Revise and refresh for MST124:
Welcome to Session 2

Friday 10th September 2021

We'll start at 7.00pm and aim to finish by 9.00pm

Please check your Audio levels:

Speaker and Microphone Setup

This session will cover the topics in Algebra

Please feel free to use the chat box while waiting

Have paper, pen and your calculator to hand.

Tutorial Etiquette

It is expected that a lot of students will be attending this evening. For this reason can I ask that questions are kept to the topics being covered this evening.

If you do have other questions then the Revise and Refresh forum is often a good place to post them. Alternatively I am happy to wait for a while after the main tutorial for individual questions.

Can I also ask that you tend to use the chat box rather than microphones as otherwise it can get noisy very quickly!

Finally when you are working out answers to problems during the tutorial could you not add your solutions to the chat box in order that other students have time to work on the problems themselves.

What we aim to cover tonight

- Terminology
- Simplifying and evaluating expressions
- Multiplying out brackets
- Factorising expressions
- Algebraic fractions
- Algebraic indices
- Writing mathematics

TERMINOLOGY

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

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Variable: A letter used to represent different numbers

TERMINOLOGY

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

Expression: A collection of letters, numbers and / or mathematical symbols

TERMINOLOGY

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

Equation: Two expressions with an equals sign between them

TERMINOLOGY

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

Term: An item that can be added or subtracted in an expression

TERMINOLOGY

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

Constant term: Just a number

TERMINOLOGY

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

Coefficient: A number multiplied by a combination of letters

TRUE OR FALSE?

Consider $-x^2 + 49x - 3xy + 2\pi$

a) $-x^2 + 49x - 3xy + 2\pi$ is an equation.

b) There are 4 terms in $-x^2 + 49x - 3xy + 2\pi$.

c) The coefficient of x is 49.

d) $-x^2 + 49x$ is a term in x.

e) We could write the above as $3xy - x^2 + 49x + 2\pi$.

f) 2π is a variable in the expression $-x^2 + 49x - 3xy + 2\pi$.

EVALUATING ALGEBRAIC EXPRESSIONS

When we substitute numbers for the letters in an expression and work out its value, we're evaluating the expression.

Evaluate the expression

$$9x^2 - 5y$$

when $x = 10$ and $y = -3$.

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Evaluate the expression

$$9x^2 - 5y$$

when $x = 10$ and $y = -3$.

$$\begin{aligned} 9x^2 - 5y &= 9 \times 10^2 - 5 \times (-3) \\ &= 900 + 15 \\ &= 915 \end{aligned}$$

ADDING AND SUBTRACTING ALGEBRAIC FRACTIONS

Evaluate the following expressions when $x = \sqrt{2}$ and $y = -3$

a) $3x - 2(4y - x)$

b) $\frac{3x^2 - 2y^2}{3x}$

Evaluate the following expressions when $x = \sqrt{2}$ and $y = -3$

a) $3x - 2(4y - x) = 3 \times \sqrt{2} - 2(4 \times (-3) - \sqrt{2})$

$$= 3\sqrt{2} - 2(-12 - \sqrt{2})$$

$$= 3\sqrt{2} + 24 + 2\sqrt{2}$$

$$= 24 + 5\sqrt{2}$$

Evaluate the following expressions when $x = \sqrt{2}$ and $y = -3$

b) $\frac{3x^2-2y^2}{3x} = \frac{3\times(\sqrt{2})^2-2\times(-3)^2}{3\times\sqrt{2}}$

$$= \frac{3\times2-2\times9}{3\sqrt{2}}$$

$$= \frac{6-18}{3\sqrt{2}}$$

$$= \frac{-12}{3\sqrt{2}} \times \frac{\sqrt{2}}{\sqrt{2}}$$

$$= \frac{-12\sqrt{2}}{3\times2}$$

$$= -2\sqrt{2}$$

SIMPLIFYING ALGEBRAIC EXPRESSIONS

When we're working with an algebraic expression, we should usually try to write it in as simple a form as we can. One way in which some expressions can be simplified is by collecting like terms.

Simplify the following expressions:

$3h + 9h - h =$

$a^2 + 3ab - 5a^2 - ab =$

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Simplify the following expressions:

$3h + 9h - h = 11h$

$a^2 + 3ab - 5a^2 - ab = a^2 - 5a^2 + 3ab - ab = 2ab - 4a^2$

SIMPLIFYING ALGEBRAIC EXPRESSIONS

Simplify the following expressions:

a) $\frac{1}{9}k + \frac{2}{9}k$

b) $2m^{\frac{1}{2}} + m^{\frac{3}{2}} - m^{\frac{1}{2}}$

c) $2ab - a^2b - 5ba$

d) $4x + 2X + 3 - 1$

SIMPLIFYING ALGEBRAIC EXPRESSIONS

Simplify the following expressions:

a) $\frac{1}{9}k + \frac{2}{9}k = \frac{3}{9}k = \frac{1}{3}k$

b) $2m^{\frac{1}{2}} + m^{\frac{3}{2}} - m^{\frac{1}{2}} = m^{\frac{1}{2}} + m^{\frac{3}{2}}$

c) $2ab - a^2b - 5ba = -3ab - a^2b$

d) $4x + 2X + 3 - 1 = 4x + 2X + 2$

MULTIPLYING OUT BRACKETS

To rewrite an expression with brackets as one without brackets: multiply each of the numbers inside the brackets individually by the number outside the brackets. This is called multiplying out the brackets, expanding the brackets, or simply removing the brackets.

Multiply out the brackets in the following expressions:

$3(x + 5)$

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$$4(5 - 2y + x^3)$$

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$$3(x+5) = 3 \times x + 3 \times 5 = 3x + 15$$

$$\begin{aligned} 4(5 - 2y + x^3) &= 4 \times 5 + 4 \times (-2y) + 4 \times x^3 \\ &= 20 - 8y + 4x^3 \end{aligned}$$

MULTIPLYING OUT BRACKETS

Multiply out the brackets in the following expressions:

a) $2a(3a - 6)$

b) $(x + x^2)y$

c) $-(4 - 2a)$

d) $\sqrt{a}(b + c) - b(\sqrt{a} - c)$

MULTIPLYING OUT BRACKETS

Multiply out the brackets in the following expressions:

a) $2a(3a - 6) = 2a \times 3a + 2a \times (-6) = 6a^2 - 12a$

b) $(x + x^2)y = y(x + x^2) = y \times x + y \times x^2 = xy + x^2y$

c) $-(4 - 2a) = -1 \times 4 + (-1) \times (-2a) = 2a - 4$

d) $\sqrt{a}(b + c) - b(\sqrt{a} - c)$

$$= \sqrt{a} \times b + \sqrt{a} \times c - b \times \sqrt{a} - b \times (-c)$$

$$= b\sqrt{a} + c\sqrt{a} - b\sqrt{a} + bc = bc + c\sqrt{a}$$

TAKING OUT COMMON FACTORS

The highest common factor (HCF) of two or more terms is a common factor of the terms such that no other common factor is higher. We can use this to factorise algebraic expressions.

To factorise the expression $9c^2d + 6cef$ note that the two terms in this expression, $9c^2d$ and $6cef$, have $3c$ as the HCF. So the expression can be written as

$$3c \times 3cd + 3c \times 2ef.$$

From the work on multiplying out brackets, we know that this is the same as

$$3c(3cd + 2ef).$$

TAKING OUT COMMON FACTORS

Fractions and negatives can also be taken out as common factors

$$-\frac{1}{2}x^3y-\frac{3}{4}xy^2$$

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$$-\frac{1}{2}x^3y-\frac{3}{4}xy^2=-\frac{1}{4}xy(2x^2+3y)$$

TAKING OUT COMMON FACTORS

Factorise the following expressions:

a) $12x^2y^3 - 9x^3y^2$

b) $\pi r^2 + 2\pi rh$

c) $\frac{1}{9}abc - \frac{2}{3}bcd$

d) $\sqrt{2}m^4\sqrt{p} - \sqrt{8}m^2p^{1/2}q^3$ [*]

TAKING OUT COMMON FACTORS

Factorise the following expressions:

a) $12x^2y^3 - 9x^3y^2 = 3x^2y^2(4y - 3x)$

b) $\pi r^2 + 2\pi rh = \pi r(r + 2h)$

c) $\frac{1}{9}abc - \frac{2}{3}bcd = \frac{1}{9}bc(a - 6d)$

d) $\sqrt{2}m^4\sqrt{p} - \sqrt{8}m^2p^{\frac{1}{2}}q^3 = \sqrt{2p}m^2(m^2 - 2q^3)$

ALGEBRAIC FRACTIONS

Algebraic expressions written using fraction notation are called algebraic fractions. The expressions above and below the line in an algebraic fraction are called the *numerator* and *denominator*, respectively, just as they are for ordinary fractions.

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An algebraic fraction is valid only for the values of the variables that make the denominator non-zero:

$$F = \frac{GmM}{r^2}$$

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$$F = \frac{GmM}{r^2}$$

This equation cannot be applied with $r = 0$.

SIMPLIFYING ALGEBRAIC FRACTIONS

Two algebraic fractions are equivalent if one can be obtained from the other by multiplying or dividing both the numerator and the denominator by the same expression.

Simplify the following algebraic fractions:

$$\frac{60p^3q}{35p^5r}$$

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Simplify the following algebraic fractions:

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$$\frac{60p^3q}{35p^5r} = \frac{5p^3 \times 12q}{5p^3 \times 7p^2r} = \frac{12q}{7p^2r} \quad (p \neq 0, r \neq 0)$$

SIMPLIFYING ALGEBRAIC FRACTIONS

Simplify the following algebraic fractions:

a) $\frac{(5-x)^6y^5}{(5-x)^2y^3}$

b) $\frac{-16s^3t-12s^2t}{-4s^2t^3-3st^3}$

SIMPLIFYING ALGEBRAIC FRACTIONS

Simplify the following algebraic fractions:

a) $\frac{(5-x)^6 y^5}{(5-x)^2 y^3} = (5-x)^4 y^2$

b) $\frac{-16s^3t-12s^2t}{-4s^2t^3-3st^3} = \frac{-4s^2t(4s+3)}{-st^3(4s+3)} = \frac{4s}{t^2} \quad (t \neq 0)$

MULTIPLYING AND DIVIDING ALGEBRAIC FRACTIONS

The rules for multiplying and dividing algebraic fractions are the same as those for multiplying and dividing numerical fractions.

To multiply two algebraic fractions, multiply the numerators together and multiply the denominators together:

$$\frac{x}{4} \times \frac{2}{3y}$$

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To divide one algebraic fraction by another, multiply the first fraction by the reciprocal of the second fraction:

$$\frac{5\sqrt{y}}{2} \div \frac{2\sqrt{y}}{5}$$

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$$\frac{5\sqrt{y}}{2} \div \frac{2\sqrt{y}}{5} = \frac{5\sqrt{y}}{2} \times \frac{5}{2\sqrt{y}}$$

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To divide one algebraic fraction by another, multiply the first fraction by the reciprocal of the second fraction:

$$\frac{5\sqrt{y}}{2} \div \frac{2\sqrt{y}}{5} = \frac{5\sqrt{y}}{2} \times \frac{5}{2\sqrt{y}} = \frac{5 \times 5}{2 \times 2} = \frac{25}{4}$$

MULTIPLYING AND DIVIDING ALGEBRAIC FRACTIONS

Write each of the following expressions as a single algebraic fraction, simplifying your answer if possible.

a) $\frac{2a}{b} \times \frac{b^2}{4a}$

b) $\frac{10}{x^8(5x-1)^7} \div \frac{7x^6}{(5x-1)^{10}}$

For part (b) don't expand the brackets in $(5x - 1)$

MULTIPLYING AND DIVIDING ALGEBRAIC FRACTIONS

Write each of the following expressions as a single algebraic fraction, simplifying your answer if possible.

a) $\frac{2a}{b} \times \frac{b^2}{4a} = \frac{2a \times b^2}{b \times 4a} = \frac{1 \times b}{1 \times 2} = \frac{b}{2}$

MULTIPLYING AND DIVIDING ALGEBRAIC FRACTIONS

$$\frac{10}{x^8(5x-1)^7} \div \frac{7x^6}{(5x-1)^{10}} = \frac{10}{x^8(5x-1)^7} \times \frac{(5x-1)^{10}}{7x^6}$$

$$= \frac{10\times(5x-1)^3}{x^8\times 7x^6}$$

$$= \frac{10(5x-1)^3}{7x^{14}}$$

ADDING AND SUBTRACTING ALGEBRAIC FRACTIONS

The rules for adding and subtracting algebraic fractions are the same as those for adding and subtracting numerical fractions. If the denominators are the same, then we just add or subtract the numerators. If the denominators are different, then we first need to write the fractions with a common denominator.

Write each of the following expressions as a single algebraic fraction

$$\frac{a}{b} + \frac{c}{d} = \frac{ad + bc}{bd}$$

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Write each of the following expressions as a single algebraic fraction

$$\frac{a}{b}+\frac{c}{d}=\frac{ad+bc}{bd}$$

$$\frac{2}{b}+\frac{c}{4a}=\frac{2}{b}\times\frac{4a}{4a}+\frac{c}{4a}\times\frac{b}{b}$$

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$$\frac{a}{b}+\frac{c}{d}=\frac{ad+bc}{bd}$$

$$\frac{2}{b}+\frac{c}{4a}=\frac{2}{b}\times\frac{4a}{4a}+\frac{c}{4a}\times\frac{b}{b}=\frac{8a}{4ab}+\frac{bc}{4ab}=\frac{8a+bc}{4ab}$$

ADDING AND SUBTRACTING ALGEBRAIC FRACTIONS

Write each of the following expressions as a single algebraic fraction, simplifying your answer if possible

a) $\frac{a}{b} - c$

b) $-\frac{-6s^2-4}{8s} - \frac{10}{3s}$

ADDING AND SUBTRACTING ALGEBRAIC FRACTIONS

Write each of the following expressions as a single algebraic fraction, simplifying your answer if possible

a) $\frac{a}{b} - c = \frac{a}{b} - \frac{bc}{b} = \frac{a-bc}{b}$

ADDING AND SUBTRACTING ALGEBRAIC FRACTIONS

Write each of the following expressions as a single algebraic fraction, simplifying your answer if possible

b) $-\frac{-6s^2-4}{8s}-\frac{10}{3s}=\frac{6s^2+4}{8s}\left(\frac{3}{3}\right)+\left(-\frac{10}{3s}\right)\left(\frac{8}{8}\right)$

$$=\frac{3(6s^2+4)}{24s}+\frac{-80}{24s}$$

$$=\frac{18s^2+12-80}{24s}$$

$$=\frac{9s^2-34}{12s}$$

ADDING AND SUBTRACTING ALGEBRAIC FRACTIONS

When no common factors in the denominator can be seen then the cross multiply technique can be used

$$\frac{3t+5}{2t} - \frac{4s-6}{5s}$$

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When no common factors in the denominator can be seen then the cross multiply technique can be used

$$\frac{3t+5}{2t} - \frac{4s-6}{5s} = \frac{3t+5}{2t} \times \frac{5s}{5s} - \frac{4s-6}{5s} \times \frac{2t}{2t}$$

$$= \frac{5s(3t+5)}{10st} - \frac{2t(4s-6)}{10st}$$

$$= \frac{15st+25s-8st+12t}{10st}$$

$$= \frac{7st+25s+12t}{10st}$$

ADDING AND SUBTRACTING ALGEBRAIC FRACTIONS

Write each of the following expressions as a single algebraic fraction, simplifying your answer if possible

c) $\frac{7t}{3t-4} - \frac{5t}{4t+2}$

Note: you do not need to expand the denominator

d) $\frac{4a}{5b} + \frac{3b}{2c} - \frac{2c}{a}$

Note: Try combining two fractions, then combine the third

Write each of the following expressions as a single algebraic fraction, simplifying your answer if possible

c) $\frac{7t}{3t-4} - \frac{5t}{4t+2} = \frac{7t(4t+2)}{(3t-4)(4t+2)} - \frac{5t(3t-4)}{(3t-4)(4t+2)}$

$$= \frac{28t^2+14t-15t^2+20t}{(3t-4)(4t+2)}$$

$$= \frac{13t^2+34t}{(3t-4)(4t+2)}$$

ADDING AND SUBTRACTING ALGEBRAIC FRACTIONS

Write each of the following expressions as a single algebraic fraction, simplifying your answer if possible

d) $\frac{4a}{5b}+\frac{3b}{2c}-\frac{2c}{a}=\frac{8ac+15b^2}{10bc}-\frac{2c}{a}$

$$=\frac{a(8ac+15b^2)}{10abc}-\frac{20bc^2}{10abc}$$

$$=\frac{8a^2c+15ab^2-20bc^2}{10abc}$$

EXPANDING ALGEBRAIC FRACTIONS

An alternative way of writing algebraic expressions is when there's more than one term in the numerator, such as

$$\frac{2a - 5b + c}{3d}.$$

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An alternative way of writing algebraic expressions is when there's more than one term in the numerator, such as

$$\frac{2a-5b+c}{3d}.$$

Since dividing by something is the same as multiplying by its reciprocal, we can write this expression as

$$\frac{1}{3d}(2a-5b+c)=\frac{2a}{3d}-\frac{5b}{3d}+\frac{c}{3d}$$

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$$\frac{1}{3d}(2a - 5b + c) = \frac{2a}{3d} - \frac{5b}{3d} + \frac{c}{3d}$$

Comparing the expressions, we can see that the overall effect is that each term on the numerator has been individually divided by the denominator. This is called expanding the algebraic fraction.

EXPANDING ALGEBRAIC FRACTIONS

Expand the following algebraic fractions, and simplify the resulting expressions where possible.

a) $\dfrac{10\pi x+18y}{6}$

b) $\dfrac{5p+p^2q-3pq}{pq}$

c) $\dfrac{22+x}{x}$

EXPANDING ALGEBRAIC FRACTIONS

Expand the following algebraic fractions, and simplify the resulting expressions where possible.

a) $\frac{10\pi x+18y}{6}=\frac{10\pi x}{6}+\frac{18y}{6}=\frac{5\pi x}{3}+3y$

b) $\frac{5p+p^2q-3pq}{pq}=\frac{5p}{pq}+\frac{p^2q}{pq}-\frac{3pq}{pq}=\frac{5}{q}+p-3$

c) $\frac{22+x}{x}=\frac{22}{x}+\frac{x}{x}=\frac{22}{x}+1$

ALGEBRAIC INDICES

The rules for manipulating powers of algebraic expressions are the same as those for numbers. In addition, we should simplify an algebraic expression that contains fractional indices in the same ways as an expression that contains only integer indices.

Simplify the following expressions:

$$\left(3y^{1/2}\right)^3$$

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Simplify the following expressions:

$$\left(3y^{1/2}\right)^3 = 3^3\left(y^{1/2}\right)^3 = 27y^{1/2\times 3}$$

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$$\frac{p^{5/8}}{p^{9/8}}$$

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$$\frac{p^{5/8}}{p^{9/8}} = p^{(5/8-9/8)}$$

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$$\frac{p^{5/8}}{p^{9/8}} = p^{(5/8-9/8)} = p^{-4/8}$$

ALGEBRAIC INDICES

The rules for manipulating powers of algebraic expressions are the same as those for numbers. In addition, we should simplify an algebraic expression that contains fractional indices in the same ways as an expression that contains only integer indices.

Simplify the following expressions:

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ALGEBRAIC INDICES

Simplify the following expressions:

a) $\dfrac{\left(b^{-2}\right)^{3}}{(3c)^{2}}$

b) $\left(\dfrac{x^{5m}x^{-2m}}{x^{-3m}}\right)^{-3}$

ALGEBRAIC INDICES

Simplify the following expressions:

a) $$\frac{(b^{-2})^3}{(3c)^2} = \frac{b^{-2\times 3}}{3^2c^2} = \frac{b^{-6}}{9c^2} = \frac{1}{9b^6c^2}$$

b) $$\left(\frac{x^{5m}x^{-2m}}{x^{-3m}}\right)^{-3} = (x^{5m}x^{-2m}x^{3m})^{-3}$$
$$= (x^{6m})^{-3}$$
$$= x^{-18m}$$
$$= \frac{1}{x^{18m}}$$

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An important part of studying mathematics is learning how to communicate it effectively. As well as writing down your working, it is just as important to clearly explain how you reached your answer.

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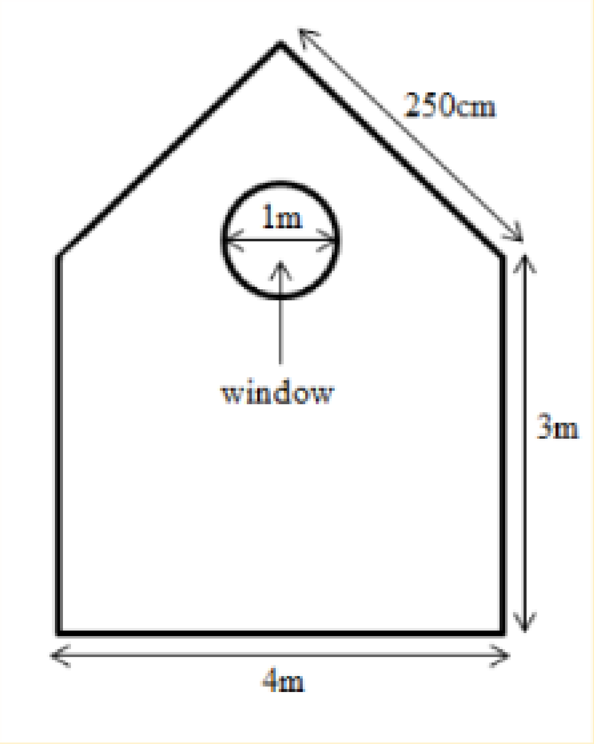
- Finishing with a conclusion that clearly answers the question

WRITING MATHEMATICS

Bob wants to paint the two ends of a hut. In order to work out how much paint to buy he needs to work out the surface area of the two ends. His calculations are:



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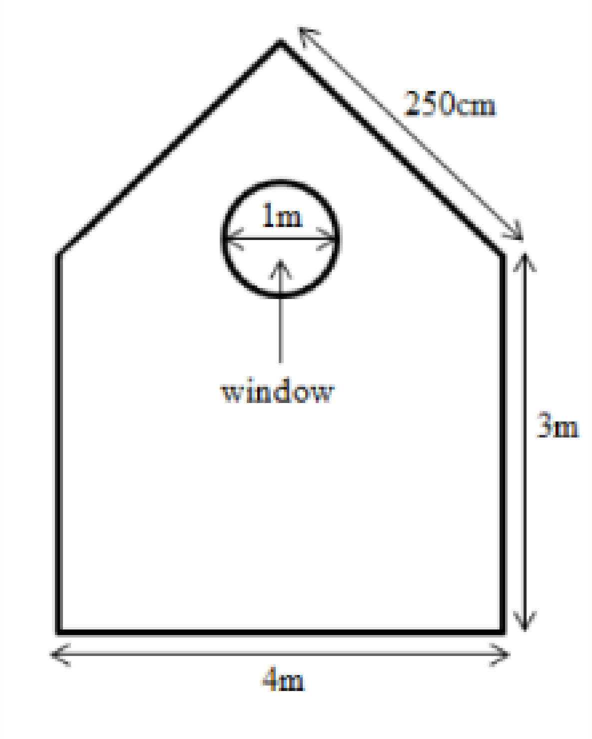

Rectangle: $3 * 4 = 12$

Triangle: $250 \Rightarrow 2.5$

$$2.5^2 = h^2 + 2^2$$
$$h^2 = 2.5^2 - 2^2 = 2.25$$
$$= h = 1.5$$
$$0.5 * 4 * 1.5 = 3$$

Circle: $r = 0.5 \Rightarrow A = \pi * 0.5^2 = 0.8$

$$A = 12 + 3 - 0.8 = 14.2 * 2 = 28.4$$

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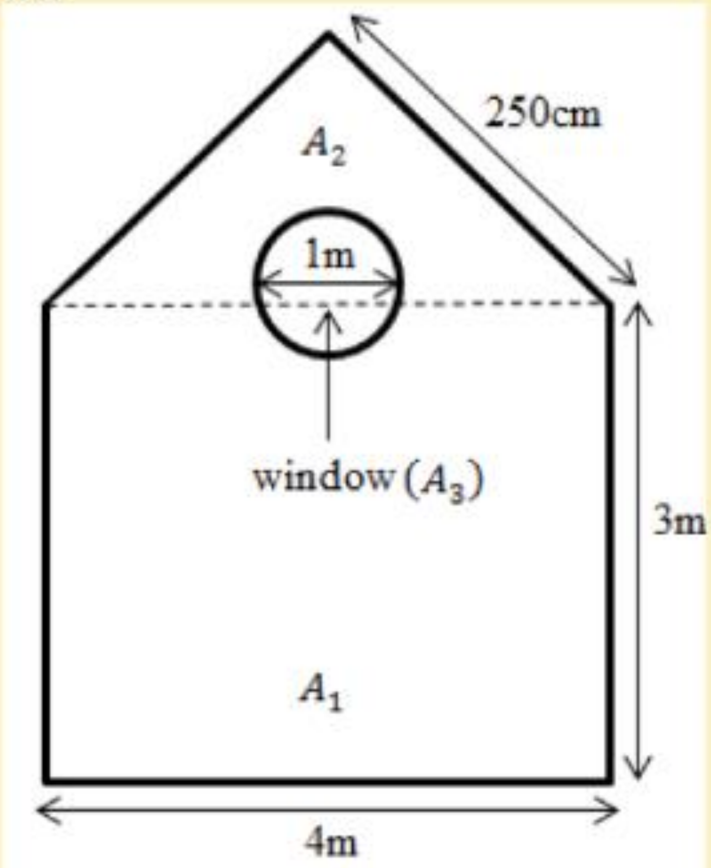

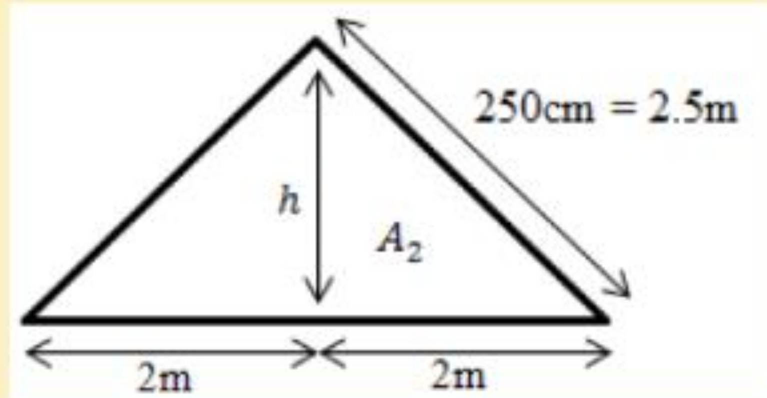

WRITING MATHEMATICS

The area of the rectangle, A_1, is $A_1 = \text{length} \times \text{height}$

$$= 4 \times 3 = 12 \text{ m}^2$$

To find the area of the triangle, A_2, with base b we need to know the height h. By Pythagoras' Theorem we have

$$2.5^2 = h^2 + 2^2$$

So

$$h^2 = 2.5^2 - 2^2 = 2.25$$

$h = \sqrt{2.25} = 1.5 \text{ m}$

Hence, $A_2 = \frac{1}{2} b \times h = \frac{1}{2} \times 4 \times 1.5 = 3 \text{ m}^2$

WRITING MATHEMATICS

To find the area of the circular window, A_3, we need the radius r which is equal to half the diameter, that is $r = 0.5$ m. So

$$A_3 = \pi r^2 = \pi \times 0.5^2 = 0.785\ldots \text{ m}^2$$

Hence the area of each end is given by

$$A_1 + A_2 - A_3 = 12 + 3 - 0.785\ldots = 14.14\ldots \text{ m}^2$$

There are two ends to the hut, so the total area to be painted is $2 \times 14.214\ldots = 28$ m^2 (to the nearest square metre)

Preparing for MST124: Session 3 is on Tuesday 14th January

We'll start at 7.00pm and finish at 9.00pm

This session will cover the topics in
Linear Equations and their Graphs
that you will need to know

Have paper, pen and your calculator to hand.