Part D	Problems 20–27 which require complete solutions.
Test time	120 minutes.
Resources	Digital tools, formula sheet and ruler.

The test consists of three written parts (part B, C and D).
Together they give a total of 60 points consisting of 22 E-, 22 C- and 16 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: 40 points of which 5 points on A-level
A: 47 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 tools.

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

Name: ____

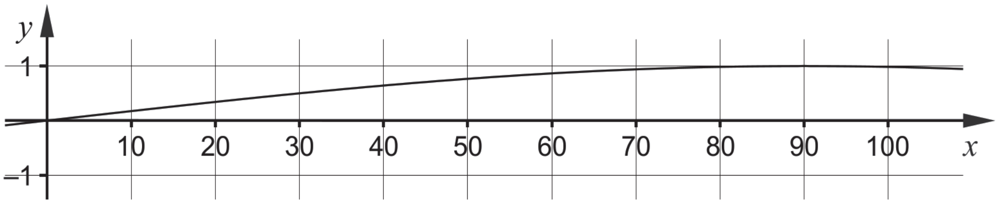
Date of birth: ______________________________________

Educational programme: ______________________________

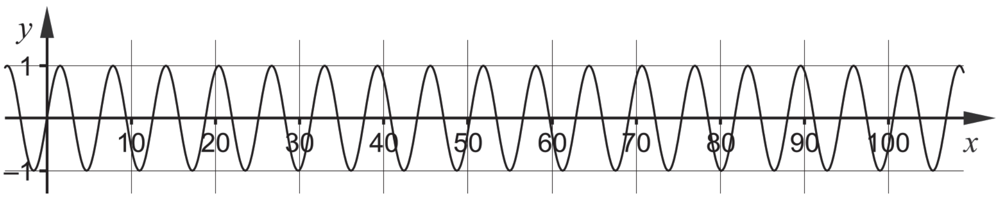
Part D: Digital tools are allowed. Several of the tasks require that you use digital tools to solve them. For the other tasks, it can be an advantage to use digital tools when solving the task. Write down your solutions on separate sheets of paper.

20. Yosef and Zara each draw the curve $y = \sin x$ using their digital tools. When they compare their curves, they discover that the curves look different. See figure.

Yosef's curve

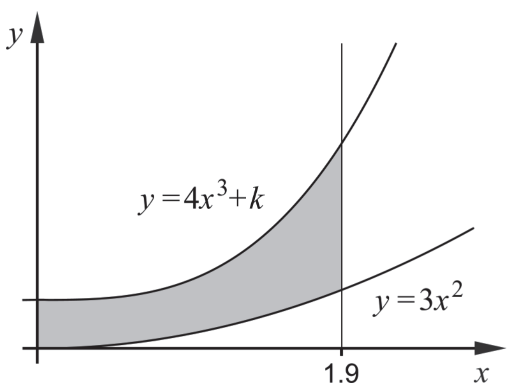


Zara's curve



Explain why the curves differ like this. (1/0/0)

21. The figure shows a shaded region bounded by the y-axis, the line $x = 1.9$ and the curves $y = 3x^2$ and $y = 4x^3 + k$ where k is a positive constant.



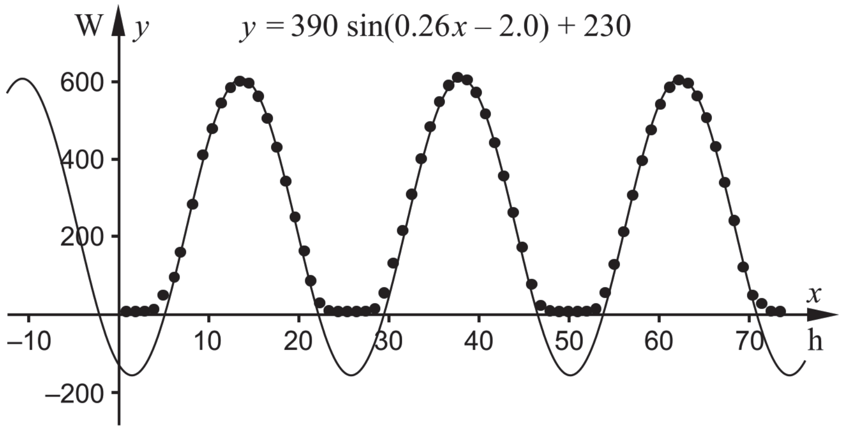
For one particular value of k, the area of the shaded region is 13 area units.

Determine this value of k. Give your answer to at least one decimal place. (2/0/0)

22. In a solar panel, energy from solar radiation is transformed into electricity.

Sunny has put up a small solar panel and measures the power it generates during a few cloud-free days. She discovers that the measurements vary periodically and fits a sine curve to the measurements. The equation of the sine curve is $y = 390\sin(0.26x - 2.0) + 230$ where x is the time in hours counting from 00:00 on July 23, 2020 and y is the power in watt (W).

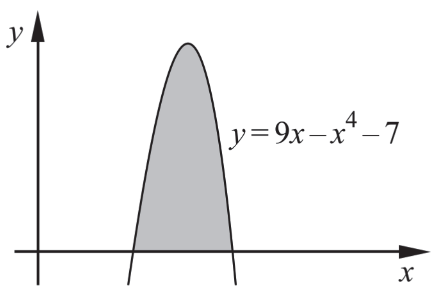
The figure shows her measurements and the fitted sine curve.



a) Determine how large the power was at 19:00 on July 23, 2020. Give your answer to at least two significant digits.
Only answer is required (1/0/0)

b) Determine the rate of change of the power at 15:30 on July 23, 2020 measured in W/h. Give your answer to at least two significant digits. (2/0/0)

23. The figure shows a shaded region bounded by the curve $y = 9x - x^4 - 7$ and the x-axis. The shaded region is rotated around the x-axis and forms a solid of revolution.



Determine the volume of the solid of revolution. Give your answer to at least two decimal places. (0/2/0)

24. The students in class TE19C have been to a lecture, and are therefore late for the subsequent maths class that started at 12:00.

The number of minutes a student is late for the maths class can be described by a probability distribution with density function $f(t) = 0.02t \cdot \mathrm{e}^{-0.01t^2}$ where t is the number of minutes a student is late for the maths class.

Determine how many of the 32 students in TE19C have reached the maths class by 12:05. (0/2/0)

25. During a windy day, the wind speed at a wind power plant can be described by the model

$v(x) = 11\sin(0.11x - 0.89) + 28, \quad 0 \le x \le 24$

where v is the wind speed in km/h and x is the time in hours counting from 00:00.

a) Determine the fastest wind speed during this day.
Only answer is required (1/0/0)

At wind speeds above 36 km/h the turbine blades are set at an angle to reduce wear.

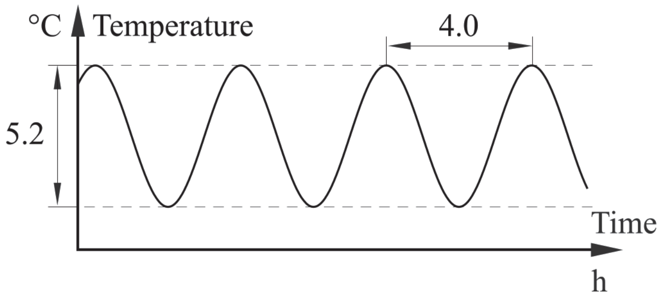
b) Determine for how long the wind speed is above 36 km/h during the day in question. (0/1/0)

At wind speeds between 0 and 36 km/h the amount of electrical energy produced can be calculated using the formula $P(v) = 0.42 \cdot v^3$ where $P(v)$ is the amount of electrical energy generated per hour in MJ/h and v is the wind speed in km/h.

At wind speeds above 36 km/h the amount of electrical energy produced per hour is the same as for wind speeds of 36 km/h.

c) Determine the total amount of electrical energy generated by the wind power plant during this day. (0/0/3)

26. The temperature in a cold storage room varies periodically with a period of 4.0 h because of a malfunctioning cooling unit. The difference in temperature between the highest and lowest temperatures is 5.2 °C. See figure.



At 08:30 the temperature is maximal and one hour later it has gone down to 3.9 °C.

The temperature in the cold storage room can be described by the model

$T(t) = A \cdot \cos(Bt + C) + D$

where $T(t)$ is the temperature in °C and t is the time in hours counting from 00:00.

Determine the constants A, B, C and D. *Only answer is required* (0/1/2)

27. Let $C = \int_a^b (7x - x^2 - 10)\,\mathrm{d}x$ where $a < b$.

a) Determine the value of $(b - a)$ when C assumes its maximum value. *Only answer is required* (0/0/1)

b) Determine the maximum value $(b - a)$ can assume if $C = 0$
Give your answer to at least one decimal place. (0/0/2)