ET 21 - 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 TWO of:

- Earth rod
- Buried electrode
- Metallic reinforcing

Or variations

(2 marks)

(b) They have a balanced rotating magnetic field (not a pulsating one).

(2 marks)

(c) To ensure it has not frozen closed (½ mark if the term "frozen" is only used)
or
To ensure trip mechanism operates

(2 marks)

(d) The volt drop occurs due to the impedance of the windings.

Note: Answers that relate to the impedance of the windings (leakage flux, resistance) are acceptable)

(2 marks)

(e) (i) 1 MΩ minimum

(1 mark)

(ii) 1Ω maximum

(1 mark)

(f) Connect a suitable discharge resistor or suitable voltmeter across the capacitor terminals or similar.

(2 marks)

(g) (i) $I = \frac{V}{R}$

$= \frac{240}{24}$

(½ mark)

$= 10A$

(1 mark)

(ii) More

(½ mark)

(h) Change the connections to either the start winding or the run winding.

(2 marks)

(i)
- Current (load)
- Length of run, or similar

(2 marks)

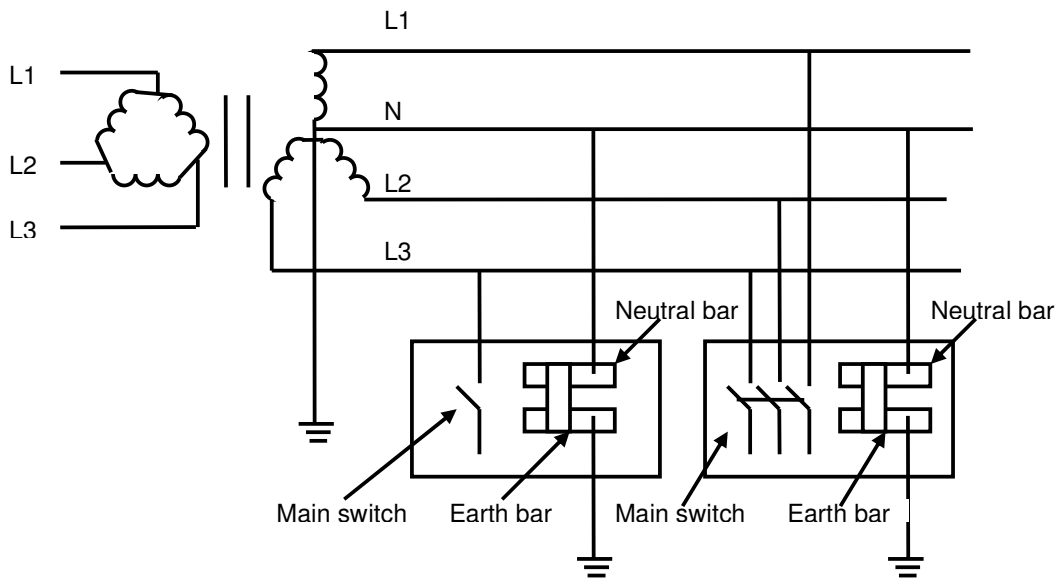
(j) As current through the protective device increases the time taken to operate decreases.

Note: A drawn representation of the characteristic is acceptable.

(2 marks)

QUESTION 2

(a)



- Delta-star connected 11kV / 400V supply transformer including output lines

(1 mark)

- Single-phase consumer including main switch and neutral and earth bar connections.

(1½ marks)

- Three-phase consumer including main switch and neutral and earth bar connections.

(1½ marks)

- All earthing arrangements.

(1 mark)
(Total 5 marks)

(b) 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 230 V to earth.
- 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)

(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

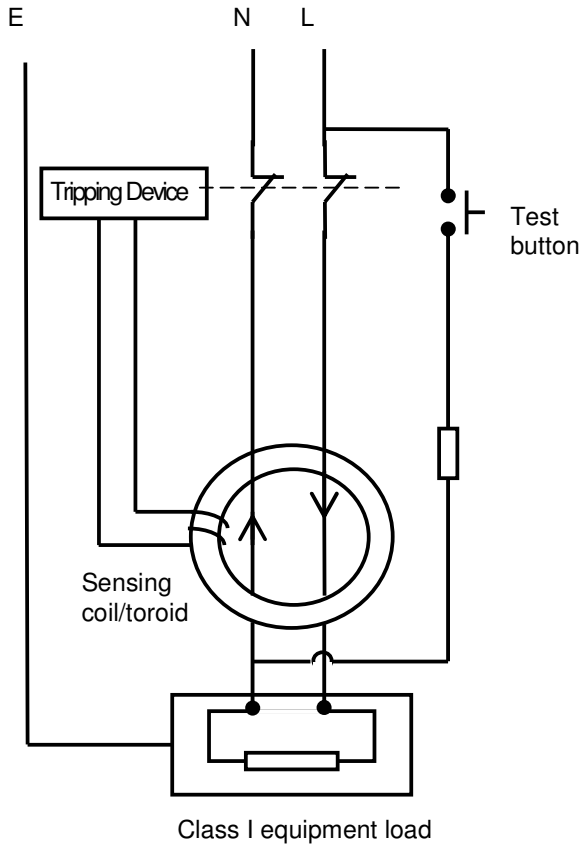
(2 marks)

(d) MEN switchboard

(1 mark)

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.

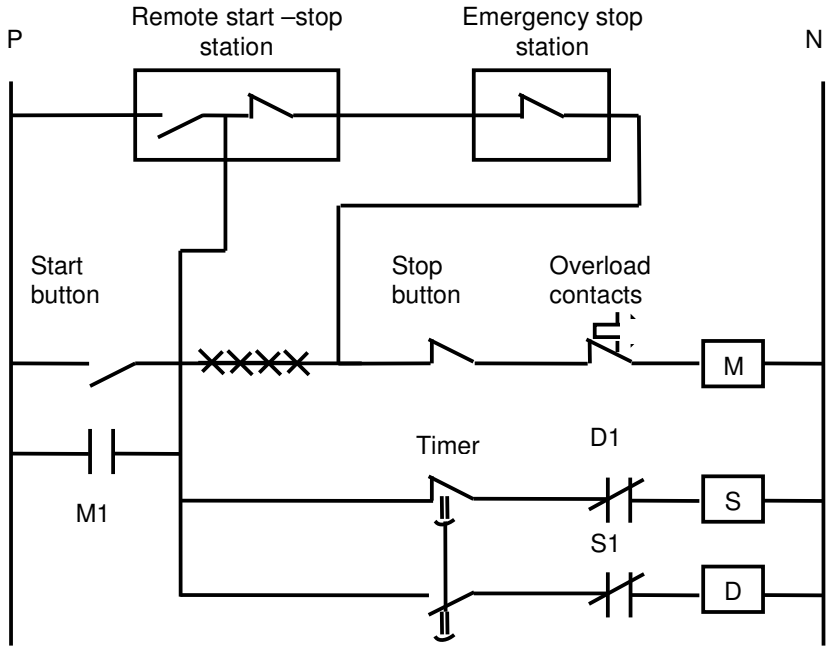
(1 mark)

RCBO **R**esidual Current-Operated **C**ircuit **B**reaker with **O**vercurrent Protection

(1 mark)

QUESTION 4

(a)



- ½ mark each for four correctly connected conductors
- 1 mark for a removing the correct conductor

Note: 1 Candidates receive no marks if the circuit shows a short circuit between P and N or is dangerous

2. Marks can be awarded for a circuit that does not work, but parts are correctly connected.

(3 marks)

(b) (i) Eff. = $\frac{\text{output}}{\text{input}}$

Input = $\frac{\text{output}}{\text{eff.}}$

(½ mark)

= $\frac{8}{0.84}$

(½ mark)

= 9.5 kW

(1 mark)

(ii) kVA = $\frac{\text{kW}}{\text{Pf}}$

(½ mark)

= $\frac{9.5}{0.81}$

(½ mark)

= 11.7 kVA

(1 mark)

(iii) $P = \sqrt{3}\ V_L\ I_L\ PF$

$$I_L = \frac{P}{\sqrt{3}\ V_L\ PF}$$

(½ mark)

$$I_L = \frac{9500}{\sqrt{3} \times 400 \times 0.84}$$

(½ mark)

$I_L = 16.3A$

(1 mark)

(c) Any ONE of:

- Reduce starting current
- Permits the installation of a smaller cable
- Smaller transformer size can be used
- Reduce mechanical shock
- Reduce the effect of volt drop on the system.

(1 mark)

QUESTION 5

(a) The description has to cover:

1. An insulation resistance test showing:
(½ mark)

- the use of an insulation resistance tester
(½ mark)
- a 500V d.c. test voltage
(½ mark)
- testing between phase and earth and neutral and earth
(½ mark)
- an expected test result of 10,000 ohms or 0.01 Mohms
(1 mark)
- the test result being a minimum value
(½ mark)

2. A protective earthing conductor test showing:
(½ mark)

- the use of a meter that can accurately read values of 1 ohm or less
(½ mark)
- a testing between the PEC conductor of the flexible cord and the case of the cylinder
(½ mark)
- an expected test result of 1 ohm
(½ mark)
- the test result being a maximum value
(½ mark)

(b) The procedure has to cover:

- Identifying the correct fuse on the switchboard.
(1 mark)
- Attaching a Danger tag to the circuit.
(1 mark)
- Removing the isolator cover and testing for voltage at the supply side of the isolator using the prove-test-prove method.
(2 marks)

QUESTION 6

(a)
- Overload caused by too many appliances in use.
- A faulty appliance
- A faulty circuit.

(3 marks)

(b) (i) Overload caused by too many appliances in use.

<u>Action taken to establish that this is the cause</u>

- Total up the rating of appliances

(1 mark)

<u>Remedial action taken or recommended</u>

- Use fewer appliances.

(1 mark)

(ii) A faulty appliance.

<u>Action taken to establish that this is the cause</u>

- Carry out an insulation resistance test of each appliance in turn to establish which is faulty.

(1 mark)

<u>Remedial action taken or recommended</u>

- Repair the faulty appliance.

(1 mark)

(iii) A faulty circuit.

<u>Action taken to establish that this is the cause</u>

- Disconnect circuit at switchboard.

(1 mark)

- Carry out an insulation resistance test of the circuit to establish fault.

(1 mark)

<u>Remedial action taken or recommended</u>

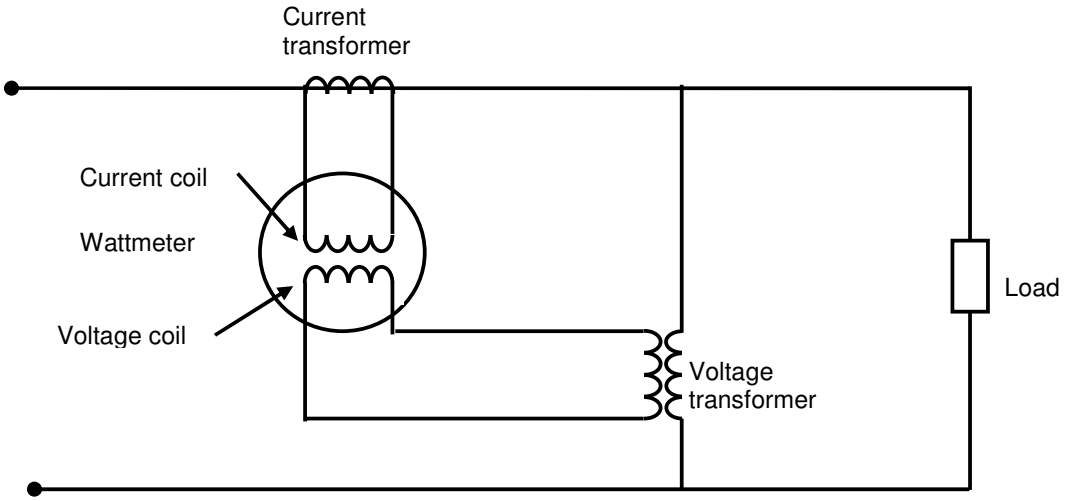
- Repair or replace the faulty circuit component.

(1 mark)

Note: Re-setting the MCB for a third (or more) time before any testing is taken to establish the cause of the fault is considered hazardous.

QUESTION 7

(a)



- Correctly connected current transformer (1 mark)
- Correctly connected voltage transformer (1 mark)
- Correctly connected load (1 mark)
- Correctly connected wattmeter (2 marks)

(b) (i) $V_{SPH} = \frac{6600}{27.5}$ (½ mark)

$= 240$ V (1 mark)

(ii) $V_{SL} = 240 \times \sqrt{3}$ (½ mark)

$= 416$ V (1 mark)

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

$= \frac{150000}{\sqrt{3} \times 6600}$ (½ mark)

$= 13.1$ A (1 mark)

QUESTION 8

(a) Current in earth continuity conductor = $\frac{230}{14}$ = 16.4 A

(1 mark)

Total current in the line = 16.4+ 27 = 43.4 A

(1 mark)

(Total 2 marks)

(b) Fusing factor of motor-rated fuse is 2 (accept any factor in the range 1.75 – 2.5) so fusing current is 32 x 2 = 64 A (accept 56 – 80).
This is greater than the 43.4 A line current. The circuit protection will not operate.

(3 marks)

(c) Current in earth continuity conductor = $\frac{230}{24}$ = 9.6 A

(1 mark)

Vd across earth continuity conductor = 9.6 x 10 = 96 V

(1 mark)

Shock hazard of 96 V

(2 marks)

between the frame of the appliance and "earth"

(1 mark)

(Total 5 marks)

QUESTION 9

(a) Any THREE of:

- Smoother starting - less wear and tear on the motor.
- Easier to adjust for overcurrent and other parameters.
- Visual feed-back through display panels.
- Physical size smaller than auto-transformer.
- More economical to maintain – less equipment involved.
- Reduces mechanical shock to equipment
- More even current flow
- More even torque
- Torque is very constant at start
- Cheaper in the larger sizes
- Built-in protection and monitoring

(3 marks)

(b) Any TWO of:

- To prevent the starter from switching motor windings to delta before run-up in star.
- To prevent a phase-to-phase short circuit.
- To prevent both star and delta contactors becoming energised at the same time.

(2 marks)

(c) (i) Any ONE of:

- Because there is a higher starting torque per amp of line current.
- There is a closer match between the tapping and load at start.
- Smoother start up.

(1 mark)

(ii) Any ONE of:

- To keep starting current to a minimum.
- To ensure there is less voltage drop on the system

(2 marks)

(iii) The next higher tapping should be tried. This will increase starting voltage, current and torque.

(2 marks)