# ELGIN ACADEMY

*Prelim Examination 2008 / 2009*
*(Assessing Units 1 & 2)*

## MATHEMATICS

### Advanced Higher Grade

**Time allowed - 2 hours**

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**Read Carefully**

1. Calculators may be used in this paper.
2. Candidates should answer **all** questions
3. **Full credit will only be given where the solution contains appropriate working**

**All questions should be attempted**

**1.** Given $x = \sin^{-1} t,\ \ y = \ln t$ where $0 < t < 1$, use parametric differentiation to obtain $\frac{dy}{dx}$ in terms of $t$. Simplify your answer. **3**

**2.** Find the coefficient of $x^{-4}$ in the expansion of $\left(\frac{x^2}{2} - \frac{4}{x^3}\right)^8$. **5**

**3.** Find partial fractions for $\frac{2x^2+6x+36}{(x^2+9)(x+3)}$ . **4**

**4.** Express $z = \frac{5i}{1+2i}$ in the form $a + ib$ where $a$ and $b$ are real numbers. **2**

Verify that $z$ is a solution of the equation $z^4 - 4z^3 + 6z^2 - 4z + 5 = 0$ and find the other three roots. **4**

**5.** Prove by induction that $8^n - 7n + 6$ is divisible by 7 for all natural numbers $n$. **5**

**6.** A curve is defined by the equation $x^3y^2 - 2xy + 8 = 0$, $x < 0$ and $y < 0$.

Use implicit differentiation to find $\frac{dy}{dx}$. **3**

Hence find the equation of the tangent to the curve at the point where $x = -1$. **3**

**7.** (*a*) Evaluate $\sum_{r=1}^{3} 16 \times \left(\frac{3}{4}\right)^{r-1}$. **2**

(*b*) Explain why the sum to infinity of the geometric series 16 + 12 + 9 + … exists and find this sum. **3**

**8.** Use Gaussian elimination to solve the system of equations

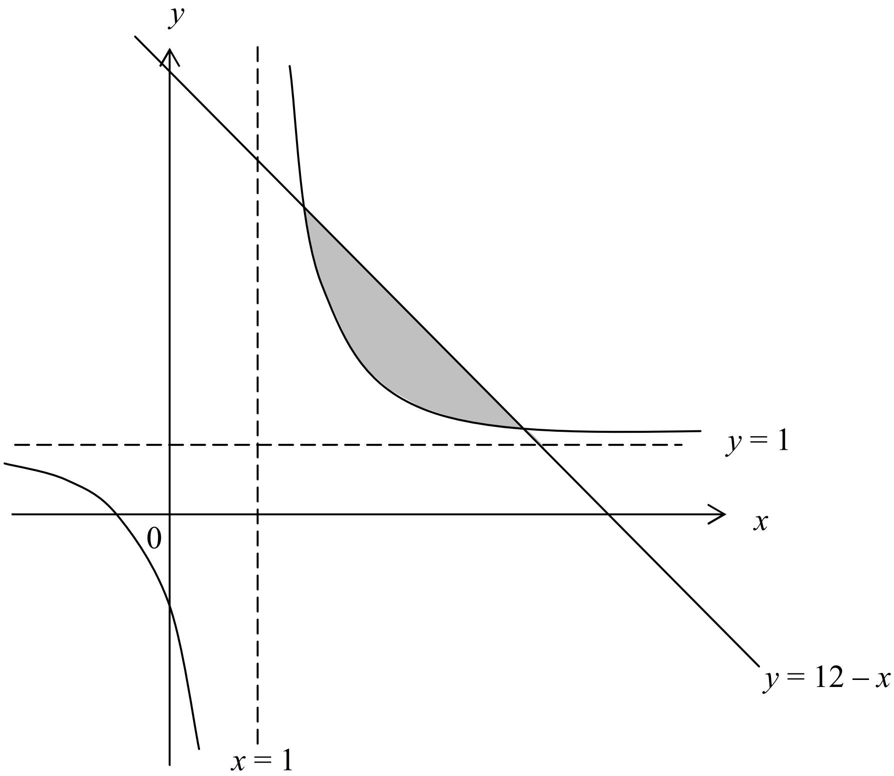
$$\begin{aligned} 2x - 7y + 10z &= -1 \\ x - 3y + 4z &= 2 \\ 5x - 18y + 26z &= -6. \end{aligned}$$

**5**

**9.** (*a*) Express $\frac{x+8}{x-1}$ in the form $A + \frac{B}{x-1}$. **2**

(*b*) The diagram below shows the curve with equation $y = \frac{x+8}{x-1}$ and the line with equation $y = 12 - x$.

Show that the shaded area can be written as $40 - \ln 9^9$. **6**




**10.** $I = \int_0^2 e^{\sqrt{4x+1}}\,dx.$

(*a*) Use the substitution $u = \sqrt{4x+1}$ to express $I$ in the form $\int_a^b \frac{1}{k} u e^u \, du$, where $a$, $b$ and $k$ are integers. **3**

(*b*) Use integration by parts to evaluate the integral found in (*a*). **5**

**11.** The function $g$ is given by $g(x) = e^{2x} \sin 2x$.

(*a*) Determine whether $g$ is odd, even or neither. **2**

(*b*) Find the coordinates of the stationary point of $g$ in the interval $0 < x < \frac{\pi}{2}$. **5**

(*c*) Obtain a formula for $y = g''(x)$. **1**

(*d*) Use your answer to (*c*) to determine the nature of the stationary point found in (*b*). **2**

**12.** Let $z = \cos\theta + i \sin\theta$.

(*a*) Use de Moivre's theorem to express $z^3$ in terms of $3\theta$. **1**

(*b*) Use the binomial theorem to express $z^3$ in terms of $\sin\theta$ and $\cos\theta$. **2**

(*c*) Hence express

(i) $\cos 3\theta$ in terms of $\cos\theta$

(ii) $\sin 3\theta$ in terms of $\sin\theta$. **2,2**

(*d*) Use your answers to (*c*)(i) and (*c*)(ii) to show that

$$\cot 3\theta = \frac{1 - 3\tan^2\theta}{3\tan\theta - \tan^3\theta}.$$ **4**

[ END OF QUESTION PAPER ]