

## ET 10 - Electrician Theory Examination Marking Schedule

- Notes: 1. (1 mark) means that the preceding statement/answer earns 1 mark.
2. 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.
3. Symbols and terms - alternatives
- |         |             |
|---------|-------------|
| Power   | W or P      |
| Voltage | V or E or U |
| Phase   | Active      |

### QUESTION 1

(Each part of question 1 is worth 1 mark)

(a) Any ONE of:

- With double-tube fittings one ballast has a capacitor connected in series.
- Where more than one fitting is used they may be placed on different phases.
- Intersperse incandescent and fluorescent lighting.

(b) Any ONE of:

- The slip speed increases.
- The speed reduces.

(c)  $120^\circ$ .

(d)  $20 \times 1.5 = 30\text{A}$

(e)  $1\text{ M}\Omega$

(f) Any ONE of:

- To change the internal a.c. generated current flow to a d.c. output current flow.
- As a rotary switch for providing power to the rotor.

(g) 30 milliamps

(h) 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.

(i) In Star

(j) The fuse can safely interrupt a prospective fault current of 80,000 A.

(k) Power factor is unity

- (l) Any TWO of:
- Capacitors
  - Inductors
  - Resistors
- (m) To disconnect the start winding.
- (n)
- Hysteresis loss
  - Eddy current loss
- (o) Any ONE of:
- An MEN switchboard has an MEN link between the neutral and earth busbars
  - A distribution switchboard does not have an MEN link between the neutral and earth busbars.
  - In an MEN system, an MEN switchboard must be the closest switchboard to the point of supply.
- (p) Any ONE of:
- Ohmmeters do not have sufficient voltage to stress the insulation.
  - Does not have an output of 500V d.c. or 250V d.c.
- (q) The RCCB does not provide overcurrent or short-circuit protection.
- (r) Any ONE of:
- Has better mechanical protection.
  - The screen is a safety shield.
  - Safe to handle while live.
  - Provides electrical shielding.
- (s) The maximum value of torque the motor can produce.
- (t) A certificate of compliance

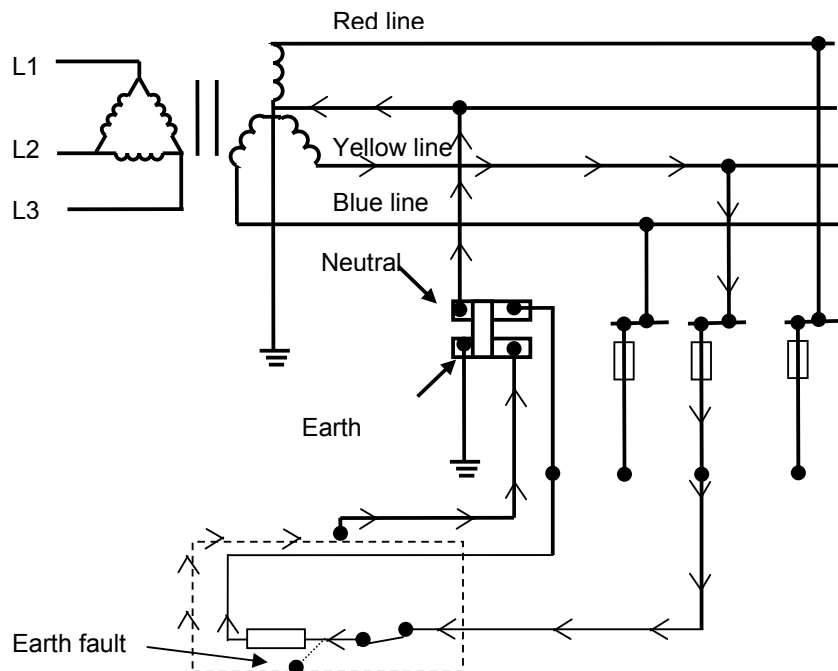
## QUESTION 2

- (a) • Use a 500V d.c insulation resistance tester (1 mark)
- Test between each of the three windings. (1 mark)
- Test between each of the three windings and the motor framework (1 mark)
- Each test result must be not less than 1 Megohm. (1 mark)
- (b) • Use an ohmmeter or any other instrument with a low reading ohms scale. (1 mark)
- Test the resistance of each winding. (1 mark)
- Each winding must have the same resistance. (1 mark)
- (c) • Protective earthing conductor continuity test. (1 mark)
- Visual test. (1 mark)
- Polarity test. (1 mark)

### QUESTION 3

- (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 potential across each single phase load is 230V 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 230 V to earth.
  - Mass of earth provides an alternative return path for the current if neutral is lost. (2 marks)

#### QUESTION 4

(a) (i) The current rating is too low for the circuit, and could blow for no apparent reason well below the circuit full-load current. (1 mark)

(ii) The current rating is too large, and the circuit current could increase to a high level causing damage, before the fuse blows. (1 mark)

(b) Any FOUR of:-

- It will safely interrupt short circuit currents of much higher values.
- It eliminates arcing because the fuse element is sealed.
- It is obtainable in a range of Utilisation category (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.

(4 marks)

(c) As current through a fuse or circuit breaker increases beyond its current rating, the time taken to operate decreases.

Note: A drawn representation of the characteristic is acceptable.

(2 marks)

(d) 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.

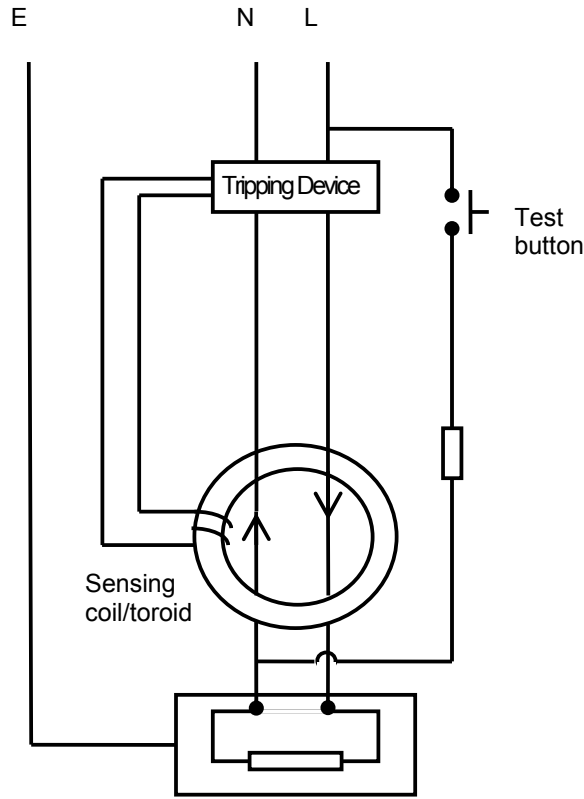
Electromagnetic

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 5**

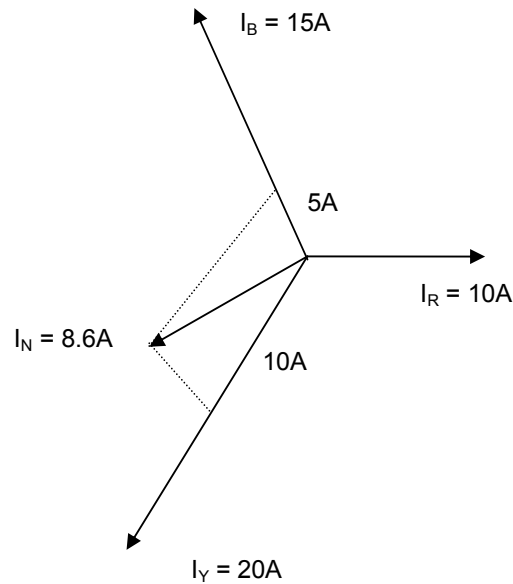
(a)



- Correctly connected test circuit and resistance (1 mark)
  - Correctly connected sensing coil/toroid (1 mark)
  - Correctly connected load (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, isolating the circuit (1 mark)
- (c)
- PRCD    Portable residual current device. (1 mark)
- RCBO    Residual current-operated circuit breaker with over current protection (1 mark)

**QUESTION 6**

(a)



- Neutral (2 marks)
- Diagram and labels (2 marks)

(b)  $V_{PH} = \frac{V_L}{\sqrt{3}}$   
 $= \frac{300}{\sqrt{3}}$   
 $= 231 \text{ V}$

$P_R = 231 \times 10$   
 $= 2310 \text{ W}$  (1 mark)

$P_Y = 231 \times 20$   
 $= 4620 \text{ W}$  (1 mark)

$P_R = 231 \times 15$   
 $= 3465 \text{ W}$  (1 mark)

(c) Total P = 2310 + 4620 + 3465  
 $= 10\,395 \text{ W}$  (1 mark)

(d) The neutral current will decrease. (1 mark)

The loads are more balanced among the 3 phases. If the yellow line current was also 15 A, then the neutral current would be zero. (1 mark)

## QUESTION 7

(a) Any FOUR of:

- Isolate and tag circuit
- Each conductor must be insulated and made electrically safe.
- Each conductor should be marked and labelled to permit reconnection to the correct terminals.
- Protect the cables to prevent damage
- Take steps to prevent access to the cables.

(4 marks)

(b) Isolation – means deliberately disconnected from the electricity supply and precautions taken to prevent reconnection  
Switched off means that the electricity ceases to be supplied to the appliance

(3 marks)

(c) Any THREE 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.

(3 marks)

### QUESTION 8

(a) (i) Primary  $I_L = \text{Primary } I_{PH} \times \sqrt{3}$   
 $= 15 \times \sqrt{3}$  (½ mark)  
 $= 25.98 \text{ Amps}$  (½ mark)

(ii) Se.  $V_{PH} = \frac{\text{Sec } V_L}{\sqrt{3}}$  (½ mark)  
 $= \frac{11000}{\sqrt{3}}$  (½ mark)  
 $= 6351 \text{ volts}$  (1 mark)

Turns ratio  $= \frac{33000}{6351}$  (½ mark)  
 $= 5.196 \text{ to } 1$  (1 mark)

Sec  $I_L = 15 \times 5.196$  (½ mark)  
 $= 77.94 \text{ Amps}$  (1 mark)

(iii) kVA  $= \sqrt{3} \times PV_L \times PI_L$  (½ mark)  
 $= \sqrt{3} \times 33000 \times 25.98$  (½ mark)  
 $= 1485 \text{ kVA}$  (1 mark)

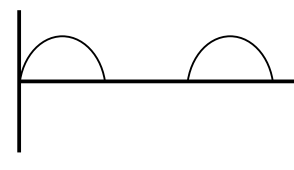
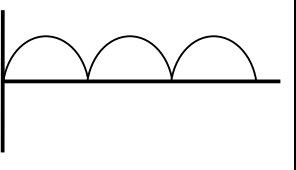
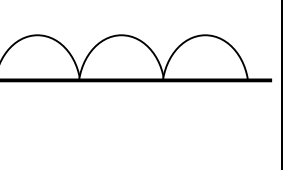
(b) Any TWO of:

- Air cooled.
- Oil cooled.
- Pumped or natural convection.
- Forced or natural ventilation.

(2 marks)

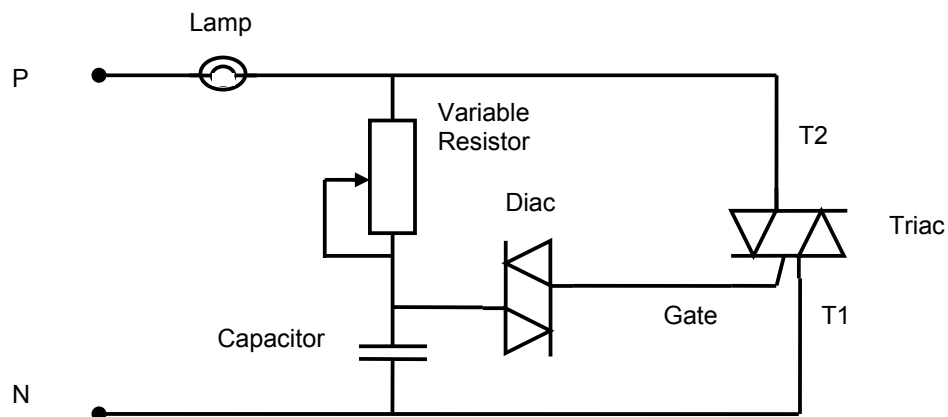
### QUESTION 9

(a)

	Single-phase half-wave rectifier	Centre-tapped full-wave rectifier	Single-phase full-wave bridge rectifier
Output waveform			
Ripple frequency	f	2 x f	2 x f

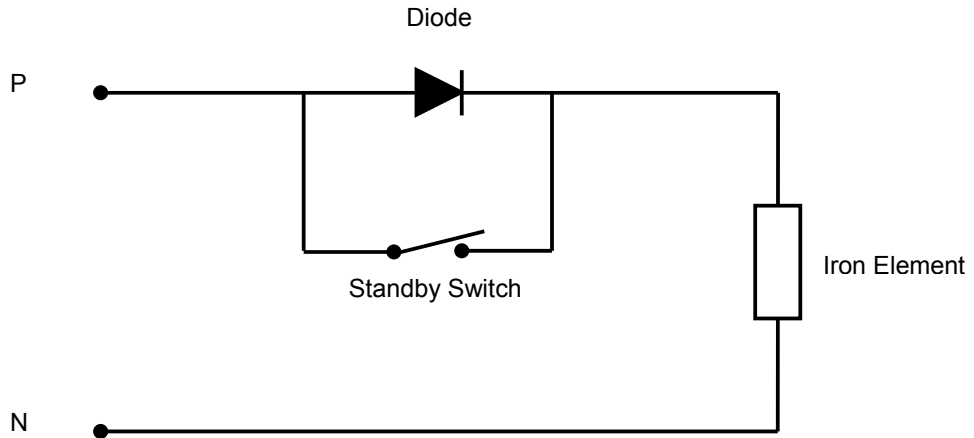
(3 marks)

(b) (i)



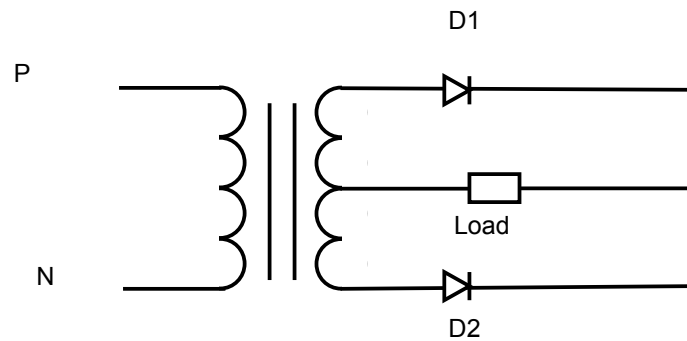
- Correctly connected supply. (½ mark)
- Correctly connected lamp. (½ mark)
- Correctly connected variable resistor. (½ mark)
- Correctly connected capacitor. (½ mark)
- Correctly connected Diac. (½ mark)
- Correctly connected Triac. (½ mark)

(ii)



- Correctly connected supply. (½ mark)
- Correctly connected Diode. (½ mark)
- Correctly connected standby switch. (½ mark)
- Correctly connected iron element. (½ mark)

(iii)



- Correctly connected supply. (½ mark)
- Correctly connected transformer. (½ mark)
- Correctly connected Diodes. (½ mark)
- Correctly connected load. (½ mark)

### QUESTION 10

$$(a) P_{\text{input}} = \frac{P_{\text{output}}}{\text{Efficiency}} \quad (\frac{1}{2} \text{ mark})$$

$$= \frac{4000}{0.75} \quad (\frac{1}{2} \text{ mark})$$

$$= 5333 \text{ W} \quad (1 \text{ mark})$$

$$P = \sqrt{3} \times V_L \times I_L \times \text{pf} \quad (\frac{1}{2} \text{ mark})$$

$$I_L = \frac{P}{\sqrt{3} \times V_L \times \text{pf}} \quad (\frac{1}{2} \text{ mark})$$

$$= \frac{5333}{\sqrt{3} \times 400 \times 0.8} \quad (\frac{1}{2} \text{ mark})$$

$$= 9.6 \text{ A} \quad (1 \text{ mark})$$

$$(b) N_s = \frac{F \times 60}{P} \quad (\frac{1}{2} \text{ mark})$$

$$= \frac{50 \times 60}{2} \quad (\frac{1}{2} \text{ mark})$$

$$= 1500 \text{ RPM} \quad (1 \text{ mark})$$

$$\text{Slip} = \frac{N_s - N_R}{N_s} \quad (\frac{1}{2} \text{ mark})$$

$$= \frac{1500 - 1440}{1500} \quad (\frac{1}{2} \text{ mark})$$

$$= 4\% \quad (1 \text{ mark})$$

$$(c) T_{\text{START}} = 0.33 T_{\text{DOL}} \quad (\frac{1}{2} \text{ mark})$$

$$= 0.33 \times 180 \quad (\frac{1}{2} \text{ mark})$$

$$= 60\% \quad (1 \text{ mark})$$