



AEM questions are taken from past exam papers - they have been carefully chosen to represent a typical exam question at each level of difficulty. If you can do these questions, you're ready to move onto past papers for this topic.

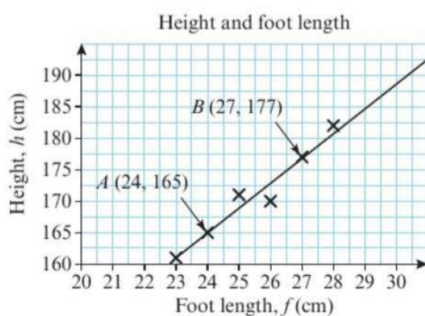
APPRENTICE

The cost of electricity, E , in pounds and the number of kilowatt hours, h , are shown in the table.

Kilowatt hours, h	0	15	40	60	80	110
Cost of electricity, E	45	46.8	49.8	52.2	54.6	58.2

- Draw a graph of the data.
- Explain how you know a linear model would be appropriate.
- Deduce an equation in the form $E = ah + b$
- Interpret the meaning of the coefficients a and b .
- Use the model to find the cost of electricity for 3 days..

EXPERT



The scatter graph shows the height h and foot length f of 8 students. A line of best fit is drawn on the scatter graph.

- Explain why the data can be approximated to a linear model.
- Use points A and B on the scatter graph to write a linear equation in the form $h = af + b$.
- Calculate the expected height of a person with a foot length of 26.5cm.

MASTER

The average August temperature in Exeter is 20°C or 68°F .

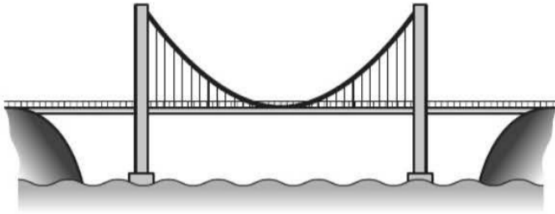
The average January temperature in the same place is 9°C or 48.2°F .

- Write an equation linking Fahrenheit F and Celsius C in the form $F = aC + b$
- Interpret the values of a and b .
- The highest recorded on the UK was 101.3°F . Calculate this temperature in Celsius.



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APPRENTICE



The diagram shows a section of a suspension bridge carrying a road over water.

The height of the cables above water level in metres can be modelled by the function $h(x) = 0.00012x^2 + 200$, where x is the displacement in metres from the centre of the bridge.

- Interpret the meaning of the constant term **200** in the model.
- Use the model to find the two values of x at which the height is **346m**.
- Given that the towers at each end are **346m** tall, use your answer to part (b) to calculate the length of the bridge to the nearest metre.

EXPERT

A car manufacturer uses a model to predict the fuel consumption, y miles per gallon (**mpg**), for a specific model of a car travelling at a speed of x **mph**.

$$y = -0.01x^2 + 0.975x + 16, x > 0$$

- Use the model to find two speeds at which the car has a fuel consumption of **32.5mpg**.
- Rewrite y in the form $A - B(x - C)^2$, where A , B and C are constants to be found.
- Using your answer to part (b), find the speed at which the car has the greatest fuel efficiency.
- Use the model to calculate the fuel consumption of a car travelling at **120mph**.

Comment on the validity of using this model for very high speeds.

MASTER

A fertiliser company uses a quadratic model to determine how the amount of fertiliser used, f kilograms per hectare, affects the grain yield g , measured in tonnes per hectare.

The maximum grain yield possible is $\frac{39}{4}$ tonnes per hectare, which is achieved by using **250** kg of fertiliser.

Without any fertiliser, the yield of grain is **6** tonnes per hectare.

- Find an equation giving g in terms of f
- One farmer currently uses **20** kilograms of fertiliser per hectare. How much more fertiliser would he need to use to increase his grain yield by **1** tonne per hectare?



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APPRENTICE

- Factorise $9x - 4x^3$ completely
- Sketch the curve C with equation $y = 9x - 4x^3$

Show on your sketch the coordinates at which the curve meets the x -axis.

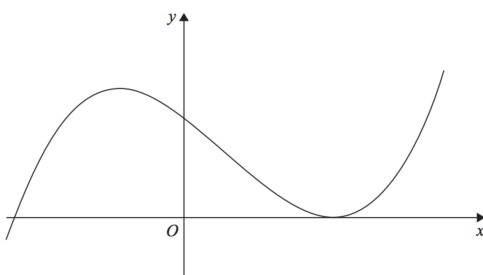
EXPERT

$$f(x) = (x - 2)(2x + 3)(5 - x)$$

The graph of $y = f(x)$ is translated by $\begin{pmatrix} 1 \\ 0 \end{pmatrix}$ to obtain the graph of $y = g(x)$.

State the equation of $y = g(x)$ and sketch its graph, showing the coordinate intercepts.

MASTER



The sketch shows part of the curve

$$f(x) = (2x - 5)^2(x + 3), x \in \mathbb{R}$$

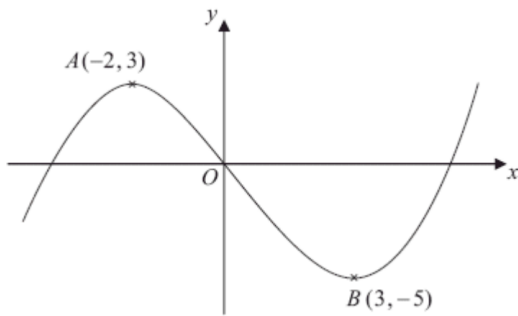
- Given that the curve with equation $y = f(x) + k$ passes through the origin, find the value of the constant k ,
- The curve with equation $y = f(x + c)$ passes through the origin. Find the possible values of the constant c .



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APPRENTICE

The diagram above shows a sketch of the curve with equation $y = f(x)$. The curve has a maximum point A at $(-2, 3)$ and a minimum point B at $(3, -5)$.



On separate diagrams sketch the curve with equation

a. $y = f(x + 3)$

b. $y = 2f(x)$

On each diagram show clearly the coordinates of the maximum and minimum points.

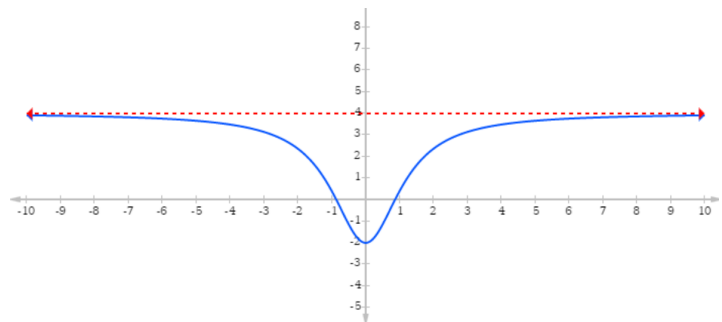
c. The graph of $y = f(x) + a$ has a minimum at $(3, 0)$, where a is a constant. Write down the value of a .

EXPERT

The graph of the function $y = f(x)$ is shown.

It has a horizontal asymptote $y = 4$ and a minimum point at $P(0, -2)$

Sketch the graph of $2 - f(3x)$ showing the equation of the asymptote and the new coordinates of the point P



MASTER

A function $f(x)$ is defined by $f(x) = x^2 - 2x$.

The minimum point of the graph of $y = kf(x)$ is the same coordinate as the minimum point of the graph of $y = f(x) - c$.

Find the relationship between k and c



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APPRENTICE

- a. The graph of $f(x) = 2 - (x + 3)^2$ is translated left 2 then stretched scale factor 3 parallel to the y axis.
What is the equation of this transformed graph?
- b. The graph of $f(x) = -2(x - 3)(x + 5)$ is translated right 1 then reflected over the x axis.
- What is the equation of this transformed graph?
 - What is the equation of the transformed graph if we reflect over the x axis first, then translate right 1?

EXPERT

- a. Factorise completely $x^3 - 6x^2 + 9x$
- b. Sketch the curve with equation $f(x) = x^3 - 6x^2 + 9x$ showing the coordinates of the points at which the curve meets the x -axis.
- c. State and fully simplify the equation of $f(-2x)$
- d. Using your answer to part (b), sketch, on a separate diagram, the curve with equation

$$y = (x - 2)^3 - 6(x - 2)^2 + 9(x - 2)$$

showing the coordinates of the points at which the curve meets the x -axis

MASTER

- a. The graph of $g(x) = 4^x$ is translated right 1 then stretched scale factor 2 parallel to the y axis.
Write the equation of the transformed graph in the form 4^k where k is a function of x
- b. Describe fully a single transformation that transforms the curve $y = 2\sqrt{x}$ to $y = 3\sqrt{5x}$.



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APPRENTICE

Sketch the following graphs on separate axes:

a. $y = (x - 4)^3 + 1$

b. $y = 4 - (x + 1)^3$

c. $y = 4(x - 1)^4 + 1$

b. $y = 2 - 5(x + 1)^4$

EXPERT

Describe the sequence of transformations which maps

a. $y = (x + 1)^4$ onto $y = -(x - 2)^4$

b. $y = -2x^3 + 1$ onto $y = -4x^3 + 1$

MASTER

Find the equation of the graph $y = x^3$ after the following transformations:

a. Reflection over the y axis followed by translation $\begin{pmatrix} -4 \\ 1 \end{pmatrix}$

b. Translation $\begin{pmatrix} 0 \\ -2 \end{pmatrix}$ followed by vertical stretch scale factor 6



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APPRENTICE

Sketch the following graphs on separate axes:

a. $y = \frac{2}{x-4}$

b. $y = 4 - \frac{1}{x+1}$

c. $y = \frac{4}{x^2} - 1$

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

EXPERT

a. Describe the transformations which maps the graph of $y = \frac{1}{5x}$ onto the graph of $y = \frac{1+10x}{5x}$

b. Describe the transformations which maps the graph of $y = \frac{1}{x+1}$ onto the graph of $y = \frac{1}{x-4} + 3$

MASTER

a. Find the equation of the graph $y = \frac{1}{x}$ after the following transformations:

Reflection over the y axis followed by translation $\begin{pmatrix} -4 \\ 1 \end{pmatrix}$

b. Find the equation of the graph $y = \frac{1}{x^2}$ after the following transformations:

Translation $\begin{pmatrix} 0 \\ -2 \end{pmatrix}$ followed by vertical stretch scale factor 6



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APPRENTICE

State the equations of the asymptotes of the graph of $y = \frac{x-2}{2x+1}$

EXPERT

Write $\frac{x-2}{x+1}$ in the form $A + \frac{B}{x+1}$ where A and B are constants to be found

Sketch $y = \frac{x-2}{x+1}$ showing the axis intercepts and equations of the asymptotes

MASTER

Sketch $y = \frac{2x-1}{x+5}$ showing the axis intercepts and equations of the asymptotes



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APPRENTICE

A curve has equation $y = 2x^2 + x - 10$.

Determine the set of values of x for which the graph of the curve lies above the x -axis.

EXPERT

Find the set of values of x for which

- a. $3(2x + 1) > 5 - 2x$
- b. $2x^2 - 7x + 3 > 0$
- c. both $3(2x + 1) > 5 - 2x$ and $2x^2 - 7x + 3 > 0$.

MASTER

The width of a rectangular sports pitch is x metres, $x > 0$. The length of the pitch is 20m more than its width. Given that the perimeter of the pitch must be less than 300m,

- a. Form a linear inequality in x

Given that the area of the pitch must be greater than 4800m^2 ,

- b. Form a quadratic inequality in x .
- c. By solving your inequalities, find the set of possible values of x .

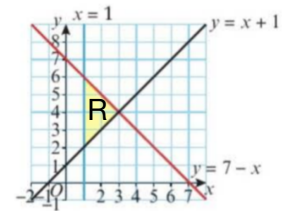


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APPRENTICE

The sketch shows the graphs of the lines $x = 1$, $y = x + 1$ and $y = 7 - x$

- Find the coordinates of the points of intersection of these lines
- Write down a set of inequalities that represent the shaded region R shown in the sketch



EXPERT

On coordinate axes, sketch the region satisfied by the following inequalities:

$$x \geq -1$$

$$y + x < 4$$

$$2x + y \leq 5$$

$$y > -2$$

MASTER

- On coordinate axes, shade the region satisfying the inequalities

$$x \geq -1 \quad y + x < 4 \quad 2x + y \leq 5 \quad y > -2$$

- Which of the vertices of the shaded region lie inside the region identified by the inequalities?
- Find the area of the shaded region