## SPARKS MAGAZINE – SUMMER (MAY) ISSUE – ANSWER SHEET

## Principles and practices for testing electro-technical systems:

(Covering Unit 307 'Understand principles, practices and legislation for the inspection, testing commissioning and certification of electro-technical systems and equipment in buildings, structures and the environment' (Level 3 NVQ Diploma in Installing Electro-Technical Systems and Equipment 2357-13 / 91 and the EAL equivalent)

### Test instruments:

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

1) List the instruments which, during an electrical commissioning test on an installation, gave the following readings.

a) 20MΩ
b) 8kA
c) 22mS

*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.

- *Test probes should have finger guards*
- *Test probe metal tips should not exceed 4mm but preferably 2mm*
- *Test leads should be fused*

3) State the test voltages required to test insulation resistance on circuits operating at

a) 25 V
b) 200 V
c) 600V

*a) 250 V dc SELV circuit*

*b) 500 V dc Low voltage circuit*

*c) 1000 V dc Low voltage circuit*

4) With reference to insulation resistance testing, state the tabulated test voltages to be applied and the minimum tabulated acceptable value of insulation resistance for EACH of the following circuits:

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

*a) 250 V d.c. 0.5MΩ*
*b) 500V d.c. 1.0MΩ*
*c) 1000V d.c. 1.0MΩ*

5) List in the correct sequence, the first THREE tests that should be performed during an initial verification on a new domestic installation.

*Continuity of protective conductors including main and supplementary bonding*

*Continuity of ring final circuit conductors*

*Insulation resistance*

6) The test for the continuity of a cpc in a radial circuit feeding one socket-outlet uses a temporary link and a low reading ohmmeter. State:

d) where the temporary link is connected
e) where the low reading ohmmeter is connected
f) what the meter reading actually represents

*a) between line and circuit protective (earth) conductor at the consumers control unit*
*b) between line and earth at the socket – outlet*
*c) the value measured is ($R_1$ + $R_2$) for the circuit*

7) List THREE precautions to be taken before conducting an insulation resistance test on an installation.

*i) check for electronic equipment*
*ii) check for neon lamps, capacitors etc…*
*iii) all switches closed and accessories or equipment removed*

*Alternatively*

*iv) no dangers to persons or livestock by conducting the test*

8) Before starting a periodic inspection and test, state

a) What must be agreed with the customer or client
b) Who needs to agree this with the client
c) Where this agreement must be recorded

*a) the extent of the inspection and test*
*b) the inspector/test engineer*
*c) the Electrical Installation Condition Report (EICR)*

9) State the main reason for conducting a periodic inspection and testing on an electrical installation.

BS7671: 2008 +A1 2011; Regulation 621.1 …Periodic inspection and testing of every electrical installation shall be carried out …in order to determine, so far as is reasonably practicable, whether the installation is in a satisfactory condition for continued service…

10) State the maximum re-inspection and test intervals for the following locations:

i. Caravans
ii. Caravan parks
iii. Construction sites

*i. 3 years*
*ii. 1 year*
*iii. 3 months*

## Electrical supply systems:

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

### Cable selection:

BS7671: 2008 +A1 2011, (Section 132 Design) states that circuits must be designed and that design data should be made readily available.

Before a cable can be selected the following steps must be taken:

- Make an Assessment of General Characteristics for the installation. (Part 3)
- Decide on the method of cable installation, (Part 5)
- Identify the type of cable and protective measures for shock and over-current, (Part 4).

### Stages of cable selection:

The following six - step procedure for calculating the current - carrying - capacity and voltage - drop for cables can be used to determine the cross-sectional-area of cable/s for distribution and final circuits, (Appendix 4):

1) Determine the design Current **(Ib)**

2) Select rating of suitable protective device **(In)** (Appendix 3 or Tables 41Part 4)

3) Identify the rating factors that may be applicable to the installation:

**Ca** – ambient temperature **Table 4B1**

**Cg** – grouping **Table 4C1**

**Ci** – thermal insulation **0.5 or see Table 52.2**

**Cf** – BS3036 fuse, **0.725** *fixed rating factor*

Determine the overall rating factor **(C).** **C = Ca x Cg x Ci x Cf**

**NOTE**: In practical situations be selective with the actual rating factors, e.g. if a thermal factor applies then will the ambient temperature factor make a great deal of difference, if not then use only the most appropriate rating factor.

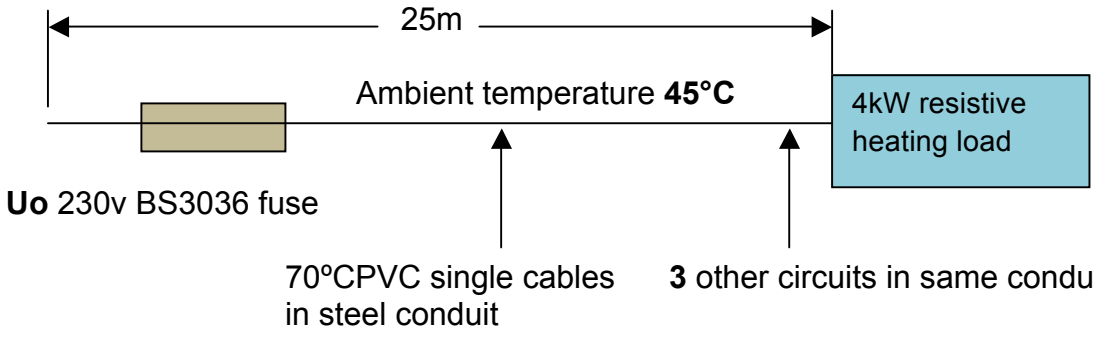
4) Calculate the tabulated current **(It)** from **In / C**

5) Choose a cable to match **(It)** from **Appendix 4** cable tables.

6) Check voltage drop does not exceed limits. (See Table 4Ab)

The following example provides boxes into which the reference or answer can be written.

Final circuit requirements are shown in this simple labeled line diagram:




| | |
|---|---|
| **Ib** | 17.4A |
| **In** | 20A |

← Calculated or referenced

← Chosen from manufacturers data or Appendix 3

| | Factor | Table Reference (BS7671) |
|---|---|---|
| **Ca** | 0.79 | 4B1 |
| **Cg** | 0.65 | 4C1 |
| Ci | N/A | |
| **Cf** | 0.725 | 5.1.1 Appendix 4 |

| | |
|---|---|
| **Cable installation reference method** | B |

| | |
|---|---|
| **Total rating factor:**<br>**C** = **Ca** x **Cg** x Ci x **Cf** | Current Carrying Capacity of cable required: **(It)**<br>$\mathbf{It} = \frac{\mathbf{In}}{\mathbf{C}}$ $It = \frac{20}{0.79 \times 0.65 \times 0.725}$ = **53.7A** |

**Cable size**

| | |
|---|---|
| Table No. | 4D1A |
| Column | 4 |
| Current rating | 57 |
| Cable size | **10mm²** |

**Voltage drop**

| | |
|---|---|
| Table No: | 4D1B |
| Column | 3 |
| Voltage drop | 4.4 mV/A/m |

**Actual Voltage drop (AVD)** = $\frac{\text{mV/A/M} \times \text{Ib} \times \text{Length of circuit (L)}}{1000}$

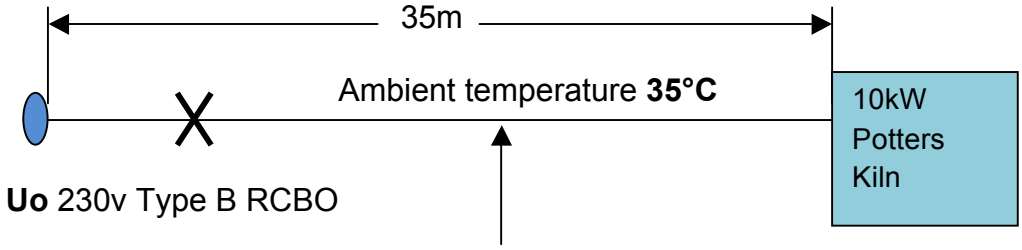
= $\frac{4.4 \times 17.4 \times 25}{1000}$ = **1.9 V** (Cable is okay. within 5% allowance)

## Electrical supply systems:

(Covering Outcome 6 of Unit 305, 'Understand the practices and procedures for installing wiring systems, associated equipment and enclosures', (Level 3 NVQ Diploma in Installing Electro-Technical Systems and Equipment 2357-13 / 91 or EAL equivalent)

**Cable selection:** You will need access to BS7671:2008 + A1 2011, for this exercise.

Final circuit requirements:




| | |
|---|---|
| **Ib** | 43.5 A |
| **In** | 50A |

← Calculated or referenced

← Chosen from manufacturers data or Appendix 3

| | Factor | Table Reference (BS7671) |
|---|---|---|
| **Ca** | 0.94 | 4B1 |
| Cg | N/A | |
| Ci | N/A | |
| Cf | N/A | |

| | |
|---|---|
| **Cable installation reference method** | B |

**Total rating factor:**

**C = Ca** ~~x Cg x Ci x Cf~~
Only Ca applies

Current Carrying Capacity of cable required: **(It)**

$$\mathbf{It} = \frac{\mathbf{In}}{\mathbf{C}} \qquad It = \frac{50}{0.94} \qquad = \mathbf{53.2A}$$

### Cable size

| | |
|---|---|
| Table No. | 4D2A |
| Column | 6 |
| Current rating | 63A |
| Cable size | **10mm²** |

### Voltage drop

| | |
|---|---|
| Table No: | 4D2B |
| Column | 3 |
| Voltage drop | 4.4 mV/A/m |

**Actual Voltage drop (AVD)** = $\frac{\text{mV/A/M} \times I_b \times \text{Length of circuit (L)}}{1000}$

= $\frac{4.4 \times 43.5 \times 35}{1000}$ = **6.7 V** (Cable is okay. 5% allowance)

## Safe Isolation power supplies:

(Covering Outcome 1 of Unit 307 'Understand principles, practices and legislation for the inspection, testing, commissioning and certification of electro-technical systems and equipment in buildings, structures and the environment' (Level 3 NVQ Diploma in Installing Electro-Technical Systems and Equipment 2357-13 / 91)

### Check your knowledge:

Regulation 14 of the Electricity at Work Regulations 1989 clearly states that *'no person shall be engaged in any work activity on or so near to any live conductor…'*

It is therefore essential that safe isolation of the power supply or supplies be made before commencing work on a circuit, or a group of circuits or on permanently connected electrical equipment.

**Question 1**:
List the HSE recommended test equipment that will be needed before safe isolation can be carried out?

**Question 2:**
State the precaution / s that need to be considered before isolating any electrical circuit, groups of circuits or electrical equipment?

**Question 3:**
Briefly explain the recommended procedure for isolating a circuit or groups of electrical circuits.

The basic principle of safe isolation is that the point of isolation is under the control of the person who is carrying out the work on the isolated conductors.

**Question 4:**
Identify all of the possible means of isolation for a final circuit.

All personnel involved in work on electrical systems and equipment must be skilled (electrically) and, where necessary, be suitably instructed (electrically), on safe systems of work.

Personnel should be provided with written instructions, and have access to, appropriate locking-off devices, warning notices, a voltage detector and proving unit.

**Further information:**

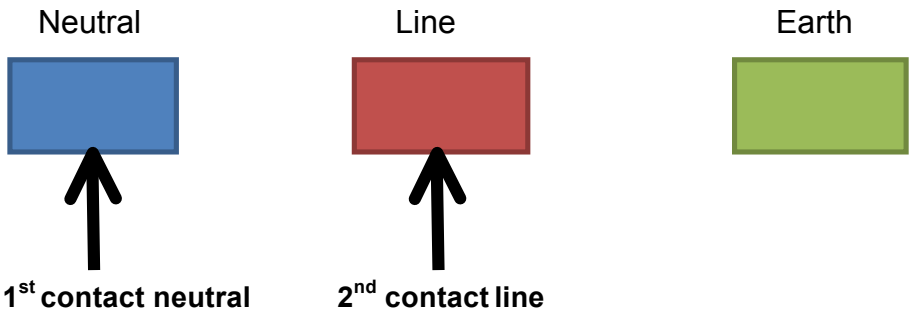
Most leading agencies provide step-by-step guidance for carrying out safe-isolation. It will be helpful to explore the guidance by looking at web sites. The HSE provide comprehensive information regarding electricity at work and the precautions that need to be taken when working on or near live conductors. See www.hse.gov.uk

**Question 4:**
Complete the recommended sequence of safe isolation for single-phase supplies using arrows and statements to which probe is connected first and second etc…

To ensure that RCD's and RCBO's do not trip when connecting an approved - voltage tester to circuits that may not be isolated, the following sequence of test probe connections is recommended.

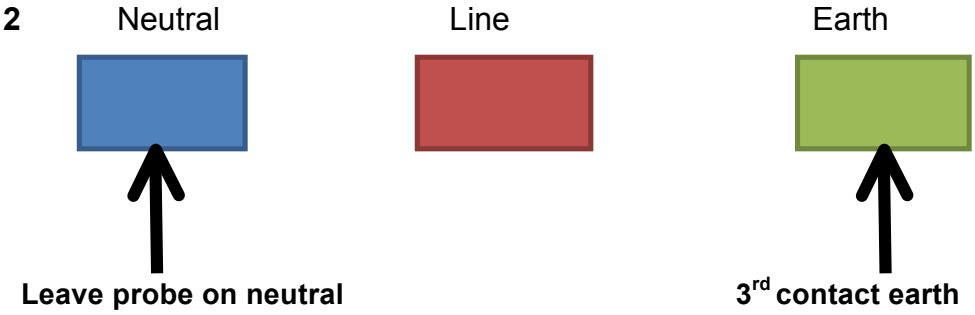
**NOTE:**
It is good practice to make probe contact with **neutral** first before **line** so if the supply is not isolated correctly the one free probe is not live.

**Step 1**

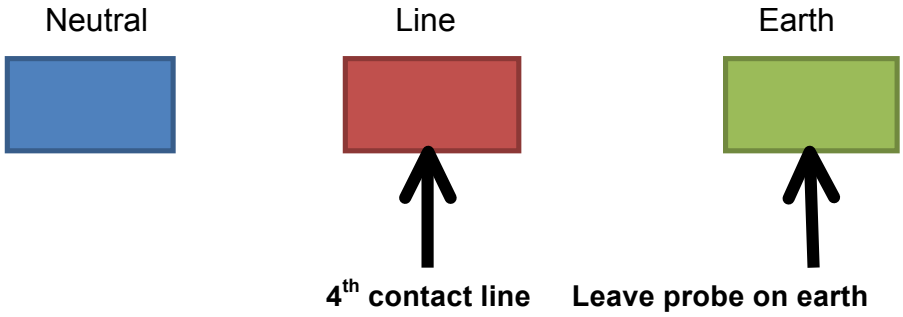



NOTE: Providing that Step 1 proves dead then it is assumed safe to check to earth without tripping RCD's or RCBO's

**Step 2**




**Step 3**




**NOTE:** If you are training to be a qualified electrician it is essential that you practice this procedure under the guidance of an electrically skilled person.

## Periodic Inspection and Testing of electrical installations:

(Covering Unit 307 'Understand principles, practices and legislation for the inspection, testing commissioning and certification of electro-technical systems and equipment in buildings, structures and the environment' (Level 3 NVQ Diploma in Installing Electro-Technical Systems and Equipment 2357-13 / 91 and the EAL equivalent)

## Practice Multiple-choice questions:

| No. | Question. | Answer |
|---|---|---|
| **1** | Which one of the following is not a statutory document? | |
| **a** | Electricity at Work Regulations 1989 | |
| **b** | Building Regulations | |
| **c** | Electricity, Safety, Quality and Continuity Regulations | |
| **d** | IET Guidance Note 3 | **X** |

| No. | Question. | Answer |
|---|---|---|
| **2** | When producing a specification, advice should be obtained from which one of the following? | |
| **a** | Electricity supply company | |
| **b** | Main contractor | |
| **c** | Installation owner / user | **X** |
| **d** | Billing authority | |

| No. | Question. | Answer |
|---|---|---|
| **3** | Precise details regarding electrical equipment to be installed must be obtained from? | |
| **a** | The equipment manufacturer | **X** |
| **b** | The client | |
| **c** | Main contractor | |
| **d** | Electricity supplier | |

| No. | Question. | Answer |
|---|---|---|
| **4** | Guidance regarding electrical test equipment for use by electricians is found in which of the following documents? | |
| **a** | HS (G) 141 | |
| **b** | HSE Guidance | |
| **c** | EAWR 1989 | |
| **d** | HSE GN GS 38 | **X** |

| No. | Question. | Answer |
|---|---|---|
| **5** | In an isolated system, electric shock risk may arise from parts of the installation except from? | |
| **a** | Resistive loads | **X** |
| **b** | Solar photovoltaic panels | |
| **c** | Voltages on earthed metalwork during testing | |
| **d** | Capacitive loads | |

| No. | Question. | Answer |
|---|---|---|
| **6** | The responsibilities of an inspector are each of the following except? | |
| **a** | No danger occurs to persons, livestock and property during testing | |
| **b** | Comparing the test results with design criteria | |
| **c** | Consider the condition of the installation and advise accordingly | |
| **d** | Issue prohibition notices | **X** |

| No. | Question. | Answer |
|---|---|---|
| **7** | Confirmation that an installation complies with the original design criteria is obtained by? | |
| **a** | Inspection | |
| **b** | Inspection & testing | |
| **c** | Initial verification | **X** |
| **d** | Comparison with previous test results | |

| No. | Question. | Answer |
|---|---|---|
| **8** | When inspecting an installation for the first time the purpose is to verify each of the following except? | |
| **a** | No part of the installation is damaged | |
| **b** | Test results comply with design specification | **X** |
| **c** | Parts of the fixed installation are correctly selected and erected | |
| **d** | Installed electrical equipment is of the correct type | |

| No. | Question. | Answer |
|---|---|---|
| **9** | Maximum demand, number of live conductors and type of earthing is information required by? | |
| **a** | The person ordering the work | |
| **b** | The Building Control Officer | |
| **c** | The electrical contractor | |
| **d** | The person carrying out the inspection and testing | **X** |

| No. | Question. | Answer |
|---|---|---|
| **10** | A re-inspection & next test date for a new installation is decided by? | |
| **a** | The client | |
| **b** | Electrical designer | **X** |
| **c** | Electrical contractor | |
| **d** | The owner of the installation | |

| No. | Question. | Answer |
|---|---|---|
| 11 | Completion of the electrical design, construction and inspection when carried out by the same person requires the issue of? | |
| a | A Minor Works Certificate | |
| b | Multiple signature Electrical Installation Certificate | |
| c | Schedule of test results | |
| d | Single signature Electrical Installation Certificate | X |

| No. | Question. | Answer |
|---|---|---|
| 12 | Inspection can be undertaken? | |
| a | Throughout different stages of construction | X |
| b | On completion of the installation | |
| c | On completion of the construction | |
| d | If required during commissioning of the installation | |

| No. | Question. | Answer |
|---|---|---|
| 13 | The correct test sequence on a lighting circuit is | |
| a | Continuity of protective conductor / continuity of ring final conductors / polarity | |
| b | Continuity of protective conductor / polarity / insulation resistance | |
| c | Continuity of protective conductor / insulation resistance / polarity | X |
| d | Insulation resistance / polarity / continuity of protective conductors | |

| No. | Question. | Answer |
|---|---|---|
| 14 | Which of the following is correct for Method 1 ‘continuity of protective conductor test’? | |
| a | R1+Ze | |
| b | R1+R2 | X |
| c | R1+Zs | |
| d | R2+Zs | |

| No. | Question. | Answer |
|---|---|---|
| 15 | A radial circuit 40m in length is wired with a cable having 7.41mΩ/m at 20°C the expected cable resistance when a Method 2 test is carried out will be? | |
| a | 296Ω | |
| b | 2.964Ω | |
| c | 0.592Ω | |
| d | 0.296Ω | X |

**Periodic Inspection and Testing of electrical installations:**

(Covering Unit 307 'Understand principles, practices and legislation for the inspection, testing commissioning and certification of electro-technical systems and equipment in buildings, structures and the environment' (Level 3 NVQ Diploma in Installing Electro-Technical Systems and Equipment 2357-13 / 91 and the EAL equivalent)

**Task:** complete the following questions regarding the principles, practices and legislation for the periodic inspection and testing of electrical installations.

*Reference (GN) refers to the IET Guidance Note 3 'Inspection & Testing' 2011*

1) Periodic inspection and testing is carried out for the safety of persons and livestock against the effects of?

*Answer: electric shock and burns (page 61 GN3)*

2) List **five** reasons for carrying out periodic inspection and testing

*Answer: damage / wear & tear / corrosion / excessive electrical loading / ageing (Page 61 GN3)*

3) Periodic inspection and testing may be required for specific reasons, state **four** reasons.

*Answer: to assess compliance with BS7671 / on change of occupancy / change of use of premises (page 62 GN3)*

4) Routine checks of the electrical installation in commercial or industrial premises can be carried out by whom?

*Answer: an electrically skilled person or somebody who is able to recognise defects (page 63 GN3)*

5) The date for the first periodic inspection and test is the responsibility of whom?

*Answer: the installation designer (page 64 GN3)*

6) State the maximum re-inspection and test intervals for the following locations: Caravans; caravan parks and construction sites

*Answer: 3 years / 1 year / 3 months (page 65 GN3)*

7) Briefly explain how to carry-out an 'overview' of an installation prior to conducting a periodic inspection and test.

*Answer: obtain information from diagrams and charts and a walk round survey of the premises (page 67 3.8.3 paragraph: 3)*

8) State **two** important facts that should be noted during the pre-inspection / testing survey.

*Answer: dangers that may arise during testing / the location of any equipment that will need safety precautions to be taken before testing (page 67 GN3)*

9) The periodic inspection sample should consider a number of factors, identify **four** factors.

*Answer: age of property / type and use of the installation / effectiveness of on-going maintenance / period of time since the last inspection and test (page 68 GN3)*

10) If a sample inspection and test reveals the installation to be in poor condition the inspector will need to increase the sample, briefly explain the actions to be taken.

*Answer: See page 69 GN3*

11) If an inspector finds inadequacies in distributors equipment the recommended action is to?

*Answer: the person ordering the work will need to inform the district network authority (DNO) (Page 70 GN3)*

12) With regards the termination of cables at enclosures, list **four** checks that an inspector should make.

*Answer: connections not under strain / no basic insulation of a conductor showing outside enclosure / live conductor connections adequately enclosed / adequately connected at point of entry to enclosure (Page 73 GN3)*

13) Explain how a loop impedance test is to be carried out on an electric motor.

*Answer: this test can only be carried out on the supply side of the motor starter / control-gear. A continuity test can be performed between the starter / control-gear and the motor itself to confirm the reading remains at a suitable value. (Page 76 GN3)*

14) Briefly describe the checks to be made on circuit-breakers during a periodic inspection and test.

*Answer: See page 78 GN3 3.10.3 (d)*

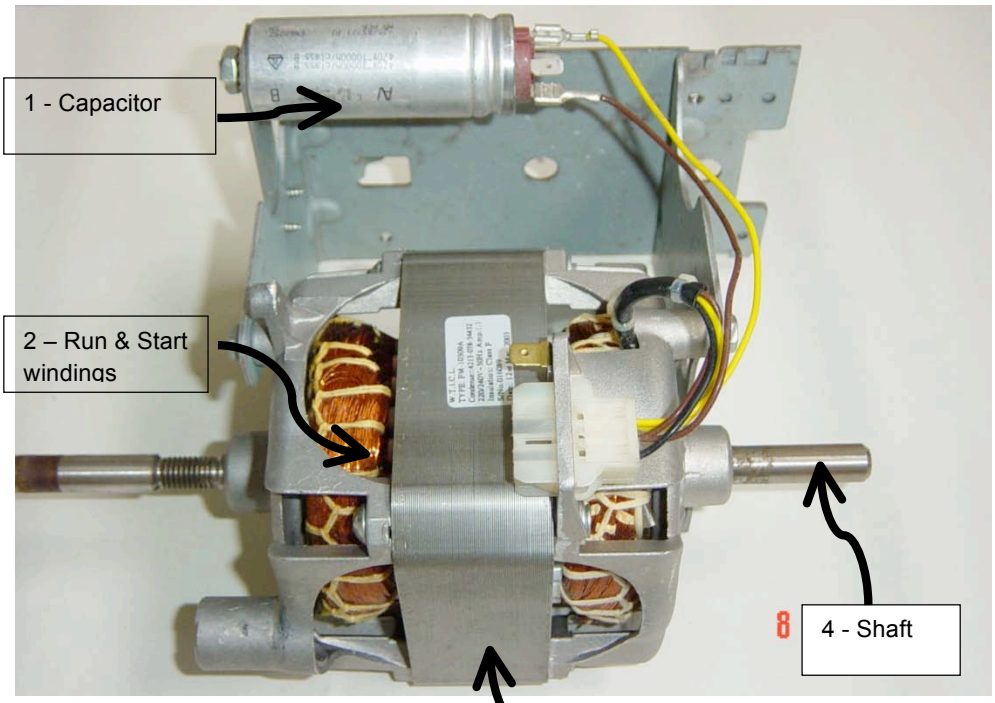
## AC / DC Motors:

(Covering Unit 309 Outcome 8, 'Understand the operating principles of dc and ac motors' (Level 3 NVQ Diploma in Installing Electro-Technical Systems and Equipment 2357-13 / 91 or EAL equivalent)

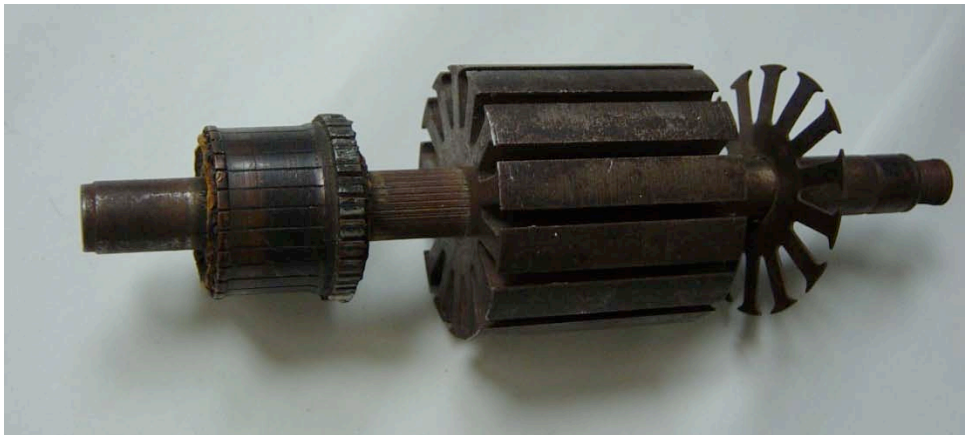
The following questions are all related to AC & DC motors:

1) Identify the type of motor and each of the components numbered in the photograph below:

Type of motor: Single – phase AC capacitor start induction motor



2) Identify the name of the component shown below and the type of motor it is used in:

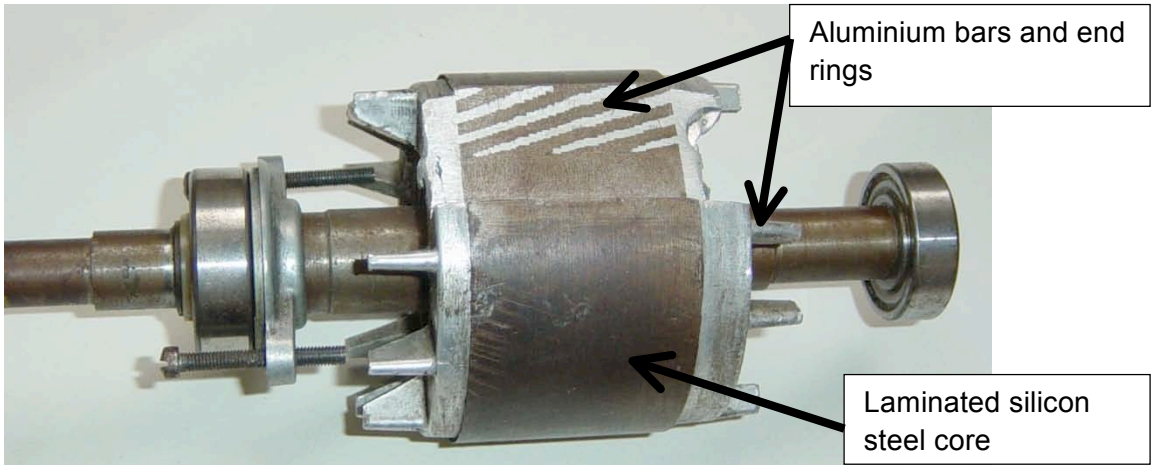


Name of component: Armature

Type of motor in which it is used:

AC Universal or DC machine i.e. (Shunt / Series or Compound motor or generator)

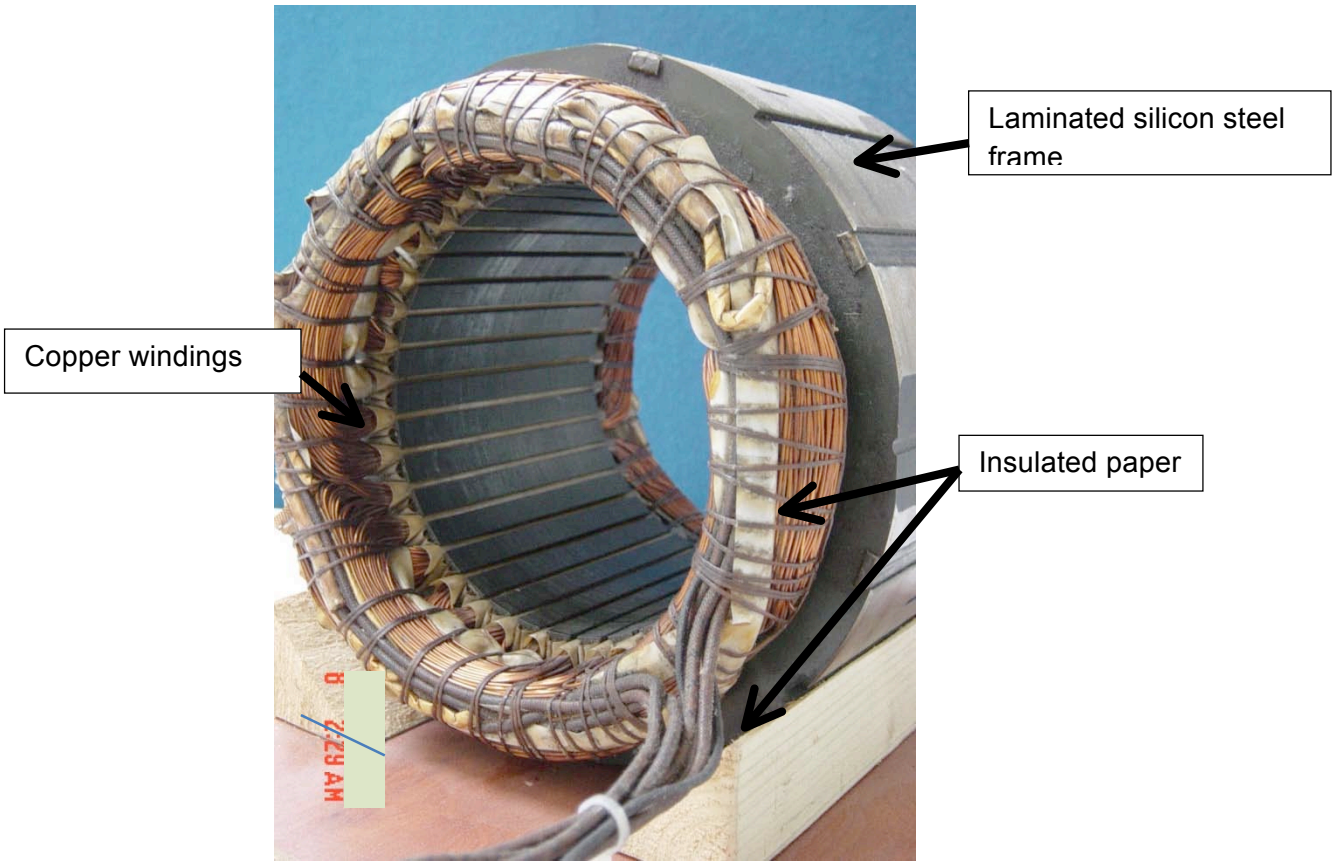
3) Identify the motor component shown and the materials used in its construction.




Component: AC cage rotor

Materials used in the construction:

4) Identify the motor component shown and the materials used in its construction




Component: AC motor Stator (3-phase Stator)

Materials used in the construction:

Laminated silicon steel frame

**Electrical supply systems:**

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

**BS7671:2008 +A1:2011 (Answers)**

The following series of questions will require you to have a copy of BS7671:2008 +A1:2011Appendix 3, Time /Current Characteristics of Overcurrent Protective Devices and RCD's

**Question 1:**

a) What information does Appendix 3 contain?

b) How is the information presented?

c) Who will require this information and when?

a) Time / current characteristics for a range of protective devices, e.g. fuses and circuit-breakers.

b) By logarithmic graph and tables.

c) Electrical circuit designers / testing & commissioning engineers

**Question 2:**

a) If the maximum earth fault loop impedance for a 230V circuit is 2.035Ω calculate the fault current that will flow in the event of a line to earth fault occurring in the circuit.

b) If the circuit in (a) is protected by a BS88-3 fuse, what is the operating time of the fuse when the fault current occurs?

a) From the formula:

$$Zs = Uo / Ia$$

By rearrangement $Ia = Uo / Zs$

Therefore $Ia = 230 / 2.035 = 113A$

b) From Figure 3A1 it can be found that the disconnection time is 0.4 sec.

**Question 3:**

a) How can different types of RCD be classified?

b) What does the symbol IΔn represent in regards to RCD's?

c) Identify the three common types of BS EN 60898 circuit – breakers.

d) For each of the circuit – breakers identified in (c) above, state the differences between their overcurrent characteristics.

a) Non – delay and 'S' type

b) Rated residual operating current expressed in mA

c) Type B / C and D

d) Type B operates at 5 x the current rating of the device

Type C operates at 10 x the current rating of the device

Type D operates at 20 x the current rating of the device

**Question 4:**

The Time / Current characteristic for any circuit-breaker, shows two overcurrent conditions, what are these conditions?

i) The curved top section of the graph represents the thermal element of the device.

ii) The straight section represents the magnetic element of the device.

**Question 5:**

a) If a 40A rated BS88-2 fuse is used to protect a single – phase 230V distribution circuit state the fault current that must flow to disconnect the circuit in 100 seconds.

b) A fault current of 20A flows through a 5A rated BS3036 semi-enclosed fuse. Determine the disconnection time.

a) From the graph Fig: 3A3(b) find 100 on the vertical (Time) axes read across to the 40A curve and then follow the vertical line downwards to the bottom of the graph. The reading will be approximately 100A

b) From Fig: 3A2(a) follow along the base of the graph, (the prospective current) to 20A, follow upwards until you meet the 5A curve, read across horizontally to the left side and read off the time: in this case approximately 0.7 seconds

**Initial verification of electrical installations:**

(Covering Unit 308 'Understand principles, practices and legislation for diagnosing and correcting electrical faults in electro-technical systems and equipment in buildings, structures and the environment' (Level 3 NVQ Diploma in Installing Electro-Technical Systems and Equipment 2357-13 / 91 and the EAL equivalent)

**Earth clamps:**

The following colour code may be found on BS951 earth bonding clamps

- **Red** is for dry non-corrosive atmospheres
- **Blue** is for corrosive or humid conditions
- **Green** is for corrosive or humid conditions large earth conductors

**Cable terminations to BS951 clamps:**

If main protective bonding is to be carried-out then a choice of terminating methods may be used:

Cables may be run separately from the main earthing terminal (MET) in the Consumers Control Unit (CCU) or using a single cable to connect, un broken, to each service clamp, see below:

**Revision questions 1:**

a) What is the warning message printed on the label of a BS951 earth bonding clamp?

| |
|---|
| *Safety Electrical Connection Do Not Remove* |

b) State the purpose of protective equipotential bonding

| |
|---|
| *To maintain all extraneous conductive parts at earth potential* |

c) The connection of the main protective bonding conductor must ideally be made within 600mm of where?

| |
|---|
| *The incoming service to the premises whether this is gas, water, oil or any other service such as compressed air in an industrial location etc…* |

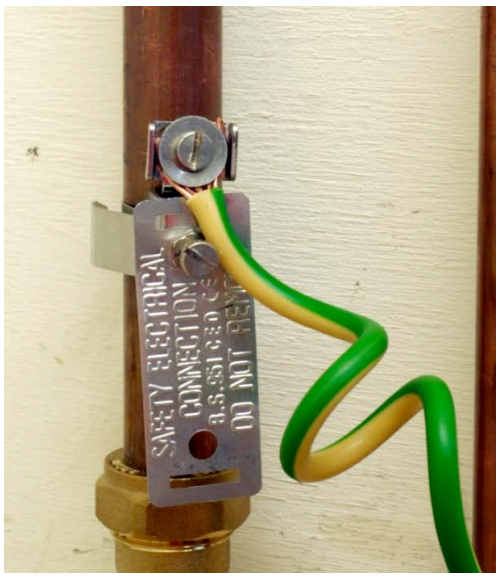
d) In the case of branch pipework where must the main protective bonding conductor be connected?

| |
|---|
| *Before any branch in the pipework* |

**Question 2:**

When carrying out an initial verification the inspector must check all earth bonding terminations. Look at each of the following images and decide whether the protective bonding installation has been correctly terminated. If 'No' state why

1)

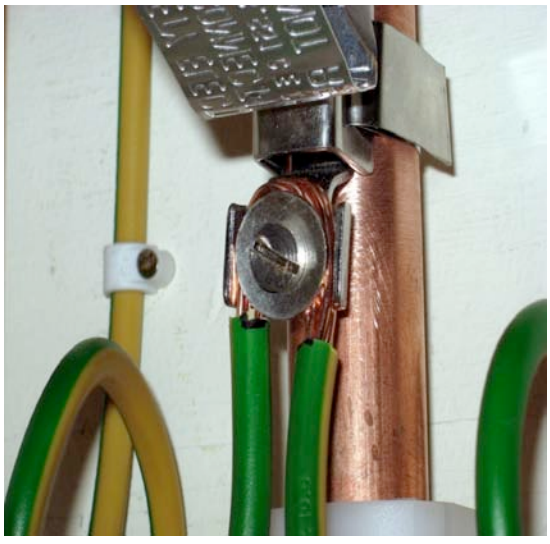



Correct termination:

| | | | |
|---|---|---|---|
| Yes | | No | **X** |

*This termination is incorrectly terminated because the conductor strands have been divided so there are four strands and three strands each side of the terminal screw, this results in uneven clamping of the conductor*

2)



Correct termination:

| | | | |
|---|---|---|---|
| Yes | **X** | No | |

Reason:

*This is an example of a correctly terminated clamp*

3)



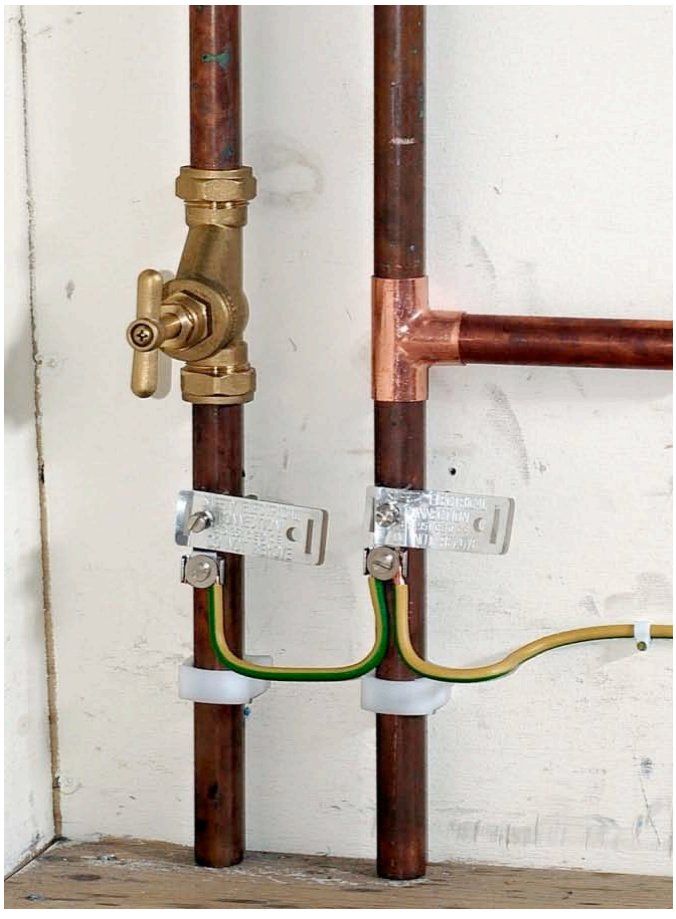
Correct termination:

| | | | |
|---|---|---|---|
| Yes | | No | **X** |

Reason:

*This is incorrect because the protective bonding conductor is not correctly terminated at either bonding clamp. The*

4)



Correct termination:

| | | | |
|---|---|---|---|
| Yes | | No | **X** |

Reason:

*This installation appears to be correctly installed with a single protective conductor used and the gas bond made before the*

5)



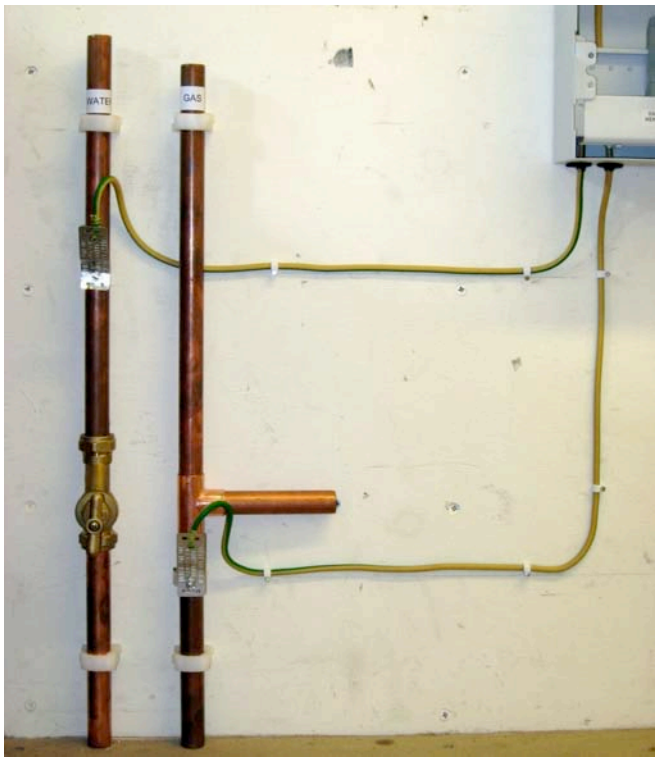

Correct termination:

| | | | |
|---|---|---|---|
| Yes | | No | **X** |

Reason:

*Incorrect, although a suitable lug is attached the protective bonding is not continuous as recommended*

6)



Correct termination:

| | | | |
|---|---|---|---|
| Yes | **X** | No | |

Reason:

*Separate protective bonding conductors*

# Electric Certification:

(Covering Outcome 5 of Unit 307 'Understand principles, practices and legislation for the inspection, testing, commissioning and certification of electro-technical systems and equipment in buildings, structures and the environment' (Level 3 NVQ Diploma in Installing Electro-Technical Systems and Equipment 2357-13 / 91)

**The Minor Electrical Installation Works Certificate:**

**Task 1:** State the purpose of the Minor Electrical Installation Works Certificate

- Alterations and additions to existing electrical installations.
- Replacement of equipment but not distribution boards or consumers control units.

The 'certificate' is a single sided A4 pro-forma on which all the necessary details relating to the minor electrical installation work are stated.

**Task 2:**State two persons that need to retain copies of the Minor Electrical Installation Works Certificate when work has been completed.

A copy of the certificate must be retained by:

- The contractor *(copy)*
- The person ordering the work/s. *(original)*

**Task 3:**The following task requires you to study the installation details and complete a copy of the attached Minor Electrical Installation Works Certificate

**INSTALLATION DETAILS SET 1:**

You have installed a fused-connection unit, (fused spur) on an existing 32A rated ring-final circuit at ABC stores, 243 Widecombe Place, Belchester, DN0 4EX on 1st April 2014. The original ring circuit was installed five years ago and looks in good condition as does the rest of the electrical installation in the store. The supply system is TN-S and fault protection is by ADS. The existing ring circuit is protected by a 32A Type B circuit-breaker to BS EN60898 and additional protection is provided by a 30mA RCD, the addition of the fused-connection unit will not compromise the current rating of the existing ring-final circuit. No previous test results are available to compare with the test results obtained when the addition was completed. The 'new' test results are all within the expected range. Continuity of circuit protective conductor and main protective bonding conductor is 0.1Ω and 0.5Ω respectively; insulation resistance between all conductors is +200MΩ; polarity was confirmed; earth fault loop impedance is 1.10Ω and the RCD reaction time test proved satisfactory with the I$\Delta$n at 25mS.

The main water service is bonded with 10mm$^2$ single-sheathed earth cable

## Connecting electrical measuring instruments:

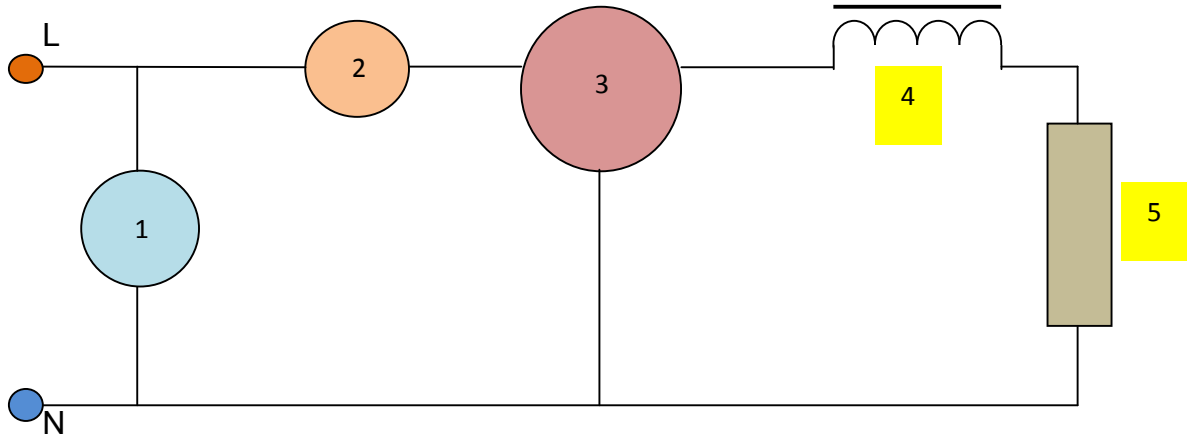
(Covering Unit 309 Outcome 7 'Understand how different electrical properties can affect electrical circuits, systems and equipment'. (Level 3 NVQ Diploma in Installing Electro-Technical Systems and Equipment 2357-13 / 91)

Understanding the type and use of various electrical test instruments is important because incorrect connection can seriously damage the instrument, the circuit in which it is connected and could pose a danger to the operator.

The following tasks relate to the measuring or determination of power in single-phase a.c. circuits.

**Task 1:**

Identify the correct name for each of the numbered components shown in the circuit diagram below:




**Answer:**

1 – Voltmeter 2 – Ammeter 3 – Wattmeter 4- Inductor (choke) 5 – Resistor or Load

**Task 2:**

State the reason for measuring the electrical quantities at the points shown in (1), (2) and (3), in the circuit shown above:

By obtaining measurements for current (2), voltage (1) and power (3) in the inductive circuit the power factor (pf) of the circuit can be calculated, the formula is:

$$pf = \frac{W}{VA} \quad \text{or} \quad pf = \frac{\text{true power}}{\text{apparent power}}$$

**Task 3:**

Calculate the power rating (W) of an inductive load if the power factor is 0.85, the current is 50A and the voltage is 230V.

**pf = true power / apparent power  pf = W / VA  therefore W = pf x V x A**

**W = 0.85 x 230 x 50**

**W = 9775 watts or 9.78kW *(rounded up)***

**Fault Diagnosis & Rectification: Revision multiple-choice questions**

| No. | Question. | Answer |
|---|---|---|
| **1** | Which of the following combinations is the correct sequence of events when carrying out safe isolation?<br><br>1 reprove test instrument<br><br>2 isolate supply and lock off<br><br>3 prove isolation with test instrument<br><br>4 test instrument on known supply | |
| **a** | 1,3,4,2 | |
| **b** | 1,4,3,2 | |
| **c** | 4,2,3,1 | **X** |
| **d** | 1,2,3,4 | |

| No. | Question. | Answer |
|---|---|---|
| **2** | A 12v 50W triple spot light is supplied from a single 230v to 12v double-wound transformer. If the original transformer fails and is to be replaced what is the VA rating that will be required? | |
| **a** | 12VA | |
| **b** | 12.5VA | |
| **c** | 50V | |
| **d** | 150VA | **X** |

| No. | Question. | Answer |
|---|---|---|
| **3** | When measuring the continuity of a ring final circuit wired in 2.5mm² Twin and earth cable, the resistance of the circuit protective conductor should be? | |
| **a** | Lower than the line and neutral conductors | |
| **b** | Lower than the line conductor only | |
| **c** | Higher than the line and neutral conductors | **X** |
| **d** | Higher than the cpc | |

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| No. | Question. | Answer |
|---|---|---|
| **4** | It has been reported that a D-O-L motor starter does not 'hold – on' when the start push button is released, the most likely cause of this problem is? | |
| **a** | No link between the auxiliary contact and the start push | **X** |
| **b** | No link between the start push and the stop push | |
| **c** | No supply to the starter | |
| **d** | No supply to the motor | |

| No. | Question. | Answer |
|---|---|---|
| **5** | When carrying out continuity checks on the windings of a single-phase, capacitor - start electric motor, which of the following is most likely to be found? | |
| **A** | Start winding will have a lower resistance than the run winding | |
| **b** | Auxiliary winding will have a lower resistance than the main winding | |
| **c** | Start winding will have a higher resistance than the run winding | **X** |
| **d** | Run winding will have a higher resistance than the starting capacitor | |

| No. | Question. | Answer |
|---|---|---|
| **6** | A domestic customer reports that the landing lighting circuit has failed. The lamp has been replaced but fails to operate; which one of the following is most likely to be the cause? | |
| **a** | Circuit breaker has operated following the failure of the first lamp | **X** |
| **b** | The two – way switch is not wired correctly between the switches | |
| **c** | The intermediate switch is in the off position | |
| **d** | The second lamp is faulty | |

| No. | Question. | Answer |
|---|---|---|
| 7 | Which one of the following senses is usually **not** required when carrying out fault finding? | |
| a | Hearing | |
| b | Seeing | |
| c | Touching | |
| d | Tasting | X |

| No. | Question. | Answer |
|---|---|---|
| 8 | Which one of the following statements is true? | |
| a | A neutral conductor is connected to the centre pin of an Edison Screw lamp-holder | |
| b | When viewed from the rear the line terminal of a BS1363 socket – outlet is on the left | X |
| c | A blue coloured BS EN 60309-2 plug is used on 400V ac supplies | |
| d | A solar photovoltaic array can be connected directly into a domestic consumer unit | |

| No. | Question. | Answer |
|---|---|---|
| 9 | A domestic central heating system fails to operate following an Electrical Installation Condition Report being undertaken on the property. What is the most likely cause of this failure? | |
| a | The heating system needs to be overhauled | |
| b | The electronic control panel has been damaged due to insulation resistance test voltages being applied | |
| c | The power supply has been isolated at the fused-connection unit for insulation tests to be made. | X |
| d | There is an closed circuit on the phase conductor | |

| No. | Question. | Answer |
|---|---|---|
| **10** | A single tube, glow – type start fluorescent luminaire fails to start following the replacement of the tube, which of the following is most likely to be the cause of this problem? | |
| **a** | Choke failure | |
| **b** | Power factor correction capacitor has open circuited | |
| **c** | Incorrect tube has been fitted | |
| **d** | Starter failure | **X** |

| No. | Question. | Answer |
|---|---|---|
| **11** | When carrying out a commissioning test of a star – delta motor it is found that the motor starts in star but in delta the motor immediately goes into reverse and makes a loud sound. What is the cause of this problem? | |
| **a** | One phase disconnected | |
| **b** | Incorrect wiring on the delta contactor | **X** |
| **c** | Incorrect setting of the overload device | |
| **d** | Two phases disconnected | |

| No. | Question. | Answer |
|---|---|---|
| **12** | A customer reports that the sitting room light dimmer switch has failed to dim the light and that, when the dimmer is operated the light dims slightly then goes out. What is the most likely cause? | |
| **a** | Wiring failure at the light point | |
| **b** | Dimmer switch has been damaged | |
| **c** | A compact fluorescent lamp has been installed | **X** |
| **d** | The circuit breaker is the wrong type | |

| No. | Question. | Answer |
|---|---|---|
| 13 | The value of Ze can be obtained by enquiry, calculation or measurement. Where can the measurement be made and what type of instrument is required? | |
| a | At the main switch in the CCU / Earth loop impedance tester | X |
| b | At the last socket in the ring / earth loop impedance tester | |
| c | At a light point / continuity tester | |
| d | Main supply at the CCU / High reading Ohmmeter | |

| No. | Question. | Answer |
|---|---|---|
| 14 | Which of the following is issued following remedial work that does not extend to a new circuit? | |
| a | Installation Certificate | |
| b | Minor Electrical Installation Work Certificate | X |
| c | Permit to Work | |
| d | Electrical Installation Condition Report | |

| No | Question | |
|---|---|---|
| 15 | The type of instrument used to determine the Prospective Fault Current (PFC) of an installation is? | |
| a | Low reading Ohmmeter | |
| b | High reading Ohmmeter | |
| c | RCD tester | |
| d | Earth fault loop impedance tester | X |

| No. | Question. | Answer |
|---|---|---|
| **16** | Damage can be caused to electronic components in a circuit due to which of the following? | |
| **a** | Under-voltage caused by voltage drop in a circuit | |
| **b** | Over-voltage from a transient | **X** |
| **c** | Over-current due to a line – earth fault | |
| **d** | Frequent switching on-off of the equipment | |

| No. | Question. | Answer |
|---|---|---|
| **17** | A damaged cable must be replaced. Which of the following documents must be used following completion of the circuit? | |
| **a** | Electrical Installation Certificate for the circuit | **X** |
| **b** | Minor works certificate for the whole installation | |
| **c** | Periodic inspection report for the circuit | |
| **d** | Schedule of test results for the whole circuit | |

| No. | Question. | | Answer |
|---|---|---|---|
| **18** |  | If the bonding clamp shown had a RED stripe the most suitable environmental conditions in which it can be used is? | |
| **a** | Damp / wet | | |
| **b** | Outside locations | | |
| **c** | Dry inside locations | | **X** |
| **d** | Corrosive atmospheres | | |

| No. | Question. | Answer |
|---|---|---|
| **19** | Following a rewire of a domestic property the person who is required to fill out the required documentation is? | |
| **a** | A person with a high IQ | |
| **b** | A person who has been in the electrical trade for several years | |
| **c** | A competent person | **X** |
| **d** | A person acting on behalf of the property insurance company | |

| No. | Question. | Answer |
|---|---|---|
| **20** | Which one of the following will **not** require special precautions to be adopted prior to inspection and testing? | |
| **a** | Circuits supplying IT equipment | |
| **b** | Circuits supplying remote buildings | **X** |
| **c** | Intruder alarm sensors | |
| **d** | Fibre optic cables | |

## End of Year Revision: Electrical Science & Principles

(Covering Unit 309: 'Understanding the electrical principles associated with the design, building, installation, and maintenance of electrical equipment and systems' (Level 3 NVQ Diploma in Installing Electro-Technical Systems and Equipment 2357-13 / 91 or EAL equivalent)

### Attempt the following Multiple Choice questions

| No. | Question. | Answer |
|---|---|---|
| **1** | Three resistors of 12Ω, 15Ω and 23Ω are connected in parallel with each other. The total resistance will be? | |
| **a** | Higher than 23Ω | |
| **b** | Higher than 15Ω | |
| **c** | Lower than 15Ω | |
| **d** | Lower than 12Ω | **X** |

| No. | Question. | Answer |
|---|---|---|
| **2** | Two resistors each having a resistance of 17Ω are connected in parallel with a resistor of 3.5Ω. The total resistance is? | |
| **a** | 12Ω | **X** |
| **b** | 13.5Ω | |
| **c** | 20.5Ω | |
| **d** | 59.5Ω | |

| No. | Question. | Answer |
|---|---|---|
| **3** | The total resistance of a circuit is 126Ω. If the circuit consists of four resistors, and one resistor is 14Ω, what is the value of the remaining three? | |
| **a** | 140Ω | |
| **b** | 112Ω | **X** |
| **c** | 100Ω | |
| **d** | 9Ω | |

| No. | Question. | Answer |
|---|---|---|
| **4** | What is the total current flowing in a circuit consisting of three 66Ω resistors connected in parallel with each other and connected to a 50V d.c. supply? | |
| **a** | 0.25A | |
| **b** | 0.72A | |
| **c** | 0.76A | |
| **d** | 2.27A | **X** |

| No. | Question. | Answer |
|---|---|---|
| **5** | Which one of the following shows the symbol for self - inductance? | |
| **a** | H | |
| **b** | C | |
| **c** | L | **X** |
| **d** | M | |

| No. | Question. | Answer |
|---|---|---|
| **6** | The unit symbol for Current is? | |
| **a** | A | **X** |
| **b** | C | |
| **c** | V | |
| **d** | I | |

| No. | Question. | Answer |
|---|---|---|
| **7** | The quantity symbol for Power is represented by? | |
| **a** | A | |
| **b** | C | |
| **c** | W | |
| **d** | P | **X** |

| No. | Question. | Answer |
|---|---|---|
| **8** | The symbol for Energy is ***W***, what is the unit symbol? | |
| **a** | W | |
| **b** | J | **X** |
| **c** | P | |
| **d** | C | |

| No. | Question. | Answer |
|---|---|---|
| **9** | A conductor 45m long and carrying 5A is lying at 90º to magnetic field of 2T, what is the force on the conductor? | |
| **a** | 450N | **X** |
| **b** | 225N | |
| **c** | 150N | |
| **d** | 100N | |

| No. | Question. | Answer |
|---|---|---|
| **10** | Calculate the length of conductor in which 50V is induced when it is passing through a flux density of 4T at a rate of 3m/s | |
| **a** | 4.2m | **X** |
| **b** | 4.0m | |
| **c** | 3.9m | |
| **d** | 3.5m | |

| No. | Question. | Answer |
|---|---|---|
| **11** | What is the resistance of 100m of 1.5mm² copper cable is if the conductor resistivity is given as 17.2μΩ/mm? | |
| **a** | 0.50 Ω | |
| **b** | 0.95 Ω | |
| **c** | 1.00 Ω | |
| **d** | 1.15 Ω | **X** |

| No. | Question. | Answer |
|---|---|---|
| 12 | The electron has what type of electrical charge? | |
| a | Negative | X |
| b | Positive | |
| c | None | |
| d | Equal positive and negative | |

| No. | Question. | Answer |
|---|---|---|
| 13 | What is the assumed current demand for an electric shower rated at 9.5kW when connected to a 230V supply? | |
| a | 30A | |
| b | 38A | |
| c | 39.58A | |
| d | 41.30A | X |

| No. | Question. | Answer |
|---|---|---|
| 14 | If a distribution circuit cable is supplied at end A with 230v, and resistive loads are taken from it at points B and C, if the overall voltage drop from A to C is 6v, B to C is 2.5v; the voltage at B is? | |
| a | 228V | |
| b | 226.5V | X |
| c | 225V | |
| d | 220.5V | |

| No. | Question. | Answer |
|---|---|---|
| **15** | If an electric motor is rated at 28kW and has an efficiency of 75%, the electrical input to the motor will be? | |
| **a** | 20.05kW | |
| **b** | 21.00kW | |
| **c** | 28.00kW | |
| **d** | 37.33kW | **X** |

| No. | Question. | Answer |
|---|---|---|
| **16** | A double-wound transformer operates on what principle? | |
| **a** | Self -induction | |
| **b** | Mutual induction | **X** |
| **c** | Impedance | |
| **d** | resistance | |

| No. | Question. | Answer |
|---|---|---|
| **17** | A transformer has a rating of 600VA, if the output voltage is 12V what is the total current that can be delivered? | |
| **a** | 5A | |
| **b** | 32A | |
| **c** | 45A | |
| **d** | 50A | **X** |

| No. | Question. | Answer |
|---|---|---|
| **18** | A step – down transformer has a primary voltage of 230V and a secondary voltage of 24V The turns ration for the transformer is | |
| **a** | 9.6 : 1 | **X** |
| **b** | 6.9 : 1 | |
| **c** | 4.3 : 1 | |
| **d** | 4.2 : 1 | |

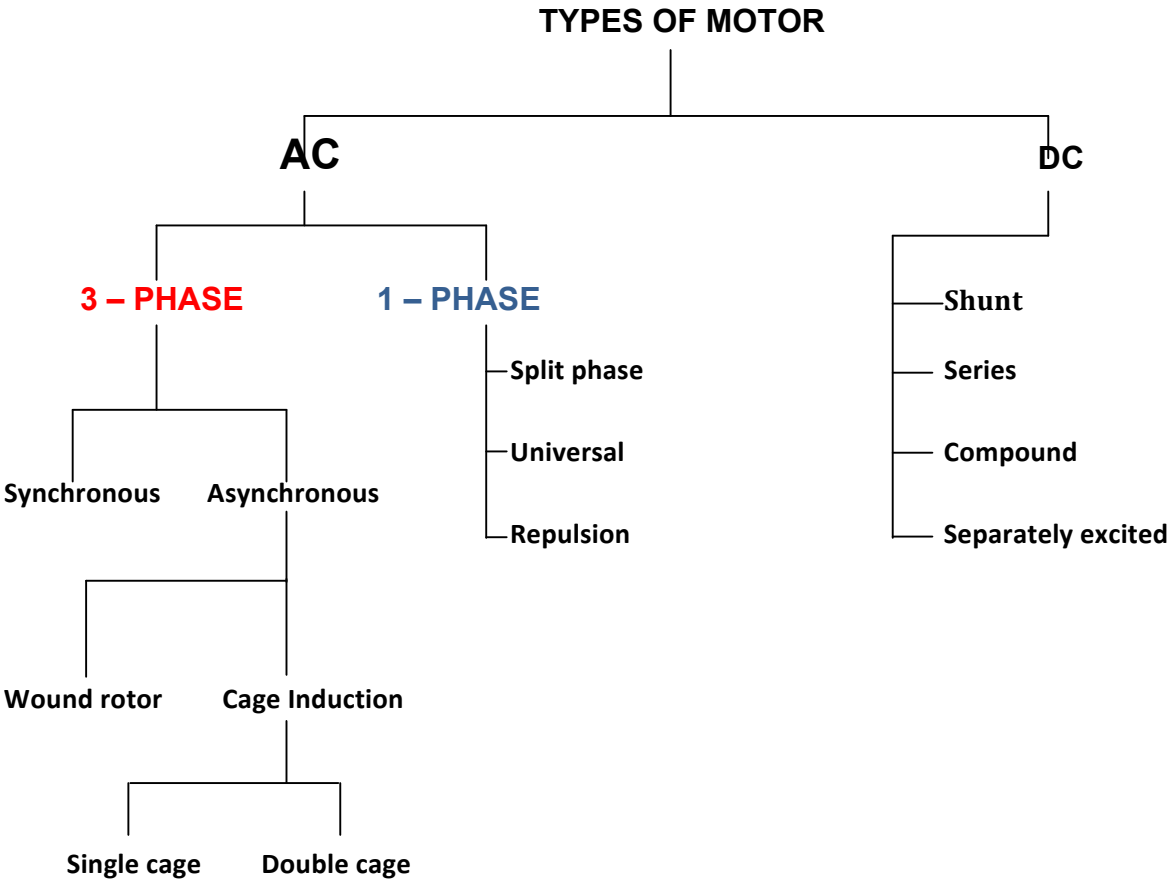
| No. | Question. | Answer |
|---|---|---|
| **19** | The phase voltage of a star connected transformer is 250V. What is the line voltage? | |
| **a** | 400V | |
| **b** | 433V | **X** |
| **c** | 445V | |
| **d** | 460V | |

| No. | Question. | Answer |
|---|---|---|
| **20** | If the measuring range of an ammeter is to be extended which one of the following is used? | |
| **a** | Multiplier | |
| **b** | Shunt resistor | **X** |
| **c** | Diode | |
| **d** | Diode shunt | |

## Understanding Electrical Principles:

(Covering Unit 309 Outcome 8 'Understand the operating principles and applications of DC and AC machines' (Level 3 NVQ Diploma in Installing Electro-Technical Systems and Equipment 2357-13 / 91)

### Electric motors:




Motors are often categorised by the starting method used, however care must be taken to be sure you understand the type of motor for which the starting method is suitable.

**AC motor starting methods:**

**Task:**

Identify the motor power supplies suitable for each of the following starting methods:

| Starting device / method | AC 3 phase | AC 1 phase | DC |
|---|---|---|---|
| Direct – on – Line (D-O-L) starter | ✓ | ✓ | N/A |
| Star – Delta starting | ✓ | N/A | N/A |
| Rotor Resistance starter | ✓ | N/A | N/A |
| Auto – Transformer starter | ✓ | N/A | N/A |
| Soft – Start | ✓ | ✓ | N/A |
| Face – plate starter | N/A | N/A | ✓ |