ET 24 - 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)
- Under fault conditions the earthing of the metal frame keeps the frame of appliance at earth potential.

(1 mark)

- This ensures the operation of protective devices

(1 mark)

(b) Any TWO of:

- Reducing starting current
- Reducing voltage surges
- Limiting mechanical shock

(2 marks)

(c) (i) Any ONE of:

- Slip ring motor
- Wound rotor induction motor

(1 mark)

(ii) By reversing any two of the supply lines to the motor

(1 mark)

(d) Any ONE of:

- Earth leakage current in the circuit.
- Earth leakage current in the appliance.
- An imbalance in current between phase and neutral

(2 marks)

(e) Any ONE of:

- To increase the leading phase displacement of start- winding current.
- To increase the starting torque.
- To create a rotating magnetic field in one direction.

(2 marks)

(f) To safely clear the prospective short-circuit current.

(2 marks)

(g) It will cause a high voltage to develop in the circuit.

(2 marks)

(h) Any TWO of:-

- It will safely interrupt short circuit currents of much higher values or higher rupturing capacity.
- It eliminates arcing because the fuse element is sealed.
- It is obtainable in a range of Utilisation categories (fusing factors).
- Current rating is clearly marked.
- Reliable operation within prescribed limits.
- Good discrimination.
- Constant fusing characteristics.
- Faster operation/acting.
- Doesn't deteriorate over time.

(2 marks)

(i) (i) Decrease
(ii) Decrease

(2 marks)

(j) • To the main earthing terminal or the earth bar.

(1 mark)

- At the MEN switchboard.

(1 mark)

QUESTION 2

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

(2 marks)

(b) 60A Is the maximum current the fuse can continuously carry (½ mark)

without deterioration. (½ mark)

440V is the maximum voltage the fuse can withstand (½ mark)

without flashover. (½ mark)

AC40. 40,000A (½ mark)

is the maximum (½ mark)

prospective short circuit current (½ mark)

the fuse can safely interrupt (½ mark)

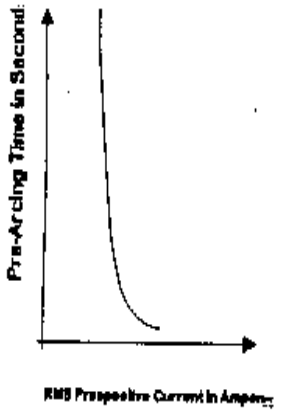
(c) To provide short-circuit protection in a circuit (½ mark)

when another protective device has inadequate breaking capacity. (½ mark)

(d) As current through a protective device increases, the time taken to operate decreases.

(2 marks)

(e)



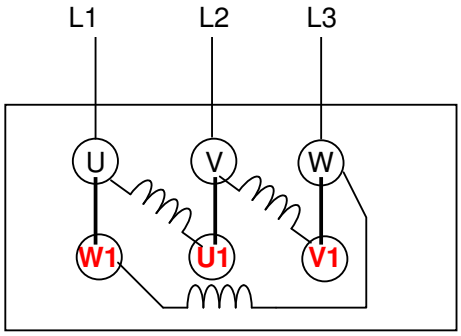
(1 mark)

QUESTION 3

(a) (i)
- Test to find the ends of the windings (1 mark)
- Test to find the polarity of the windings (1 mark)

(ii) The motor is connected in delta with a line voltage of 400V (1 mark)

(iii)



The broken lines are the windings.

- Correctly connected windings (1 mark)
- Correctly labelled terminals (1 mark)
- Links connected to achieve a delta configuration (1 mark)
- Correctly connected supply. (1 mark)

(b) Any TWO of:

- Internal connections of one winding reversed
- Mechanical overload
- Supply voltage insufficient
- Loss of one phase
- Mechanical faults (bent rotor, excessive bearing wear)

(2 marks)

(c) Any ONE of:

- Mechanical overload
- Winding fault
- Worn bearings causing contact between rotor and stator
- Fan not operational
- Ventilation holes blocked (restricted air flow)
- Wrong motor for application (ambient temperature too high)
- Reduced line voltage

(1 mark)

QUESTION 4

(a) (i)
- The protective earthing conductor test is carried out before the insulation resistance test

(1 mark)

(ii) The protective earthing conductor test has to show:

- The use of a meter that can accurately read values of 1 ohm or less

(½ mark)
- A test between the PEC conductor of the flexible cord and the frame of the motor

(½ mark)
- An expected test result of 1 ohm

(½ mark)
- The test result being a maximum value

(½ mark)

The insulation resistance test has to show:

- The use of an insulation resistance tester

(½ mark)
- A 500V d.c. test voltage

(½ mark)
- Testing between each conductor of the flexible cord and the frame of the motor.

(½ mark)
- An expected test result of 1 Megohm

(½ mark)
- The test result being a minimum value

(½ mark)

(b)
- Check and prove isolation using Prove-Test-Prove method.

(½ mark)
- Add your Danger Tag to the isolator.

(½ mark)
- Lock the isolator

(½ mark)

(c) Any THREE of:

- Check all screens and guards are in place.
- Check that the planer is functionally earthed
- Rotational test
- Ensure correct connections
- Check the planer for operational safety
- Ensure the protection is rated correctly
- Visual check
- Remove danger tag and lock

Note: Award only a half mark for "visual check" only
Award only a half mark if just the removal of the danger tag is stated

(3 marks)

QUESTION 5

(a) (i) $V_{ph} = \frac{V_L}{\sqrt{3}}$

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

(½ mark)

$= 231V$

(½ mark)

$I_{fault} = \frac{V}{R}$

$= \frac{231}{8}$

(½ mark)

$= 28.88A$

(½ mark)

$I_{total} = I_{fault} + I_{load} = 28.88 + 20$

(½ mark)

$= 48.88A$

(½ mark)

(ii) The 32A fuses have a fusing factor (gG Utilisation Category) of 1.5
Fusing current = 1.5 x 32 = 48A

(1 mark)

Total current is 48.88, which is more than the fusing current 48A

(½ mark)

The fuses will operate
Or
The fuses will not operate within 0.4s

(½ mark)

(b) (i) $I_{fault} = \frac{230}{(12 + 8)}$

(½ mark)

$= 11.5A$

(½ mark)

$I_{total} = I_{fault} + I_{load} = 11.5 + 20$

(½ mark)

$= 31.5A$

(½ mark)

(ii) Total current is 31.5A, which is less than the rated current 32A.
The fuse will not operate as intended.

(1 mark)

Vd across Earth conductor equals shock voltage

Vd_E = I x R
= 11.5 x 12

(½ mark)

= 138V

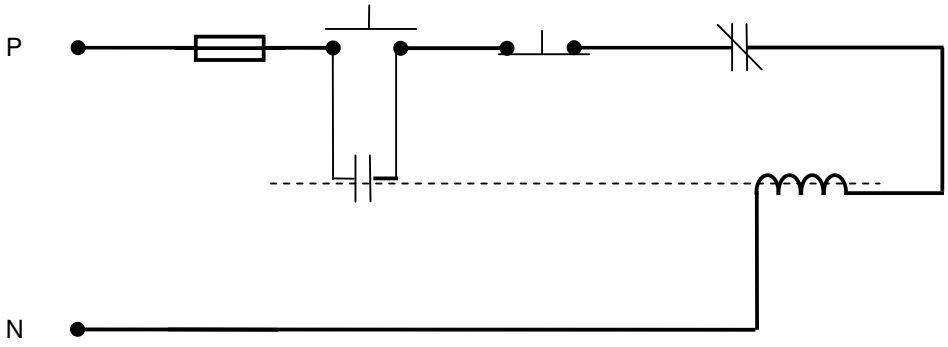
(½ mark)

Electric shock hazard of 138V frame to earth exists

(1 mark)

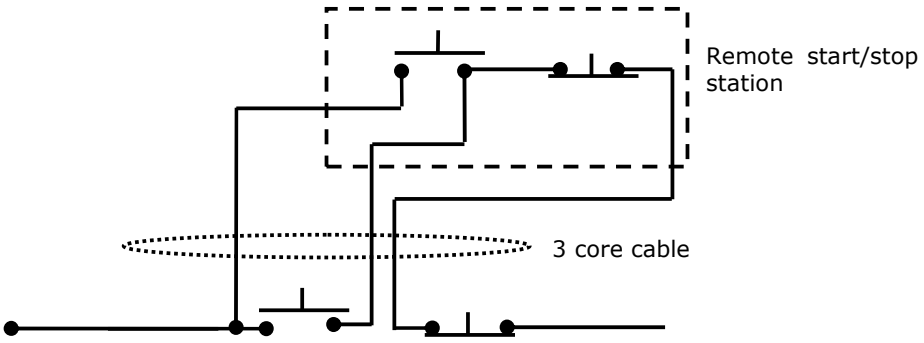
QUESTION 6

(a)



- The fuse is in the phase and protects the entire circuit (1 mark)
- The start button controls the entire circuit (1 mark)
- The stop button disconnects the coil (1 mark)
- Hold-in contacts in parallel with the start button (1 mark)
- The 230V coil correctly connected (1 mark)
- Thermal overload contacts correctly connected (1 mark)

(b)



The cable is connected so that:

- The remote stop is in series with the local stop button (1 mark)
- The remote start in parallel with the local start button (1 mark)
- The link between the stop and the start buttons is removed (1 mark)

(c) A thermistor (1 mark)

QUESTION 7

(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)

(The answers given by candidates have to be distinct from each other)

(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)
- 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.

(c) Any TWO of:

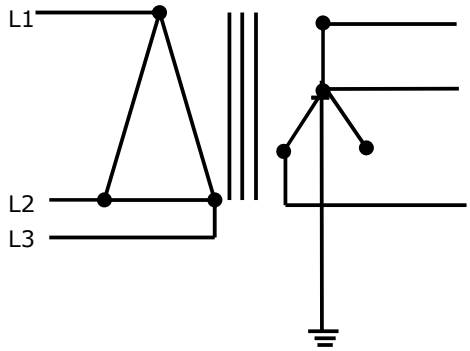
- The main neutral in the house is open-circuited (or high resistance)
- The main distribution neutral is open-circuited (or high resistance)
- The earth at the distribution transformer is open-circuited (or high resistance)
- There is a voltage rise in the installation earthing system
- The earth pin on the socket outlet is spread and there is an earth fault on the machine
- There in a broken or high resistance protective earthing conductor and there is an earth fault on the machine.

(or any other explanation that results in a high impedance neutral)

(2 marks)

QUESTION 8

(a) (i)



- Correct delta connections (½ mark)
- Correct star connections (½ mark)
- Star point earthed (½ mark)

(ii) Secondary phase voltage

$= \frac{11000}{43.3}$ (½ mark)

= 254 V (1 mark)

(iii) Secondary line voltage

= 254 x √3 (½ mark)

= 440 Volts (1 mark)

(iv) Primary line current

$= \frac{kVA \times 1000}{\sqrt{3} \times V_L}$ (½ mark)

$= \frac{150000}{\sqrt{3} \times 11000}$ (½ mark)

= 7.87 A (1 marks)

(v) Secondary line current

$= \frac{150000}{\sqrt{3} \times 440}$ (½ mark)

= 196.83 A (1 mark)

(b) Any ONE of:

- The iron core is laminated.
- Special types of alloys are used for the core

(2 marks)

QUESTION 9

(a) (i) Danger Tag

Where is a possibility of personal danger through someone turning on the electricity a Danger Tag must be fastened to the relevant isolating switch.

(2 marks)

(ii) Out-of-Service Tags

Where equipment is faulty or damaged and using that equipment would cause damage or injury an Out-of-Service Tag must be fastened to it.

(2 marks)

(iii) Any THREE of:

- Make sure the correct isolating switch is tagged.
- Make sure the switch is in the "OFF" position before it is tagged
- Fasten the Danger Tag securely so that it will not come off.
- Ensure your tag is fastened even though others may also be attached
- Test to ensure isolation has taken place.

(3 marks)

(b)
- The test instrument is checked to be operating correctly on a known live source.
- The equipment is tested to confirm (or otherwise) that it is isolated.
- The test instrument is again checked on a known live source to ensure is still operates correctly.

(3 marks)