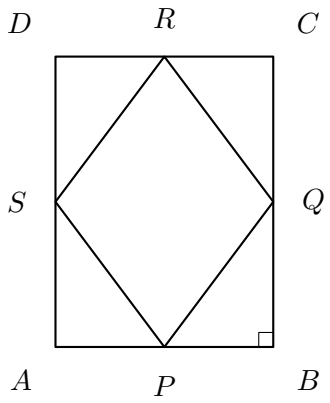
1. The points P, Q, R and S are the midpoints of the sides AB, BC, CD and DA of rectangle $ABCD$, respectively.

The perimeter of rhombus $PQRS$ is 20 cm, and $AB = 6$ cm.

What is the area of rectangle $ABCD$?



A 24 cm^2

B 36 cm^2

C 48 cm^2

D 60 cm^2

E 100 cm^2

2. A differentiable function f satisfies

$$f'(x) = 3x^2 - 18x + 15$$

for all real x.

The curve $y = f(x)$ has two stationary points, A and B.

What is the gradient of the straight line AB?

A -32

B -8

C 0

D 8

E 32

3. A water bill consists of a fixed monthly charge of 6 pounds plus a fixed price for each unit of water used.

A household's January bill is 30 pounds. It uses 25% less water in February than in January, and the charges do not change.

What is its February bill, in pounds?

A 22.50

B 24

C 28.50

D 36

E 37.50

4. A straight line with y-intercept -3 meets the curve $y = x^2$ at two distinct points P and Q. The sum of the x-coordinates of P and Q is 4.

What is the sum of their y-coordinates?

A 3

B 4

C 9

D 10

E 13

F 16

5. A sequence has nth term

$$u_n = an^2 + bn + c \qquad (n = 1, 2, 3, \ldots),$$

where a, b and c are real constants.

It is given that

$$u_4 - u_1 = 15 \qquad \text{and} \qquad u_7 - u_4 = 33.$$

What is $u_{10} - u_7$?

A 18

B 33

C 51

D 66

E 69

6. Triangle ABC has $BC = 7$, angle $BAC = 60°$, and area $6\sqrt{3}$.

What is its perimeter?

A 11

B $7 + \sqrt{73}$

C $7 + \sqrt{85}$

D $7 + \sqrt{97}$

E 18

7. For which real values of k does the equation

$$\sqrt{x} + 2\sqrt{5 - x} = k$$

have exactly one real solution for x?

A $\sqrt{5} \leq k \leq 2\sqrt{5}$

B $\sqrt{5} \leq k < 2\sqrt{5}$

C $\sqrt{5} \leq k < 2\sqrt{5}$ or $k = 5$

D $\sqrt{5} < k < 2\sqrt{5}$ or $k = 5$

E $2\sqrt{5} < k \leq 5$

F $k = 5$

8. Players A and B play games until one of them has won two games. There are no draws. In each game, A has probability $2/3$ of winning, independently of the results of the other games.

Given that A wins the contest, what is the probability that three games were played?

A $\frac{1}{4}$

B $\frac{8}{27}$

C $\frac{2}{5}$

D $\frac{4}{9}$

E $\frac{2}{3}$

9. A function f, defined for all real x, satisfies

$$f''(x) = 6x \qquad \text{and} \qquad f'(1) = 2.$$

What is the positive difference between the x-coordinates of the two points where the curve $y = f(x)$ has a horizontal tangent?

A 0

B $\dfrac{1}{\sqrt{3}}$

C $\dfrac{2}{3}$

D $\dfrac{2}{\sqrt{3}}$

E $2\sqrt{3}$

10. The integer n satisfies $n \geq 6$. In the expansion of $(1+x)^n$, the coefficients of x^4, x^5 and x^6, in that order, form an arithmetic progression.

What is the sum of all possible values of n?

A 0

B 7

C 14

D 17

E 21

11. A polynomial $P(x)$ has degree 4 and leading coefficient 1. It is divisible by $x^2 + 1$. When $P(x)$ is divided by $x^2 - 1$, the remainder is $4x + 6$.

What is $P(2)$?

A 10

B 14

C 50

D 70

E 90

12. There are two distinct circles which pass through both $(1, 0)$ and $(5, 0)$ and are tangent to the line $y = x$.

What is the sum of their areas?

A 38π

B 42π

C 44π

D 46π

E 56π

13. A histogram represents waiting times t, in minutes. Its classes and frequency densities are shown below.

Waiting time	$0 \leq t < 4$	$4 \leq t < 12$	$12 \leq t < 24$
Frequency density	2	1	1

The lower and upper quartiles are estimated by linear interpolation at one-quarter and three-quarters of the total frequency, respectively.

What is the estimated interquartile range, in minutes?

A $\frac{27}{4}$

B 10

C $\frac{27}{2}$

D 16

E 17

14. The function f is given by

$$f(x) = a\cos(bx) + c,$$

where x is measured in radians and a and b are positive constants. The maximum value of f is 7, its minimum value is 1, and its least positive period is $2\pi/3$.

What is $f(\pi/9)$?

A $\frac{3}{2}$

B $\frac{5}{2}$

C $\frac{9}{2}$

D $\frac{11}{2}$

E 7

15. The curve C has equation

$$y = x^4 - 6x^2.$$

For a real number a, let L_a be the tangent to C at the point with x-coordinate a.

For which values of a is every point of C on or above L_a?

A $a \leq -1$ or $a \geq 1$

B $a < -\sqrt{3}$ or $a > \sqrt{3}$

C $-\sqrt{3} \leq a \leq \sqrt{3}$

D $a \leq -\sqrt{3}$ or $a \geq \sqrt{3}$

E $a \geq \sqrt{3}$

F $a \leq -\sqrt{2}$ or $a \geq \sqrt{2}$

16. The expression

$$\left(2x^2 - \frac{1}{x}\right)^6$$

is expanded as a sum of powers of x, where $x \neq 0$.

What is the sum of the coefficients of all the terms in which the power of x is negative?

A -12

B -11

C 1

D 13

E 49

17. For certain real values of k, the equation

$$x^4 - 6x^3 + (k^2 + 13)x^2 - (2k + 12)x + 5 = 0$$

has at least one real solution for x.

What is the sum of all these distinct values of k?

A $-\frac{3}{2}$

B $\frac{1}{2}$

C 1

D $\frac{3}{2}$

E 3

18. A three-digit positive integer N has digits whose sum is 12. Its tens digit is the arithmetic mean of its hundreds digit and its units digit.

Reversing the order of its digits gives a number that is 198 less than N.

What is the hundreds digit of N?

A 3

B 4

C 5

D 6

E 8

19. In trapezium $ABCD$, the vertices are named in order around its boundary and AB is parallel to DC. The lengths are

$$AB = 6, \qquad DC = 2, \qquad AD = 4.$$

The diagonals AC and BD are perpendicular.

What is the area of the trapezium?

A $2\sqrt{15}$

B $8\sqrt{3}$

C $4\sqrt{15}$

D 16

E $6\sqrt{15}$

20. The function f is defined by

$$f(x) = \frac{2x+3}{x+2}, \qquad x \neq -2.$$

For which real values of x is $f(f(x)) > 1$?

A $x > -\frac{5}{3}$

B $x < -\frac{7}{4}$ or $x > -\frac{5}{3}$

C $x < -2$ or $-2 < x < -\frac{7}{4}$ or $x > -\frac{5}{3}$

D $-\frac{7}{4} < x < -\frac{5}{3}$

E $x < -2$ or $-2 < x < -\frac{7}{4}$ or $x \geq -\frac{5}{3}$