ES5 – Security Theory/Regulations Answer 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

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

Question 1

(a) Any ONE 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.
- Limit the potential to earth under fault conditions.

(2 marks)

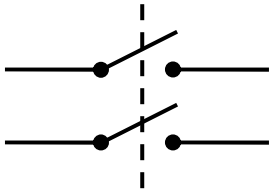
(b) It must be connected to the main earthing terminal in the main switchboard

(2 marks)

(c) (i) **Single pole switch** shown in the **on** position.

(1 mark)

(ii) **Double pole switch** shown in the **off** position.



(1 mark)

(d) Disconnect the supply if any circuit fault occurs.

(2 marks)

(e) A certificate of compliance

(2 marks)

Question 2

(a)
- When a fault occurs the protective device ("minor" device) nearest the fault operates.
- Before any other protective device ("major" device).

(2 marks)

(b) 60A The maximum current the fuse can continuously carry without overheating the fuse link and causing deterioration.

440V The maximum voltage the fuse can safely withstand across it, without flashover.

AC40 This indicates the maximum fault current the fuse can interrupt.

(3 marks)

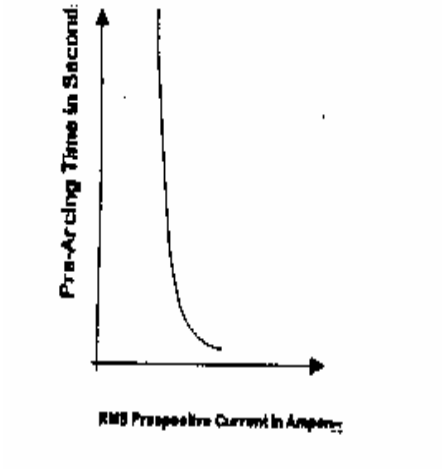
(c) When a protective device cannot withstand the prospective short circuit current, it must be backed-up by a device which can.

(2 marks)

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

(2 marks)

(e)



(1 mark)

Question 3

(a) (i) The maximum current that a fuse-link will carry continuously without deterioration or operating.
OR
The maximum level of protection for the circuit

(2 marks)

(ii) Current rating = Fusing Current / Utilisation Category (fusing factor)

$$= \frac{67.5}{1.5}$$

$$= 45 \text{ A}$$

(1 mark)

(b) Any TWO of:

- If correctly threaded, prevents fuse element from bulging out the side of the carrier and being accessible to touch.
  or
  If incorrectly threaded, contact could be made with the fuse element.

- If correctly threaded, under overload conditions the heat produced in the element is confined to the tunnel area.
  or
  If incorrectly threaded, the arc or molten metal may escape under overload conditions.

- If correctly threaded, under fault conditions the arc and molten element is confined within the fuse carrier and base.
  or
  If incorrectly threaded, the arc or molten metal may escape under fault conditions.

- If correctly threaded, the fuse wire is sheltered in the tunnel and well clear of the terminals which act as a heat sink.
  Or
  If incorrectly threaded, will be slow to respond to overload fault.

(2 marks)

(c) Any THREE of:

- If the fuse blows again an arc may be established between the fuse terminals causing damage or injury
- Cannot safely interrupt short circuit currents of much higher values.
- Fuse wire may protrude past the holder which creates an exposure to shock.
- Suitable fixing for the fuse wire is not generally available.
- Fuse holder is not fire proof.
- Slower operation/acting.
- Alters protection characteristics – changes Utilisation category

(3 marks)

(d) 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 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.

(2 marks)

Question 4

(a) (i) To shunt excess current away from the load.

(1 mark)

(ii) A Zener diode is designed to carry significant reverse current but a normal rectifier diode cannot.

(1 mark)

(iii) ● The resistance limits the current through the Zener diode.

(1 mark)

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● To the maximum value capable of being handled by the diode without damage.

(2 marks)

● In the event of the load becoming disconnected or open circuited

(1 mark)

(b) Any TWO:

- Inductor
- Capacitor
- Resistor

(2 marks)

(c) Any TWO:

- Current drops to zero
- Current drops to less than holding current
- Remove anode to cathode voltage.
- Apply reverse polarity voltage across the SCR.

(2 marks)

Question 5

(a)
- Imbalance between the phase and neutral currents. (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 limits the time a current can flow through a body. (2 marks)

(d) The RCCB does not provide overcurrent or short-circuit protection. (1 mark)

(e)
- Yes
- The PRCD will not reliven when supply is restored.
  or
  The device must be reset before use. (2 marks)

Question 6

(a) (i) Effectively connected to the general mass of Earth

(1 mark)

(ii) In relation to fittings or electrical appliances, means that the fittings or appliances are deliberately disconnected from any source of electricity.

(1 mark)
ER2

(b) (i) 5% of 230 volts = 11.5 volts

(ii) 5% of 400 volts = 20 volts

ER 53(3)

(c) Any TWO of:

Final subcircuits that supply:

- Socket-outlets having rated currents not exceeding 63A
- Hand-held Class I equipment
- Portable equipment intended for manual movement during use.

AS/NZS 3000: 1.7.4.3.4(a)
(2 marks)

(d) Circuits including submains and final subcircuits supplying fixed or stationary equipment.

AS/NZS 3000: 1.7.4.3.4(b)
(2 marks)

(e) ● Red
or
● Any colour except Black, Light Blue, Green or Green/Yellow.

AS/NZS 3000: Table 3.5.1
(2 marks)

Question 7

(a)
- Insulation, in accordance with Clause 1.7.3.3.
- Barriers or enclosures, in accordance with Clause 1.7.3.4.
- Obstacles, in accordance with Clause 1.7.3.5.
- Placing out of reach, in accordance with Clause 1.7.3.6.

AS/NZS 3000: 1.7.3.2
(4 marks)

(b) Any TWO of:

- IPXXB
- IP2X.
- IP4X for horizontal top surfaces that are readily accessible.

AS/NZS 3000: 1.7.3.4.1
(2 mark)

(c)
- The use of a key or tool
- An interlocking device is fitted
- An intermediate barrier is provided

AS/NZS 3000: 1.7.3.4.3
(3 marks)

(d) Two

(1 mark)

Question 8

(a) AS: /NZS 3760

(1 mark)

(b)

Type of test	(i) Type of instrument required	(ii) Test result
Earthing continuity	***Ohmmeter or other instrument with a low reading ohms scale***	***Max 1 ohm resistance***
Insulation resistance test	***Insulation resistance tester***	***min 1 Mohm***

AS/NZS 3760: Table 2

(c) Any **FIVE** of – from AS/NZS 3760:2001:

- Check for obvious damage or defects in the accessories, connectors, or plugs.
- Check that flexible cords are effectively anchored to equipment and plugs.
- Check that the inner cores of flexible supply cords are not exposed or twisted;
- Check that the external sheaths are not cut, abraded, twisted, or damaged to such an extent that the insulation of the inner cores is visible
- Check that unprotected conductors or insulation tape are not in evidence.
- Check that any controls are in good working order i.e. they are secure, aligned and appropriately identified.
- Check that covers, guards and the like are secured in the manner intended by the manufacturer or supplier.
- Check that safety facilities and devices are in good working order.

AS/NZS 3760: 2.3.2
(5 marks)

Or

Any **FIVE** of – from AS/NZS 3760:2003:

- Check for obvious damage or defects in the accessories, connectors or plugs and for discolouration that may indicate exposure to heat, chemicals and moisture.
- Check that flexible cords are effectively anchored to equipment and plugs.
- Check that the inner cores of flexible supply cords are not exposed or twisted;
- Check that the external sheaths are not cut, abraded, twisted, or damaged to such an extent that the insulation of the inner cores is visible
- Check that unprotected conductors or banding insulation tape are not in evidence.
- Check that any operating controls are in good working order i.e. they are secure, aligned and appropriately identified.
- Check that covers, guards and the like are secured in the manner intended by the manufacturer or supplier.

AS/NZS 3760: 2.3.2

Question 9

(a) Lodge a written complaint with the Registrar

(2 marks)
EA 119

(b) Any TWO of:

* Cancellation of the registration
* suspension of the registration
* limited to such work as the Board may specify
* limited to work only on approved premises
* limited to work only in the employ of an approved employer
* impose a fine

EA 127(2)
(2 marks)

(c) (i) Practising licence

EA 95
(1 mark)

(ii) The Registrar

EA 96(1)
(1 mark)

(iii) When the holder ceases to be registered.

(2 marks)
EA 138

(c) That consists of or includes loss of consciousness

or

That necessitates the person suffering the injury
(i) Being admitted to hospital
(ii) Receiving medical treatment from a health care professional

(2 marks)
EA 16(2)(a)(b)

Question 10

(a) Any FOUR of:

- Continuity of the earthing system
- Insulation resistance
- Polarity
- Correct circuit connects
- Operation of RCDs

AS/NZS 3000: 6.3.3.1
(2 marks)

(b) Any TWO of:

- To ensure that the insulation resistance between all live conductors and earth is adequate.
- To ensure that the insulation resistance between all live parts and earth is adequate.
- Prevent electrical shock hazard from inadvertent contact.
- To prevent fire hazards from short circuits.
- To prevent equipment damage.

AS/NZS 3000: 6.3.3.3.1
(2 marks)

(c) 500 V d.c.

AS/NZS 3000: 6.3.3.3.1
(1 mark)

(d) Maintain its terminal voltage with +20%, -10% of the nominal open circuit terminal voltage.

(1 mark)

When measuring a resistance of 1 MΩ on the 500 V d.c. range or 10 MΩ on the 1000 V d.c. range.

(1 mark)
AS/NZS 3000: 6.3.3.3.1

(e) Any ONE of:

- To ensure protective earthing conductors do not normally carry current.

AS/NZS 3000: 6.3.3.5(a)

- To ensure no short circuit exists, because a short-circuit current flowing between live conductors and through part of the earthing system can cause considerable fire damage or personal injury, particularly in high current locations.

AS/NZS 3000: 6.3.3.5(b)

- To prevent the transposition of active and neutral conductors of the consumers mains or submains (with MEN connection at outbuilding or detached portion) resulting in the electrical installation earthing system becoming energized; and

AS/NZS 3000: 6.3.3.4.1(a)

- To prevent combinations of incorrect active, neutral and earthing conductor connections resulting in the exposed conductive parts of the electrical installation becoming energized; and

AS/NZS 3000: 6.3.3.4.1(b)

- To prevent the connection of switches in neutral conductors, resulting in parts of appliances, such as heating elements and lampholders, remaining energized when the switches are in the 'OFF' position.

AS/NZS 3000: 6.3.3.4.1(c)

(f)
- To ensure that the earthing systems has been installed in a manner that will cause circuit protective devices to operate if there is a fault between live parts, other than the neutral, and the mass of earth.
- Will ensure that electrical equipment parts that are earthed do not reach dangerous voltages when earth faults occur.

(2 marks)
AS/NZS 3000 6.3.3.2.1