

Anamaria-Cristina Finta

by Anamaria Cristina Finta

Submission date: 11-Jan-2025 02:27PM (UTC+0000)

Submission ID: 248033472

File name: 53254_Anamaria_Cristina_Finta_Anamaria-Cristina_Finta_633625_1077921034.docx (334.86K)

Word count: 23

Character count: 201

Applied Analytics (ACMA4009)

MODULE CODE: ACMA4009

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1. Write down the base units for the following:

- a) Temperature – **Kelvin symbol (K)**
- b) Luminous Intensity – **Candela symbol (cd)**
- c) Volume – **Cubic meter symbol (m³)**
- d) Displacement – **Meter symbol (m)**
- e) Time – **Second symbol (s)**

2. Given that Pressure is defined as;

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

Write down the base units of Pressure.

The Force is measured in Newtons, symbol (N) – and it is defined as following: kg·m/s²

KG - is kilogram (unit of mass)

M - is meter (unit of length)

S - is second (unit of time)

Area is measured in square meters

Now, I am going to substitute the base units of force and area:

$$\text{Pressure} = \frac{\text{Fraction}}{\text{Area}} = \frac{\text{kg} \cdot \text{m}/\text{s}^2}{\text{m}^2}$$

I am going to simplifying this:

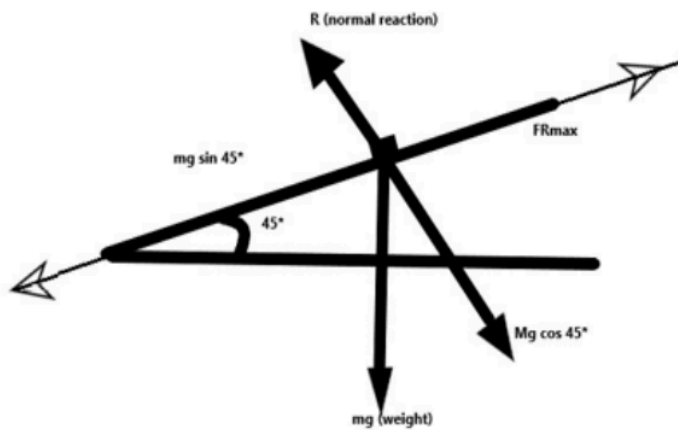
$$\text{Pressure} = \frac{\text{kg}}{\text{m} \cdot \text{s}^2}$$

Now, the base units of pressure are:

$$\text{kg} \cdot \text{m}^{-1} \cdot \text{s}^{-2}$$

3. A body of mass 2kg rests in limiting equilibrium on a rough inclined plane, which is at an angle of 45° to the horizontal.

- a) Draw a free body diagram in your answer booklet showing the frictional force, normal reaction and the component of weight that acts down the slope.



- b) Calculate the maximum magnitude of frictional force.

The frictional force equals the component of the weight parallel to the slope

$$F = mg \sin 45^\circ$$

Values

$$M = 2 \text{ kg}$$

$$g = 9.8 \text{ m/s}^2 \text{ (approximate acceleration due to gravity near the Earth's surface)}$$

$$\cos 45^\circ = \frac{1}{\sqrt{2}} \approx 0.707$$

$$F = 2 \cdot 9.8 \cdot 0.707 \approx 13.86\text{N}$$

$$F \approx 13.86\text{N}$$

- c) State which of the other forces are equal and give a reason why you can state this without calculation.

i. The frictional force (F) equals the component of weight down the slope ($mg \sin 45^\circ$) because the body is in limiting equilibrium (no acceleration).

ii. The normal reaction (R) equals the component of weight perpendicular to the slope ($mg \cos 45^\circ$) because there is no vertical motion perpendicular to the plane.

- d) Calculate the magnitude of the normal reaction to the surface.

The normal reaction (R) balances the perpendicular component of weight

$$R = mg \sin 45^\circ$$

Values

$$M = 2 \text{ kg}$$

$$g = 9.8 \text{ m/s}^2 \text{ (approximate acceleration due to gravity near the Earth's surface)}$$

$$\sin 45^\circ = \frac{1}{\sqrt{2}} \approx 0.707$$

$$R = 2 \cdot 9.8 \cdot 0.707 \approx 13.86\text{N}$$

$$R \approx 13.86\text{N}$$

Solve the following by factorising:

i) $x^2 - 5x + 6 = 0$ ii) $x^2 + 7x + 6 = 0$ iii) $x^2 + 10x = -25$ iv) $x^2 - 2x - 15 = 0$ v)
 $2x^2 + 3x + 1 = 0$

Answer:

1) $x^2 - 5x + 6 = 0$

$(-2) \times (-3) = 6$ and $(-2) + (-3) = -5$

$x^2 - 5x + 6 = x^2 - 2x - 3x + 6$

$(x^2 - 2x) - (3x - 6) = 0$

$x(x - 2) - 3(x - 2) = 0$

$x - 2 = 0 \Rightarrow x = 2$

$x - 3 = 0 \Rightarrow x = 3$

Solutions|

$x = 2$

$x = 3$

2) $x^2 + 7x + 6 = 0$

$1 \times 6 = 6$ and $1 + 6 = 7$

$x^2 + 1x + 6x + 6 = 0$

$(x^2 + 1x) + (6x + 6) = 0$

$(x + 1)(x + 6) = 0$

$x + 1 = 0 \Rightarrow x = -1$

$x + 6 = 0 \Rightarrow x = -6$

$x = -1$

$x = -6$

3) $x^2 + 10x = -25$

$$x^2+10x+25=-25+25$$

$$a=1, b=10, c=25$$

$$5 \times 5 = 25 \text{ and } 5+5=10$$

$$x^2+5x+5x+25=0$$

$$(x^2+5x) + (5x+25) = 0$$

$$(x+5)(x+5)=0$$

$$x+5=0 \Rightarrow x=-5$$

$$x=-5$$

$$\text{iv) } x^2-2x-15=0$$

$$(-5) \times 3 = -15 \text{ and } (-5) + 3 = -2$$

$$x^2-5x+3x-15=0$$

$$(x^2-5x) + (3x-15) = 0$$

$$x(x-5) + 3(x-5) = 0$$

$$(x-5)(x+3) = 0$$

$$x-5=0 \Rightarrow x=5$$

$$x+3=0 \Rightarrow x=-3$$

$$x=5$$

$$x=-3$$

$$\text{v) } 2x^2+3x+1=0$$

$$a=2, b=3, c=1$$

$$2 \times 1 = 2$$

$$1 \times 2 = 2 \text{ and } 1+2=3$$

$$2x^2 + 1x + 2x + 1 = 0$$

$$(2x^2 + 1x) + (2x + 1) = 0$$

$$x(2x + 1) + 1(2x + 1) = 0$$

$$(2x + 1)(x + 1) = 0$$

$$2x + 1 = 0 \Rightarrow x = -\frac{1}{2}$$

$$x + 1 = 0 \Rightarrow x = -1$$

$$x = -\frac{1}{2}$$

$$x = -1$$

5. Solve the following (to 2 d. p's) by using the quadratic formula:

$$(i) x^2 - 4x - 1 = 0$$

$$(ii) 2x^2 + 3x - 1 = 0$$

Answer:

$$(i) x^2 - 4x - 1 = 0$$

$$a = 1, b = -4, c = -1,$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \quad x = \frac{-(-4) \pm \sqrt{4^2 - 4 \cdot 1 \cdot (-1)}}{2 \cdot 1} \quad x = \frac{4 \pm \sqrt{20}}{2} \quad x = 2 \pm \sqrt{5}$$

$$x = 2 + \sqrt{5} \Rightarrow \sqrt{5} \approx 2.236 \Rightarrow x = 2 + 2.236 \approx 4.24$$

$$x = 2 - \sqrt{5} \Rightarrow \sqrt{5} \approx 2.236 \Rightarrow x = 2 - 2.236 \approx -0.24$$

Solutions

$$1. x \approx 4.24$$

$$2. x \approx -0.24$$

$$(ii) 2x^2 + 3x - 1 = 0$$

$$a = 2, b = 3, c = -1, x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \quad x = \frac{-3 \pm \sqrt{3^2 - 4 \cdot 2 \cdot (-1)}}{2 \cdot 2}$$

$$x = -3 \pm \sqrt{172 \times 2} \Rightarrow x = -3 \pm \sqrt{174}$$

positive square root

$$\sqrt{17} \approx 4.12$$

$$x = -3 + 4.124 \approx 1.124 \approx 0.28$$

$$\text{negative square root } x = -3 - \sqrt{174} \quad x = -3 - 4.124 \approx -7.124 \approx -1.78$$

$$x \approx 0.28$$

$$x \approx -1.78$$

6 Solve the following equations

$$(i) 3(x-1)2 = x+24$$

$$(ii) 2x + 5y = 7$$

$$3x + 2y = 5$$

Answers:

$$(i) 3(x-1)2 = x+24$$

$$3(x-1)2 = x+24 \Rightarrow 3x-32 = x+24$$

$$3x-32 = x+24 \Rightarrow 4(3x-3) = 2(x+2)$$

$$4(3x-3) = 2(x+2) \Rightarrow 12x-12 = 2(x+2) \quad 12x-12 = 2(x+2) \Rightarrow 12x-12 = 2x+4 \\ 12x-12 = 2x+4 \Rightarrow 12x-12-2x = 4 \quad 12x-2x = 4+12 \Rightarrow 10x = 4+12 \quad 10x = 16 \Rightarrow \\ x = 85$$

$$(ii) 2x + 5y = 7$$

$$3x + 2y = 5$$

Eliminate one variable

Multiply the first equation by 3 and the second equation by 2 to align the coefficients of x

$$1. 3(2x+5y) = 3 \cdot 7 \Rightarrow 6x+15y=21$$

2. $2(3x+2y) = 2 \cdot 5 \Rightarrow 6x+4y=10$

3. $(6x+15y) - (6x+y) = 21-10 \Rightarrow 11y=11$

4. $11y=11 \Rightarrow y=1$

5. $y=1$

6. $y=1$ in $3x+2y=5$

7. $3x+2(1) = 5 \Rightarrow 3x+2=5$

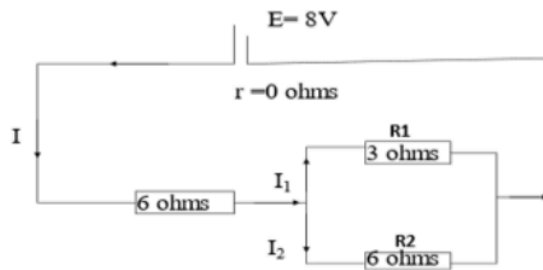
8. $3x+2=5-2 \Rightarrow 3x=3 \Rightarrow x=1$

$X=1, Y=1$

7. For the following electrical circuit

Find:

- The total resistance of the circuit
- Current I_2 in the branched circuit.
- The power supplied by the cell.



a) The total resistance of the circuit

$$E=8V$$

6Ω in series with a parallel branch

Parallel resistors: 3Ω and 6Ω

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} \Rightarrow \frac{1}{R_p} = \frac{1}{3} + \frac{1}{6} \Rightarrow \frac{1}{R_p} = \frac{2}{6} + \frac{1}{6} = \frac{3}{6}$$

$$R_p = 6 \cdot \frac{3}{3} = 2\Omega \Rightarrow R_T = R_s + R_p = 6 + 2 = 8\Omega$$

Result $R_T = 8\Omega$

b) Current I_2 in the branched circuit:

Ohm's law:

$$\mathcal{E} = E = 8V \text{ and } R_T = 8\Omega \Rightarrow \mathcal{I} = \frac{E}{R_T} = \frac{8}{8} = 1A \quad V_{parallel} = \mathcal{I} \cdot R_s = 1 \cdot 6 = 6V$$

Ohm's law for $R_2 = 6\Omega$

$$I_2 = \frac{V_{parallel}}{R_2} = \frac{6}{6} = 1A$$

Result $I_2 = 1A$

c) The power supplied by the cell.

The total power P supplied by the cell is given by:

$$P = E \cdot I$$

Substituting $E=8V$ and $I=1A$

$$P = 8 \cdot 1 = 8W$$

Result $P=8W$

FINAL GRADE

83/100

GENERAL COMMENTS

Q1 BASE UNITS

[5MARKS]

All correct, (Cd) is symbol for Candela
[5 marks]

Q2 DERIVED UNITS

[5 MARKS]

All correct [5 marks]

Q3 EQUILIBRIUM OF AN OBJECT ON AN INCLINED PLANE

[11 MARKS]

All correct [11 marks]

Q4 SOLVING QUADRATIC EQUATIONS BY FACTORISING

[15 MARKS]

2 is incorrectly factorised, 3, $x = -5$ twice, $x = -1/2$ in 4 not 12!!

[12 marks]

Q5 SOLUTION OF QUADRATIC EQUATIONS BY FORMULA

[10 MARKS]

All correct [10 marks]

Q6 SIMULTANEOUS LINEAR EQUATIONS

[10 MARKS]

First part incorrect expansion and calculation,
second part all correct

[6 marks]

Q7 SIMPLE ELECTRICAL CIRCUIT

[9 MARKS]

Errors in calculation of current PD and branched
circuit currents, most of ideas are correct though

[5 marks]

total = 54/65 83%

Submitted a week late, student claims to have been
ill and have advised to put in an EC form.

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