UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
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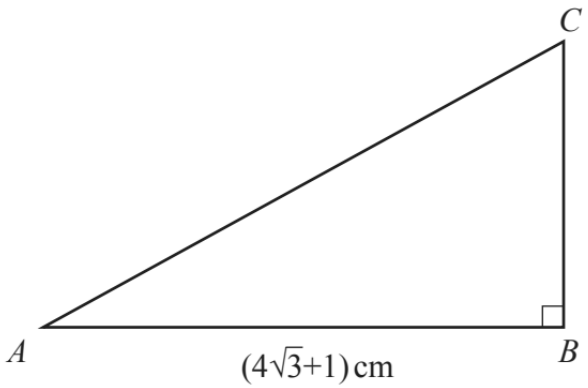
ADDITIONAL MATHEMATICS **0606/11**
INDICES and SURDS

Nov 2015 P13 - Qu 4

You are not allowed to use a calculator in this question.



The diagram shows triangle ABC with side $AB = (4\sqrt{3} + 1)$ cm. Angle B is a right angle. It is given that the area of this triangle is $\frac{47}{2}$ cm^2.

(i) Find the length of the side BC in the form $(a\sqrt{3} + b)$ cm, where a and b are integers. [3]

(ii) Hence find the length of the side AC in the form $p\sqrt{2}$ cm, where p is an integer. [2]

Nov 2015 P13 - Qu 12

(a) Given that $2^{2x-1} \times 4^{x+y} = 128$ and $\frac{9^{2y-x}}{27^{y-4}} = 1$, find the value of each of the integers x and y. [4]

(b) Solve $2(5)^{2z} + 5^z - 1 = 0$. [4]

Nov 2015 P23 - Qu 4

Solve the following simultaneous equations, giving your answers for both x and y in the form $a + b\sqrt{3}$, where a and b are integers.

$$2x + y = 9$$

$$\sqrt{3}x + 2y = 5$$ [5]

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ADDITIONAL MATHEMATICS **0606/11**
QUADRATICS

Nov 2015 P11 - Qu 1

Find the range of values of k for which the equation $kx^2 + k = 8x - 2xk$ has 2 real distinct roots. [4]

Nov 2015 P13 - Qu 11

The line $x - y + 2 = 0$ intersects the curve $2x^2 - y^2 + 2x + 1 = 0$ at the points A and B. The perpendicular bisector of the line AB intersects the curve at the points C and D. Find the length of the line CD in the form $a\sqrt{5}$, where a is an integer. [10]

Nov 2015 P23 - Qu 2

Find the values of k for which the line $y = 2x + k + 2$ cuts the curve $y = 2x^2 + (k+2)x + 8$ in two distinct points. [6]

Nov 2015 P23 - Qu 2

Given that $\mathrm{f}(x) = 3x^2 + 12x + 2$,

(i) find values of a, b and c such that $\mathrm{f}(x) = a(x+b)^2 + c$, [3]

(ii) state the minimum value of $\mathrm{f}(x)$ and the value of x at which it occurs, [2]

(iii) solve $\mathrm{f}\left(\frac{1}{y}\right) = 0$, giving each answer for y correct to 2 decimal places. [3]

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ADDITIONAL MATHEMATICS **0606/11**

REMAINDER THEOREM

Nov 2015 P21 - Qu 1

It is given that $f(x) = 4x^3 - 4x^2 - 15x + 18$.

(i) Show that $x + 2$ is a factor of $f(x)$. [1]

(ii) Hence factorise $f(x)$ completely and solve the equation $f(x) = 0$. [4]

Nov 2015 P23 - Qu 5

The roots of the equation $x^3 + ax^2 + bx + c = 0$ are 1, 3 and 3. Show that $c = -9$ and find the value of a and of b. [4]

ADDITIONAL MATHEMATICS **0606/11**
SETS

Nov 2015 P11 - Qu 6

It is given that $\mathscr{E} = \{x : 1 \leqslant x \leqslant 12, \text{where } x \text{ is an integer}\}$ and that sets A, B, C and D are such that

$A = \{\text{multiples of } 3\}$,

$B = \{\text{prime numbers}\}$,

$C = \{\text{odd integers}\}$,

$D = \{\text{even integers}\}$.

Write down the following sets in terms of their elements.

(i) $A \cap B$ [1]

(ii) $A \cup C$ [1]

(iii) $A' \cap C$ [1]

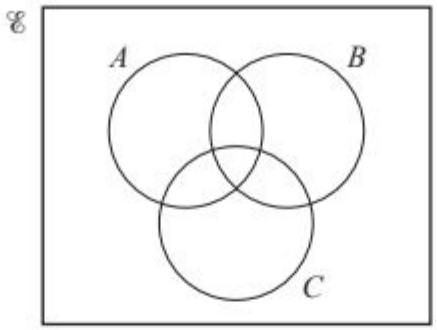
(iv) $(D \cup B)'$ [1]

(v) Write down a set E such that $E \subset D$. [1]

Nov 2015 P13 - Qu 1

On the Venn diagrams below, shade the regions indicated.

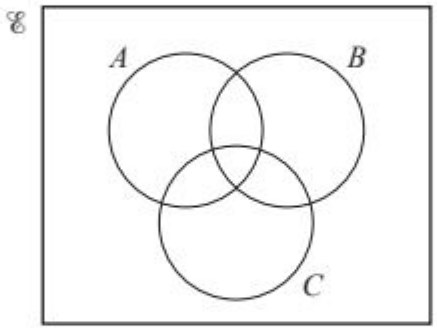
(i)



$A \cap (B \cup C)$

[1]

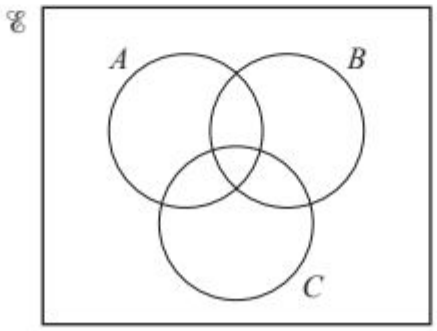
(ii)



$A \cup (B \cap C)$

[1]

(iii)



$(A \cup B)' \cap C$

[1]

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ADDITIONAL MATHEMATICS **0606/11**

BINOMIAL THEOREM

Nov 2015 P13 - Qu 8

(a) Given that the first 4 terms in the expansion of $(2+kx)^8$ are $256+256x+px^2+qx^3$, find the value of k, of p and of q. [3]

(b) Find the term that is independent of x in the expansion of $\left(x-\frac{2}{x^2}\right)^9$. [3]

Nov 2015 P21 - Qu 2

(i) Find, in the simplest form, the first 3 terms of the expansion of $(2-3x)^6$, in ascending powers of x. [3]

(ii) Find the coefficient of x^2 in the expansion of $(1+2x)(2-3x)^6$. [2]

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ADDITIONAL MATHEMATICS **0606/11**
CALCULUS

Nov 2015 P11 - Qu 2

A curve, showing the relationship between two variables x and y, passes through the point $P(-1, 3)$.

The curve has a gradient of 2 at P. Given that $\frac{d^2y}{dx^2} = -5$, find the equation of the curve. [4]

Nov 2015 P11 - Qu 5

Variables x and y are such that $y = (x-3)\ln(2x^2+1)$.

(i) Find the value of $\frac{dy}{dx}$ when $x = 2$. [4]

(ii) Hence find the approximate change in y when x changes from 2 to 2.03. [2]

Nov 2015 P11 - Qu 8

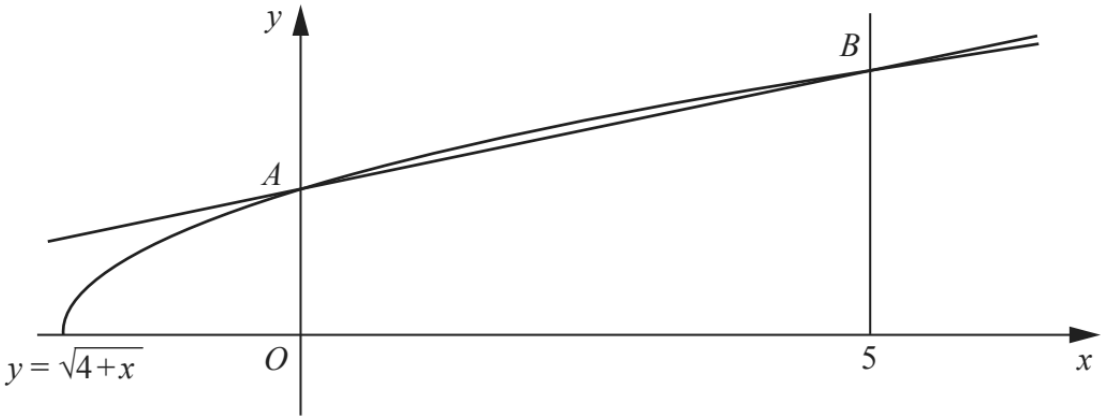
Find the equation of the tangent to the curve $y = \frac{2x-1}{\sqrt{x^2+5}}$ at the point where $x = 2$. [7]

Nov 2015 P11 - Qu 9

You are not allowed to use a calculator in this question.

(i) Find $\int \sqrt{4+x}\,dx$. [2]

(ii)



The diagram shows the graph of $y = \sqrt{4+x}$, which meets the y-axis at the point A and the line $x = 5$ at the point B. Using your answer to part **(i)**, find the area of the region enclosed by the curve and the straight line AB. [5]

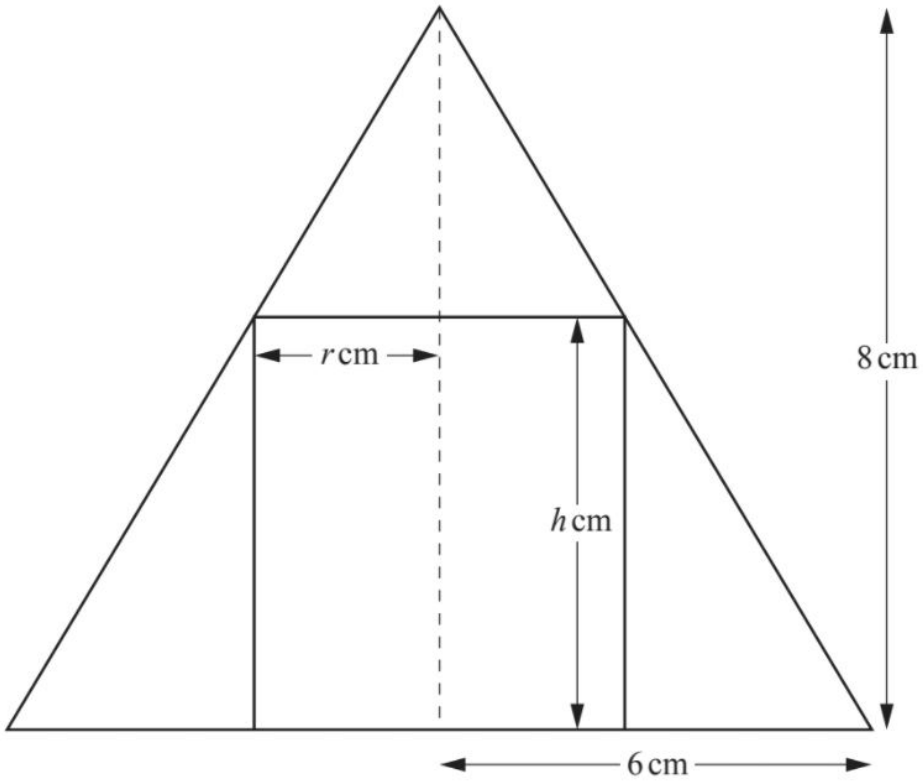
Nov 2015 P13 - Qu 5

Find the equation of the normal to the curve $y = 5\tan x - 3$ at the point where $x = \frac{\pi}{4}$. [5]

Nov 2015 P13 - Qu 7

A curve, showing the relationship between two variables x and y, is such that $\frac{d^2y}{dx^2} = 6\cos 3x$. Given that the curve has a gradient of $4\sqrt{3}$ at the point $\left(\frac{\pi}{9}, -\frac{1}{3}\right)$, find the equation of the curve. [6]

Nov 2015 P21 - Qu 7



A cone, of height 8 cm and base radius 6 cm, is placed over a cylinder of radius r cm and height h cm and is in contact with the cylinder along the cylinder's upper rim. The arrangement is symmetrical and the diagram shows a vertical cross-section through the vertex of the cone.

(i) Use similar triangles to express h in terms of r. [2]

(ii) Hence show that the volume, V cm^3, of the cylinder is given by $V = 8\pi r^2 - \frac{4}{3}\pi r^3$. [1]

(iii) Given that r can vary, find the value of r which gives a stationary value of V. Find this stationary value of V in terms of π and determine its nature. [6]

Nov 2015 P23 - Qu 1

Find the equation of the tangent to the curve $y = x^3 + 3x^2 - 5x - 7$ at the point where $x = 2$. [5]

Nov 2015 P23 - Qu 3

(a) Given that $y = \dfrac{x^3}{2-x^2}$, find $\dfrac{\mathrm{d}y}{\mathrm{d}x}$. [3]

(b) Given that $y = x\sqrt{4x+6}$, show that $\dfrac{\mathrm{d}y}{\mathrm{d}x} = \dfrac{k(x+1)}{\sqrt{4x+6}}$ and state the value of k. [3]

Nov 2015 P23 - Qu 10

(i) Given that $\dfrac{\mathrm{d}}{\mathrm{d}x}(\mathrm{e}^{2-x^2}) = kx\mathrm{e}^{2-x^2}$, state the value of k. [1]

(ii) Using your result from part **(i)**, find $\int 3x\mathrm{e}^{2-x^2}\,\mathrm{d}x$. [2]

(iii) Hence find the area enclosed by the curve $y = 3x\mathrm{e}^{2-x^2}$, the x-axis and the lines $x = 1$ and $x = \sqrt{2}$. [2]

(iv) Find the coordinates of the stationary points on the curve $y = 3x\mathrm{e}^{2-x^2}$. [4]

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ADDITIONAL MATHEMATICS **0606/11**
COORDINATE GEOMETRY

Nov 2015 P11 - Qu 12

The line $2x - y + 1 = 0$ meets the curve $x^2 + 3y = 19$ at the points A and B. The perpendicular bisector of the line AB meets the x-axis at the point C. Find the area of the triangle ABC. [9]

Nov 2015 P21 - Qu 8

Solutions to this question by accurate drawing will not be accepted.

Two points A and B have coordinates $(-3, 2)$ and $(9, 8)$ respectively.

(i) Find the coordinates of C, the point where the line AB cuts the y-axis. [3]

(ii) Find the coordinates of D, the mid-point of AB. [1]

(iii) Find the equation of the perpendicular bisector of AB. [2]

The perpendicular bisector of AB cuts the y-axis at the point E.

(iv) Find the coordinates of E. [1]

(v) Show that the area of triangle ABE is four times the area of triangle ECD. [3]

ADDITIONAL MATHEMATICS **0606/11**
EXPONENTIALS and LOGARITHMS

Nov 2015 P11 - Qu 7

Two variables, x and y, are such that $y = Ax^b$, where A and b are constants. When $\ln y$ is plotted against $\ln x$, a straight line graph is obtained which passes through the points $(1.4, 5.8)$ and $(2.2, 6.0)$.

(i) Find the value of A and of b. [4]

(ii) Calculate the value of y when $x = 5$. [2]

Nov 2015 P21 - Qu 5

(a) Solve the following equations to find p and q.

$$8^{q-1} \times 2^{2p+1} = 4^7$$
$$9^{p-4} \times 3^q = 81$$ [4]

(b) Solve the equation $\lg(3x-2) + \lg(x+1) = 2 - \lg 2$. [5]

Nov 2015 P23 - Qu 6

Solve the following equation.

$$\log_2(29x - 15) = 3 + \frac{2}{\log_x 2}$$ [5]

Nov 2015 P23 - Qu 11

The trees in a certain forest are dying because of an unknown virus.

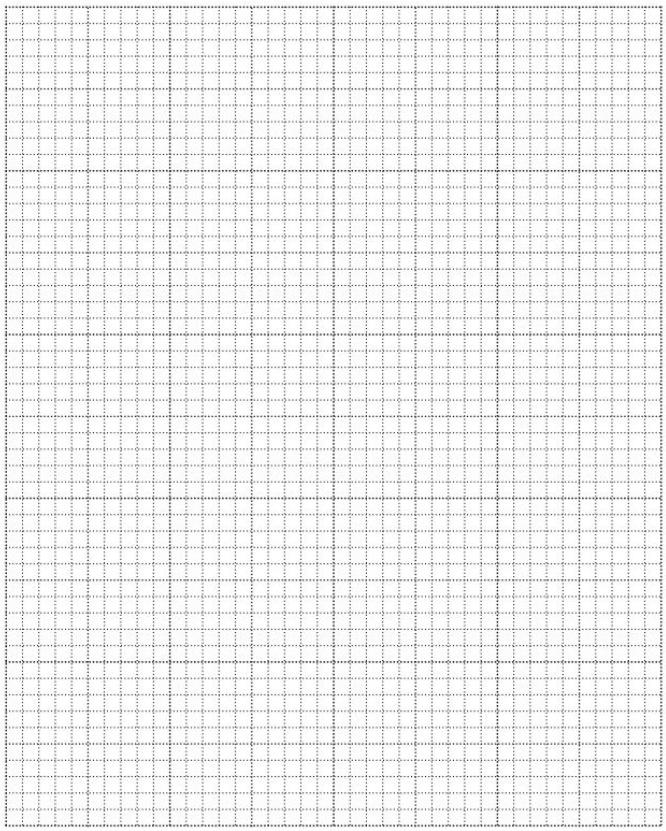
The number of trees, N, surviving t years after the onset of the virus is shown in the table below.

t	1	2	3	4	5	6
N	2000	1300	890	590	395	260

The relationship between N and t is thought to be of the form $N = Ab^{-t}$.

(i) Transform this relationship into straight line form. [1]

(ii) Using the given data, draw this straight line on the grid below. [3]



(iii) Use your graph to estimate the value of A and of b. [3]

If the trees continue to die in the same way, find

(iv) the number of trees surviving after 10 years, [1]

(v) the number of years taken until there are only 10 trees surviving. [2]

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ADDITIONAL MATHEMATICS **0606/11**

FUNCTIONS (incl MODULUS FUNCTIONS)

Nov 2015 P11 - Qu 11

(a) A function f is such that $\mathrm{f}(x) = x^2 + 6x + 4$ for $x \geqslant 0$.

(i) Show that $x^2 + 6x + 4$ can be written in the form $(x + a)^2 + b$, where a and b are integers. [2]

(ii) Write down the range of f. [1]

(iii) Find f^{-1} and state its domain. [3]

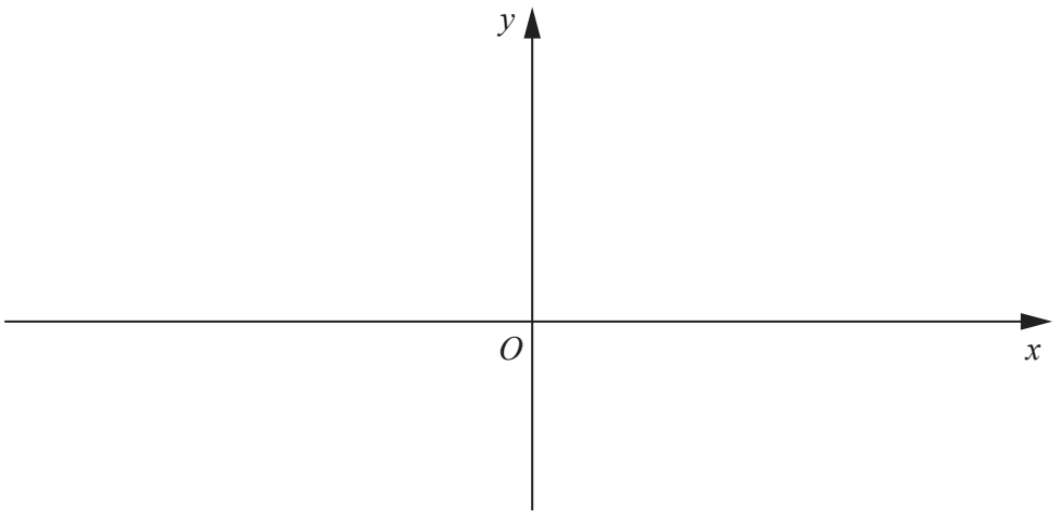
(b) Functions g and h are such that, for $x \in \mathbb{R}$,

$$\mathrm{g}(x) = \mathrm{e}^x \quad \text{and} \quad \mathrm{h}(x) = 5x + 2.$$

Solve $\mathrm{h}^2\mathrm{g}(x) = 37$. [4]

Nov 2015 P13 - Qu 6

(i) On the axes below, sketch the graph of $y = |x^2 - 4x - 12|$ showing the coordinates of the points where the graph meets the axes. [3]



(ii) Find the coordinates of the stationary point on the curve $y = |x^2 - 4x - 12|$. [2]

(iii) Find the values of k such that the equation $|x^2 - 4x - 12| = k$ has only 2 solutions. [2]

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ADDITIONAL MATHEMATICS **0606/11**
KINEMATICS

Nov 2013 P21 - Qu 10

A particle is moving in a straight line such that its velocity, v ms^{-1}, t seconds after passing a fixed point O is $v = e^{2t} - 6e^{-2t} - 1$.

(i) Find an expression for the displacement, s m, from O of the particle after t seconds. [3]

(ii) Using the substitution $u = e^{2t}$, or otherwise, find the time when the particle is at rest. [3]

(iii) Find the acceleration at this time. [2]

Nov 2013 P23 - Qu 7

The velocity, v ms^{-1}, of a particle travelling in a straight line, t seconds after passing through a fixed point O, is given by $v = \frac{10}{(2+t)^2}$.

(i) Find the acceleration of the particle when $t = 3$. [3]

(ii) Explain why the particle never comes to rest. [1]

(iii) Find an expression for the displacement of the particle from O after time t s. [3]

(iv) Find the distance travelled by the particle between $t = 3$ and $t = 8$. [2]

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ADDITIONAL MATHEMATICS **0606/11**
MATRICES

Nov 2015 P13 - Qu 3

(a) Matrices **A** and **B** are such that $\mathbf{A} = \begin{pmatrix} 2 & 1 \\ 4 & 3 \end{pmatrix}$ and $\mathbf{B} = \begin{pmatrix} 3 & 8 & 1 \\ 6 & 0 & 2 \end{pmatrix}$. Find **AB**. [2]

(b) Given that matrix $\mathbf{X} = \begin{pmatrix} 4 & 6 \\ 2 & -8 \end{pmatrix}$, find the integer value of m and of n such that $\mathbf{X}^2 = m\mathbf{X} + n\mathbf{I}$, where **I** is the identity matrix. [5]

(c) Given that matrix $\mathbf{Y} = \begin{pmatrix} a & 2 \\ 3 & a \end{pmatrix}$, find the values of a for which det **Y** = 0. [2]

Nov 2015 P21 - Qu 4

(a) Given that $\mathbf{A} = \begin{pmatrix} 2 & -1 \\ 3 & 5 \\ 7 & 4 \end{pmatrix}$ and $\mathbf{B} = \begin{pmatrix} 1 & -2 & 4 \\ -2 & 3 & 0 \end{pmatrix}$, calculate **2BA**. [3]

(b) The matrices **C** and **D** are given by $\mathbf{C} = \begin{pmatrix} 1 & 2 \\ -1 & 6 \end{pmatrix}$ and $\mathbf{D} = \begin{pmatrix} 3 & -2 \\ 1 & 4 \end{pmatrix}$.

(i) Find $\mathbf{C}^{-1}$. [2]

(ii) Hence find the matrix **X** such that $\mathbf{CX} + \mathbf{D} = \mathbf{I}$, where **I** is the identity matrix. [3]

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ADDITIONAL MATHEMATICS **0606/11**
PERMUTATIONS and COMBINATIONS

Nov 2015 P11 - Qu 4

(a) 6 books are to be chosen from 8 different books.

(i) Find the number of different selections of 6 books that could be made. [1]

A clock is to be displayed on a shelf with 3 of the 8 different books on each side of it. Find the number of ways this can be done if

(ii) there are no restrictions on the choice of books, [1]

(iii) 3 of the 8 books are music books which have to be kept together. [2]

(b) A team of 6 tennis players is to be chosen from 10 tennis players consisting of 7 men and 3 women. Find the number of different teams that could be chosen if the team must include at least 1 woman. [3]

Nov 2015 P13 - Qu 9

(a) Five different books are to be arranged on a shelf. There are 2 Mathematics books and 3 History books. Find the number of different arrangements of books if

(i) the Mathematics books are next to each other, [2]

(ii) the Mathematics books are not next to each other. [2]

(b) To compete in a quiz, a team of 5 is to be chosen from a group of 9 men and 6 women. Find the number of different teams that can be chosen if

(i) there are no restrictions, [1]

(ii) at least two men must be on the team. [3]

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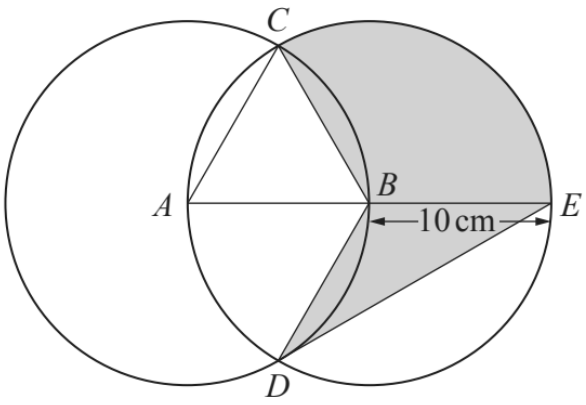
ADDITIONAL MATHEMATICS **0606/11**
RADIAN MEASURE

Nov 2015 P11 - Qu 10



The diagram shows two circles, centres A and B, each of radius 10 cm. The point B lies on the circumference of the circle with centre A. The two circles intersect at the points C and D. The point E lies on the circumference of the circle centre B such that ABE is a diameter.

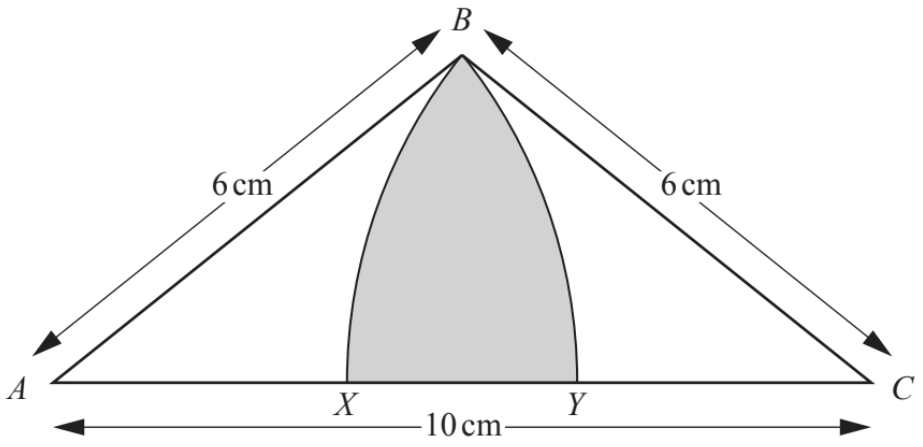
(i) Explain why triangle ABC is equilateral. [1]

(ii) Write down, in terms of π, angle CBE. [1]

(iii) Find the perimeter of the shaded region. [5]

(iv) Find the area of the shaded region. [3]

Nov 2015 P13 - Qu 10



The diagram shows an isosceles triangle ABC such that $AC = 10$ cm and $AB = BC = 6$ cm. BX is an arc of a circle, centre C, and BY is an arc of a circle, centre A.

(i) Show that angle $ABC = 1.970$ radians, correct to 3 decimal places. [2]

(ii) Find the perimeter of the shaded region. [4]

(iii) Find the area of the shaded region. [3]

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ADDITIONAL MATHEMATICS **0606/11**
TRIGONOMETRY

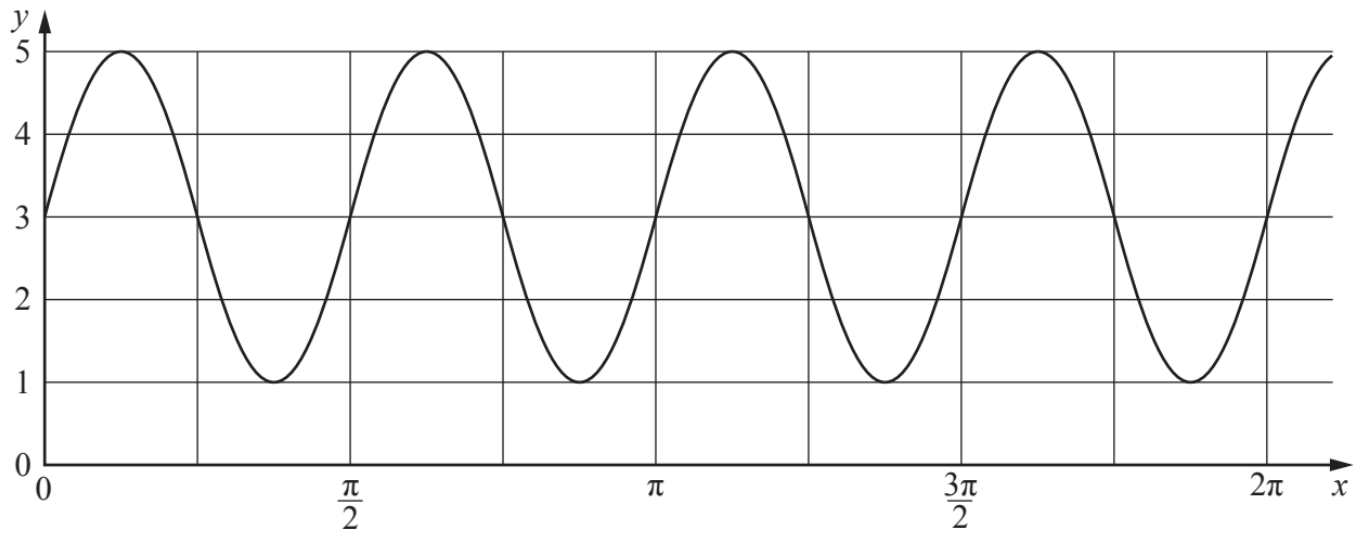
Nov 2015 P11 - Qu 3

Show that $\sqrt{\sec^2\theta - 1} + \sqrt{\operatorname{cosec}^2\theta - 1} = \sec\theta \operatorname{cosec}\theta$. [5]

Nov 2015 P13 - Qu 2

Solve $2\cos^2\left(3x - \frac{\pi}{4}\right) = 1$ for $0 \leqslant x \leqslant \frac{\pi}{3}$. [4]

Nov 2015 P21 - Qu 6



The figure shows part of the graph of $y = a + b\sin cx$.

(i) Find the value of each of the integers a, b and c. [3]

Using your values of a, b and c find

(ii) $\frac{dy}{dx}$, [2]

(iii) the equation of the normal to the curve at $\left(\frac{\pi}{2}, 3\right)$. [3]

Nov 2015 P21 - Qu 9

Solve the following equations.

(i) $4\sin 2x + 5\cos 2x = 0$ for $0° \leqslant x \leqslant 180°$ [3]

(ii) $\cot^2 y + 3\,\text{cosec}\, y = 3$ for $0° \leqslant y \leqslant 360°$ [5]

(iii) $\cos\left(z + \frac{\pi}{4}\right) = -\frac{1}{2}$ for $0 \leqslant z \leqslant 2\pi$ radians, giving each answer as a multiple of π [4]

Nov 2015 P23 - Qu 8

(i) Prove that $\sec^2 x + \text{cosec}^2 x = \sec^2 x\,\text{cosec}^2 x$. [4]

(ii) Hence, or otherwise, solve $\sec^2 x + \text{cosec}^2 x = 4\tan^2 x$ for $90° < x < 270°$. [4]

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ADDITIONAL MATHEMATICS **0606/11**
VECTORS

Nov 2015 P21 - Qu 3

Relative to an origin O, points A, B and C have position vectors $\begin{pmatrix}5\\4\end{pmatrix}$, $\begin{pmatrix}-10\\12\end{pmatrix}$ and $\begin{pmatrix}6\\-18\end{pmatrix}$ respectively. All distances are measured in kilometres. A man drives at a constant speed directly from A to B in 20 minutes.

(i) Calculate the speed in kmh^{-1} at which the man drives from A to B. [3]

He now drives directly from B to C at the same speed.

(ii) Find how long it takes him to drive from B to C. [3]

Nov 2015 P23 - Qu 12

A plane that can travel at $250\,\text{kmh}^{-1}$ in still air sets off on a bearing of 070°. A wind with speed $w\,\text{kmh}^{-1}$ from the south blows the plane off course so that the plane actually travels on a bearing of 060°.

Find, in kmh^{-1}, the resultant speed V of the plane and the windspeed w. [5]