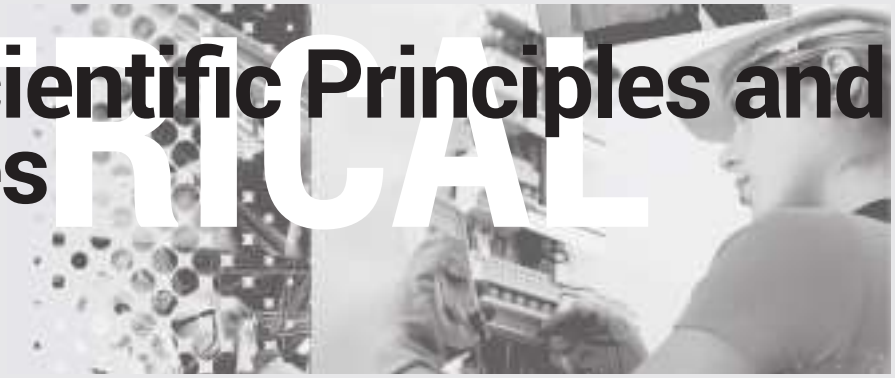
Delivery Unit

Level 3

# Electrical Scientific Principles and Technologies



Unit Code: NETK3-08

115 GLH

# Delivery Unit

## Unit Aim

This unit is designed to enable learners to understand the relationship between electrical scientific principles and the competencies required of a qualified electrical operative. Its content is the knowledge needed by a learner to underpin the application of skills in the installation and maintenance of electrical systems and equipment.

## Summary of Learning Outcomes

The learner will:

1. Understand mathematical principles which are appropriate to electrical installation, maintenance and design work.
2. Understand standard units of measurement used in electrical installation, maintenance and design work.
3. Understand basic mechanics and the relationship between force, work, energy and power.
4. Understand the relationship between resistance, resistivity, voltage, current and power.
5. Understand the fundamental principles which underpin the relationship between magnetism and electricity.
6. Understand the types, applications and limitations of electronic components in electrical systems and equipment.
7. Understand electrical supply systems.
8. Understand how different electrical properties can affect electrical circuits, systems and equipment.
9. Understand the operating principles and applications of d.c. machines and a.c. motors.
10. Understand the operating principles of electrical components.
11. Understand the principles and applications of electrical lighting systems.
12. Understand the principles and applications of electrical heating.

## Assessment

Two graded exams:

- Learning outcomes **1 - 6** are assessed by a graded on-screen exam. **It is graded on the first attempt only: Pass, Merit, Distinction; (or Fail). Any resitting will only be subject to a Pass grade maximum.**
- Learning outcomes **7 - 12** are assessed by a centre marked and graded written paper. **It is graded on the first attempt only: Pass 50% (39 Marks), Merit 65% (51 Marks), Distinction 80% (63 Marks) or Fail. Any resitting will only be subject to a Pass grade maximum.**

There is also a centre marked practical assessment covering transformers.

The purpose of the standalone grades is to indicate to an employer the learner's ability in electrical science and principles, which is useful if an employer wishes to develop the learner further; for example on higher level qualifications. The grades from the examinations will not contribute toward the overall apprenticeship grade.

## Guidance

Delivery advice has been included adjacent to the assessment criteria. This also gives a range of items to be covered with some ideas to help the delivery.

The content covered in learning outcomes 1-6 will underpin learning outcomes 7-12.

## Delivery Unit

| **Learning Outcomes** The learner will: | **Assessment Criteria** The learner can: | **Delivery Advice** (not exhaustive): |
|---|---|---|
| **1. Understand mathematical principles which are appropriate to electrical installation, maintenance and design work.**<br><br>***(This outcome is assessed by a graded on-screen exam)*** | **1.1 Identify and apply appropriate mathematical principles which are relevant to electrical work tasks.** | Mathematical principles:<br>Fractions and percentages<br>Algebra<br>Statistics<br>Transposition<br>Triangles and trigonometry<br>Indices. |
| **2. Understand standard units of measurement used in electrical installation, maintenance and design work.**<br><br>***(This outcome is assessed by a graded on-screen exam)*** | **2.1 Identify and use internationally recognised base and derived (SI) units of measurement.** | (SI) Units of measurement for:<br>• Length, Area, Volume, Mass; Density<br>• Time, Temperature; Velocity. |
| | **2.2 Identify and determine values of base and derived SI units which apply specifically to electrical quantities.** | Electrical quantities (SI units):<br>• Resistance,<br>• Resistivity,<br>• Power.<br>• Frequency,<br>• Current,<br>• Voltage<br>• Energy<br>• Impedance<br>• Inductance and inductive reactance<br>• Capacitance and capacitive reactance<br>• Power factor. |

## Delivery Unit

| **Learning Outcomes** The learner will: | **Assessment Criteria** The learner can: | **Delivery Advice** (not exhaustive): |
|---|---|---|
| **2. Understand standard units of measurement used in electrical installation, maintenance and design work (continued).**<br><br>***(This outcome is assessed by a graded on-screen exam)*** | **2.3 Identify appropriate electrical instruments for the measurement of different electrical quantities.** | Electrical quantities( measurement):<br>• Resistance<br>• Power<br>• Current<br>• Voltage<br>• Energy. |
| **3. Understand basic mechanics and the relationship between force, work, energy and power.**<br><br>***(This outcome is assessed by a graded on-screen exam)*** | **3.1 Specify what is meant by mass and weight.** | |
| | **3.2 Explain the principles of basic mechanics as they apply to levers, gears and pulleys.** | Cover Class I, Class II and Class III levers. |
| | **3.3 Describe the main principles of the following and their inter-relationships:**<br>• **force**<br>• **work**<br>• **energy (kinetic and potential)**<br>• **power**<br>• **efficiency.** | |
| | **3.4. Calculate values of mechanical energy, power and efficiency.** | |

## Delivery Unit

| **Learning Outcomes** The learner will: | **Assessment Criteria** The learner can: | **Delivery Advice** (not exhaustive): |
|---|---|---|
| **4. Understand the relationship between resistance, resistivity, voltage, current and power.**<br><br>***(This outcome is assessed by a graded on-screen exam)*** | **4.1 Describe the basic principles of electron theory.** | |
| | **4.2 Identify and distinguish between materials which are good conductors and insulators.** | Relate to cables used in electrical installation work. |
| | **4.3 Describe what is meant by resistance and resistivity in relation to electrical circuits.** | |
| | **4.4 Explain the relationship between current, voltage and resistance in parallel and series d.c. circuits.** | Cover basic types of circuits. |
| | **4.5 Calculate the values of current, voltage and resistance in parallel and series D.C. circuits.** | |
| | **4.6 Calculate values of power in parallel and series d.c. circuits.** | |
| | **4.7 State what is meant by the term voltage drop in relation to electrical circuits.** | This can link to unit NETK3/04, in terms of cable selection and circuit design |
| | **4.8 Describe the chemical and thermal effects of electric currents.** | Such as: Chemical: primary and secondary cells, electroplating. Heating: Cookers, water heaters, soldering irons, electric fires etc. See if the learners can think of examples of each. |

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| **Learning Outcomes** The learner will: | **Assessment Criteria** The learner can: | **Delivery Advice** (not exhaustive): |
|---|---|---|
| **5. Understand the fundamental principles which underpin the relationship between magnetism and electricity.**<br><br>***(This outcome is assessed by a graded on-screen exam)*** | **5.1 Describe the effects of magnetism in terms of attraction and repulsion.** | Cover the fundamental laws of magnetism. |
| | **5.2 State the difference between magnetic flux and flux density.** | The SI unit of magnetic flux is the weber (Wb).<br>The tesla (symbol T) is the SI derived unit of magnetic flux density, denoted as B. One tesla is equal to one weber per square metre. $T = Wb/m^2$ . As a simple memory aid 'Magnetic flux densi**T**y is measured in **T**eslas.<br><br>The amount of magnetic flux a magnet displays is a direct result of the material that makes up the magnet. The magnetic flux density is a product of the magnetic flux and the area that this flux is present within. |
| | **5.3 Describe the magnetic effects of electrical currents in terms of:**<br>• **production of a magnetic field**<br>• **force on a current-carrying conductor in a magnetic field**<br>• **electromagnetism**<br>• **electromotive force.** | Examples of magnetic effects can be seen in bells, motors, relays, transformers and generators. Cover: Maxwell's right hand grip rule and right handed screw rule.<br><br>Cover fleming's left hand rule in relation to motors. As a memory aid ***motors*** drive on the left hand side (LHS). RHS is for generators - see below. |
| | **5.4 Describe the basic principles of generating an a.c. supply in terms of:**<br>• **a single-loop generator**<br>• **sine-wave**<br>• **frequency**<br>• **EMF**<br>• **magnetic flux.** | You-tube has videos of generators to help explain the process. Also link topic to motors.<br><br>A lesson could involve students using a simple hand wound generator connected to an oscilloscope. Learners can generate and a.c. and calculate RMS, average value, peak to peak value, periodic time, frequency and amplitude (see below). Can also construct simple generators out of magnets, cardboard and coils of wire. Cover Fleming's right hand rule in relation to generators. |
| | **5.5 Identify the characteristics of sine-waves.** | In terms of a.c. cover: Root mean square (RMS) value, average value, peak to peak value, periodic time, frequency and amplitude. |

## Delivery Unit

| **Learning Outcomes** The learner will: | **Assessment Criteria** The learner can: | **Delivery Advice** (not exhaustive): |
|---|---|---|
| **6. Understand the types, applications and limitations of electronic components in electrical systems and equipment.**<br><br>***(This outcome is assessed by a graded on-screen exam)*** | **6.1 Describe the function and application of electronic components that are used in electrical systems.** | Electronic components and devices:<br>• Capacitors<br>• Resistors<br>• Rectifiers<br>• Diodes: Zener, LED; photo<br>• Thermistors<br>• Diacs<br>• Triacs<br>• Transistors<br>• Thyristors<br>• Invertors.<br><br>Electrical systems:<br>• Security alarms<br>• Telephones<br>• Dimmer switches<br>• Heating/boiler controls<br>• Motor control<br>• Wireless control systems. |
| | **6.2 State the basic operating principles of electronic components and devices.** | |