MARKING GUIDELINE

MARKS	DURATION	QUESTIONS
33	50 minutes	3

Name: ..... Class: .....

Date: .....

MARK ____ / 33

INSTRUCTIONS AND INFORMATION

1. Answer **ALL** the questions in this question paper.
2. Answer QUESTION 1 by **circling** the letter (A–D) in the answer grid at the end of that section.
3. Show **ALL** calculations clearly.
4. Show all units where applicable.
5. Number the answers correctly according to the numbering system used in this question paper.
6. A non-programmable calculator may be used, unless stated otherwise.
7. Write neatly and legibly.

QUESTION 1 [10 MARKS]

Four options are given as possible answers to the following questions. Choose the correct answer and circle the letter (A–D) in the grid at the end of this section. If you want to change your choice, put a cross through the wrong letter and circle your new choice.

1.1 The DISCRIMINANT of $ax^2 + bx + c = 0$ is ... (1)

A) $\sqrt{b^2 - 4ac}$ **B)** $b^2 + 4ac$

C) $-b^2 - 4ac$ **D)** $\boldsymbol{b^2 - 4ac}$ ✓

> **Answer: D** — $\Delta = b^2 - 4ac$ — the expression under the root in the quadratic formula.
>
> - **A** — the discriminant is that expression itself, not its square root
> - **B** — the sign is a MINUS, not a plus
> - **C** — the $-b$ belongs outside the root, not inside it

1.2 If $\Delta > 0$ AND Δ is a perfect square, the roots are ... (1)

A) real and equal **B)** **real, rational and unequal** ✓

C) non-real **D)** real, irrational and unequal

> **Answer: B** — A perfect-square discriminant has a whole-number square root, so the roots come out rational.
>
> - **A** — equal roots need $\Delta = 0$
> - **C** — non-real roots need $\Delta < 0$
> - **D** — irrational roots come from a discriminant that is positive but NOT a perfect square

1.3 If $\Delta = 0$, the roots are ... (1)

A) one real and one non-real
B) non-real
C) real and unequal
D) real and equal ✓

> **Answer: D** — With $\Delta = 0$ the $\pm\sqrt{\Delta}$ term vanishes, leaving one repeated root.
> - **A** — the roots of a real quadratic are either both real or both non-real
> - **B** — non-real roots need $\Delta < 0$
> - **C** — unequal roots need $\Delta > 0$

1.4 For $x^2 - 6x + 9 = 0$, the roots are ... (1)

A) non-real
B) rational and unequal
C) real and equal ✓
D) real and unequal

> **Answer: C** — $\Delta = (-6)^2 - 4(1)(9) = 36 - 36 = 0$.
> - **A** — $\Delta = 0$, which is not negative
> - **B** — $\Delta = 0$ gives ONE repeated root, so the roots are equal
> - **D** — $\Delta = 0$, which is not greater than 0

1.5 For $2x^2 + 3x + 5 = 0$, the roots are ... (1)

A) non-real ✓
B) real and rational
C) real and equal
D) real and irrational

> **Answer: A** — $\Delta = 3^2 - 4(2)(5) = 9 - 40 = -31$, which is negative.
> - **B** — a negative discriminant gives no real roots at all
> - **C** — equal roots need $\Delta = 0$, not $\Delta < 0$
> - **D** — a negative discriminant gives no real roots, irrational ones included

1.6 For $x^2 - 5x + 3 = 0$, the roots are ... (1)

A) non-real
B) real and equal
C) real, rational and unequal
D) real, irrational and unequal ✓

> **Answer: D** — $\Delta = 25 - 12 = 13$, which is positive but not a perfect square.
> - **A** — $\Delta = 13$ is positive, so the roots ARE real
> - **B** — equal roots need $\Delta = 0$
> - **C** — 13 is not a perfect square, so the roots are irrational

1.7 For which value(s) of k does $x^2 + kx + 4 = 0$ have EQUAL roots? (1)

A) $k = 4$ or $k = -4$ ✓
B) $k = 4$ only
C) $k = 16$
D) $k = 2$

> **Answer: A** — $\Delta = k^2 - 16 = 0$ gives $k^2 = 16$, so $k = \pm 4$.
> - **B** — $k^2 = 16$ has TWO solutions
> - **C** — forgot to take the square root of 16
> - **D** — square-rooted twice instead of once

1.8 If $\Delta < 0$, the graph of the quadratic ... (1)

A) lies entirely below the x-axis
B) touches the x-axis once
C) does not cut the x-axis ✓
D) cuts the x-axis twice

> **Answer: C** — No real roots means no x-intercepts at all.
> - **A** — it lies wholly on ONE side of the axis, but which side depends on the sign of a
> - **B** — that happens when $\Delta = 0$
> - **D** — that happens when $\Delta > 0$

1.9 For $3x^2 - 12x + 12 = 0$, $\Delta = ...$ (1)

A) 0 ✓
B) 288
C) 144
D) -144

> **Answer: A** — $\Delta = (-12)^2 - 4(3)(12) = 144 - 144 = 0$.
> - **B** — ADDED $4ac$ instead of subtracting it
> - **C** — left out b^2, keeping only $-4ac$
> - **D** — subtracted b^2 from $4ac$ instead of the other way round

1.10 For which values of k does $x^2 + 2x + k = 0$ have REAL roots? (1)

A) $k \geq 1$
B) $k \leq 1$ ✓
C) $k < 1$
D) $k = 1$

> **Answer: B** — $\Delta = 4 - 4k \geq 0$ gives $4 \geq 4k$, so $k \leq 1$.
> - **A** — did not reverse the inequality when moving the k across
> - **C** — $k = 1$ gives $\Delta = 0$, and equal roots ARE real, so 1 is included
> - **D** — that gives equal roots only, not every case of real roots

ANSWER GRID — MARKING GUIDELINE

1.1	A	B	C	(D)
1.2	A	(B)	C	D
1.3	A	B	C	(D)
1.4	A	B	(C)	D
1.5	(A)	B	C	D
1.6	A	B	C	(D)
1.7	(A)	B	C	D
1.8	A	B	(C)	D
1.9	(A)	B	C	D
1.10	A	(B)	C	D

QUESTION 2 [9 MARKS]

Use the discriminant $\Delta = b^2 - 4ac$ to answer the questions below.

2.1 Describe the nature of the roots of $x^2 - 4x + 4 = 0$. (3)

> $\Delta = 16 - 16$ *(2)* $= 0$ *(1)*
> The roots are **real, rational and EQUAL**

2.2 Describe the nature of the roots of $x^2 + 3x + 5 = 0$. **(3)**

> $\Delta = 9 - 20$ *(2)* $= -11$ *(1)*
> $\Delta < 0$, so the roots are **NON-REAL**

2.3 Describe the nature of the roots of $2x^2 - 7x + 3 = 0$. **(3)**

> $\Delta = 49 - 24 = 25$ *(2)*
> $\Delta > 0$ and a perfect square, so the roots are **real, rational and unequal** *(1)*

QUESTION 3 [14 MARKS]

Answer the questions below.

3.1 Determine the value(s) of k for which $kx^2 + 4x + 2 = 0$ has REAL roots. **(5)**

> Real roots means $\Delta \geq 0$ *(1)*
> $16 - 8k \geq 0$ *(2)*
> $k \leq 2$ *(1)*
> $k \neq 0$, or the equation is not quadratic: $\boldsymbol{k \leq 2, k \neq 0}$ *(1)*

3.2 Determine the value(s) of p for which $x^2 + px + 9 = 0$ has equal roots. **(4)**

> $p^2 - 36 = 0$ *(2)*
> $p^2 = 36$ *(1)*
> $\boldsymbol{p = 6}$ **or** $\boldsymbol{p = -6}$ *(1)*

3.3 State what the discriminant tells you about the GRAPH of $y = ax^2 + bx + c$. **(3)**

> $\Delta > 0$: it cuts the x-axis twice *(1)*
> $\Delta = 0$: it touches once *(1)*
> $\Delta < 0$: it never meets the x-axis *(1)*

3.4 Explain the difference between roots that are RATIONAL and roots that are IRRATIONAL. **(2)**

> With a, b and c rational, the roots are rational when Δ is a perfect square *(1)*; otherwise the surd does not simplify and the roots are irrational *(1)*

TOTAL: 33 marks

This question paper consists of 3 questions.

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