IB DP MATHEMATICS

AA Topic 5 · Calculus

TOPICAL WORKSHEET

5.1 Differentiation Basics · 5.2 Applications of Differentiation
5.3 Integration Basics · 5.4 Applications of Integration

Standard and Higher Level · Syllabus 2025

Fahad H. Ahmad

+92 323 509 4443 | Megalecture.com

Original exam-style questions written for the IB Diploma Programme Mathematics course (first assessment 2025)

Section A — Multiple Choice (15 marks)

Circle the letter of the best answer to each question. Each question is worth 1 mark.

1. Using the power rule, the derivative of x^n with respect to x is **[1]**

A x^{n-1}

B nx^n

C nx^{n-1}

D $(n-1)x^n$

2. If $f(x) = 5x^3$, then $f'(x)$ is **[1]**

A $5x^2$

B $15x^2$

C $15x^3$

D $5x^3$

3. The gradient of the tangent to the curve $y = x^2$ at the point where $x = 3$ is **[1]**

A 3

B 6

C 9

D 2

4. The derivative of a constant, such as $f(x) = 7$, with respect to x is **[1]**

A 7

B 1

C 0

D x

5. At a stationary point of a curve $y = f(x)$, the value of $f'(x)$ is **[1]**

A undefined

B equal to 1

C equal to 0

D always negative

6. At a stationary point, if the second derivative $f''(x) > 0$, the point is **[1]**

A a local maximum

B a local minimum

C a point of inflexion

D not a stationary point

7. If two lines are perpendicular, the product of their gradients is **[1]**

A 0

B 1

C -1

D undefined

8. For a function y = f(x), the derivative $dy \div dx$ represents **[1]**

A the area under the curve

B the y-intercept of the curve

C the instantaneous rate of change of y with respect to x

D the average value of y

9. Using the power rule for integration ($n \neq -1$), $\int x^n dx$ is equal to **[1]**

A $nx^{n-1} + C$

B $x^{n+1} \div (n+1) + C$

C $x^{n-1} + C$

D $(n+1)x^n + C$

10. $\int 6x\, dx$ is equal to **[1]**

A $6x + C$

B $3x^2 + C$

C $6x^2 + C$

D $x^2 + C$

11. A definite integral $\int_a^b f(x)dx$, where $f(x) \geq 0$ on [a,b], represents **[1]**

A the gradient of f(x) at x = b

B the area enclosed between the curve y=f(x) and the x-axis, from x=a to x=b

C the value of f(x) at the midpoint of [a,b]

D the number of roots of f(x) between a and b

12. $\int 5\, dx$ is equal to **[1]**

A $5 + C$

B $5x + C$

C $x + C$

D 0

13. The area enclosed between two curves y=f(x) and y=g(x), where $f(x) \geq g(x)$ on [a,b], is given by **[1]**

A $\int_a^b f(x) \times g(x)\, dx$

B $\int_a^b (f(x)-g(x))\, dx$

C $f(b)-g(a)$

D $\int_a^b (f(x)+g(x))\, dx$

14. For a particle moving in a straight line, if s(t) is displacement and v(t) is velocity, then **[1]**

A v(t) = ds÷dt

B s(t) = dv÷dt

C v(t) = $s(t)^2$

D v(t) and s(t) are unrelated

15. Given the velocity function v(t) of a particle, the displacement function s(t) can be found by **[1]**

A differentiating v(t)

B integrating v(t)

C squaring v(t)

D finding the maximum of v(t)

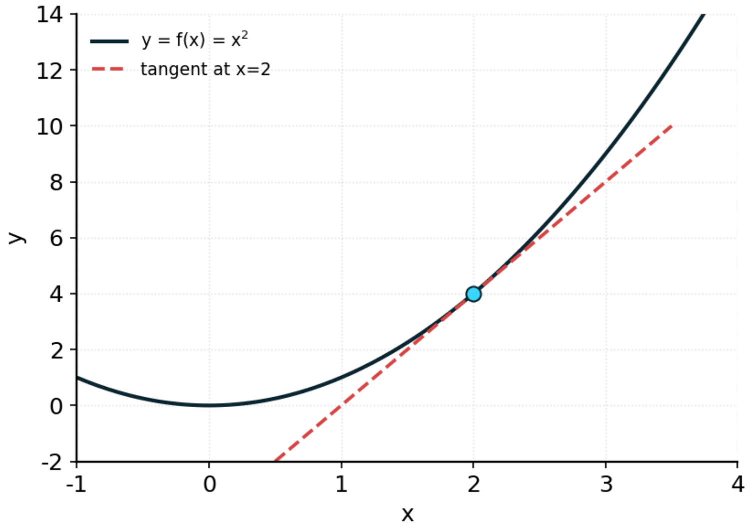
Section B — Structured Questions (65 marks)

Answer all questions in the space provided. Working must be shown for full marks.

5.1 Differentiation Basics

Question 1 [7 marks]

The graph shows the curve $y = f(x) = x^2$, together with the tangent line at the point where $x = 2$ (computed).



$y = x^2$ with the tangent line at $x = 2$ (computed).

(a) Using the graph, estimate the gradient of the tangent line shown. **[2]**

(b) Using the power rule, differentiate $f(x) = x^2$, and hence calculate the exact gradient of the tangent at $x = 2$. **[2]**

(c) Find the equation of the tangent line to $y = x^2$ at $x = 2$, and confirm it matches the line shown on the graph. **[3]**

Question 2 [6 marks]

Polynomial functions can be differentiated term-by-term using the power rule.

(a) State the power rule for differentiating x^n with respect to x. **[2]**

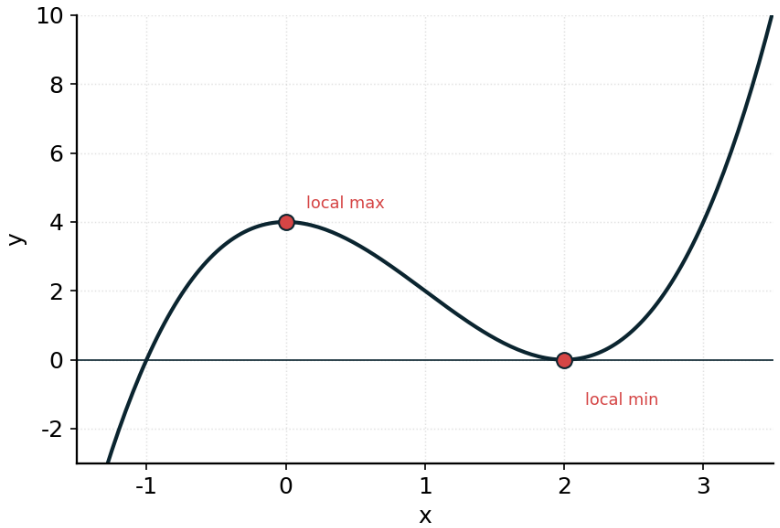
(b) Differentiate $f(x) = 3x^4 - 5x^2 + 7$ with respect to x. **[2]**

(c) Calculate $f'(1)$. **[2]**

5.2 Applications of Differentiation

Question 3 [7 marks]

The graph shows the curve $y = f(x) = x^3 - 3x^2 + 4$, with its two stationary points marked (computed).



$y = x^3 - 3x^2 + 4$ (computed), with stationary points marked.

(a) Using the graph, write down the x-coordinate of the local maximum and the x-coordinate of the local minimum. **[2]**

(b) Find $f'(x)$, and hence find the x-coordinates of the stationary points algebraically. **[2]**

(c) Find $f''(x)$, and use it to classify each stationary point found in part (b). **[3]**

Question 4 [6 marks]

The tangent and normal to a curve at a point are perpendicular to each other.

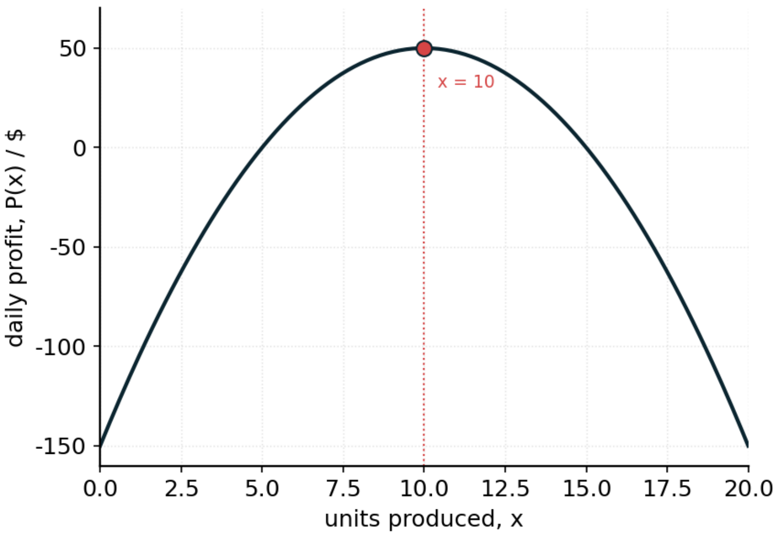
(a) State the relationship between the gradient of the tangent and the gradient of the normal to a curve at a given point. **[2]**

(b) For the curve $y = x^3$ at the point (1, 1), find the gradient of the tangent. **[2]**

(c) Hence find the gradient of the normal to the curve at the point (1, 1). **[2]**

Question 5 [7 marks]

The graph shows the daily profit, $P(x)$ (in dollars), of a company producing x units of a product, where $P(x) = -2x^2+40x-150$ (computed).



$P(x) = -2x^2+40x-150$ (computed), showing the maximum profit.

(a) Using the graph, estimate the number of units, x, that maximizes the daily profit. **[2]**

(b) Find $P'(x)$, and hence find the exact value of x that maximizes the profit. **[2]**

(c) Calculate the maximum daily profit. **[3]**

5.3 Integration Basics

Question 6 [6 marks]

Integration is the reverse process of differentiation, and follows its own power rule.

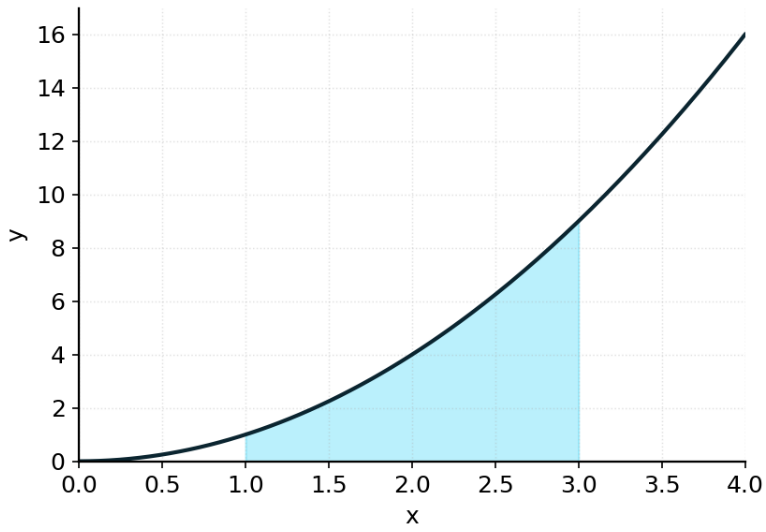
(a) State the power rule for integration, $\int x^n dx$ (for $n \neq -1$). **[2]**

(b) Find $\int (3x^2 - 4x + 5) dx$. **[2]**

(c) Evaluate the definite integral $\int_0^2 (3x^2 - 4x + 5) dx$. **[2]**

Question 7 [7 marks]

The graph shows the curve $y = x^2$, with the region between $x = 1$ and $x = 3$ shaded (computed).



$y = x^2$ (computed), with the shaded region between x=1 and x=3.

(a) State what the shaded area on the graph represents, in terms of a definite integral. **[2]**

(b) Find the indefinite integral $\int x^2 dx$. **[2]**

(c) Calculate the exact value of the shaded area, giving your answer as an exact fraction. **[3]**

Question 8 [6 marks]

A curve has gradient function dy÷dx = 6x−4, and passes through the point (1, 3).

(a) Explain what the constant of integration, C, represents when finding y from dy÷dx by integration. **[2]**

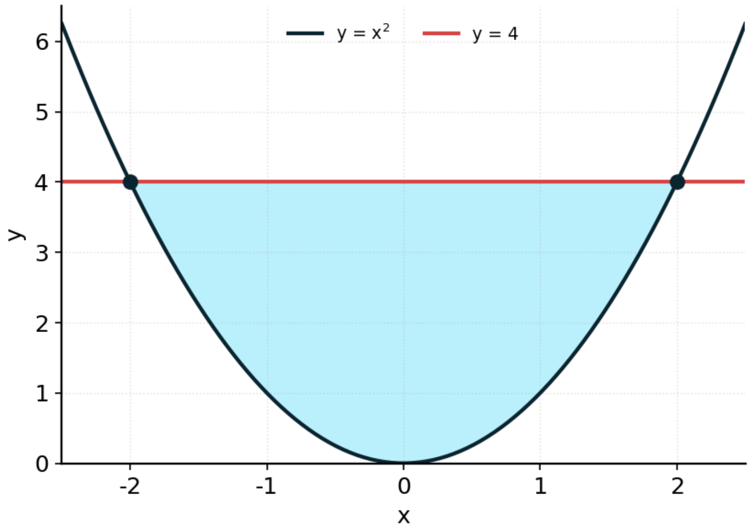
(b) Find the equation of the curve y = f(x), using the given point to find the value of C. **[2]**

(c) Find the value of y when x = 2. **[2]**

5.4 Applications of Integration

Question 9 [7 marks]

The graph shows the region enclosed between the curve $y = x^2$ and the line $y = 4$ (computed).



Region enclosed between $y = x^2$ and $y = 4$ (computed).

(a) Using the graph, write down the x-coordinates of the points where the curve and the line intersect. **[2]**

(b) State the formula used to find the area between two curves $y = f(x)$ (upper) and $y = g(x)$ (lower), for $a \le x \le b$. **[2]**

(c) Calculate the exact area of the shaded region, using $\int_{-2}^{2}(4-x^2)dx$. **[3]**

Question 10 [6 marks]

A particle moves in a straight line with velocity $v(t) = 6t-t^2$ (m/s), and starts at displacement $s(0) = 0$.

(a) State the relationship between displacement s(t), velocity v(t), and acceleration a(t) in terms of derivatives and integrals. **[2]**

(b) Find the displacement function s(t), using the given initial condition s(0) = 0. **[2]**

(c) Calculate the displacement of the particle at t = 3 seconds. **[2]**