Title	**Demonstrate knowledge of electrical calculations and theory, test instruments, and components of electrical equipment**		
Level	**2**	**Credits**	**6**

Purpose	This unit standard is for people who are currently working, or intend to work to provide electrical equipment in the electrotechnology industry and require a basic understanding of electricity and electrical calculations. People credited with this unit standard are able to demonstrate knowledge of: – mathematics for electrical equipment; – electrical conductors and insulators; – resistance, resistivity, and resistors; – electrical test instruments; and – capacitors.

Classification	Electrical Engineering > Electrical Equipment

Available grade	Achieved

Guidance Information

1 This unit standard has been developed for learning and assessment on-job or off-job.

2 For assessment purposes:
- a Candidates will be supplied with formulae for electrical calculations involving more than three quantities.
- b Use of a calculator during assessment is permitted.
- c Candidates are expected to express calculated values in the relevant Système International (SI) units, including multiples and sub-multiples (pico, nano, micro, milli, kilo, mega, etc) and be able to convert between them.

3 Definitions
a.c. – alternating current.
d.c. – direct current.
Industry practice – practice used and recommended by organisations involved in the electrotechnology industry.
Current regulations and standards refers to the requirements of the references below.

4 References

Electricity Act 1992;
Electricity (Safety) Regulations 2010;
Health and Safety at Work Act 2015;
Health and Safety in Employment Regulations 1995;
Resource Management Act 1991;
local body regulations;
AS/NZS 3000:2007, *Electrical installations (known as the Australian/New Zealand Wiring Rules),* including Amendments;
and all subsequent amendments and replacements.

Outcomes and performance criteria

Outcome 1

Demonstrate knowledge of mathematics for electrical equipment.

Performance criteria

1.1 Arithmetical calculations are completed to up to seven significant figures.

Range add, subtract, multiply, divide.

1.2 Fractions are converted to decimals and percentages, and vice versa.

1.3 Multiples are expressed as powers of 10 and vice versa.

Range giga, mega, kilo, unit, milli, micro, nano, pico.

1.4 Area and volume calculations are carried out for simple two and three dimensional shapes using given data.

Range area – square, oblong rectangle, triangle, circle;
volume – box, cylinder.

1.5 Formulae for Ohm's law and resistivity are transposed to solve for an unknown quantity.

Outcome 2

Demonstrate knowledge of electrical conductors and insulators.

Performance criteria

2.1 The nature of conductors and insulators is described in terms of the availability of loosely-bound electrons.

2.2 Materials commonly used for conductors and insulators are identified, and examples of their use in electrical equipment are stated.

Range conductors – copper, brass, silver, gold, aluminium, steel; insulators – rubber, polyvinyl chloride (PVC), ceramics.

Outcome 3

Demonstrate knowledge of resistance, resistivity, and resistors.

Performance criteria

3.1 Resistance is described in terms of opposition to current flow.

3.2 The unit for resistance is stated, and the symbol drawn.

3.3 The factors affecting resistance and the relationship between them are stated.

Range factors – length, cross-sectional area, resistivity of material, temperature, temperature co-efficient of resistance;
relationship – $R = \frac{\rho l}{A}$.

3.4 Ohm's Law is defined using industry terms.

3.5 The relationship between resistance, voltage, and current is described in terms of the effect that a change in any one quantity has on the other two.

3.6 Resistor markings relating to resistance, rating, and tolerance are identified and interpreted according to industry practice.

Range evidence relating to three different linear resistors is required. Use of resistor colour code chart is permitted.

Outcome 4

Demonstrate knowledge of electrical test instruments.

Performance criteria

4.1 Digital instruments are described in terms of their principles of operation and their applications.

Range instruments – multimeter, clip-on ammeter, insulation tester; applications – a.c. and d.c. voltage and current, resistance, insulation, continuity, diode testing; other specialised functions.

4.2 Instruments are identified from physical or pictorial displays, and how each would be connected to perform a measurement is sketched.

Range voltmeter, ammeter, ohmmeter, multimeter, clip-on ammeter, insulation tester. Instruments may be analogue or digital.

4.3 Consequences of incorrect use of test instruments are stated.

Range incorrect uses include – polarity reversed, use of wrong instrument, incorrect connection to the circuit, incorrect range or function selection, open circuit fuse in fused lead, broken test lead, open circuit test lead.

Outcome 5

Demonstrate knowledge of capacitors.

Performance criteria

5.1 Capacitor types are described in terms of their physical construction.

Range stacked-plate, rolled, electrolytic, variable, ceramic.

5.2 Capacitance is defined in terms of voltage and charge, and its symbol and units are stated.

5.3 The factors influencing capacitance are stated, together with the effect of each when it is increased and decreased.

Range factors – area, distance between plates, dielectric permittivity.

5.4 Charge is calculated from given values of capacitance, applied voltage, live current, and time.

Range simple calculations using formulae Q = CV and Q = It.

5.5 Charge/discharge curves are sketched or recognised for current and voltage.

5.6 Practical applications are stated for air, paper, mica ceramic, electrolytic, and solid dielectric capacitors, according to industry practice.

5.7 Voltage rating and capacitance are identified from capacitor markings according to industry practice.

5.8 Combined capacitance of series and parallel connected capacitors is calculated.

5.9 The regulatory requirements relating to capacitors used for radio and television interference suppression are stated with reasons, according to current regulations and standards.

5.10 The safety precautions necessary to prevent electric shock from charged capacitors are stated.

This unit standard is expiring. Assessment against the standard must take place by the last date for assessment set out below.

Status information and last date for assessment for superseded versions

Process	Version	Date	Last Date for Assessment
Registration	1	25 July 2007	31 December 2019
Rollover and Revision	2	15 March 2012	31 December 2019
Revision	3	15 January 2014	31 December 2019
Rollover and Revision	4	31 May 2018	31 December 2027
Rollover and Revision	5	25 March 2021	31 December 2027
Review	6	25 May 2023	31 December 2027

Consent and Moderation Requirements (CMR) reference	0003

This CMR can be accessed at http://www.nzqa.govt.nz/framework/search/index.do.