3. Command the command terms

In this chapter you will gain an understanding of command terms and how they relate to exam questions; these will help you to decide how much work to show when responding to a question.

Command terms are usually action verbs that tell you what to do in a question. They also give you a clue as to how to approach the question and how much working may be expected.

Below is a list of the official IB mathematics SL command terms and their meanings. The list is not exhaustive as some terms may be used that have their usual meaning (for example, "explain", "estimate"), but most questions in the exams use these terms to direct the student in their approach. It is also smart to note mentally the number of marks any question is worth. A "find" question worth 2 marks will require much less working than a "show that" question worth 6 marks.

Take your time to familiarize yourself with these terms—they will be used on exam papers without any explanation of their meaning.

Write down

This means that full marks are awarded for a correct answer to a question and that working does not need to be shown. Little or no calculation will be necessary as often an answer can be known from the information provided. For example:

- The fifth term in the expansion of the binomial $(a + b)^n$ is given by $\binom{10}{4}p^6(2q)^4$.
  Write down the value of n. *[1 mark]*

If you know the pattern of terms in a binomial expansion, simply writing down the answer of "$n = 10$" earns the mark.

Be especially attentive to this command in paper 2 as it is often a clue that you can obtain an answer by using your GDC. Here is an example of a "write down" question from a past paper 2:

- Consider the curve $y = \ln(3x - 1)$. Let P be the point on the curve where $x = 2$.
  Write down the gradient of the curve at P. *[2 marks]*

If all you write down on your paper is "gradient is 0.6" you will earn both marks. You can use the numerical derivative feature of the GDC to find an answer because there is no expectation of any working. If you choose to find $\frac{dy}{dx}$ and substitute $x = 2$, you will still earn both marks if the question is answered correctly.

However, any error that leads to a wrong answer earns zero marks. The "write down" command is a clue that such an approach is not required.

Calculate
Find
Determine

These terms mean that any answer found should be accompanied by any relevant working. Typically, this means you need to give the mathematical set-up and then any major steps that lead to a solution. Here is an example from a past paper 1.

- The graph of $y = \sqrt{x}$ between $x = 0$ and $x = a$ is rotated 360° about the x-axis.
  The volume of the solid formed is 32π. **Find** the value of a. *[7 marks]*

Calculate
Find
Determine
(continued)

To gain full marks you should write down a correct integral set-up, $\pi\int_0^a x\,dx = 32\pi$, as this is the main mathematical issue in the question. You should then also include the integration and substitution steps, as these are what lead to the answer of "$a = 8$". If you find this answer and show little or no working, significantly fewer marks will be awarded.

In paper 2, where answers can often be found without any algebraic steps, the required "working" is to give the mathematical set-up that is considered when finding the answer. For example:

- In an arithmetic series, the first term is -7 and the sum of the first 20 terms is 620.

  Find the common difference. *[3 marks]*

Using the formula for an arithmetic series found in the information booklet, you can write the equation used to solve for d, the common difference: $620 = \frac{20}{2}(-14 + 19d)$. No additional working is required as you can now use the GDC to solve and "$d = 4$".

Solve

This means to find the solution or solutions to an equation, sometimes called roots. In paper 1, this will typically involve some algebraic manipulation. For example:

- **Solve** the equation $\ln x - 3 = \ln\frac{1}{x}$, $x > 0$. *[4 marks]*

Your working might look like this:

$\ln x - 3 = \ln 1 - \ln x$

$2\ln x = 3$

$\ln x = \frac{3}{2}$

$x = e^{3/2}$

In paper 2, you are expected to show the mathematical set-up before using the GDC to find a solution. For example:

- Let $\boldsymbol{A} = \begin{pmatrix} 5 & 1 \\ 6 & 2 \end{pmatrix}$, $\boldsymbol{X} = \begin{pmatrix} x \\ y \end{pmatrix}$ and $\boldsymbol{C} = \begin{pmatrix} 8 \\ -4 \end{pmatrix}$.

  Solve the matrix equation $\boldsymbol{AX} = \boldsymbol{C}$. *[3 marks]*

Your working might look like this:

$\boldsymbol{X} = \boldsymbol{A}^{-1}\boldsymbol{C}$

$\boldsymbol{X} = \begin{pmatrix} 5 \\ -17 \end{pmatrix}$

Draw

More demanding than the "sketch" command, this term means that you should create an accurate diagram with appropriate labels. You should **draw** to scale and use a straight edge for any straight lines, including axes. Any points should be plotted accurately and joined in a straight line or smooth curve, whichever is appropriate to the diagram. Often such a command is used for drawings such as histograms or box-and-whisker plots, but can also be used for function graphing as well. You should use a pencil to draw a graph or diagram, and it should be done on the square-ruled paper provided for your exam.

Sketch

When asked to sketch a graph, you are expected to hand **sketch** a correct shape with major features in approximately correct positions. These include intercepts, maxima, minima, points of inflexion, asymptotes and, if a domain or range is included, end points.

Plot

This means to mark the position of a point on a diagram.

Deduce

This means to **show** a result using some known information. It is like a "show that" question, and so all relevant working should be given in a complete manner.

Justify

Give a valid mathematical reason for your answer or conclusion. You may be directed to use a particular concept in your **justification**, or it could be left open for you to decide. For example:

- The area of a rectangle, A, is given by $A = 18\sin 2\theta$.

  (a) **Find** $\frac{dA}{d\theta}$. *[2 marks]*

  (b) **Hence**, find the exact value of θ that maximizes the area of the rectangle. *[3 marks]*

  (c) Use the second derivative to **justify** that this value of θ does give a maximum. *[3 marks]*

To **justify** the maximum in part (c), you have to **state** and **show that** $\frac{d^2A}{d\theta^2} < 0$, which means you find the second derivative and substitute the value found in part (b) to obtain a negative value.

Show that

This means that you should show **all** relevant working, often in a "step-by-step" approach, when finding an answer that is given to you. You cannot work backwards in a "show that" question. That is, you cannot use the given answer in your work. Rather, you must show the mathematical steps that achieve it. Continue your working until you reach a stage where the given answer follows obviously and immediately from your last line of work. For example:

- Let $f(x) = e^{x+3}$. **Show that** $f^{-1}(x) = \ln x - 3$. *[2 marks]*

Your working might look like this:

$x = e^{y+3}$

$\ln x = \ln e^{y+3}$

$\ln x = y + 3$

$f^{-1}(x) = \ln x - 3$

If you are unable to show the required result, be sure to use the given answer in subsequent parts.

Hence

This means to use your preceding work to find a required result. If you find a correct answer and do not use the preceding work, fewer or possibly no marks will be awarded. For example:

- The area of a rectangle, A, is given by $A = 18\sin 2\theta$.

  (a) **Find** $\frac{dA}{d\theta}$. *[2 marks]*

  (b) **Hence**, find the exact value of θ that maximizes the area of the rectangle. *[3 marks]*

To answer part (b), it is a requirement that you use your answer from part (a). If you use some other method, perhaps using a graph in the GDC, no marks will be awarded even if your answer is correct.

Hence or otherwise

This means that using the preceding work is the suggested approach to answer the question, but other correct methods can earn full marks as well.

Other useful terms

Some command terms will tell you to perform a specific mathematical operation. To **differentiate** is to find a derivative expression, to **integrate** is to find an integral expression, and to **simplify** is to write your answer in a simple form using arithmetical or algebraic properties. Any other such terms will have their usual mathematical meaning.