General Certificate of Education Ordinary Level
JUYING SECONDARY SCHOOL, SINGAPORE
Secondary Four Express/Five Normal Academic
Preliminary Examination

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| CANDIDATE NAME | | | | | | | | | |
| CENTRE NUMBER | S | | | | | INDEX NUMBER | | | | |

# ADDITIONAL MATHEMATICS

**4049/02**

Paper 2

**27 August 2024**

**2 hours 15 minutes**

Candidates answer on the Question Paper.

**READ THESE INSTRUCTIONS FIRST**

Write your Centre number, index number and name on all the work you hand in.
Write in dark blue or black pen.
You may use a pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions.
The number of marks is given in brackets [ ] at the end of each question or part question.

If working is needed in any question it must be shown with the answer.
Omission of essential working will result in loss of marks.
The total number of marks for this paper is 90.

The use of an approved scientific calculator is expected, where appropriate.
If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.
For $\pi$, use either your calculator value or 3.142.

This document consists of **18** printed pages.

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Vetted by: Mdm Norhafiani Bte Abdul Majid



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***Mathematical Formulae***

## 1. ALGEBRA

*Quadratic Equation*

For the equation $ax^2 + bx + c = 0$,

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

*Binomial expansion*

$$(a + b)^n = a^n + \binom{n}{1} a^{n-1} b + \binom{n}{2} a^{n-2} b^2 + \ldots + \binom{n}{r} a^{n-r} b^r + \ldots + b^n,$$

where $n$ is a positive integer and $\binom{n}{r} = \frac{n!}{r!(n-r)!} = \frac{n(n-1)\ldots(n-r+1)}{r!}$

## 2. TRIGONOMETRY

*Identities*

$$\sin^2 A + \cos^2 A = 1$$

$$\sec^2 A = 1 + \tan^2 A$$

$$\operatorname{cosec}^2 A = 1 + \cot^2 A$$

$$\sin(A \pm B) = \sin A \cos B \pm \cos A \sin B$$

$$\cos(A \pm B) = \cos A \cos B \mp \sin A \sin B$$

$$\tan(A \pm B) = \frac{\tan A \pm \tan B}{1 \mp \tan A \tan B}$$

$$\sin 2A = 2 \sin A \cos A$$

$$\cos 2A = \cos^2 A - \sin^2 A = 2\cos^2 A - 1 = 1 - 2\sin^2 A$$

$$\tan 2A = \frac{2 \tan A}{1 - \tan^2 A}$$

*Formulae for $\Delta ABC$*

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$a^2 = b^2 + c^2 - 2bc \cos A$$

$$\Delta = \frac{1}{2} ab \sin C$$



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Answer **ALL** the questions

**1** **(a)** Express $3x^2 - 8x - 3$ in the form $a(x + b)^2 + c$, where $a, b$ and $c$ are constants to be determined. [3]

**(b)** Hence, find the turning point and the value of $x$ where it occurs. [2]



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**2** **(a)** Write down and simplify the first three terms in the expansion, in ascending powers of $x$, of $\left(2+\frac{x}{2}\right)^n$, where $n$ is a positive integer. [3]

**(b)** The first two terms in the expansion, in ascending powers of $x$, of $\left(\frac{4}{3}-3x\right)\left(2+\frac{x}{2}\right)^n$ are $a + bx^2$. Find the value of $n$. [3]

**(c)** Find the term independent of $x$ in the expansion of $\left(x-\frac{1}{2x^2}\right)^9$. [3]



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**3** Radiocarbon dating, or carbon-14 dating, is a scientific method that can accurately determine the age of organic materials as old as approximately 60,000 years. The technique is based on the decay of the carbon-14 isotope. The time in which half of the original number of atom decay is defined as the half-life. It is modelled by the equation $N = N_0 e^{-kt}$, where $k$ is a constant and $t$ is the time in years. $N_0$ is the initial amount of material in an object.

Carbon-14 has a half life of 5730 years, meaning that 5730 years after an organism dies, half of its carbon-14 atoms have decayed.

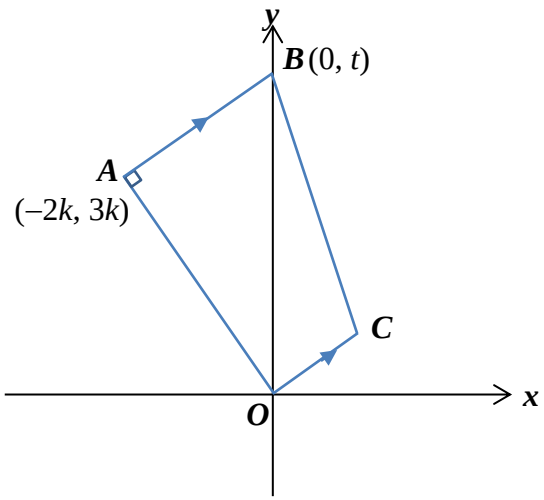
**(a)** Find the value of $k$. [2]

**(b)** A mummified body was found to have 8% of its original atoms left. How many years ago did the person die? Leave your answer to the nearest whole number. [2]



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




*OABC* is a trapezium with right angle *OAB*. The coordinates of *A* and *B* are $(-2k, 3k)$ and $(0, t)$ respectively, where $k > 0$, and $OA = \sqrt{117}$ units. Find

**(a)** the value of $k$ and show that $A$ is $(-6, 9)$, [2]

**(b)** the equation of $AB$, [3]



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**(c)** the coordinates of $C$ if $OC = \frac{1}{2}AB$, [1]

**(d)** the area of $OABC$. [2]

Triangle $OAB$ lies in a circle $C$.

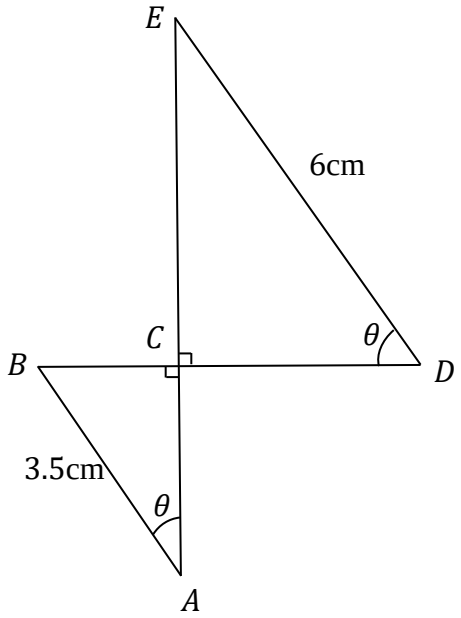
**(e)** Explain if $OB$ is the diameter of the circle. [1]

**(f)** Find the equation of the circle $C$. [3]



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**5** The diagram shows two right-angled triangles, *ABC* and *DEC*. $\angle BAC = \angle CDE = \theta$, *AB* = 3.5 cm and *DE* = 6 cm.




**(a)** Show that $BD = 6\cos\theta + 3.5\sin\theta$. [2]

**(b)** Express *BD* in the form $R\cos(\theta - \alpha)$, where $R > 0$ and $\alpha$ is an acute angle. [3]

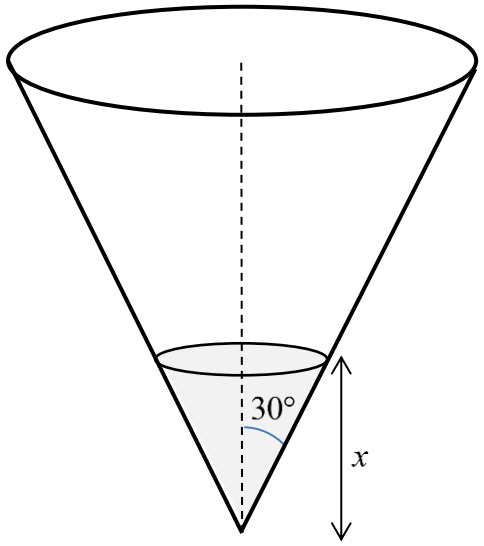
**(c)** State the maximum length of *BD* and the corresponding value of $\theta$. [2]



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**(d)** Find the value of $\theta$ when $BD = 6$ cm. [2]

**6** A conical vessel, whose vertical angle is $30°$ as shown in the diagram, has water poured into it at such a rate that after $t$ seconds, the depth of the water is $x$ cm and the radius of the water surface is $r$ cm.




**(a)** Show that the volume of water, $V = \frac{\pi x^3}{9}$ cm$^3$. [3]



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**(b)** Given further that the volume of water, $V = 8t$, find the rate of which the water level is increasing after 3 seconds. [5]



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**7** Show that $2^{n+5} + 2^{n+3} + 81(2^n)$ is a multiple of 11. [3]

**8.** Evaluate $\int_0^{\frac{\pi}{3}} \left(\frac{1}{2}\sin 3x - \cos^2 x\right)\, dx$, correct to 2 decimal places. [4]



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**9.** A particle moves in a straight line and its initial velocity is 21 cm/s. After $t$ seconds, its acceleration, $a$ cm/s$^2$, is given by $a = 2t - 10$. When $t = 0$, its displacement, $s$ cm, from a fixed point $O$ is 4 cm.

Find the distance travelled by the particle during the first 7 seconds. [8]



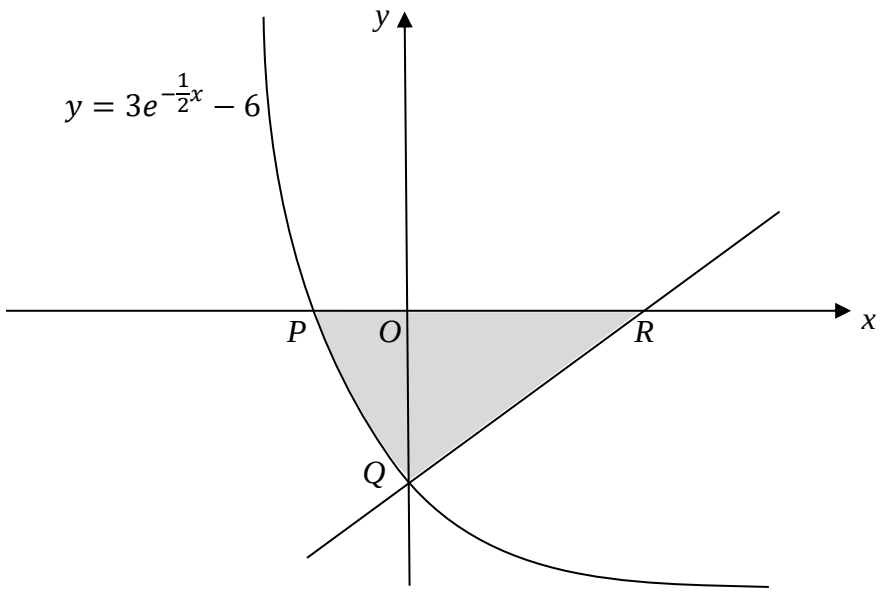
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**10.**




The diagram shows part of the curve $y = 3e^{-\frac{1}{2}x} - 6$ which crosses the *x*-axis at *P* and the *y*-axis at *Q*. The normal to the curve at *Q* meets the *x*-axis at *R*. Find

**(a)** the equation of the normal, [4]



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**(b)** the area of the shaded region. [6]



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**11.** The function $f$ is defined, for $0 \leq x \leq 2\pi$, by $f(x) = 1 - 2\cos 2x$.

**(a)** State the period and amplitude of $f$. [2]

**(b)** Sketch the graph of $y = f(x)$ for $0 \leq x \leq 2\pi$. [3]




**(c)** On the same diagram in part **(b)**, sketch the graph of $y = \frac{4x}{\pi} - 2$. [1]

**(d)** Hence, state the number of solutions, $0 \leq x \leq 2\pi$, to the equation

$2\cos 2x - 3 + \frac{4x}{\pi} = 0$. [1]



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**12.** The gradient function of a curve is given by $\frac{dy}{dx} = -\frac{1}{x^2} + 6\cos 3x$. The coordinates of the point $P$, which lies on the curve, is $\left(\frac{\pi}{2}, \pi\right)$. A point $Q$ exists such that the mid-point of $PQ$ is $\left(\frac{3}{4}\pi, 2\pi\right)$. Find

**(a)** the coordinates of the point $Q$, [3]

**(b)** the equation of the curve. [2]



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**13.** Without using the calculator, simplify the following trigonometric functions.

**(a)** $\sin\left(x + \frac{4\pi}{3}\right)$ [2]

**(b)** $\cos 75°$ [2]

**(c)** $\tan(\theta - 45°)$ [2]



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