Calculator Instructions Guidance for
Pearson Edexcel AS/A level Mathematics

In order to help students know when, and to what extent they are allowed to use their calculators, some questions start with the instruction:

In this question you must show all stages of your working.

followed by either

Solutions relying entirely on calculator technology are not acceptable.

or

Solutions relying on calculator technology are not acceptable.

What does each statement mean?

Solutions relying entirely on calculator technology are not acceptable.

This statement tells candidates that they can use their calculator to assist them with the processing of their solution. This means that calculators may be used in this question, but **not** to solve the problem.

Examples of acceptable calculator use may include:

- evaluation of a numerical expression
- finding the square root of a number
- inverse trigonometry calculations
- evaluating logs

Examples where solutions would **not** be accepted include:

- using graphical technology to solve a problem, for example finding the point of intersection of two lines
- using calculator technology to integrate or differentiate
- using calculator technology to solve cubic equations

Solutions relying on calculator technology are not acceptable.

This statement informs candidates that they cannot use their calculator to help them answer the question i.e. candidates must show all workings and calculations.

Examples of questions of this type may include:

- solving quadratic equations and inequalities
- finding exact solutions to trigonometric equations
- factorising and solving cubic equations
- solving equations involving surds and indices

Examples of 'Solutions relying entirely on calculator technology are not acceptable.'

Example 1: 9MA0-02 Summer 2022 Question 1

1. **In this question you must show all stages of your working.**

Solutions relying entirely on calculator technology are not acceptable.

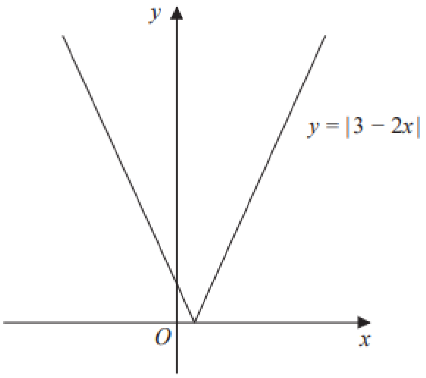

Figure 1

Figure 1 shows a sketch of the graph with equation $y = |3 - 2x|$

Solve

$$|3 - 2x| = 7 + x$$

(4)

It is possible to solve this question on a calculator to give the correct final answer with no workings. However, as the instruction states:

Solutions relying entirely on calculator technology are not acceptable.

candidates must show their workings how they **solved** the problem.

Question	Scheme	Marks	AOs
1	For an attempt to solve **Either** $3-2x=7+x \Rightarrow x=...$ **or** $2x-3=7+x \Rightarrow x=...$	M1	1.1b
	Either $x=-\frac{4}{3}$ **or** $x=10$	A1	1.1b
	For an attempt to solve **Both** $3-2x=7+x \Rightarrow x=...$ **and** $2x-3=7+x \Rightarrow x=...$	dM1	1.1b
	For **both** $x=-\frac{4}{3}$ **and** $x=10$ with no extra solutions	A1	1.1b
		(4)	
ALT	**Alternative by squaring:**		
	$(3-2x)^2=(7+x)^2 \Rightarrow 9-12x+4x^2=49+14x+x^2$	M1	1.1b
	$3x^2-26x-40=0$	A1	1.1b
	$3x^2-26x-40=0 \Rightarrow x=...$	dM1	1.1b
	For **both** $x=-\frac{4}{3}$ **and** $x=10$ with no extra solutions	A1	1.1b
			(4 marks)

*Example of a solution scoring **full** marks (Using the alternative method by squaring)*

$$|3-2x| = 7+x$$
$$(3-2x)^2 = (7+x)^2$$
$$9-12x+4x^2 = 49+14x+x^2$$

M1: Attempts to square both sides

$$3x^2 - 26x - 40 = 0$$

A1: Correct quadratic equation

$$(3x+4)(x-10) = 0$$
$$3x+4=0 \quad \text{OR} \quad x-10=0$$
$$x = -\frac{4}{3} \qquad x = 10$$

dM1: Correct attempt to solve a three-term quadratic and the first Method mark also awarded

A1: For both correct answers

*Example of a solution **relying entirely** on calculator technology*

$|3-2x| = 7+x$

Using solver with $x = 0$

M0: No attempt to solve the equation using non-calculator technology

$x = -1.33333333$

A0: This mark cannot be awarded as the previous Method mark has not been awarded

or

Using solver with $x = 10$

$x = 10$

dM0: This mark cannot be awarded as it is dependent on the previous Method mark being awarded

A0: This mark cannot be scored as the previous Method mark has not been awarded

Example 2: 9MA0-01 Summer 2022 Question 14

14. **In this question you must show all stages of your working.**

Solutions relying entirely on calculator technology are not acceptable.

(a) Given that

$$2\sin(x - 60°) = \cos(x - 30°)$$

show that

$$\tan x = 3\sqrt{3}$$

(4)

(b) Hence or otherwise solve, for $0 \leqslant \theta < 180°$

$$2\sin 2\theta = \cos(2\theta + 30°)$$

giving your answers to one decimal place.

(4)

It is possible to solve part (b) on a calculator to give the correct final answer with no workings. However, as the instruction states:

Solutions relying entirely on calculator technology are not acceptable.

candidates must show their workings on how they **solved** the problem.

Question	Scheme	Marks	AOs
(b)	Deduces that $x = 2\theta + 60°$	B1	2.2a
	$\tan(2\theta + 60°) = 3\sqrt{3} \Rightarrow 2\theta + 60° = 79.1°, 259.1°, ...$	M1	1.1b
	Correct method to find one value of θ E.g $\theta = \dfrac{79.1° - 60°}{2}$	dM1	1.1b
	$\theta =$ awrt $9.6°, 99.6°$ (See note)	A1	2.1
		(4)	
			(8 marks)

*Example of a solution scoring **full** marks*

$$2\sin 2\theta = \cos(2\theta + 30)$$
$$2\theta = x - 60$$
$$2\theta + 60 = x$$

B1: Deduces that $x = 2\theta + 60$

$$\tan x = 3\sqrt{3}$$
$$\tan(2\theta + 60) = 3\sqrt{3}$$
$$\text{Let } X = 2\theta + 60$$
$$\tan X = 3\sqrt{3}$$
$$X = 79.109...$$
and
$$X = 180 + 79.109...$$
$$X = 259.106...$$

M1: Correct method to find one of 79.1°, 259.1°,....

*A calculator can be used here as calculators can assist with the processing of solutions, but **not** to solve the problem.*

$$X = 2\theta + 60$$
$$\theta = \frac{X - 60}{2}$$
$$\theta = \frac{79.109... - 60}{2} \quad \text{and} \quad \theta = \frac{259.106... - 60}{2}$$
$$\theta = 9.6° \qquad \theta = 99.6°$$

dM1: Correct method to find one value of θ

A1: Both correct values of θ

*Example of a solution **relying entirely** on calculator technology*

$2\sin 2\theta = \cos(2\theta + 30)$

Using solver with $x = 0$
$\theta = 9.6°$

Using solver with $x = 100$
$\theta = 99.6°$

B0: No attempt to deduce that $x = 2\theta + 60$

M0: No attempt to use non calculator technology methods to solve the equation.

dM0: No attempt to use non calculator technology methods to solve for θ

A0: This mark cannot be scored as the previous Method mark has not been awarded

Examples of 'Solutions relying on calculator technology are not acceptable.'

Example 3: 8MA0-01 June 2023 Question 15(b)

15. **In this question you must show detailed reasoning.**

Solutions relying on calculator technology are not acceptable.

The curve C_1 has equation $y = 8 - 10x + 6x^2 - x^3$

The curve C_2 has equation $y = x^2 - 12x + 14$

(a) Verify that when $x = 1$ the curves C_1 and C_2 intersect.

(2)

The curves also intersect when $x = k$.

Given that $k < 0$

(b) use algebra to find the exact value of k.

(5)

It is possible to solve part (b) on a calculator to give the correct final answer with minimal workings. However, as the instruction states:

Solutions relying on calculator technology are not acceptable.

candidates must show their complete workings to the problem as credit will not be awarded for any calculations carried out on a calculator without full workings.

Question	Scheme	Marks	AOs
(b)	(Curves intersect when) $x^2 - 12x + 14 = 8 - 10x + 6x^2 - x^3$ $\Rightarrow x^3 - 5x^2 - 2x + 6 = 0$	M1	1.1b
	For the key step in dividing by $(x-1)$ $x^3 - 5x^2 - 2x + 6 = (x-1)(x^2 + px \pm 6)$	dM1	3.1a
	$x^3 - 5x^2 - 2x + 6 = (x-1)(x^2 - 4x - 6)$	A1	1.1b
	Solves $x^2 - 4x - 6 = 0$ $(x-2)^2 = 10 \Rightarrow x = \ldots$	ddM1	1.1b
	$x = 2 - \sqrt{10}$ only	A1	1.1b
		(5)	
			(7 marks)

*Example of a solution scoring **full** marks*

$$x^2 - 12x + 14 = 8 - 10x + 6x^2 - x^3$$
$$x^3 - 5x^2 - 2x + 6 = 0$$

M1: Equates the two equations and rearranges to set equal to 0

As $x = 1$, $(x-1)$ is a factor

$$(x-1)(x^2 + px + q) = x^3 - 5x^2 - 2x + 6$$
$$x^3 + px^2 + qx - x^2 - px - q = x^3 - 5x^2 - 2x + 6$$
$$x^3 + (p-1)x^2 + (q-p)x - q = x^3 - 5x^2 - 2x + 6$$

dM1: For realising $(x-1)$ is a factor and dividing by this factor to get a quadratic.

Full workings, as shown here, are not required but candidates are always encouraged to show their complete method.

By equating coefficients:

$$-q = 6$$
$$p - 1 = -5$$
$$q - p = -2$$

So

$$q = -6$$
$$p = -4$$
$$x^3 - 5x^2 - 2x + 6 = (x-1)(x^2 - 4x - 6)$$

A1: Correct quadratic factor following algebraic division

Solving

$$x^2 - 4x - 6 = 0$$
$$x = \frac{4 \pm \sqrt{(-4)^2 - 4(1)(-6)}}{2(1)}$$
$$x = \frac{4 \pm \sqrt{40}}{2}$$
$$x = \frac{4 \pm \sqrt{40}}{2}$$
$$x = \frac{4 \pm 2\sqrt{10}}{2}$$
$$x = 2 \pm \sqrt{10}$$

ddM1: Attempt to solve the three-term quadratic

Full workings, as shown here, are not required but candidates are always encouraged to show their complete method.

As $k < 0$, $k = 2 - \sqrt{10}$

A1: Correct for final answer

*Example of a solution **relying** on calculator technology*

$x^2 - 12x + 14 = 8 - 10x + 6x^2 - x^3$

$x^3 - 5x^2 - 2x + 6 = 0$

Using polynomial solver

$x = 5.1622..$, $x = 1$, $x = -1.1622....$

As $k < 0$, $k = -1.1622....$

M1: Equates the two equations and rearranges to set equal to 0
The cubic equation is solved using a calculator and no method is shown so no further marks are awarded. **dM0**: No attempt to divide by (*x*-1). **A0**: No quadratic following algebraic division. **ddM0**: Follows dM0. There is no attempt at solving a quadratic equation. **A0**: Follows M0. There is no exact value of *k*. If this was given in exact form, this mark would still not be awarded.

Example 4: 9MA0-02 Summer 2022 Question 8

8. **In this question you must show all stages of your working.**

Solutions relying on calculator technology are not acceptable.

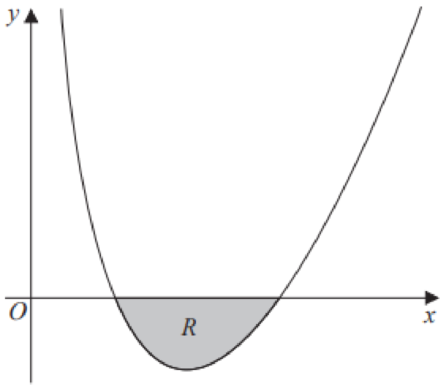

Figure 3

Figure 3 shows a sketch of part of a curve with equation

$$y = \frac{(x-2)(x-4)}{4\sqrt{x}} \qquad x > 0$$

The region R, shown shaded in Figure 3, is bounded by the curve and the x-axis.

Find the exact area of R, writing your answer in the form $a\sqrt{2} + b$, where a and b are constants to be found.

(6)

It is possible to solve this question on a calculator to give the correct final answer with no workings. However, as the instruction states:

"Solutions relying on calculator technology are not acceptable."

candidates must show their complete workings to the problem as credit will not be awarded for any calculations carried out on a calculator without full workings.

Question	Scheme	Marks	AOs
8	$y = \frac{(x-2)(x-4)}{4\sqrt{x}} = \frac{x^2-6x+8}{4\sqrt{x}} = \frac{1}{4}x^{\frac{3}{2}} - \frac{3}{2}x^{\frac{1}{2}} + 2x^{-\frac{1}{2}}$	M1 A1	1.1b 1.1b
	$\int \frac{1}{4}x^{\frac{3}{2}} - \frac{3}{2}x^{\frac{1}{2}} + 2x^{-\frac{1}{2}}\,dx = \frac{1}{10}x^{\frac{5}{2}} - x^{\frac{3}{2}} + 4x^{\frac{1}{2}}\,(+c)$	dM1 A1	3.1a 1.1b
	Deduces limits of integral are 2 and 4 and applies to their $\frac{1}{10}x^{\frac{5}{2}} - x^{\frac{3}{2}} + 4x^{\frac{1}{2}}$	M1	2.2a
	$\left(\frac{32}{10} - 8 + 8\right) - \left(\frac{2}{5}\sqrt{2} - 2\sqrt{2} + 4\sqrt{2}\right) = \frac{16}{5} - \frac{12}{5}\sqrt{2}$ Area $R = \frac{12}{5}\sqrt{2} - \frac{16}{5}$ $\left(\text{or } \frac{16}{5} - \frac{12}{5}\sqrt{2}\right)$	A1	2.1
		(6)	
			(6 marks)

*Example of a solution scoring **full** marks*

$y=\frac{(x-2)(x-4)}{4\sqrt{x}}$

x intersection when $y=0$

$0=\frac{(x-2)(x-4)}{4\sqrt{x}}$

$0=(x-2)(x-4)$

$x=2$ or $x=4$

$\int_2^4 \frac{(x-2)(x-4)}{4\sqrt{x}}dx$

M1: Deduces limits of the integral are 2 and 4 and applies to integral

$\int_2^4 \frac{x^2-6x+8}{4\sqrt{x}}dx$

M1: Correct attempt to write fraction as sum of terms with indices

$\int_2^4 \frac{1}{4}x^{\frac{3}{2}}-\frac{3}{2}x^{\frac{1}{2}}+2x^{-\frac{1}{2}}dx$

A1: Correct sum of terms with indices

$=\left[\frac{1}{10}x^{\frac{5}{2}}-x^{\frac{3}{2}}+4x^{\frac{1}{2}}\right]_2^4$

dM1: Correct integration for at least 2 terms, dependent on the previous Method mark being awarded

A1: Correct integration of all terms

$=\left[\frac{32}{10}-8+8\right]-\left[\frac{2}{5}\sqrt{2}-2\sqrt{2}+4\sqrt{2}\right]$

M1: Substitutes in the limits and subtracts

$=\frac{16}{5}-\frac{12}{5}\sqrt{2}$

Area $R=\frac{12}{5}\sqrt{2}-\frac{16}{5}$

A1: Correct working shown leading to correct final answer

*Example of a solution **relying** on calculator technology*

$y=\frac{(x-2)(x-4)}{4\sqrt{x}}$

x intersection when $y=0$

$0=\frac{(x-2)(x-4)}{4\sqrt{x}}$

$0=(x-2)(x-4)$

$x=2$ or $x=4$

$\int_2^4 \frac{(x-2)(x-4)}{4\sqrt{x}}dx$

Using the calculator

Area $R=-0.1941...$

M1: Deduces limits of the integral are 2 and 4 and applies to integral

The integral is evaluated using a calculator and no method is shown so no further marks are awarded.

M0: No attempt to write the fraction as sum of terms with indices.

A0: There is no correct sum of terms with indices shown.

dM0: Follows M0. There is no attempt at integration.

A0: Follows M0. There is no integration shown.

M0: No substitution of limits shown

A0: Incorrect final answer as the question asks for the exact area

Summary of changes between this version and the previous version:

Example 3 has been replaced