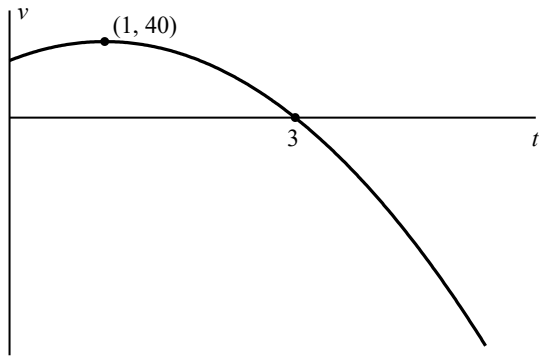
Homework — Part 2: Exam practice (IB past papers)

10 real IB questions: Paper 1 (no calculator) and Paper 2 (calculator), mixed. Total: **75 marks**. In IB exams, "total change from a rate" is usually a **velocity → displacement / distance** question. Calculator in **radians**.

Displacement $= \int_a^b v\,dt$ (can be negative). Distance travelled $= \int_a^b |v|\,dt$. The particle changes direction when v changes sign. Acceleration $a = \dfrac{dv}{dt}$.

1. Paper 1 IB May 2025

An object moves in a straight line. Its velocity v m s^{-1}, at time t seconds, is given by $v(t) = 30 + 20t - 10t^2$ for $0 \leq t \leq 5$. The graph of v is shown in the following diagram. The graph of v has a local maximum point where $t = 1$ and intersects the t-axis at $t = 3$.



(a) **Determine** the object's (i) maximum velocity; (ii) maximum speed. **[4]**

At $t = T$, the object changes direction.

(b) (i) **Write down** the value of T. (ii) **Find** the distance travelled by the object in the first T seconds. **[5]**

(c) **Determine** whether the object returns to its initial position during the time period $0 \leq t \leq 5$, justifying your answer. **[4]**

2. Paper 2 IB May 2026

The velocity, v m s^{-1}, of a particle at time t seconds, is given by $v = 10\left(\dfrac{t^2}{5} - e^{-0.2t}\right)$ for $t \geq 0$.

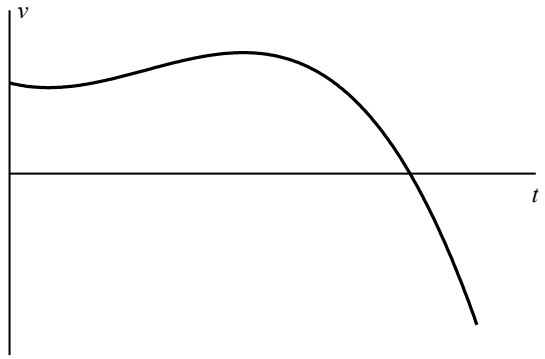
(a) **Find** the initial velocity of the particle. **[1]**

(b) **Find** the distance travelled by the particle in the first five seconds. **[2]**

(c) **Find** the time when the acceleration of the particle is 19.3 m s^{-2}. **[2]**

3. Paper 1 IB May 2023 (one part)

An object moves along a straight line. Its velocity, v m s^{-1}, at time t seconds is given by $v(t) = -t^3 + \frac{7}{2}t^2 - 2t + 6$, for $0 \leq t \leq 4$. The graph of v is shown in the following diagram. At $t = 0$, the object is at the origin.



Find the displacement of the object from the origin at $t = 1$. **[5]**

4. Paper 2 IB May 2026

A particle moves along a straight line with an initial displacement at O. Its velocity, v m s^{-1}, at time t seconds is given by $v(t) = (3t^2 - 10t + 4)e^{-0.5t} - 4\cos t$, where $0 \leq t \leq 6$.

(a) **Find** the maximum displacement of the particle. **[4]**

(b) **Determine** the intervals of time when the acceleration of the particle is negative. **[3]**

5. Paper 2 IB May 2025

A particle P moves in a straight line. The velocity v m s^{-1} of P, at time t seconds is given by $v(t) = e^{-\sin t}\cos(2t)$, for $0 \leq t \leq 5$.

(a) **Find** the maximum speed of P. **[2]**

(b) **Find** the total distance travelled by P. **[2]**

(c) **Find** the acceleration when P changes direction for the second time. **[3]**

6. Paper 1 IB May 2026 (parts of one question)

Consider the function $f(x) = \frac{-x - 7}{x^2 + 4x + 3}$, where $x \in \mathbb{R},\ x \neq -3,\ x \neq -1$.

(a) Use partial fractions to **show that** $f(x)$ can be expressed as $\frac{2}{3 + x} - \frac{3}{1 + x}$. **[3]**

(b) **Show that** the area of the region enclosed by the graph of $y = f(x)$, the x-axis and the lines $x = 0$ and $x = 1$ is $\ln\frac{9}{2}$. **[5]**

7. Paper 2 IB November 2023

A particle moves along a straight line. Its displacement, s metres, from a fixed point O after time t seconds is given by $s(t) = 4.3\sin\left(\sqrt{3t+5}\right)$, where $0 \leq t \leq 10$. The particle first comes to rest after q seconds.

(a) **Find** the value of q. [2]

(b) **Find** the total distance that the particle travels in the first q seconds. [3]

8. Paper 2 IB November 2025 (parts of one question)

An airplane lands on a runway 100 metres in front of a stationary car. At the instant the airplane lands, the car begins to travel in the same direction towards the airplane. Let t represent the number of seconds after the airplane lands. For $t \geq 0$, the velocities of the airplane and the car in m s^{-1} can be modelled by $v_{air} = 60e^{-0.1t}$ and $v_{car} = 5t$.

(a) When the airplane lands, **write down** the speed of (i) the airplane; (ii) the car. [2]

(b) **Find** (i) the value of t when the airplane and the car have the same speed; (ii) the speed at this time. [3]

Let $d(t)$ represent the distance, in metres, between the car and the back of the airplane after t seconds.

(c) If $d(0) = 100$, **find** $d(t)$. [7]

(d) **Hence**, find how long it takes for the car to reach the back of the airplane. [2]

9. Paper 2 IB May 2024

A particle moves in a straight line such that its velocity, v m s^{-1}, at time t seconds is given by $v(t) = 1 + e^{-t} - e^{-\sin 2t}$ for $0 \leq t \leq 2$.

(a) **Find** the velocity of the particle at $t = 2$. [1]

(b) **Find** the maximum velocity of the particle. [2]

(c) **Find** the acceleration of the particle at the instant it changes direction. [3]

10. Paper 2 IB May 2025 (parts of one question, introduction shortened)

The function f is defined by $f(t) = kte^{-3t}$ for $t \geq 0$, where $k \in \mathbb{Z}^+$. It can be shown that $\int_0^a f(t)\,dt = \frac{k}{9}\left[1 - (3a+1)e^{-3a}\right]$, where $a \in \mathbb{R}^+$.

(a) Use l'Hôpital's rule to **find** $\lim_{x\to\infty}(3x+1)e^{-3x}$. [2]

(b) It is given that $\int_0^\infty f(t)\,dt = 1$. **Hence**, by considering $\lim_{a\to\infty}\int_0^a f(t)\,dt$, **find** the value of k. [3]

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