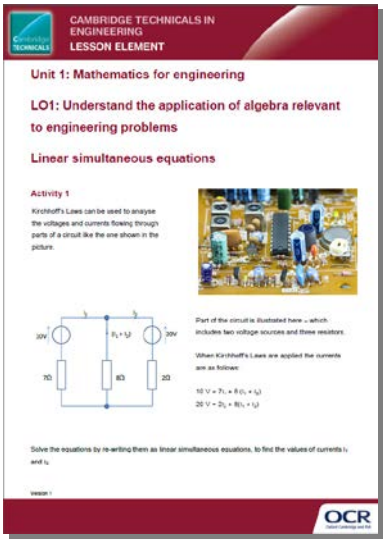
Unit 1: Mathematics for engineering

LO1: Understand the application of algebra relevant to engineering problems

Linear simultaneous equations

Instructions and answers for teachers

These instructions should accompany the OCR resource: 'Linear simultaneous equations' *activity which supports OCR Level 3 Cambridge Technicals in Engineering.*



The Activity:

Activity 1 is a problem relating to the application of Kirchhoff's Laws using linear simultaneous equations. Activity 2 is an application of an equation of motion.

This activity offers an opportunity for English skills development.

This activity offers an opportunity for maths skills development.

Suggested timings:

1 hour

Activity 1

Activity 1 is a problem relating to the application of Kirchhoff's Laws using linear simultaneous equations. Learners may use any method to solve the equations.

Teachers could further develop this problem by showing learners how the simultaneous equations are derived.

Solution

$10 = 7I_1 + 8\,(I_1 + I_2)$ ... eq1

$20 = 2I_1 + 8\,(I_1 + I_2)$ ... eq2

Multiply out and simplify eq1:

$10 = 15I_1 + 8I_2$

Multiply out and simplify eq2:

$20 = 10I_1 + 8I_2$

Re-write simultaneous equations:

$-10 = -15I_1 - 8I_2$ ... eq3 (multiply through by -1)

$20 = 10I_1 + 8I_2$ ... eq4

Solve simultaneous equations for I_1 (solved here by addition):

$-10 = -15I_1 - 8I_2$

$20 = 10I_1 + 8I_2 \quad +$

$10 = -5I_2$

$\therefore I_1 = -10/5 = -2$ amperes

(the minus sign indicates current flow in the opposite direction)

Substitute into eq1 to find I_2:

$10 = 15(-2) + 8I_2$

$10 = -30 + 8I_2$

$\therefore I_2 = (10+30)/8 = 5$ amperes

Prove the solution is correct by substituting values for I_1 and I_2 back into eq1 and eq2

Activity 2

Activity 2 is an application of an equation of motion.

Teachers could extend this activity by introducing further fundamental equations of motion, or by specifying a mass for the rollercoaster.

Again, learners may use different methods to solve the simultaneous equations.

Solution

Using the formula given: $s = ut + ½\ at^2$

Condition 1:

$24 = 2u + ½\ a\ (2)^2$

$24 = 2u + 2a$ … eq1

Condition 2:

$88 = 4u + ½\ a\ (4)^2$

$88 = 4u + 8a$ … eq2

Re-write simultaneous equations:

$24 = 2u + 2a$ … eq3

$88 = 4u + 8a$ … eq4

Solve simultaneous equations for a (solved here by multiplying eq3 by 2, and subtracting):

$88 = 4u + 8a$

$48 = 4u + 4a$ –

$40 = 4a$

$\therefore a = 40/4 = 10\ ms^{-2}$ **(solution for part a)**

Substitute into eq2 to find u:

$88 = 4u + 8(10)$

$\therefore 4u = 88 - 80 = 8$

$u = 8/4 = 2\ ms^{-1}$ **(solution for part b)**

Part c

Distance travelled after 5 seconds:

$s = ut + ½\ at^2$

$s = 2(5) + ½\ (10)(5)^2$

$s = 135\ m$

This is a pretty quick roller coaster!

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