Part D	Problems 19–26 which require complete solutions.
Test time	120 minutes.
Resources	Digital resources, formula sheet and ruler.

Level requirements

The test consists of three written parts (Part B, Part C and Part D).
Together they give a total of 61 points consisting of
21 E-, 23 C- and 17 A-points.

Level requirements for test grades
E: 15 points
D: 24 points of which 7 points on at least C-level
C: 31 points of which 13 points on at least C-level
B: 41 points of which 5 points on A-level
A: 49 points of which 9 points on A-level

The number of points you can get for a complete solution is stated after each problem. You can also see what knowledge levels (E, C and A) you can show in each problem. For example (3/2/1) means that a correct solution gives 3 E-, 2 C- and 1 A-point.

For problems labelled *"Only answer is required"* you only have to give a short answer. For other problems you are required to present your solutions, explain and justify your train of thought and, where necessary, draw figures and show how you use your digital resources.

Write your name, date of birth and educational programme on all the sheets you hand in.

Name: ____

Date of birth: ______________________________________

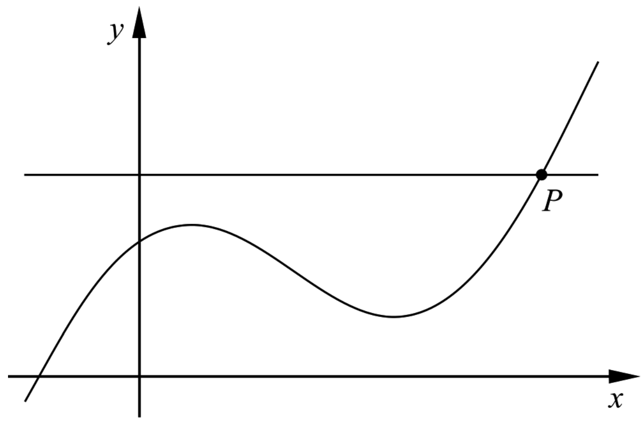
Educational programme: _______________________________

Part D: Digital resources are allowed. Do your solutions on separate sheets of paper.

19. Find $f'(\frac{\pi}{5})$ if $f(x) = 2\cos 3x$. Write your answer to two decimal places.

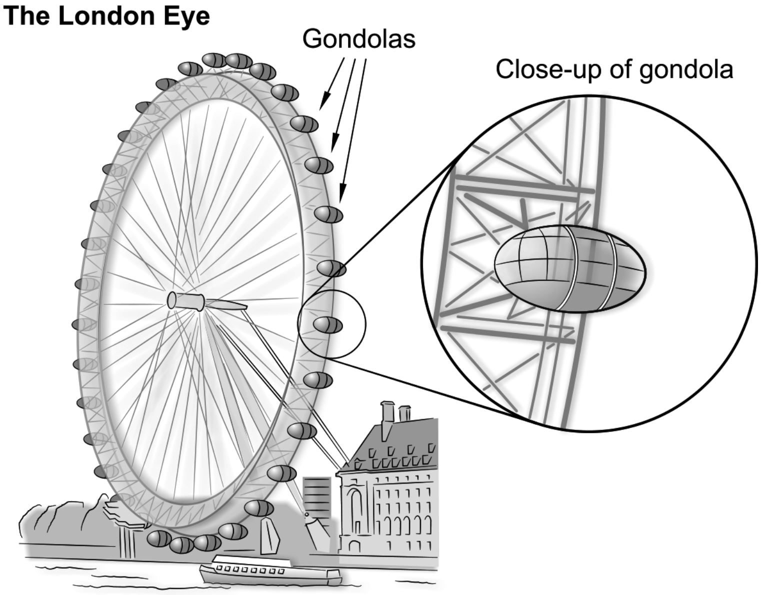
Only answer is required (1/0/0)

20. The figure shows the curve $y = x + 2\cos x$ and the line $y = 3$ and their intersection point P.



Determine the gradient of the curve $y = x + 2\cos x$ at point P.
Write your answer to at least three significant figures. (2/0/0)

21. The London Eye, a Ferris wheel, has a diameter of 135 metres and one revolution takes 30 minutes.



The height above the ground of a gondola can be described by the function
$h(t) = 67.5\sin(0.209t - 1.57) + 70; \quad 0 \le t \le 30$
where h is the height above the ground in metres and t is the time in minutes after the start.

a) What is the gondola's maximum height above the ground?
Only answer is required (1/0/0)

b) Determine how long time the gondola is at least 40 m above the ground during one revolution. (0/2/0)

22. Frida has been prescribed medicine for her high blood pressure. How quickly her body breaks down the medicine can be described by the differential equation

$$\frac{\mathrm{d}m}{\mathrm{d}t} = k \cdot m$$

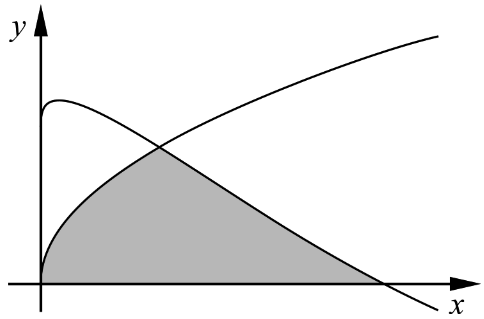
where k is a constant and m mg is the amount of medicine in the body t hours after she has been given the medicine.

a) Show that $m(t) = C \cdot \mathrm{e}^{kt}$ is a solution to the differential equation. (1/0/0)

b) When Frida takes a tablet, the amount of medicine in her body is 100 mg. After 1 hour, the amount has decreased to 90 mg.
Determine the constants C and k for the function $m(t) = C \cdot \mathrm{e}^{kt}$ in this case. (2/0/0)

c) Determine how long it takes for Frida's body to break down 90% of a given amount of medicine if no new medicine is added. (0/1/0)

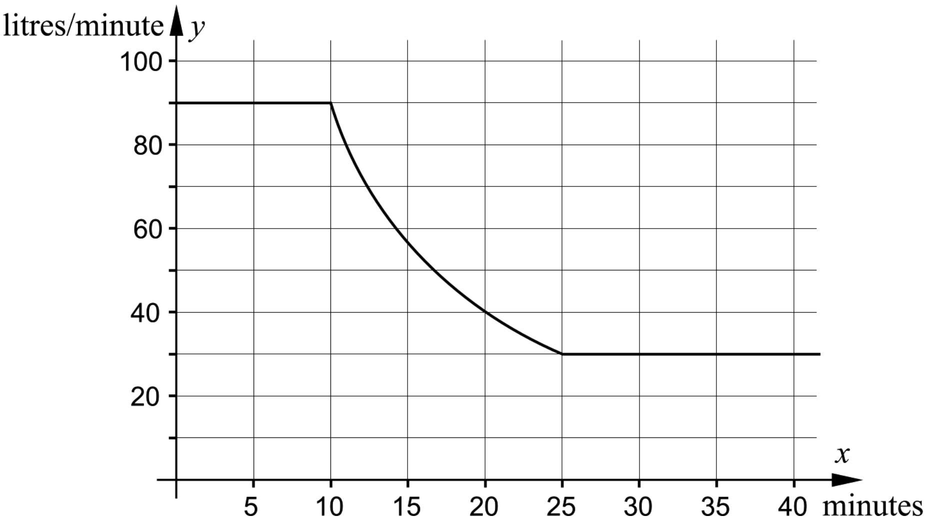
23. The figure shows the graphs of the functions $y = e^{\sqrt{x}} - 2x$ and $y = \sqrt{x}$.
The shaded region in the figure is bounded by the graphs of the functions and the x-axis.



Calculate the area of the shaded region.
Write your answer in at least three significant figures. (1/2/0)

24. An empty tank is to be filled with water. During the first 10 minutes, the filling rate is constant, 90 litres/minute. During the following 15 minutes the filling rate decreases due to lower water pressure. Then, the filling rate remains a constant 30 litres/minute.

The graph shows how the filling rate y litres/minute depends on time x minutes. During the time the water pressure decreases, the filling rate is given by the function $y = \dfrac{1000}{x} - 10$



Determine how long it takes to fill the tank with 2000 litres of water. (0/3/0)

25. A region is bounded by the curve $y = x^2 - 4$ and the line $y = 5$
Calculate the volume formed when this region is rotated around the line $y = 5$ (0/0/3)

26. A laser pointer is placed on a rotating disc. A red luminous point can be seen where the laser beam from the laser pointer hits the wall. The distance between the wall and the centre of the rotating disc is L metres. At time $t = 0$ the laser beam shines against the wall at a right angle, see figure 1.

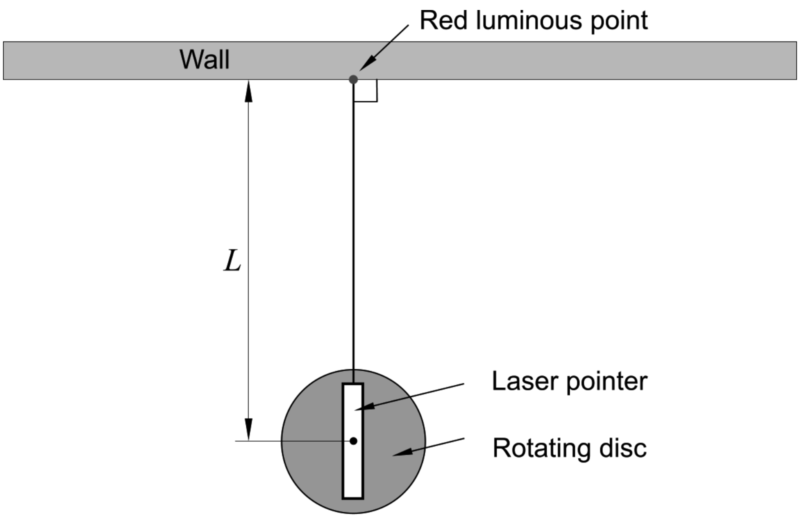


Figure 1

The disc with the laser pointer rotates so that the red luminous point moves to the right on the wall. At the time t seconds, the disc has rotated the angle v radians and the luminous point has moved a distance of x metres along the wall. See figure 2.

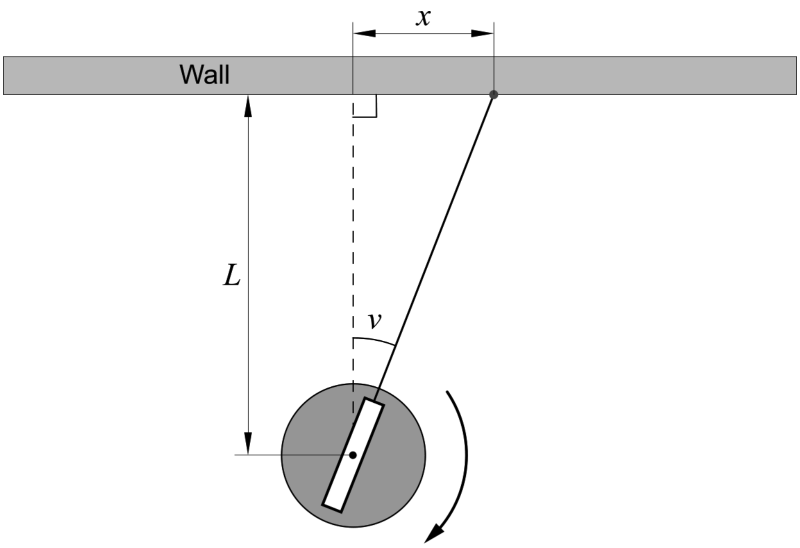


Figure 2

The disc is rotated at a constant angular velocity C radians/s so that $v = C \cdot t$

The luminous point moves along the wall at the velocity $\dfrac{\mathrm{d}x}{\mathrm{d}t}$

Determine an expression for the velocity $\dfrac{\mathrm{d}x}{\mathrm{d}t}$ (0/0/2)