SPARKS

SPARKS MAGAZINE

Autumn Issue

Answers to exercises pp. 30-46

Page 30 – Cable Selection

(Covering Outcome 4 of Unit 304 'Understand the types, applications and limitations of wiring systems and associated equipment' (Level 3 NVQ Diploma in Installing Electro-Technical Systems and Equipment 2357-13 / 91 or EAL equivalent)

The following questions require you to study the relevant sections of the IET BS7671: 2008 Requirements for Electrical Installations.

Cable Specifications:

1) Cable voltage ratings for cables to BS5467, thermosetting insulated, armoured cables with a conductor operating temperature of 90°C are:

Answer: 600 / 1000V and 1900 / 3300V *(Table 4A3)*

2) PVC insulated non-armoured cable to BS6004, rated at 450 / 750V with a conductor operating temperature of 70°C is suitable for?

Answer: electric power, lighting and internal wiring (fixed installation) *(Table 4A3)*

3) Cables having low emission of smoke and corrosive gases when affected by fire can be abbreviated using the letters?

Answer: LSF

4) Thermosetting insulted armoured cables for voltages of 600 / 1000V with low emission of smoke and corrosive gases and conductor operating temperature of 90°C, is British Standard?

Answer: BS6724 *(Table 4A3)*

5) 300 / 500V screened electric cables to BS8436 are for use in?

Answer: walls, partitions and building voids. *(Table 4A3)*

6) The maximum voltage recommended for Mineral insulated cables and their terminations, to BS EN 60702-1 is?

Answer: 750V *(Table 4A3)*

Page 31 – Cable Selection 2

(Covering Outcome 4 of Unit 304 'Understand the types, applications and limitations of wiring systems and associated equipment' (Level 3 NVQ Diploma in Installing Electro-Technical Systems and Equipment 2357-13 / 91 or EAL equivalent)

The following questions require you to study the relevant parts of Appendix 4 of the IET BS7671: 2008 Requirements for Electrical Installations.

1) The Table reference for current rating and voltage drop of 60°C thermosetting insulated flexible cable is:

Answer: 4F1

2) The percentage voltage-drop allowance for a lighting circuit supplied from a private generator is:

Answer: 6% (Table 4Ab)

3) The Rating factor for ambient temperature (Ca), of a 60°C Mineral Insulated cable covered with a 70°C PVC sheath is?

Answer: 0.45 (Table 4B1)

4) The Rating factor for a single layer of 12 PVC insulated multicore cables supported on a cable ladder is?

Answer: 0.78 (Table 4C1)

5) The maximum current rating of a 3-phase 400V, 25mm² multicore 70°C thermoplastic non-armoured cable fixed to cable tray is?

Answer: 101A (Table 4D2A Column 9)

6) The maximum voltage drop per metre for the 25mm² in question 5 above, when supplying a resistive load is?

Answer: r1.75mV/A/m (Table 4D2B)

7) A 2-core, 10mm², 90°C thermosetting insulated flexible cable with protective conductor, supplying a single-phase load, has a maximum current rating and voltage-drop of?

Answer: 76A (Table 4F2A) and 5.1mV/A/m (Table 4F2B)

8) A 50mm², 90°C multicore armoured cable with thermosetting insulation and aluminium conductors, installed to Reference Method D supplying a single-phase load has a maximum current rating of?

Answer: 128A (Table 4J4A)

Page 32

Health & Safety Quiz:

By using the letter and number codes match the abbreviation with the correct meaning:

Number	Answer letter
1	J
2	E
3	G
4	A
5	C
6	I
7	B
8	D
9	H
10	F

Page 36-7 - The use of BS7671:2008 +A3 2015: Requirements for Electrical Installations

(Covering Outcome 7 of Unit 305 'Understanding the practices and procedures for the preparation and installation of wiring systems and electro-technical equipment in buildings, structures and the environment', (Level 3 NVQ Diploma in Installing Electro-Technical Systems and Equipment 2357-13 / 91 or EAL equivalent)

Practice multiple-choice questions

No.	Question.	Answer
1	Which one of the following electrical installations falls within the scope of BS7671?	
a	Equipment on aircraft	
b	Lightning protection systems	
c	Equipment of mobile and fixed offshore installations	
d	Medical locations	X 110.1.1

No.	Question.	Answer
2	Which one of the following installations would NOT be within the statutory control of an authoritative body?	
a	Petrol filling station	
b	Caravan site	
c	Theatre	
d	Agricultural site	X 115.1 App 2 & 6

No.	Question.	Answer
3	A device that is intended to limit transient over-voltages and direct surge currents is defined as	
a	An over-current device	
b	A protective device	
c	A surge protective device	X Part 2

d	A residual current device	

No.	**Question.**	**Answer**
4	When assessing the nature of supply demand the number and type of circuits required shall NOT be determined by	
a	Loads to be expected on various circuits	
b	Any special conditions such as harmonics	
c	Anticipated future demand if specified	
d	Unexpected loads on various circuits	**X 132.3**

No.	**Question.**	**Answer**
5	The abbreviation ESQCR used in BS7671 refers to the	
a	Electricity Safety, Quality and Continuousness Regulations	
b	Electricity Safety, Quality and Continuity Regulations	**X Page 40**
c	Engineering Safety, Quality and Continuity Regulations	
d	Engineering Safety, Quality and Continuousness Regulations	

No.	**Question.**	**Answer**
6	Which one of the following is NOT a classification of external influence?	
a	Current reading	**X App 5**
b	Environmental conditions	

c	Construction of buildings	
d	Utilisation	

No.	**Question.**	**Answer**
7	For a cable totally surrounded by thermal insulation for a length of ***400mm*** the rating factor to be used is?	
a	0.50	
b	0.51	**X T52.2**
c	0.68	
d	1.00	

No.	**Question.**	**Answer**
8	A circuit with a design current of 44A is installed using a cable with a current rating of 52A. If the voltage drop for the cable is 4.4mV/A/m, the circuit voltage drop for a 15m run of cable is?	
a	1.50V	
b	2.90V	**X App 4**
c	3.43V	
d	4.16V	

No.	**Question.**	**Answer**
9	A device intended, for safety reasons, to cut - off all or a discrete section of an installation by separating the installation or section from every source of electrical energy provides?	
a	Functional switching	

b	Isolation	**X Part 2**
c	Switching off for mechanical maintenance	
d	Emergency switching	

No.	**Question.**	**Answer**
10	A 32Amp protective device conforming to BS88-2 when carrying a fault current of 125A should operate in	
a	0.1s	
b	0.2s	
c	0.4s	
d	5s	**X App 3 3A3 (a)**

No.	**Question.**	**Answer**
11	Which one of the following British Standards applies to cooker control units?	
a	BS3535	
b	BS1363	
c	BS5655	
d	BS4177	**X App 1**

No.	**Question.**	**Answer**
12	Where practicable main protective bonding to the gas service in a building shall be made within	

a	600mm of the meter on the supply side	
b	600mm of the meter on the customers side	**X 544.1.2**
c	3m of the meter on the supply side	
d	3m of the meter on the customers side	

No.	**Question.**	**Answer**
13	The <u>minimum</u> c.s.a. of the main protective bonding conductor in relation to a supply neutral of 120mm^2 is?	
a	10mm^2	
b	16mm^2	
c	25mm^2	
d	35mm^2	**X T54.8**

No.	**Question.**	**Answer**
14	An AC voltage of 120V between conductors is classified as	
a	Extra low voltage ELV	
b	Low voltage LV	**X Part 2**
c	Separated extra low voltage SELV	
d	Reduced low voltage RLV	

No.	**Question.**	**Answer**
15	Skilled person (electrically) is defined as: A person who possesses, as appropriate to the nature of the electrical work to be undertaken	

a	Adequate education, training and practical skills, and who is able to perceive risks and avoid hazards which electricity can create	**x**
b	Adequate education, training and practical skills, and who is not able to perceive risks and avoid hazards which electricity can create	
c	Adequate education, training and practical skills	
d	Is able to perceive risks and avoid hazards which electricity can create	

No.	**Question.**	**Answer**
16	To ensure that protective measures for safety during the intended life of an installation shall not diminish it is necessary to assess	
a	The maximum demand of the installation	
b	The frequency and quality of maintenance	**X 341.1 (ii)**
c	How often portable electrical equipment will be replaced	
d	Possible structural alterations	

No.	**Question.**	**Answer**
17	A final circuit is the wiring between the	
a	Distribution company's fuse and energy meter	
b	Main switch and distribution board	
c	Distribution board and current using equipment	**X Part 2**
d	Distribution company's fuse and last outlet point	

No.	Question.	Answer
18	Within a domestic (house-hold) premises, consumer units and similar switch-gear assemblies shall comply with?	
a	BS EN 61539-3 and have an enclosure manufactured from non-combustible material	
b	BS EN 61439-3 and have an enclosure manufactured from non-combustible material	**X 421.1.201**
c	BS EN 61439-3 and have an enclosure manufactured from combustible material	
d	BS EN 61539-3 and have an enclosure manufactured from combustible material	

No.	Question.	Answer
19	Control equipment incorporating over-current protection must be installed with every electric motor having a rating of	
a	0.37kW	**X 552.1.2**
b	0.50kW	
c	1.00kW	
d	2.00kW	

No.	Question.	Answer
20	A luminaire installed in **zone 0** of a swimming pool shall be to?	
a	BS EN 60309-2	
b	BS EN 60937-2-6	
c	BS EN 60947-3	
d	BS EN 60598-2-18	**X 702.55.2**

Page 38 - 40 – Electric Cables

(Covering Outcome 4 of Unit 304 'Understand the types, applications and limitations of wiring systems and associated equipment' (Level 3 NVQ Diploma in Installing Electro-Technical Systems and Equipment 2357-13 / 91 or EAL equivalent)

The IET Wiring Regulations provide best practice guidance and data for cable selection and installation.

The IET On-Site Guide provides guidance regarding cable installation including bends, clipping distances and selection for cable containment.

Question 1: Use the IET On-Site Guide: Table D5, bends in cables, to complete the following extract:

Insulation	Finish	Overall diameter*	Factor to be applied to overall diameter of cable to determine minimum internal radius of bend
Thermosetting or thermoplastic (pvc) (circular, or circular stranded copper or aluminium conductors)	Non - armoured	Not exceeding **10mm** Exceeding **10mm** but not exceeding **25mm** Exceeding **25mm**	**3 (2)†** **4 (3)†** **6**

Question 2: Complete the following key associated with Table D5

i. For **flat cables** the diameter refers to the major axis, *i.e. the widest part of the cable*

ii. † The figure in brackets relates to single – core circular conductors of stranded construction installed in conduit, ducting or trunking.

Question 3: By using the IET On-Site Guide: Table D1 supports for cables in accessible positions, complete the following table of information

Maximum spacing of clips		
Overall diameter of cable*	Non – armoured thermosetting or thermoplastic sheathed cables.	
	Generally	
	Horizontal	Vertical

mm	mm	mm
not exceeding 9	250	400
exceeding 9 and not exceeding 15	300	400
Exceeding 15 but not exceeding 20	350	450
Exceeding 20 but not exceeding 40	400	550

Question 4: Use the IET On-Site Guide: Appendix E, and any other resource to complete the following tasks:-

Task 1:

What is the difference between thermosetting and thermoplastic PVC insulation?

Answer:

PVC (Poly Vinyl chloride), insulation is thermoplastic

XLPE (Cross linked Poly Ethylene) is thermosetting plastic.

Notes:

PVC and XLPE are two plastic materials used as insulation for electric cables.

XLPE has more tolerance of high temperature and will not deteriorate until it reaches 90ºC. Even above this temperature it will not instantly be destroyed, but the overall life of the cable will be reduced.

PVC can withstand temperatures only up to 70ºC.

Task 2:

Appendix E concerns cable capacities for three specific cases, these are:-

i. Straight runs of conduit not exceeding *3 m* in length

ii. Straight runs of conduit exceeding 3 m in length, or in runs of any length with *bends or sets*

iii. Trunking

Task 3:

Find and state the cable factors for each of the following cable types and installation methods:

i. 2.5 mm^2 PVC insulated cable with solid conductors installed in a straight length of galvanised steel conduit.

Answer: *39 Table E1*

ii. 10 mm^2 PVC insulated cables with stranded conductors installed in a 2m length of galvanised steel conduit.

Answer: *146 Table E1*

iii. 10 mm^2 PVC insulated cables with stranded conductors installed in a 4m length of galvanised steel conduit.

Answer: *105 Table E3*

Task 4:

Determine a suitable size of conduit to accommodate the following sized cables in a 2.8 m straight run of steel conduit:

- 3 x 1.5 mm^2 (stranded conductors)
- 3 x 4.0 mm^2
- 1 x 10.0 mm^2
- 2 x 16.0 mm^2

Answer:

Use Tables E1 and E2 to find a suitable size of conduit.

	Cable factor (Table E1)	***Total cable factor***
• *3 x 1.5 mm^2*	*31*	*31 x 3 = 93*
• *3 x 4.0 mm^2*	*58*	*58 x 3 = 174*
• *1 x 10.0 mm^2*	*146*	*= 146*
• *2 x 16.0 mm^2*	*202*	*202 x 2 = 404*
		Total factor = ***817***

Task 5:

Determine the number of 25 mm^2 cables that can be installed in a 25 mm diameter steel conduit.

Answer:

The conduit can accommodate 2 conductors of that size.

From Table E2 the total cable factor for a 25 mm conduit is 800

Next find the cable factor for a 25 mm^2 cable. Table E1 gives this as 385.

Task 6:

Determine a suitable size of conduit that is 5m long incorporating 3 bends to accommodate the following sized cables:

- 3 x 1.5 mm^2 (solid conductors)
- 3 x 4.0 mm^2 (solid conductors)
- 2 x 10.0 mm^2 (stranded conductors)

Answer:

From Table E3 the following cable factors are obtained:

Note: cables can be stranded or solid conductor in Table E3

	Cable factor (Table E1)	***Total cable factor***
• *2 x 1.5 mm^2*	*27*	*2 x 31 = 54*
• *2 x 4.0 mm^2*	*58*	*2 x 58 = 116*
• *2 x 10.0 mm^2*	*146*	*2 x146 = 292*
		Total factor = ***462***

From table E4, 32mm conduit has a factor of 474, so this is the size needed.

Task 7:

Determine the number of 16 mm^2 cables with thermosetting insulation that can be installed in a 50 mm x 50 mm galvanised steel trunking.

Answer:

20 conductors

From Table E6 for a 50 mm x 50 mm trunking the total factor is ***1037***

From Table E5 the cable factor for a 16 mm^2 thermosetting cable is ***50.3***

Question 5:

What is the minimum inner bend radius for a 25 mm conduit?

Table E3 data states 2.5 x the outside diameter of the conduit

2.5 x 25 = ***62.5 mm***

Question 6:

What is the minimum internal radius for a 16mm^2 single- core insulated non-armoured cable with circular conductors installed in trunking?

Calculate the diameter: 4.51mm

Allow for the thickness of the insulation – say 3mm

Overall diameter is 7.51mm

Cable is less than 10mm so radius is 2 x diameter (in brackets on table D5) so 15.2mm is the minimum internal radius

Page 41 – Electric Cables 2

(Covering Outcome 4 of Unit 304 'Understand the types, applications and limitations of wiring systems and associated equipment' (Level 3 NVQ Diploma in Installing Electro-Technical Systems and Equipment 2357-13 / 91 or EAL equivalent)

Cables and Resistance:

It is helpful to review the basic principles of conductor and insulation resistance when considering electric cables?

Conductor:

Remember conductor resistance is affected by conductor length, cross – sectional – area and temperature.

Task 1:

Complete the following using either the term *'increases'* or '*decreases*'.

i) The resistance of a conductor _*increase*_ with increasing length

ii) The resistance of a conductor _*increase*_ with decreasing c.s.a.

iii) The resistance of a conductor _*increase*_ with increasing temperature

Insulation:

Consider insulation resistance in the context of: length and cross – sectional – area.

Task 2:

Complete the following using either the terms *'increases'*, '*decreases*' or *'remains the same'*

i) The insulation resistance of a cable _*decrease*_ with increased length

ii) The insulation resistance of a cable _*remains the same*_ with increasing c.s.a.

iii) The insulation resistance of a cable _*increases*_ with decreasing length

Page 42 – Steel Containment Systems

(Covering Outcome 4 of Unit 304 'Understand the types, applications and limitations of wiring systems and associated equipment' (Level 3 NVQ Diploma in Installing Electro-Technical Systems and Equipment 2357-13 / 91 or EAL equivalent)

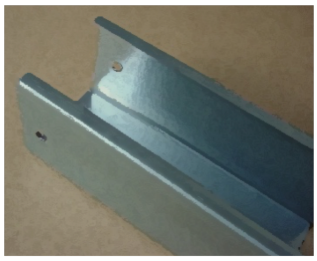
Identify the correct name, material used, and one application for each of the following containment systems:

1



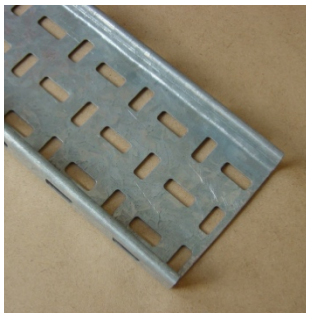
- Cable basket
- Galvanised steel wire
- Supporting multi-core cables; inside a building

2



- Steel trunking *(no lid shown)*
- Galvanised steel
- Enclosing single and multi-core cables; for inside use

3



- Heavy duty cable tray
- Galvanised steel
- Supporting PVC SWA cables; for inside or outside use

4



- Steel conduit *(Seam welded)*
- Black enamel covered mild steel
- Enclosing single insulated cables; only for use indoors in dry, corrosion free environments

Page 43 - Practice multiple-choice questions for wiring containment:

(Covering Outcome 4 of Unit 304 'Understand the types, applications and limitations of wiring systems and associated equipment' (Level 3 NVQ Diploma in Installing Electro-Technical Systems and Equipment 2357-13 / 91 or EAL equivalent)

No 1	Which one of the following is classed as 'containment'	**Answer**
a	Standard power cables	
b	PVC Conduit	X
c	Flexible cable	
d	MICC cables	

No 2	Grey enamel is often used as a surface finish of which one of the following?	**Answer**
a	Conduit and cable tray	
b	Conduit	
c	Trunking	X
d	Cable tray	

No 3	The cable capacity rating for a conduit allows for	**Answer**
a	Additional cables to be installed at a later date	
b	Expansion of cables when in use	
c	Sufficient cable temperature rise without damage	
d	Circulating air space allowing cables to shed heat in use	X

No 4	A cable ladder can be installed	Answer
a	Vertically	
b	Horizontally	
c	In outside locations	
d	All of the above situations	X

No 5	The accessory used to join lengths of metal trunking is a	Answer
a	Connector	X
b	Screwed sleeve	
c	Joiner	
d	Coupler	

No 6	The device used to prevent undue strain on cables in a vertically mounted trunking is a	Answer
a	Clamp	
b	Pin - rack	X
c	Support block	
d	Off-set	

No 7	The best practice method for connecting Mineral Insulated Copper Covered cable, (MICC), to a motor terminal box is	Answer
a	To form an anti-vibration loop where the cable terminates	X
b	Terminate to a plastic box first	

c	Terminate to a metal box and complete circuit with SWA	
d	Use a 90° conduit inspection box at the motor	

No 8	Which one of the following containment systems is more likely to be used underground?	**Answer**
a	Trunking	
b	Cable tray	
c	Conduit	
d	Ducting	X

No 9	Spacer-bar, distance and hospital, are all types of	**Answer**
a	Conduit	
b	Trunking support mechanisms	
c	Saddle	X
d	Support bracket	

No 10	Male and female bushes are found in which wiring containment system?	**Answer**
a	Steel Trunking	
b	Ducting	
c	Steel conduit	X
d	Cable basket	

Page 44 - Selecting and using power and hand tools:

(Covering Unit 305 'Understand the procedures for selecting and using, tools, equipment…' (Level 3 NVQ Diploma in Installing Electro-Technical Systems and Equipment 2357-13 / 91 or EAL equivalent)

Task A: Attempt the following questions concerning the selection and use of power tools.

Question 1:

What is the first action to be taken before using power tools?

Answer:

To make sure that the tool is safe to use. This requires the lead and power tool to be checked for cracks, broken or missing parts. Check that the PAT label is in date.

Question 2:

Hand-held power tools are also called?

Answer: Portable electrical equipment

Question 3:

List three power tools that are likely to be used when carrying out first-fix electrical work in domestic premises.

Answer:

1. 110V electric drilling machine plus transformer
2. 110V chasing machine
3. 110V electrically operated saw (jig – saw)

Question 4:

Identify four reasons why portable electrical equipment may cause harm to the operative.

Answer:

- Damaged enclosure; lead or plug
- Misused mainly due to lack of training and understanding by the operative
- Lack of maintenance; no appliance testing on a regular basis
- Incorrect power tool for the environment in which it is used. For example, not suitable for outside use.

Question 5:

A single-phase 110V reduced low voltage supply limits a fault voltage to earth to a value of?

Answer: 55V

Task B: Attempt the following questions concerning hand tools.

Question 1:

List the hand – tools that are likely to be required when working with steel conduit.

Answer:

- Pipe vice – to secure conduit when cutting or threading
- Hacksaw with 24 or 32 teeth per inch (tpi) blades for cutting conduit
- Tape measure
- 300mm steel rule
- Scriber, marker or pencil
- Engineers square
- Flat file *(rat – tail file if reamer is not available)*
- Reamer
- Stock and die suitable for conduit being used

Question 2:

Name the tool that allows verticals and horizontals to be checked.

Answer:

Spirit - level

Question 3:

Name three types of file that may be required when working with steel trunking.

Answer:

- Flat – smooth file
- Half-round – smooth file
- Round or Rat-Tail file

Question 4:

A metal trunking has been marked – out for a number of holes to be drilled. To maintain accuracy and to prevent the twist - drill slipping from the position marked explain what action should be taken.

Answer:
The points at which holes are required should be indented using a centre-punch

Question 5:

Name **three** types of drill or cutter that can be used in a portable drilling machine.

Answer:

- Twist – drill *(used for drilling holes in wood or metal)*
- Masonry drill *(specifically used when drilling stone or concrete)*
- Auger *(Flat-blade tool used for cutting larger holes in wood)*

Page 46 - Practice multiple-choice questions for hand and power tools:

No 1	Claw, ball-pein and sledge are all types of?	**Answer**
a	Masonry device	
b	Hammer	X
c	Screwdriver	
d	Saw	

No 2	Flat, round, half-round, square and warding are all types of?	**Answer**
a	File	X
b	Drill	
c	Cutter	
d	Hammer	

No 3	Lineman, long-nose and combination are names associated with?	Answer
a	Hammers	
b	Screwdrivers	
c	Hacksaws	
d	Pliers	X

No 4	A hand-tool marked IEC 60900 ‘VDE tested’ means that?	Answer
a	The tool can be used at 1200V	
b	The tool is insulated to a maximum of 1000V	X
c	The tool is mechanically tested	
d	The tool is only suitable for live electrical working	

No 5	The recommended hacksaw blade that ensures at least 2 – teeth in contact with metal at any time when cutting steel conduit or trunking is?	Answer
a	14 tpi	
b	18 tpi	
c	24 tpi	
d	32 tpi	X

No 6	A vice that is hinged on one side and has ‘V’ – shaped jaws is suitable for holding which of the following?	Answer

a	Flat, square metal bar	
b	Tubes, pipes and round bar	X
c	Timber planks	
d	Plastic trunking	

No 7	A twist drill has which of the following features?	**Answer**
a	Plain shaft for securing in a chuck	
b	Conical tip	
c	Spiral flutes	
d	All of the above	X

No 8	Which of the following safety equipment is essential when drilling holes in any material?	**Answer**
a	Neoprene gloves	
b	Face mask	
c	Safety helmet	
d	Safety glasses or goggles	X

No 9	A tool suitable for cutting 20mm holes in metal trunking is?	**Answer**
a	A 21mm diameter twist drill	
b	A 22mm metal punch	
c	A 20mm hole-saw	X
d	A jig-saw	

No 10	A suitable tool for obtaining levels across large distances, between locations of different height or around corners is a?	**Answer**
a	Water - level	X
b	Laser level	
c	5m tape measure	
d	Spirit level	