

SPARKS AUTUMN ISSUE EXERCISE ANSWERS

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Magnetism & Electromagnetism:

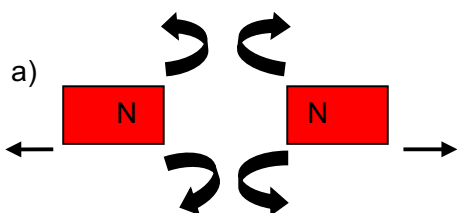
(Covering Unit 309 Outcome 5 'Understand the fundamental principles which underpin the relationship between magnetism and electricity' (Level 3 NVQ Diploma in Installing Electro-Technical Systems and Equipment 2357-13 / 91 or EAL equivalent))

A basic knowledge of magnetism and electromagnetism is an essential requirement for understanding electrical machines such as generators and motors. The following revision exercise should help you.

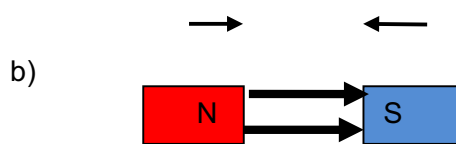
1) Complete the following statement:

In magnetism Like Poles Repel and Unlike Poles Attract

2) Show the magnetic lines and resulting force between each of the following permanent magnet poles:



Like poles repel and force the magnets apart



Unlike poles attract and force the magnets together

3) Indicate the direction of magnetic field around the following current carrying conductors:



Clockwise field
Current flowing into conductor



Anti-clockwise field
Current flowing out of the conductor

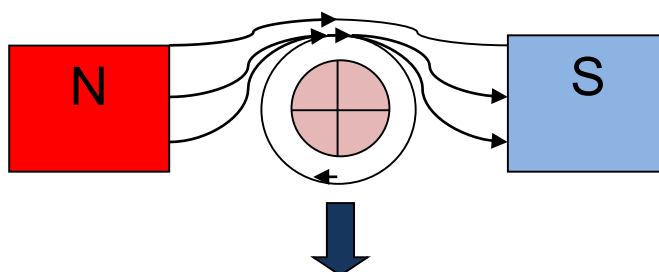
4) State the rule that is associated with magnetic fields surrounding current carrying conductors:

Answer: The Screw Rule

(Based on the idea that a woodscrew screwed into a piece of wood is turned Clockwise, if related to the direction in which current flows in a conductor, when current flows away from the viewer the magnetic field will be turning clockwise just as the screw is turned.)

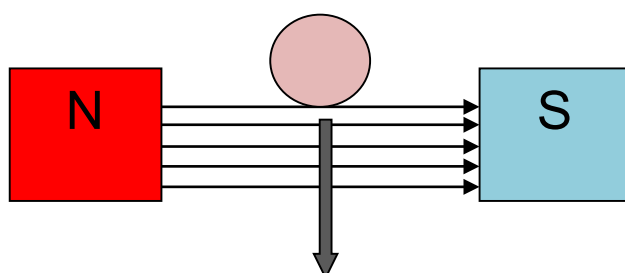
5) If a current carrying conductor is placed at 90° to a magnetic field what is the effect on the conductor?

Magnetic field is directed over the current carrying conductor



Answer: A downward force is exerted on the current carrying conductor

6) If a conductor is passed through a magnetic field in the direction shown by the arrow what is the effect on the conductor?



Answer: A voltage will be induced in the conductor, and if the conductor is part of a circuit or closed loop then a current will flow.

7) What is the effect on the conductor in question 6 if it is moved upwards through the magnetic field?

Answer: Current will flow in the opposite direction.

8) State the **hand rule** that can be used to determine (i) the direction of **force** or (ii) the direction of **current flow** in a conductor when interacting with a magnetic field.

Answer:

i) Fleming's **Left Hand Rule** is used to indicate direction of **force** on a current carrying conductor when lying in a magnetic field.

ii) Fleming's **Right Hand Rule** is used to indicate direction of **current flow** in a conductor when it is physically moved through a magnetic field.

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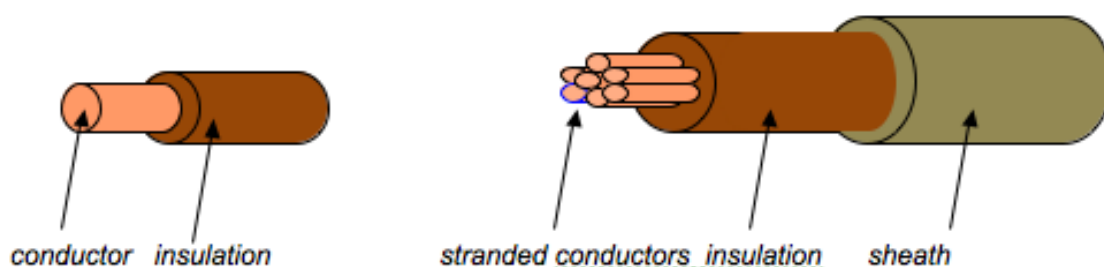
Electric Cables:

(Covering Outcome 4 of Unit 304 'Understand the principles for selecting cables and circuit protection devices' (Level 3 NVQ Diploma in Installing Electro-Technical Systems and Equipment 2357-13 / 91 or EAL equivalent))

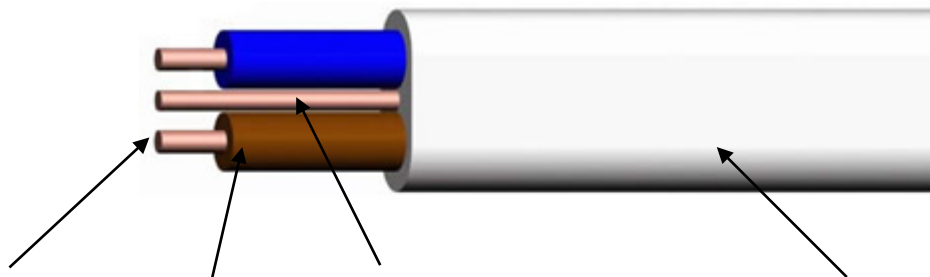
General knowledge questions:

Complete the following statements regarding cables.

- 1: An electric cable is designed to carry electric current.
- 2: A typical electric cable will have a solid or stranded conductor and a protective layer called the insulation
- 3: Cable insulation is generally a PVC layer that may be over-covered with an additional layer called the sheath
- 4: Insulating materials used in cable manufacture can be magnesium oxide, paper, plastic or in the case of bare conductors, the surrounding air
- 5: The current rating of an electric cable depends on the method of installation and the cable cross-sectional-area or c.s.a.
- 6: The cross-sectional-area of an electric cable is normally expressed in mm² and refers to the area of the conductor and not the whole cable
- 7: Complete the labels for the following cable samples



8: Composite cables can be clipped direct to a surface and consist of two or more cores. One example of a composite cable is twin & earth or T&E



Conductor insulation bare c.p.c sheath

9: The abbreviation **BASEC** is the registered mark for the British Approvals Service for Cables

10: What is the function of the BASEC mark found on electric cables?

To indicate that the cable has been tested, approved and certificated

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Electric Cables 2

(Covering Outcome 4 of Unit 304 'Understand the principles for selecting cables and circuit protection devices' (Level 3 NVQ Diploma in Installing Electro-Technical Systems and Equipment 2357-13 / 91 or EAL equivalent)

BS7671:2008 +3 2015 On-Site Guide for the Requirements for Electrical Installations

The IET On-Site Guide provides guidance regarding cable installation including **bends**, **clipping distances** and **calculation data for selecting the correct size cable containment**.

Bends in cables: (Appendix D)

Question: 1: Complete the IET On-Site Guide: Table D5 (extract).

The table shows the minimum **internal radii** of bends in cables for fixed wiring.

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 <u>10mm</u>	3 (2)†
		Exceeding 10mm but not exceeding <u>25mm</u>	4 (3)†
		Exceeding 25mm	<u>6</u>

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

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

Supports for cables in accessible positions: (Appendix D)

Question 2: Complete the IET On-Site Guide: Table D1 (extract).

Maximum spacing of clips		
Overall diameter of cable*	Non – armoured thermosetting or thermoplastic sheathed cables.	
	Generally	
	Horizontal	Vertical
mm not exceeding 9	mm <u>250</u>	mm <u>400</u>
exceeding 9 and not exceeding 15	<u>300</u>	400
Exceeding 15 but not exceeding 20	350	<u>450</u>
Exceeding 20 but not exceeding 40	<u>400</u>	550

Cable capacities of conduit and trunking: (Appendix E)

Thermosetting cables to be installed in the same trunking or conduit as thermoplastic insulated cables require the conductor operating temperature of any of the cables not to exceed that stated for the thermoplastic insulated cables.

Question 3:

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

Appendix E concerns cable capacities for three specific cases:

- 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

Question 4:

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

- i. 2.5 mm² PVC insulated cable with solid conductors installed in a short straight length of galvanised steel conduit.

39 Table E1

- ii. 10 mm² PVC insulated cables with stranded conductors installed in a 2m length of galvanised steel conduit.

146 Table E1

- iii. 10 mm² PVC insulated cables with stranded conductors installed in a 4m length of galvanised steel conduit.

105 Table E3

Question 5:

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

- 3 x 1.5 mm² (**solid conductors**)
- 3 x 4.0 mm²
- 1 x 10.0 mm²
- 2 x 16.0 mm²

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	27	27 x 3 = 81
• 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 = <u>404</u>
		Total factor = 805

Question 6:

Determine the number of **10 mm²** cables that can be installed in a short straight run of less than **3m** of 25 mm Dia. conduit.

Answer:

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

Next find the cable factor for a 10 mm² cable. Table E1 gives this as **146**

Question 7:

The next questions concern cables installed in a steel conduit that is **5 m** in length with **one 90° bend** and **two off-sets**.

Note: one off-set is equivalent to one bend

Determine a suitable size of conduit to accommodate the following sized cables:

- 2 x 1.5 mm² (solid conductors)
- 2 x 4.0 mm² (solid conductors)
- 1 x 10.0 mm² (stranded conductors)
- 1 x 16 mm² (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 E3)	Total cable factor
• 2 x 1.5 mm ²	22	2 x 22 = 44
• 2 x 4.0 mm ²	43	2 x 43 = 86
• 1 x 10.0 mm ²	105	1 x 105 = 105
• 1 x 16 mm ²	145	1 x 145 = <u>145</u>
		Total factor = <u>380</u>

Question 8:

Determine the number of **16 mm²** with thermosetting insulation that can be installed in a 50 mm x 50 mm galvanised steel trunking.

Answer:

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 mm² thermosetting cable is **50.3**

The total number of cables that can be installed is: $\frac{1037}{50.3} = \underline{20.61}$ cables

Question 9:

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

2.5 x the outside diameter of the conduit. See paragraph below table E3

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

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Cable supports:

(Covering Outcome 3 of Unit 304 'Understand the principles for selecting cables and circuit protection devices' (Level 3 NVQ Diploma in Installing Electro-Technical Systems and Equipment 2357-13 / 91 or EAL equivalent))


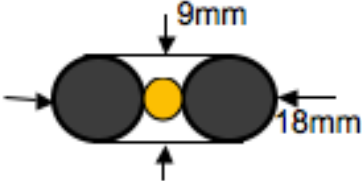
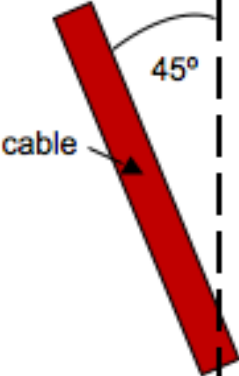
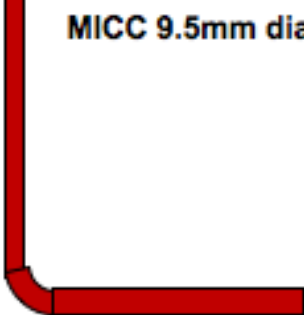
Question 1:

Complete the following table:

Type of cable	Method of installation	Precautions when installing or in use
Non – sheathed	Enclosed in conduit, trunking or ducting	Single layer of insulation can be damaged and so care must be taken when drawing-in cables to conduit or ducting, or laying cables in trunking
Sheathed	Clipped direct or enclosed as necessary	Care should be taken to ensure suitably spaced clips are provided for the support of the cable. Care must be taken when drawing – in cables to conduit, ducting or laying in trunking
Armoured	Laid in ducting or supported by clips, cleats, brackets, tray, basket or ladder	Sufficient cable clips or cleats to be used to support surface mounted cables.
Flexible	Laid directly on the ground, in ducting, trunking or other mechanical enclosure	Care should be taken to ensure cable is not in a position where it may be damaged. Suitable mechanical protection should be provided when cables installed at floor level
Metal sheathed	Clipped direct or supported on tray, basket or ladder	MICC cable in particular should not be over-worked as copper will work-harden and crack

Question 2:

Complete the following table of cable clip spacings:

Cable	Horizontal spacing	Vertical spacing
<p>Non-armoured sheathed</p>  <p>Diameter: 1 cm</p>	300mm	400mm
<p>Flat twin & earth</p> 	300mm	400mm
<p>PVC SWA 25mm dia.</p> 	450mm	N/A
<p>MICC 9.5mm dia.</p> 	900mm	1200mm

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 for each of the following steel cable containment systems and suggest one application:

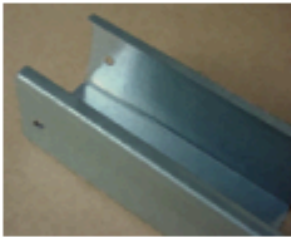
1



Cable basket

Supporting multi-core cables; for inside use

2



Galvanised steel trunking *(no lid shown)*

Enclosing single and multi-core cables; for inside use

3



Galvanised heavy duty cable tray

Supporting PVC SWA cables; for inside or outside use

4



Black enamel steel conduit *(Seam welded)*

Enclosing single insulated cables; only for use indoors in dry, corrosion free environments

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	20mm, 25mm and 32mm are diameters of	Answer
a	Standard power cables	
b	Standard conduits	X
c	Ducting	
d	MICC cables	

No 2	Stainless steel, galvanised and enamel are surface finishes used on?	Answer
a	Conduit, trunking and cable tray	X
b	Conduit only	
c	Trunking only	
d	Cable tray only	

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	Joints in trunking, cable tray or metal ducting will require	Answer
a	Sufficient set-screws and nuts to secure the joint	
b	The ends of the containment to be pushed together	
c	Protective bonding straps across each joint	X
d	Labels to indicate the position of the joint	

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

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 fixed metal conduit to a motor terminal box is	Answer
a	PVC SWA	
b	PVC conduit	
c	Direct connection of the conduit with the box	
d	Flexible conduit	X

No 8	Which one of the following containment systems may be used to support fluorescent luminaires?	Answer
a	Trunking	X
b	Cable tray	
c	Conduit	
d	Ducting	

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	Which one of the following wiring systems requires the introduction of fire barriers where it penetrates floors or ceilings?	Answer
a	Conduit 25mm and above	
b	Trunking with an area of over 710mm ²	X
c	Cable tray	
d	Cable basket	

No 11	Cable basket is designed to support all of the following cable types except	Answer
a	Single PVC insulated cables	X
b	PVC SWA	
c	PVC insulated MICC	
d	CAT 5 data cable	

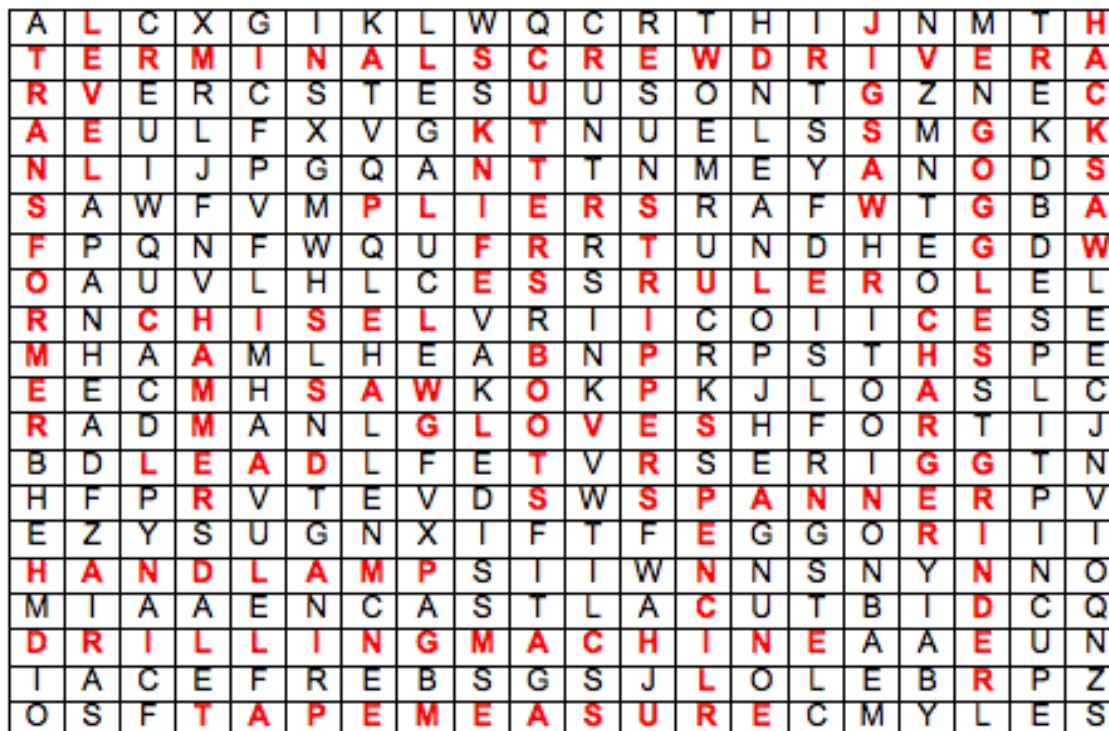
No 12	A running – coupler is sometimes used in	Answer
a	PVC conduit systems	
b	Trunking installations	
c	Underground ducting	
d	Steel conduit installations	X

WORDSEARCH – Hand and power tools

Try to locate the names listed below.

- | | | | |
|-------------|---------|----------------------|--------|
| Pliers | Cutters | Terminal screwdriver | Ruler |
| Strippers | Knife | Spanner | Level |
| Hammer | Chisel | Hacksaw | Saw |
| Transformer | Charger | Drilling machine | Lead |
| Hand lamp | Goggles | Gloves | Boots |
| Grinder | Jig saw | Tape measure | Pencil |

Words may be left to right or top to bottom



Practice multiple-choice questions for hand and power 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)

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, and square are all types of?	Answer
a	File	X
b	Drill	
c	Cutter	
d	Hammer	

No 3	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 steel 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	

No 11	A hammer with a split wooden handle should:	Answer
a	Not be used until the handle has been replaced	X
b	Be used with caution	
c	Be tapped – up so as not to cause splinters	
d	Be replaced with a metal handle	

No 12	An adjustable spanner should only be used when:	Answer
a	There is not a fixed spanner of the correct size available	X
b	Tightening steel conduit lock-nuts	
c	Tightening <u>pvc</u> conduit lock-nuts	
d	Loosening steel nuts from bolts	

