

## Electrical Science and Principles - Workbook 8

<b>Name:</b>		<b>Group:</b>	
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The purpose of this block of learning [**BLOCK 8: Steps 1 - 5**] is to try to get you to demonstrate an understanding of electrical components including **Relays, Contactors, Solenoids** and protective devices including **Fuses, Circuit Breakers, RCDs, RCBOs, SPDs, AFDDs** and their **applications and operating principles**.

This sheet contains a study plan with **Steps** that must be followed in the order laid out; skipping steps or undertaking them in the wrong order **will not help at all**.

References for study including **Text** and [YouTube video links](#), are shown below each answer box.

### **Step 1**

There are three types of electrical equipment each of which relies on the electromagnetic properties of a coil of copper conductor for its operation, those being **Relays, Contactors,** and **Solenoids**.

- a) Explain the size difference between **Relays and Contactors,** and give the main reason for it.

<b>References:</b> <ul style="list-style-type: none"><li>• Text Book B Chapter ELTK 08 page 292 and Chapter ELTK 07 pages 194 - 195</li><li>• YouTube videos: <a href="#">relays, contactors, and solenoids</a> 6:20</li></ul>

- b) Produce a diagram showing the terminals, coil and switching contacts for a **2-pole double-throw** (DPDT) relay

<b>References:</b> <ul style="list-style-type: none"><li>• Text Book B Chapter ELTK 08 pages 292 - 294</li><li>• YouTube videos: <a href="#">relays, contactors, and solenoids</a> 10:10</li></ul>

### Step 1 continued

- c) Explain how a **solenoid** operates and give an application.

<b>References:</b> <ul style="list-style-type: none"><li>• Text Book B Chapter ELTK 08 pages 297 - 298</li><li>• YouTube videos: <a href="#">relays, contactors, and solenoids</a> 12:35</li></ul>

### Step 2

The two common types of protective devices that detect and disconnect overcurrent are **Fuses, and Circuit Breakers.**

- a) State the **fusing factor** of a **BS3036 semi-enclosed fuse** and explain what this means.

<b>References:</b> <ul style="list-style-type: none"><li>• Text Book B Chapter ELTK 08 page 292 and Chapter ELTK 04A pages 30 - 31</li><li>• YouTube videos: <a href="#">Different Types of Protective Devices</a> 2:45</li></ul>

- b) Breaking capacity is the maximum short circuit current a fuse can safely interrupt without a catastrophic failure such as a fire, breakage or explosion. Without available data what should the **maximum short circuit current** of a BS3036 fuse be taken as.

<b>References:</b> <ul style="list-style-type: none"><li>• Text Book B Chapter ELTK 08 page 292 and Chapter ELTK 04A pages 38 – 39</li><li>• IET On-Site Guide page 79 Table 7.2.7 (i)</li><li>• YouTube videos: <a href="#">Different Types of Protective Devices</a> 5:15</li></ul>

**Step 2 continued**

Protective devices that detect either overcurrent, overvoltage or fault currents or a combination of more than one of these conditions, include **Fuses, Circuit Breakers, RCDs, RCBOs, SPDs, and AFDDs.**

c) State the **fusing factor** of a **BS1361 (now BS88-3) cartridge fuse** and how this is achieved.

<b>References:</b> <ul style="list-style-type: none"><li>• Text Book B Chapter ELTK 04A pages 31 - 32</li><li>• YouTube videos: <a href="#">Different Types of Protective Devices</a> 6:45</li></ul>

d) State the **fusing factor** of a **BS88 HRC fuse** and give a typical application.

<b>References:</b> <ul style="list-style-type: none"><li>• Text Book B Chapter ELTK 04A page 32</li><li>• YouTube videos: <a href="#">Different Types of Protective Devices</a> 12:25</li></ul>

e) State a typical application for the different types of **BSEN 60898 circuit breakers.**

Type	Application
B	
C	
D	

<b>References:</b> <ul style="list-style-type: none"><li>• Text Book B Chapter ELTK 04A page 36</li><li>• YouTube videos: <a href="#">Different Types of Protective Devices</a> 9:30</li></ul>
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f) State the **fusing factor** of a **BSEN 60898 circuit breaker.**

<b>References:</b> <ul style="list-style-type: none"><li>• Text Book B Chapter ELTK 04A pages 34 - 36</li><li>• YouTube videos: <a href="#">Different Types of Protective Devices</a> 10:00</li></ul>

**Step 2 continued**

g) State the name of the part of a **BSEN 60898 circuit breaker** which deals with small overload current (e.g.  $2 \times I_n$ ) and explain how it performs this function ?

**References:**

- Text Book B Chapter ELTK 04A page 34
- YouTube videos: [Different Types of Protective Devices](#) 11:45

h) State the name of the part of a **BSEN 60898 circuit breaker** which deals with large fault currents and explain how it performs this function ?

**References:**

- Text Book B Chapter ELTK 04A pages 34 - 35
- YouTube videos: [Different Types of Protective Devices](#) 11:55

i)  $I_{cn}$  and  $I_{cs}$  relate to the serviceability of circuit breakers following large fault currents. Where specified what do each of these values mean?

Symbol	Meaning of symbol
$I_{cs}$	
$I_{cn}$	

**References:**

- Text Book B Chapter ELTK 04A pages 38 – 39
- IET On-Site Guide page 79 Table 7.2.7 (i)
- YouTube videos: [How Does a Circuit Breaker Work](#) 4:35

### Step 3

The two commonly used types of protective devices that detect low levels of earth leakage current are **RCDs and RCBOs**.

a) State the meaning of the letters **R** and **C** in the abbreviations **RCD** and **RCBO**

<b>R</b>	
<b>C</b>	
<b>References:</b> <ul style="list-style-type: none"><li>• Text Book B Chapter ELTK 04A pages 27 - 29</li><li>• YouTube videos: <a href="#">How an RCD works</a> 0:55</li></ul>	

b) In simple terms, describe the **operating principle** of an RCD operates.

<b>References:</b> <ul style="list-style-type: none"><li>• Text Book B Chapter ELTK 04A pages 27 - 29</li><li>• YouTube videos: <a href="#">How an RCD works</a> 1:12</li></ul>	

c) Provide **a labelled diagram** of the internal components and connections of a RCD, including:

- 1-phase Main supply
- Double-pole contacts
- Toroid
- Load
- Sensing coil
- Trip coil
- Test button
- Resistor

<b>References:</b> <ul style="list-style-type: none"><li>• Text Book B Chapter ELTK 04A page 28 Figure 4.12</li><li>• YouTube videos: <a href="#">How an RCD works</a> 3:15</li></ul>	

**Step 3 continued**

d) With the aid of a **simple diagram**, give a typical **resistor value** and show how, along with the **test button**, it is able to trip the RCD.

**References:**

- Text Book B Chapter ELTK 04A page 28 Figure 4.12
- YouTube videos: [How an RCD works](#) 3:50

e) Give **two examples** of electrical equipment that can cause **nuisance tripping** of RCDs through leakage currents.

**References:**

- Text Book B Chapter ELTK 04A pages 27 - 29
- YouTube videos: [How an RCD works](#) 5:00

f) Explain a method of **detecting earth leakage** of an **electrical appliance**.

**References:**

- Text Book B Chapter ELTK 04A pages 27 - 29
- YouTube videos: [How an RCD works](#) 9:25

g) What **single device** combines the overcurrent protection of a circuit-breaker with the earth-leakage protection of a residual current device?

**References:**

- Text Book B Chapter ELTK 04A pages 36 - 37

**Step 4**

The device which provides **Overvoltage Protection** to electrical installations and Equipment is a Surge Protective Device (**SPD**).

a) What is the **electronic component**, abbreviated **MOV**, that is used in Surge Protective Devices?

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References:

- IET On-Site Guide pages 38 - 45
- YouTube videos: [Surge Protective Devices](#) 14:15

b) What **Type of SPD** would normally be fitted in the consumer unit of a domestic supply?

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References:

- IET On-Site Guide page 41 Table 3.7.3
- YouTube videos: [How to Fit a Type 2 SPD](#)

c) What are the maximum total lead lengths of conductors used to connect an SPD?

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References:

- IET On-Site Guide page 43 3.7.5
- YouTube videos: [How to Fit a Type 2 SPD](#) 5:15

**Step 5**

The device which provides **Arc Fault Detection** to electrical installations is an **AFDD**.

a) Give an example of a **Parallel** Arc Fault and a **Serial** Arc Fault

<b>Parallel Arc Fault</b>	
<b>Serial Arc Fault</b>	

References:

- IET On-Site Guide page 43 3.7.5
- YouTube videos: [Arc Fault Detection Devices](#) 3:50