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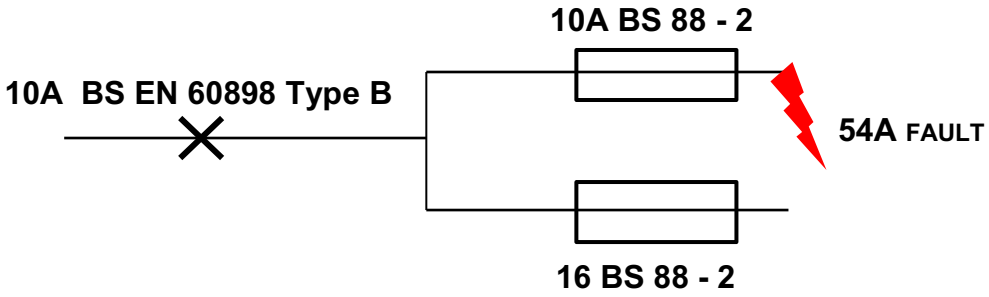
ANSWER SHEET
SPARKS MAGAZINE: Winter Edition 2021

Circuit Protection:

Electrical circuit protective devices:

Question 1:

What is the possible outcome/s if the following circuit protective devices are installed as shown and a fault occurs in the 10A protected circuit?



Answer:

The Type B breaker is likely to operate before the BS 88-2, fuse and so the supply will be lost to both circuits rather than just the circuit with the fault. This is an example of poor discrimination.

Question 2:

a) Define the term 'Over-current' in respect to an electric cable.

b) In an electrical circuit identify **three** reasons for an over-current.

Answer:

a) An over-current is a current exceeding the rated value, i.e. the current-carrying-capacity of the cable.

b) a) Circuit overload
b) Short-circuit between live conductors
c) A fault of negligible impedance between a live conductor and earth

Question 3:

Calculate the fault current that will be expected to flow in a 230V single-phase circuit if the impedance at the point of fault is **1.28Ω**

Answer:

If = Uo ÷ Z therefore If = 230 ÷ 1.28 = 179.7 A (180A

Question 4:

A residual current circuit breaker, (RCD), operates on which specific electrical principle? Briefly explain how this principle applies.

Answer:
RCD's and RCBO's operate on the **'current balance'** principle.

Note: *To explain this principle; in a healthy single-phase supply system incorporating an RCD or RCBO, a current balance exists and the current flowing in the line conductor will be equal to the current flowing in the neutral conductor.*

If a fault to earth occurs in the circuit protected by the RCD or RCBO, the current flowing in the line and neutral conductors will be different and a case of 'unbalanced' currents occurs. This causes the device to operate, i.e. to switch-off.

Question 5:

What are the code letters that identify:

(a) The maximum fault current a circuit-breaker can interrupt safely, although it may then be no longer usable afterwards.
And
(b) The maximum fault current a circuit-breaker can interrupt safely without loss of performance; i.e. it can be used again.
(c) State where and how these fault current values can be shown on a circuit-breaker

Answer:

(a) Icn
(b) Ics
(c) The Icn is normally shown in a rectangle, for example **6000** and is the prospective fault current that must not be exceeded.

The Ics is often shown as a single figure beneath Icn and is a kA value, for example

6000
3

Where the figure 3 is 3kA being the maximum fault current without loss of performance.

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Question 6:

An industrial 3-phase 400V balanced resistive load is rated at 85kW.

a) Determine the design current of the circuit.

b) State the type and rating of a suitable circuit-breaker to provide protection for this load.

Answer:

a) The design current is found from: **$I_b = P \div (\sqrt{3} \times U_L)$**

$I_b = 85000 \div (\sqrt{3} \times 400)$

$I_b =$ **<u>122.7A</u>** (123A)

Note: *This will be the current passing in each of the three lines of the three-phase supply, and therefore can also be referred to as the 'Line current' of the circuit.*

b) This being a resistive load, a Type B circuit - breaker will be suitable. From Figure 3A4 Appendix 3 of BS7671:2018, a suitable current rating is **125A**.

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Distribution boards and Consumer Units:

Attempt the following short answer questions concerning electrical distribution boards and consumer units.

Question 1:
Briefly define the term ‘Distribution Board’

Answer:
An assembly containing switching or protective devices, e.g. fuses, circuit-breakers, residual-current operated devices, associated with one or more outgoing circuits fed from one or more incoming circuits… *(IET BS7671:2018 Part 2 Definitions)*

Question 2:
Briefly define the term ‘Consumer unit’

Answer:
A particular type of distribution board…for the control and distribution of electrical energy, principally in domestic premises… *(IET BS7671:2018 Part 2 Definitions)*

Question 3:
Identify the technical requirements of a circuit-breaker

Answer:
A device capable of making, carrying and breaking normal load currents in a circuit, and when abnormal currents flow, such as in the case of short-circuit, to safely break or open the circuit automatically.

Question 4:
What is the purpose of a ‘highway distribution board’?

Answer:
A distribution point for connecting one or more highway distribution circuits to a common origin e.g. street furniture. Street furniture supplying more than one circuit can itself be defined as a highway distribution board. *(IET BS7671:2018 Part 2 Definitions)*

Question 5:
Briefly describe the technical requirements for a domestic consumer unit to protect against direct contact with live parts

Answer:
a) A suitable plastic or metallic enclosure with suitable IP rating
b) Barrier over the live line bus-bar
c) Suitably protected double-pole main switch
d) Correctly connected live conductors

See 421.1.201 BS7671:2018: - enclosures to be manufactured from non-combustible material or be enclosed in a cabinet or enclosure constructed of non-combustible material…

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Question 6:
With respect to final circuits in an electrical installation state **one** requirement concerning the method by which the circuits are to be isolated and protected.

Answer:
i) Separate circuits to be provided for parts of the installation which need to be separately controlled, e.g. ring final circuits supplying socket-outlets upstairs and downstairs in a property.
ii) Circuits are not affected by the failure of other circuits, so for example a fault in the power, socket-outlet circuit does not cause the loss of supply to the lighting circuits supplied from the same consumer unit. This means that a double-pole RCD should not be installed as the overall means of isolation for the supply to a consumers unit.

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Electrical Test Instrument readings: Answers

In the following task match each unit with its measured unit

No.	Unit		Measured Unit
1	Current 6×10^{-6}	**A**	**3000A**
2	Voltage 400×10^{3}	**B**	**250000Ω**
3	Resistance 500×10^{6}	**C**	**6kW**
4	Current 3×10^{3}	**D**	**500MΩ**
5	Resistance 250×10^{3}	**E**	**20MW**
6	Power 60×10^{2}	**F**	**400kV**
7	Power 20×10^{6}	**G**	**6µA**
8	Voltage 1000×10^{6}	**H**	**1000MV**

Solutions:

1	**G**	**5**	**B**
2	**F**	**6**	**C**
3	**D**	**7**	**E**
4	**A**	**8**	**H**

Electrical test instruments:

Complete the following True or False questions relating to electrical test instruments and testing procedure.
For each question decide if the answer or statement is true or false and consider why.

1) The basic test instrument standard is given in BS EN 61557 Electrical safety in low voltage distribution systems up to 1000V a.c. and 1500V d.c.

This reference can be found in Regulation 643.1 of BS7671:2018 or IET Guidance Note3 Inspection & Testing

TRUE	✓
FALSE	

2) The test voltage requirement of an insulation resistance test instrument used on separated extra low voltage circuits is 500V d.c.

Table 64 – minimum values of insulation resistance (IET BS7671:2018), shows the test voltage requirement to be 250V d.c.

TRUE	
FALSE	✓

3) A low - resistance ohmmeter used to carryout continuity tests is recommended to have a no-load voltage between 4V and 24V, and a short-circuit current of not less than 250mA.

The requirement is 4V and 24V for no-load voltage but 200mA minimum short-circuit current. See IET Guidance Note 3 (Test Instruments and Equipment)

TRUE	
FALSE	✓

4) In a TT system the earth electrode resistance can be determined by, (a) by using a dedicated earth electrode resistance test instrument or (b) an earth loop impedance test instrument.

There are three methods that can be used to determine the resistance of an earth electrode or stake; these can be found in the IET Guidance Note 3 (Test Instruments and Equipment)

TRUE	✓
FALSE	

5) To determine Ze of an electrical installation an earth fault loop impedance test instrument is required and is connected at the furthest point in an electrical circuit between the line conductor and the neutral.

Ze is measured at the origin of the installation between the line of the supply and the means -of –earthing, with the main switch open or all circuits / final circuits isolated. Zs is measured at the furthest point of a circuit.

TRUE	
FALSE	✓

6) When testing industrial installations incorporating three-phase electric motor circuits there is a requirement to determine the correct phase sequence using a phase sequence test instrument.

See 643.9 IET BS7671:2018 or
IET Guidance Note 3

TRUE	✓
FALSE	

7) The scale shown below is known as an analogue scale



TRUE	✓
FALSE	

This is a typical analogue scale incorporating a mirror between the red and green scales – this is designed to prevent parallax error when a reading is being observed.

8) When testing the operation of an RCD using an RCD test instrument, the test current should not be applied for more than 5 seconds.

The test current should be applied for no longer than 2 seconds.
See IET Guidance Note 3

TRUE	
FALSE	✓

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Circuit Protection: Practice multiple-choice questions.

No 1	A protective device must relate to the characteristics of the circuit it is designed to protect and operate at suitable values of the following except?	**Answer**
a	Current	
b	Voltage	
c	Time	
d	Temperature	X

No 2	A single – pole fuse, switch or circuit-breaker must be connected in which one of the following conductors?	**Answer**
a	Protective	
b	Line	X
c	Neutral	
d	Reference	

No 3	The definition of an 'overload current' is which one of the following?	**Answer**
a	Overcurrent in an electrically sound circuit	X
b	Overcurrent in a circuit with an earth fault	
c	Electric motor starting current	
d	Overcurrent due to a short - circuit	

No 4	A protective device identified as Type D generally refers to which of the following devices?	**Answer**
a	Semi-enclosed fuses	
b	High rupturing capacity fuses	
c	Circuit - breakers	X
d	Cartridge fuses	

No 5	A protective device designed to protect against overload can be omitted in all of the following situations except?	**Answer**
a	A circuit supplying a domestic refrigerator	X
b	A circuit supplying fire extinguishing devices	
c	A circuit supplying medical equipment used for life support	
d	A circuit supplying a lifting electro-magnet	

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No 6	The disconnection time for a circuit protective device can be calculated using the following information. Which item of information is not required in the calculation?	Answer
a	The circuit disconnection time requirement	
b	Voltage rating of the supply	X
c	The fault current causing operation of the device	
d	The cross-sectional-area of the circuit cable	

No 7	The actual current rating of a protective device indicates	Answer
a	The operating current of the device	
b	The load current of the device	
c	The current rating of the load protected	
d	The sustained current the device can carry	X

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Test instruments & Practices:

Complete the following questions regarding electrical test instruments and test sequence:

1) **List** the test instruments that, during a re-inspection and test on an electrical installation, gave the following readings.

a) 85MΩ
b) 4kA
c) 20mS

a) Insulation resistance ohmmeter
b) Prospective short circuit current tester
c) RCD tester

2) State **THREE** safety checks to be carried out on an earth fault loop impedance tester and leads prior to conducting a test on a lighting circuit.

- *Instrument should be in calibration*
- *Show no signs of damage to the instrument or test leads*
- *Test leads to comply to HSE GS38 requirements*

3) State the **test voltages** required to carry-out insulation resistance testing on circuits operating at

a) 40 V
b) 230 V
c) 650 V

a) 250 V dc SELV circuit
b) 500 V dc Low voltage circuit
c) 1000 V dc Low voltage circuit

4) What are the **minimum** tabulated acceptable values of insulation resistance for EACH of the following circuits?

a) SELV
b) LV circuit up to 500V
c) LV circuit over 500V

a) 0.5MΩ
b) 1.0MΩ
c) 1.0MΩ

5) An Approved Voltage Tester must comply with HSE GS38. State **<u>three</u>** requirements; regarding the test leads for this standard of test instrument.

Finger barriers should be provided
A maximum of 4mm exposed tip- preferably 2mm or less or spring- loaded retractable screens
Probes to be fused not exceeding 500mA

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WORDSEARCH

The following words all relate to ‘smart’ homes and systems. Words can be left to right or top to bottom of the grid.

Automation	Sensor	Heat pump	Security
Network	Data	Meter	Alarm
Passive	infra-red	Timer	Bluetooth
Actuator	Controller	WIFI	Smart
Panel	Solar	Ground-source	Green

A	B	C	O	N	T	A	C	T	O	R	**B**	O	N	I	Y	F	M	T	**G**
U	A	R	F	F	H	Y	G	N	I	M	**L**	I	**W**	S	L	I	N	K	**R**
T	E	S	F	R	I	D	S	**S**	**E**	**C**	**U**	**R**	**I**	**T**	**Y**	R	E	E	**O**
O	K	U	L	**A**	**L**	**A**	**R**	**M**	B	F	**E**	E	**F**	O	C	E	X	M	**U**
M	E	I	J	**C**	G	Q	A	**A**	O	T	**T**	M	**I**	**N**	**F**	**R**	**A**	C	**N**
A	L	D	F	**T**	**I**	**M**	**E**	**R**	O	N	**O**	L	A	E	A	**E**	I	L	**D**
T	M	**H**	R	**U**	E	**D**	**A**	**T**	**A**	R	**O**	V	E	R	D	**D**	B	T	**S**
I	N	**E**	O	**A**	D	M	M	O	L	I	**T**	I	F	N	M	H	I	I	**O**
O	O	**A**	N	**T**	E	G	R	L	I	V	**H**	M	A	L	I	T	T	P	**U**
N	**E**	**T**	**W**	**O**	**R**	**K**	V	A	V	I	B	D	U	T	W	E	I	O	**R**
X	R	**P**	T	**R**	A	E	O	K	A	R	L	**G**	L	L	O	R	O	L	**C**
A	E	**U**	I	Y	L	O	V	**C**	**O**	**N**	**T**	**R**	**O**	**L**	**L**	**E**	**R**	E	**E**
G	S	**M**	R	B	E	D	L	E	Z	D	N	**E**	E	V	C	V	A	S	A
R	I	**P**	**A**	**S**	**S**	**I**	**V**	**E**	U	D	J	**E**	L	I	N	E	E	W	C
E	D	D	U	**E**	H	O	O	N	C	R	H	**N**	W	T	L	P	H	I	X
B	U	S	S	**N**	C	A	**P**	R	N	E	B	A	C	K	U	P	W	T	T
M	A	A	D	**S**	**O**	**L**	**A**	**R**	N	E	C	T	I	O	N	E	S	C	Y
Y	L	O	H	**O**	I	A	**N**	A	F	P	L	F	N	M	A	A	T	H	N
M	**E**	**T**	**E**	**R**	M	P	**E**	O	T	E	C	T	I	O	N	C	Y	P	X
P	S	F	T	E	S	V	**L**	Q	S	E	B	V	J	U	Y	K	L	E	S