

**Defining terms: Earthing and bonding**

(Covering Outcome 2 of Unit 304 'Understand the principles of planning and selection for the installation of electro-technical equipment and systems in buildings, structures and the environment) (Level 3 NVQ Diploma in Installing Electro-Technical Systems and Equipment 2357-13 / 91 or EAL equivalent)

**Question 1:** Define the following terms.

i) Earthing

The connection of the exposed conductive-parts of an installation to the main earthing terminal of that installation

ii) Equipotential bonding

Electrical connection maintaining various exposed- conductive- parts and extraneous- conductive -parts at substantially the same potential

iii) Exposed-conductive-part

Conductive part of equipment which can be touched and which is not normally live, but which can become live under fault conditions

iv) Extraneous-conductive-part

A conductive part liable to introduce a potential, generally Earth potential, and not forming part of the electrical installation

v) Main earthing terminal (MET)

The terminal or bar provided for the connection of protective conductors, including protective bonding conductors and conductors for functional earthing, if any, to the means of earthing

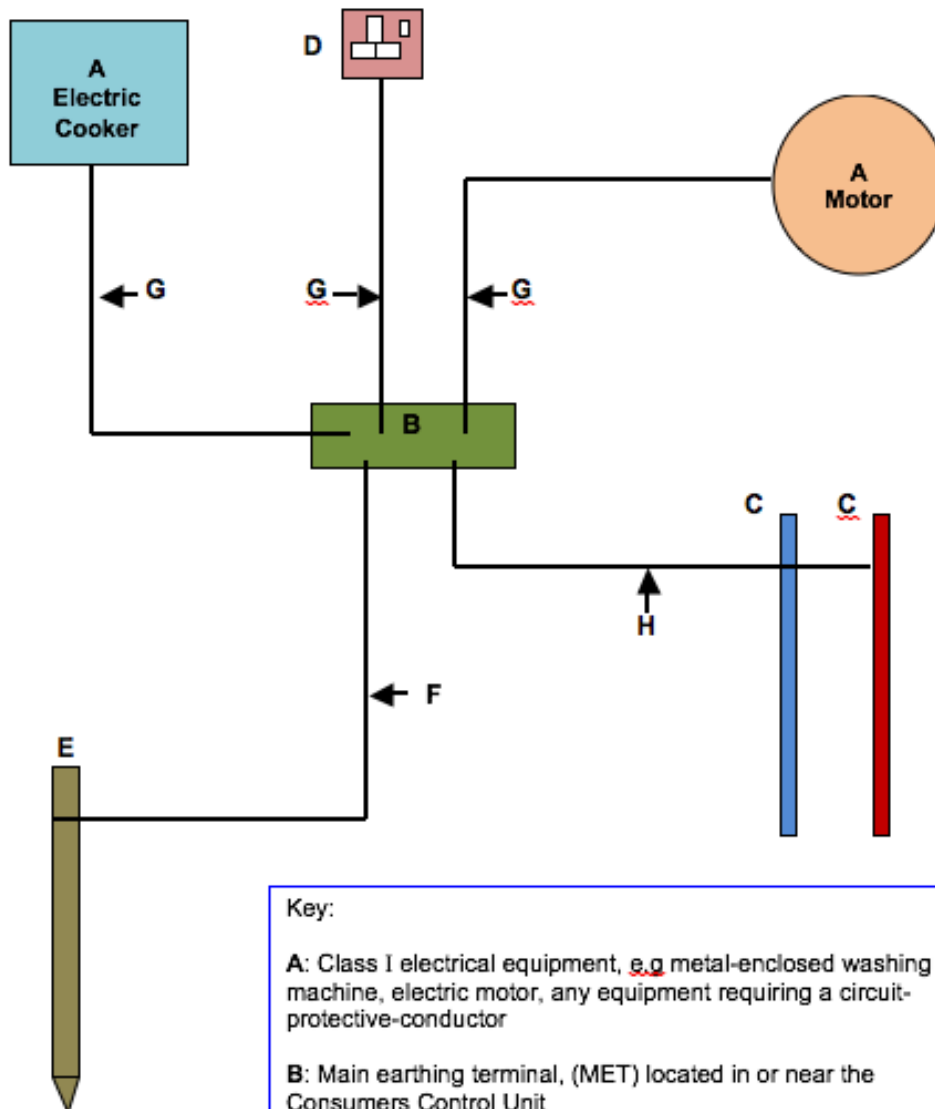
vi) Protective conductor (PE)

A conductor used for some measures of protection against electric shock and intended for connecting together any of the following parts:

Exposed-conductive-parts / Extraneous-conductive-parts / The main earthing terminal / Earth electrode(s) / The earthed point of the source, or an artificial

## Question 2:

Look at the Key and then add the correct labels to the following block diagram.



### Key:

**A:** Class I electrical equipment, e.g. metal-enclosed washing machine, electric motor, any equipment requiring a circuit-protective-conductor

**B:** Main earthing terminal, (MET) located in or near the Consumers Control Unit

**C:** Extraneous conductive part, e.g. water pipe or gas pipe

**D:** Supply for portable class I equipment

**E:** Consumers means of earthing

**F:** Earthing conductor

**G:** Circuit protective conductor

**H:** Main protective bonding conductor

## Special Locations Quiz:

(Covering Outcome 7 of Unit 305 (Level 3 NVQ Diploma in Installing Electro-Technical Systems and Equipment 2357-13 / 91 or EAL equivalent))

### True or False:

For each statement related to a special location decide if the answer or statement is true or false. You may need to refer to your notes, text books or Part 7 of BS7671: 2008 +A3 2015 Requirements for Electrical Installations

1) The space under the bath tub or shower basin is considered to be zone 1

701.32.3 Description of zone 1  
 Note:  
 If the space under the bath tub or shower basin is only accessible with a tool, it is considered to be outside the zones

TRUE	✓
FALSE	

2) Except for SELV and BS EN 61558-2-5 socket – outlets are permitted in a room containing a bath?

701.512.3  
 Other than the socket-outlets of SELV and shaver supply units to BS EN 61558-2-5, socket – outlets are NOT permitted within a distance of 3m from the boundary of zone 1

TRUE	
FALSE	✓

3) In swimming pools and other basins there is no zone 2 for fountains?

702.410.3.4.3 Zone 2  
 Note:  
 The answer is found in the last paragraph for (iii)

TRUE	✓
FALSE	

4) In a room containing electric sauna equipment the equipment must have a degree of protection of at least IPX2?

703.512.2 External influences  
The equipment shall have a degree of protection of at least IPX4

TRUE	
FALSE	✓

5) A plug and socket for use on a construction site must have a rated current equal to or greater than 16A and comply with the requirements of BS EN 60309-2?

704.511.1 Common rules  
Second paragraph

TRUE	✓
FALSE	

6) In a farm environment protective conductors must be protected against mechanical damage and corrosion, and shall be selected to avoid electro-technical effects?

705.544.2  
Opening paragraph actually states ‘...electrolytic effects’ not ‘electro-technical effects’.

TRUE	
FALSE	✓

7) Film or TV sets are excluded from Section 706 (BS 7671:2008 + A3 2015)?

706.1  
Final paragraph

TRUE	✓
FALSE	

8) The length of flexible cable used to connect a caravan to a caravan pitch socket-outlet is 22m (+/- 4m)

708.553.1.14  
Note beneath Figure 708  
Typical requirements for cable extension sets  
Cable requirements are: continuous length 25m (+/- 2m)

TRUE	
FALSE	✓

9) Electrical equipment installed above a jetty, wharf, pier or pontoon must have a degree of protection of at least IP4X?

709.512.2.1.2 Presence of solid foreign bodies (AE)  
The degree of protection should be at least IP3X not IP4X

TRUE	
FALSE	✓

10) In a Group 2 medical location, overload current protection shall not be used in either the primary or secondary circuit of the transformer of a medical IT system?

710.531.1 Overcurrent protective devices – protection of wiring systems in medical locations of Group 2

TRUE	✓
FALSE	

11) The nominal supply voltage of a temporary electrical installation in an exhibition, show or stand shall not exceed 230 / 400V a.c. or 500V d.c.?

711.313 Supplies

TRUE	✓
FALSE	

12) The maximum disconnection time of 0.4 seconds applies to all electrical circuits feeding fixed equipment used in highway power supplies?

714.411.202  
A maximum disconnection time of 5 seconds shall apply...

TRUE	
FALSE	✓

13) In an extra-low voltage lighting installation, bare conductors may be used providing the extra-low voltage does not exceed 25V a.c. or 60V d.c. and certain conditions are met?

715.521.106 Bare conductors

TRUE	✓
FALSE	

14) The periodic inspection of a caravan must preferably be not less than once every four years and annually if the caravan is used frequently?

721.514 Identification and notices  
Figure 721 Periodic Inspection  
Preferably not less than once every **three years** ...

TRUE	
FALSE	✓

15) Where an electric vehicle charging point is installed outdoors, the equipment must be selected to a degree of protection of at least IP44?

722.512.2.201 External Influences

TRUE	✓
FALSE	

16) In a fair ground situation, electric dodgems shall only be operated at voltages not exceeding 25V a.c. or 60V d.c.?

740.55.9 Electric dodgems  
Electric dodgems shall only be operated at voltages not exceeding 50V a.c. or 120V d.c. ...

TRUE	
FALSE	✓

## Inspection, Testing and Commissioning:

(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 & Practices:

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) 10M $\Omega$
- b) 6kA
- c) 20mS

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

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

- *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) 30 V
- b) 200 V
- c) 600 V

- 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. 0.5M $\Omega$*
  - b) *500V d.c. 1.0M $\Omega$*
  - c) *1000V d.c. 1.0M $\Omega$*



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 (R1 + R2) 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) When a periodic inspection and test is to be carried out, state

- a) What must be agreed with the customer or client before inspection and tests are made
- b) Who needs to agree this with the client
- c) What documentation is to be completed for this work

- a) *the extent of the inspection and test*
- b) *the inspector/test engineer*
- c) *Electrical Installation Condition Report / Condition Report Inspection Schedule and Generic Schedule of Test Results*

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

*BS7671: 2008 +A3 2015; 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. Caravan used once every five years
- ii. Caravan used annually
- iii. Construction sites

<ul style="list-style-type: none"> <li><i>i. 3 years</i></li> <li><i>ii. 1 year</i></li> <li><i>iii. 3 months</i></li> </ul>
--

## Page 40

### Fault Diagnosis & Rectification

(Covering Outcome 3 'Understand how to complete the preparatory work prior to fault diagnosis and correction work' Unit 308 NVQ Level 3 Diploma 2357 – 13 and EAL equivalent)

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

No.	Question.	Answer
2	A fluorescent tube flashes on and off repeatedly and fails to light correctly. The fault is likely to be?	

<b>a</b>	The wrong wattage tube was fitted	
<b>b</b>	The tube is old and needs replacing	
<b>c</b>	There is a wiring fault to one of the tube connections	
<b>d</b>	The starter has failed and needs replacing	<b>X</b>

<b>No.</b>	<b>Question.</b>	<b>Answer</b>
<b>3</b>	Following decoration work in the hall and landing of a domestic house the two-way operated landing light no longer works correctly, the fault is going to be?	
<b>a</b>	The switch has been removed and not refitted correctly	<b>X</b>
<b>b</b>	The light fittings were removed and not reconnected	
<b>c</b>	The hall light was removed and reconnected wrongly	
<b>d</b>	The landing light has failed	

<b>No.</b>	<b>Question.</b>	<b>Answer</b>
<b>4</b>	When the supply is connected to a capacitor – start, single-phase electric motor it fails to start and produces a continuous humming sound. The most likely fault is?	
<b>a</b>	A loose neutral connection to the motor	
<b>b</b>	An open - circuit run winding	
<b>c</b>	A blown fuse	
<b>d</b>	An open – circuit start winding	<b>X</b>

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	<b>X</b>
d	Run winding will have a higher resistance than the starting capacitor	

No.	Question.	Answer
6	A domestic customer reports that an outside PIR security light fails to operate. The lamp has been replaced with no effect. Which one of the following is NOT likely to be the cause?	
a	The protective device for the circuit has operated	
b	The PIR has developed a fault	
c	Both the old and new lamps are broken	<b>X</b>
d	There is a broken connection at the security lamp or PIR	

No.	Question.	Answer
7	Which one of the following senses is usually <b>not</b> required when carrying out fault finding?	
a	Hearing	
b	Seeing	
c	Touching	

<b>d</b>	Tasting	<b>X</b>
----------	---------	----------

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

<b>No.</b>	<b>Question.</b>	<b>Answer</b>
<b>9</b>	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?	
<b>a</b>	The heating system needs to be overhauled	
<b>b</b>	The electronic control panel has been damaged due to insulation resistance test voltages being applied	
<b>c</b>	The power supply has been isolated at the fused-connection unit for insulation tests to be made.	<b>X</b>
<b>d</b>	There is an closed circuit on the phase conductor	

<b>No.</b>	<b>Question.</b>	<b>Answer</b>
<b>10</b>	A fluorescent tube glows at each end but fails to start. The cause of this fault is most likely to be?	

<b>a</b>	Failure of the choke	
<b>b</b>	The tube has come to the end of its life	<b>X</b>
<b>c</b>	Incorrect tube has been fitted	
<b>d</b>	Failure of the starter	

No.	Question.	Answer
<b>11</b>	A customer reports that hot water is pouring from an overflow pipe when the immersion heater has been switched on for half an hour. The probable cause of this fault is?	
<b>a</b>	The immersion heater has failed	
<b>b</b>	The thermostat has failed and is permanently closed	<b>X</b>
<b>c</b>	Insufficient hot water is being used by the customer	
<b>d</b>	Water pressure has increased in the supply mains	

No.	Question.	Answer
<b>12</b>	A customer reports that a dimmer switch fails to dim a new lamp that replaces a broken 60W lamp. They notice that if the dimmer is operated from full-on the lamp dims slightly then goes out. What is the most likely reason is?	
<b>a</b>	The wiring has become disconnected at the ceiling rose	
<b>b</b>	The dimmer switch has developed a fault	
<b>c</b>	The replacement lamp is a low-energy compact fluorescent type	<b>X</b>
<b>d</b>	The new lamp is the wrong voltage	

No.	Question.	Answer
13	On inspection it is found the main neutral connection at a distribution board is discoloured and the insulation has bubbled. The most probable cause of this condition is?	
a	A loose neutral connection	X
b	Prolonged overcurrent	
c	Too many loads connected to the distribution board	
d	A short-circuit fault on one of the final circuits	

No.	Question.	Answer
14	Which of the following must be issued following the replacement of a damaged final circuit cable?	
a	Installation Certificate	
b	Minor Electrical Installation Works Certificate	X
c	Permit – to - Work	
d	Electrical Installation Condition Report	

No	Question	
15	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 resulting from a lightning strike	X
c	Over-current due to a line – earth fault	
d	Frequent switching on-off of the equipment	

No.	Question.	Answer
16	A three-phase and neutral power supply must be isolated in order to carry out a repair on an industrial machine. Which of the following procedures must be carried out after permission is given to isolate the supply?	
a	Locate the machine to be repaired	
b	Safe isolation of the supply to the machine	<b>X</b>
c	Safe isolation of the supply to the building	
d	Removal of the supply cable to the machine	

## Page 42

### Matching Terms and meanings:

(Covering Outcome 7 'Special Locations'; 'Understanding the practices and procedures for the preparation and installation of wiring systems and electro-technical equipment in buildings, structures and the environment' Unit 305 NVQ Level 3 Diploma 2357 – 13 and EAL equivalent)

The following terms can be found in BS7671:2008 +A3 2015, however the exact wording of the definition may not be as found in the Standard. Try to identify the correct definition for the terms stated below.

	Term		Definition
1	Distributor	A	A location intended for the diagnosis, treatment monitoring and care of patients.
2	Caravan	B	Assembly of photovoltaic arrays
3	Street furniture	C	An electrical system for electrical equipment provided to protect or warn persons in the event of a hazard, or essential to their evacuation from a location.



4	PV generator		D	Person/s responsible for the distribution of electrical energy to the customer
5	Safety service		E	An operation intended to remove, as quickly as possible, danger.
6	Emergency switching		F	Area where one or more stands, amusement devices or booths are erected for leisure use
7	Fair ground		G	Fixed equipment located on a highway.
8	Medical location		H	A trailer leisure accommodation vehicle ...

**Solution:**

1 – D            5 - C

2 – H            6 - E

3 – G            7 - F

4 – B            8 - A

**Page 43**

**Practice multiple-choice questions for electrical principles:**

(Covering Unit 309 'Understand 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))

Try these multiple – choice questions.

No 1	Which one of the following is a typical Distribution voltage?	Answer
a	230V	

<b>b</b>	400V	
<b>c</b>	11kV	<b>X</b>
<b>d</b>	400kV	

<b>No 2</b>	The inductive reactance of an inductor rated at 0.35H, when connected to a 50Hz supply will be?	<b>Answer</b>
<b>a</b>	200Ω	
<b>b</b>	172.8Ω	
<b>c</b>	109.97Ω	<b>X</b>
<b>d</b>	86.4Ω	

<b>No 3</b>	Three fixed resistors of 60Ω each are connected in series with each other, the combined resistance is	<b>Answer</b>
<b>a</b>	180Ω	<b>X</b>
<b>b</b>	90Ω	
<b>c</b>	60Ω	
<b>d</b>	20Ω	

<b>No 4</b>	The procedure to reverse the direction of a single-phase capacitor start motor is to	<b>Answer</b>
<b>a</b>	Reverse connect line and neutral to the motor	
<b>b</b>	Reverse the connection of the start and run winding	
<b>c</b>	Reverse the connection of the run winding only	<b>X</b>
<b>d</b>	Reverse the connection of the capacitor	


<b>No 5</b>	A <b>four pole</b> AC induction motor is connected to a three-phase supply of 60Hz. The synchronous speed of the stator magnetic flux is	<b>Answer</b>
<b>a</b>	750rpm	
<b>b</b>	1000rpm	
<b>c</b>	1800rpm	<b>X</b>
<b>d</b>	3000rpm	

<b>No 6</b>	Electrical power is measured using a	<b>Answer</b>
<b>a</b>	kWh meter	
<b>b</b>	Watt meter	<b>X</b>
<b>c</b>	Ammeter	
<b>d</b>	Voltmeter	

<b>No 7</b>	The efficiency of a motor that has an output of 50kW and an input of 60kW will be?	<b>Answer</b>
<b>a</b>	80.55%	
<b>b</b>	83.33%	<b>X</b>
<b>c</b>	90.50%	
<b>d</b>	98.87%	

<b>No 8</b>	A light source of 7000cd is positioned 5m above a horizontal surface, the illumination on the surface immediately beneath the source is?	<b>Answer</b>
<b>a</b>	280 lux	<b>X</b>
<b>b</b>	280 lumen	
<b>c</b>	1200 lux	
<b>d</b>	1200 lumen	

<b>No 9</b>	In lighting the abbreviation SOX is which type of lamp?	<b>Answer</b>
<b>a</b>	High pressure metal halide	
<b>b</b>	Low pressure sodium	<b>X</b>
<b>c</b>	High pressure mercury fluorescent	
<b>d</b>	Low pressure mercury fluorescent	

<b>No 10</b>	The symbols shows a 	<b>Answer</b>
<b>a</b>	Thyristor	
<b>b</b>	Diac	
<b>c</b>	Triac	
<b>d</b>	Diode	<b>X</b>

## Electrical measuring instruments:

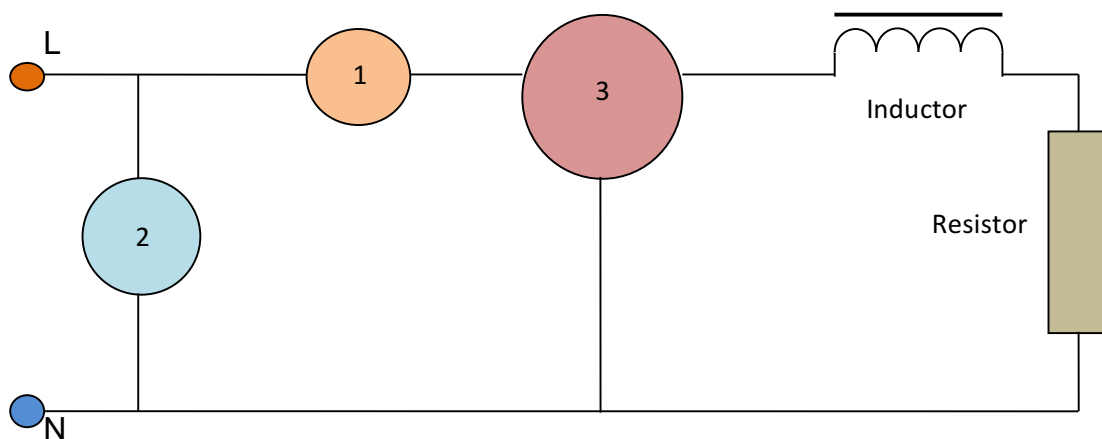
(Covering Unit 309 Outcome 7 'Understand how different electrical properties can affect electrical circuits, systems and equipment'. (Level 3 NVQ Diploma in Installing Electro-Technical Systems and Equipment 2357-13 / 91 and EAL equivalent))

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.

### Task 1:

The following 3 tasks relate to the measuring or determination of power in single-phase a.c. circuits.

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



### Answer:

1 – Ammeter    2 – Voltmeter    3 – Wattmeter

### 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 (1), voltage (2) and power (3) in the inductive circuit the power factor (pf) of the circuit can be calculated, the formula is:

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

### 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.

$pf = \frac{\text{true power}}{\text{apparent power}}$        $pf = \frac{W}{VA}$       therefore  $W = pf \times V \times A$

$$W = 0.85 \times 230 \times 50$$

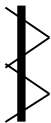
$$W = \underline{9775 \text{ watts or } 9.78\text{kW (rounded up)}}$$

#### Task 4:

Electrical measuring instruments with the symbol:  shown on the scale means that the instrument is a

Moving coil and is only suitable for connection into a d.c. circuit

#### Task 5:

Electrical measuring instruments with the symbol:  shown on the scale means that the instrument is a?

Moving iron type and is suitable for connection into a.c. or d.c. circuits

#### Task 6:

The most practical method of measuring current in a 'live' a.c. circuit cable is to use which type of instrument?

A clamp-on ammeter, sometime called a 'tong-tester'

#### Task 7:

The instrument used in Task 6 operates on which basic magnetic principle?

The principle of electro-magnetic induction

#### Task 8:

The light level produced by a newly installed lighting system in a commercial location must be measured. (a) What type of instrument is to be used for this measurement? (b) What is the unit of light measurement?

- (a) A 'photometer' or 'light-meter'  
(b) The unit of light measured by the photometer is **Lux** symbol (Lx)

#### Task 9:

Analogue instruments have a number of specific features, name **three** typical features.

- (i) Calibrated **scale** in fine divisions, bands or groups  
(ii) **Pointer** that moves across the scale when measurements are being made  
(iii) **Letter symbol** showing the unit that can be measured, for example **A** for amperes

## **Task 10:**

What action needs to be taken to ensure electrical test instruments remain accurate throughout their lifetime?

The instrument/s should be 'calibrated' on a regular basis. Calibration may be required annually or at a time when the instrument is considered to be out of calibration, maybe following a trauma such as being dropped.