can produce.

(1 mark)

(ii) Any ONE of:

- 1500 rpm
- The speed of the rotating field

(1 mark)

(i) (i) A protective device must be selected that can safely handle the maximum short-circuit current under fault conditions..

(1 mark)

(ii) An HRC fuse

(1 mark)

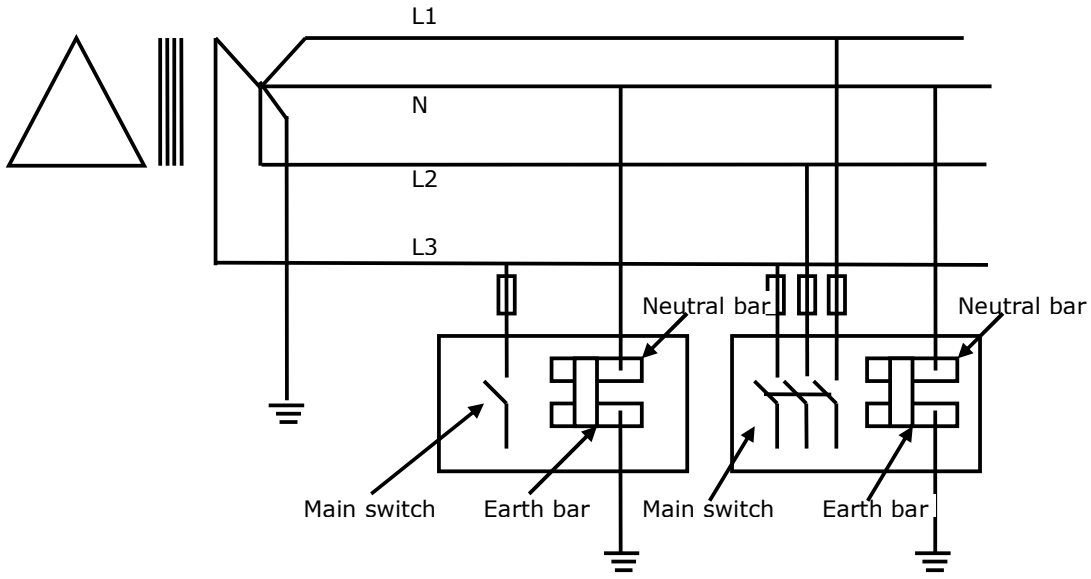
(j) Any ONE of:

- Earth leakage current in the circuit.
- Earth leakage current in the appliance.
- An imbalance in current between phase and neutral
- A neutral to earth connection has occurred
- Transposition of neutral and earth in the circuit

(2 marks)

QUESTION 2

(a)



- Correctly connected delta/star 11kV / 400V supply transformer (½ mark)
- Complete single-phase consumer switchboard (½ mark)
- Complete three-phase consumer switchboard (½ mark)
- Correct fuse protection for each installation (1 mark)
- Star point earthed correctly (½ mark)
- Correct earth, neutral and link arrangement for the single phase installation (½ mark)
- Correct earth, neutral and link arrangement for the three phase installation (½ mark)

(b) Any TWO of:

- The neutral ensures a low impedance fault loop on an earth fault.
- Limits the voltage to the nominal phase voltage.
- Mass of earth provides an alternative return path for the current if neutral is lost.
- To attempt to maintain the neutral at earth potential (2 marks)

(c) Any TWO of:

- Capacity of the supply source
- Transformer impedance.
- Circuit impedance from the transformer to the switchboard (length of cable run).

(2 marks)

(d) Any FOUR of:

- A touch voltage hazard between conductive parts and the mass of earth.
- Protective devices may not operate under fault conditions.
- Fire hazard at any high resistance joint in the main neutral.
- Fire hazard because the main earthing conductor is carrying a higher current than it can safely carry continuously.
- Over or under voltage could damage equipment – particularly on three phase installations.
- Damage could occur on neighbouring electrical installation due to load current passing through the earth.

GK
(2 marks)

QUESTION 3

(a)
- The two stator windings are spaced 90 electrical degrees apart and connected in parallel to a single-phase supply.

(1 mark)
- The start winding has a higher resistance and lower reactance than the run winding.

(1 mark)
- The current through the start winding is closer in phase with the applied voltage.

(1 mark)
- Therefore, the current through the start winding has a phase displacement to the current in the run winding.

(1 mark)
- This produces the simulated rotating magnetic field.

(1 mark)

(b) The start (or auxiliary) winding.

(1 mark)

(c) (i) The motor would not start.

(1 mark)

(ii) The motor would slow down until the centrifugal switch closed.

(1 mark)

And

- For light loads
  - The motor will speed up again as the start winding is energised.

(1 mark)
  - The centrifugal switch will open at around 75% full-load speed so the motor will cycle as the switch opens and closes.

(1 mark)

Or

- For heavy load
  - The motor will stall and eventually burn out.

(2 marks)

QUESTION 4

(a) (i)
- It shows that the higher the fault current

(1 mark)

- the shorter the time it takes the fuse to trip.

(1 mark)

(ii) The fuse curve for 10A.

(1 mark)

(b) (i) The gG utilisation category (fusing factor) is in the range between 1.2 and 1.5.

(1 mark)

(ii) Between 7.2A and 9.6A

(1 mark)

(c) The protective device nearest the fault operates, before any other protective device.

(2 marks)

(d) To provide short-circuit protection

(1 mark)

Because the existing protective devices have inadequate breaking capacity.

(1 mark)

(e) This is the maximum continuous current that the fuse can carry without deteriorating.

(1 mark)

QUESTION 5

(a) (i) Any THREE of:

- The protection will still be effective under fault conditions.
- The pump will operate normally
- The neutral would be switched
- The pump circuitry would be live when the isolating switch is in the "off" position.

(3 marks)

(ii) The RCCB will trip as the PEC would carry the return current.

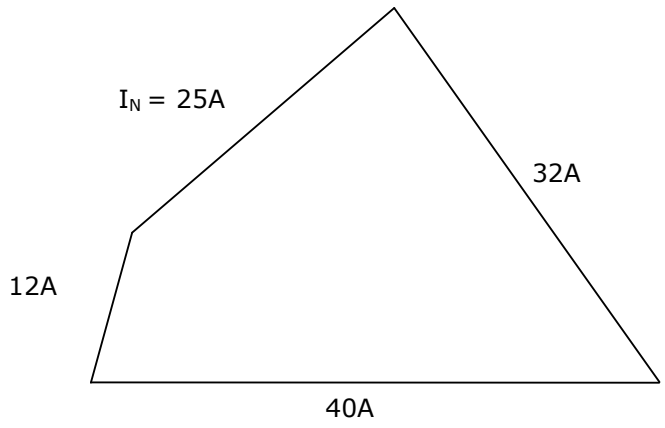
(1 mark)

(b) Any ONE of:

- Circuit connections test (polarity)
- Visual check

(1 mark)

(c)



- Correct graphical representation

(4 marks)

- Correct solution for In = 25A (allow 23-27A)

(1 mark)

Also allow resolution of 3 vectors to two, (20A vector & 28A vector) at 120° to each other. IN is the resultant between these two forces

QUESTION 6

(a) Any TWO of:

- Each conductor must be insulated and made electrically safe.
- Protect the cables to prevent damage
- Take steps to prevent access to the cables.

(2 marks)

(b)
- "Isolating" means that the motor has been deliberately disconnected from the electricity supply and precautions taken to prevent reconnection

(2 marks)

- "Switched off" means that the electricity ceases to be supplied to the motor

(1 mark)

(c) Any THREE of:

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

(3 marks)

(d)
- To ensure that the test meter/instrument operates correctly during the procedure.
- To ensure that the circuit has been isolated before it is worked on.

(2 marks)

QUESTION 7

(a) $I_{fault} = \frac{230}{0.75}$

(½ mark)

$= 306.67A$

(1 mark)

Or

$I_{load} = \frac{P}{\sqrt{3} \times V}$

$= \frac{25000}{\sqrt{3} \times 400}$

$= 36.08A$

$I_{total} = I_{fault} + I_{load}$

$= 306.67 + 36.08$

$= 342.68A$

(1½ marks)

Note: For this alternative answer (a) and (b)(i) together. The same calculation (that is, the 2nd calculation and the 1st calculation in (b)(i)) is required for both. Award 2 marks regardless of whether it is shown in either or both.

(b) (i) $I_{load} = \frac{P}{\sqrt{3} \times V}$

(½ mark)

$= \frac{25000}{\sqrt{3} \times 400}$

(½ mark)

$= 36.08A$

(1 mark)

$I_{fault} = \frac{230}{(15 + 5)}$

(½ mark)

$= 11.5A$

(1 mark)

$I_{total} = I_{fault} + I_{load}$

$= 36.08 + 11.5$

(½ mark)

$= 47.58A$

(1 mark)

(ii) The 45A fuses have a fusing factor (gG Utilisation Category) of 1.5

Fusing current = 1.5 x 45 = 67.5 A

(½ mark)

Total fault current is 47.58A so the fuse will <u>not</u> operate within the minimum disconnection time.

(1 mark)

(iii) Vd across protective earthing Earth conductor equals shock voltage

Vd_E = I x R

(½ mark)

= 11.5 x 5

(½ mark)

= 57.5V

(1 mark)

QUESTION 8

(a) (i) $Vph = \frac{VL}{\sqrt{3}}$

(½ mark)

$\frac{400}{1.732}$

(½ mark)

230.9V or 230V.

(½ mark)

$kVA = \frac{Vph \times I}{1000}$

(½ mark)

$\frac{230 \times 145}{1000}$

(½ mark)

$\frac{33350}{1000}$

(½ mark)

33.35kVA on Red phase.

(1 mark)

(ii) For 3phase load = 33.35 x 3

(½ mark)

= 100050VA
or 100kVA

(1 mark)

(b) $\frac{IP}{IS} = \frac{VS}{VP}$

(½ mark)

$IP = \frac{IS \times VS}{VP}$

(½ mark)

$= \frac{145 \times 230}{11000}$

(½ mark)

= 3.03A (phase current)

(1 mark)

Line current = IP x √3

(½ mark)

= 3.03 x 1.732

(½ mark)

5.25A

(1 mark)

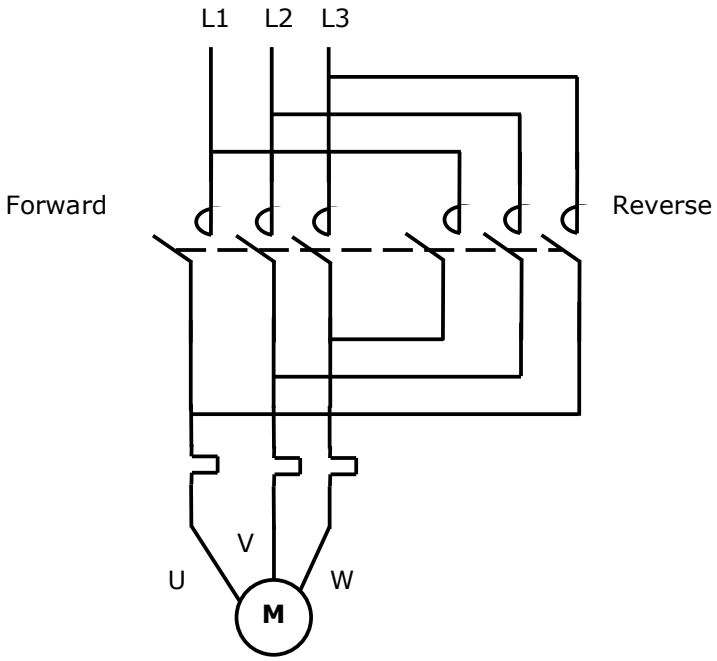
Alternatively it could be calculated by $IL = \frac{VA}{\sqrt{3} \times VL}$

$= \frac{100000\ VA}{1.732 \times 11000V}$

$5.25A$

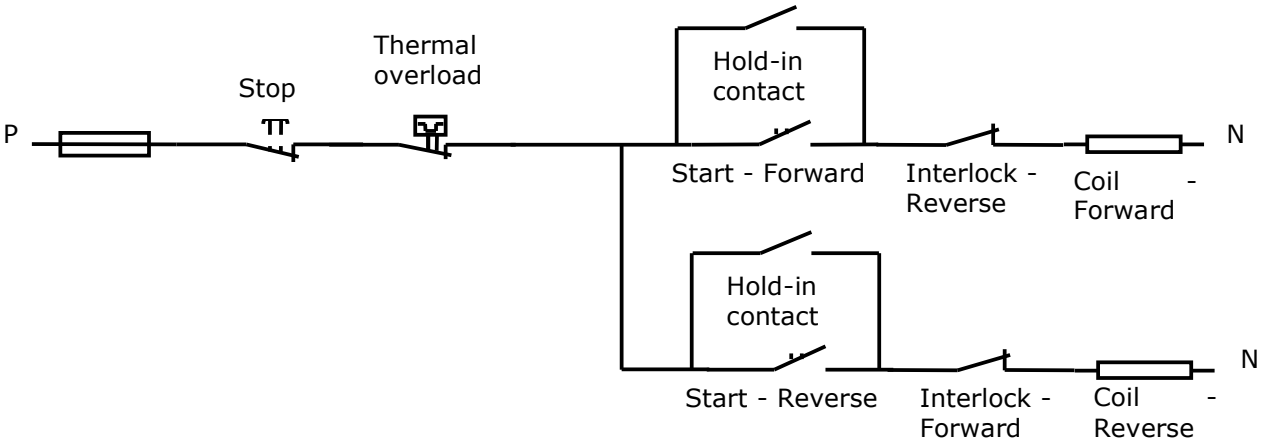
QUESTION 9

(a)



- Correct forward circuit (1 mark)
- Correct reverse circuit (1 mark)
- Overload protect motor in both directions (1 mark)
- Correct circuit (½ mark)

(b)



- ½ mark for each correctly connected component (5½ marks)
- Correct circuit (1 mark)