ESAT-style practice paper

Set B Maths 1

Mathematics 1

TIME ALLOWED
40
MINUTES

27 multiple-choice questions

An average of 89 seconds per question.

Instructions

- Attempt all 27 questions.
- Calculators are *not* permitted.
- No formula booklet is provided.
- Use scrap paper or a whiteboard for rough working.

Information

- Each question has one correct answer and is worth one mark.
- No marks are deducted for incorrect answers.
- The questions are not arranged in order of difficulty.
- The ESAT itself is taken on a computer, with erasable sheets for rough working.

Questions

Question 1 *Algebra* 2
Question 2 *Algebra* 3
Question 3 *Probability & Counting* 4
Question 4 *Geometry* 5
Question 5 *Number* 6
Question 6 *Algebra* 7
Question 7 *Functions & Graphs* 8
Question 8 *Algebra* 9
Question 9 *Number* 10
Question 10 *Sequences & Series* 11
Question 11 *Algebra* 12
Question 12 *Geometry* 13
Question 13 *Probability & Counting* 14
Question 14 *Geometry* 15
Question 15 *Algebra* 16
Question 16 *Coordinate Geometry* 17
Question 17 *Polynomials* 18
Question 18 *Trigonometry* 19
Question 19 *Geometry* 20
Question 20 *Number* 21
Question 21 *Geometry* 22
Question 22 *Trigonometry* 23
Question 23 *Geometry* 24
Question 24 *Coordinate Geometry* 25
Question 25 *Coordinate Geometry* 26
Question 26 *Probability & Counting* 27
Question 27 *Algebra* 28

Algebra

1. Evaluate

$$(\sqrt{50} - \sqrt{8})(\sqrt{18} + \sqrt{2})$$

A 4

B 12

C 24

D 28

E 48

F 56

Algebra

2. Which one of the following is a simplification of

$$\frac{\dfrac{4}{x-2}-1}{x-6}$$

where it is defined?

A $\dfrac{1}{x-2}$

B $-\dfrac{1}{x+2}$

C $-\dfrac{1}{x-2}$

D $\dfrac{1}{x+2}$

E $\dfrac{x-6}{x-2}$

F $\dfrac{x-2}{x-6}$

G $\dfrac{2-x}{(x-2)(x-6)}$

Probability & Counting

3. In a year group, 70% of students study French and 50% study Spanish.

Every student studies at least one of these languages.

A student is chosen at random from those who study exactly one of these languages.

What is the probability that this student studies French?

A $\frac{3}{8}$

B $\frac{1}{2}$

C $\frac{7}{12}$

D $\frac{5}{8}$

E $\frac{7}{10}$

F $\frac{5}{7}$

Geometry

4. A sector of a circle has radius 6 cm.

The area of the sector is $15\pi\,\text{cm}^2$.

What is the perimeter of the sector, in cm?

A 5π

B $6 + 5\pi$

C $12 + \dfrac{5\pi}{2}$

D $12 + 5\pi$

E $6 + 10\pi$

F $12 + 10\pi$

G $12 + 15\pi$

Number

5. A container is full of a mixture of red paint and white paint in the ratio 2 : 3.
Some of the mixture is removed and replaced by the same volume of white paint.
The container is now full, and the ratio of red paint to white paint is 1 : 2.
The same volume of mixture is then removed again and replaced by red paint.
What is the final ratio of red paint to white paint?

A 1 : 2

B 3 : 5

C 2 : 3

D 3 : 4

E 4 : 5

F 1 : 1

Algebra

6. A cuboid has three faces that meet at one corner.

The areas of these three faces are 6 cm^2, 10 cm^2 and 15 cm^2.

What is the distance, in cm, between two opposite corners of the cuboid?

A $\sqrt{30}$

B $\sqrt{31}$

C $\sqrt{38}$

D $\sqrt{50}$

E 10

F 19

Functions & Graphs

7. The speed–time graph below shows a car's journey, where t is the time in seconds.

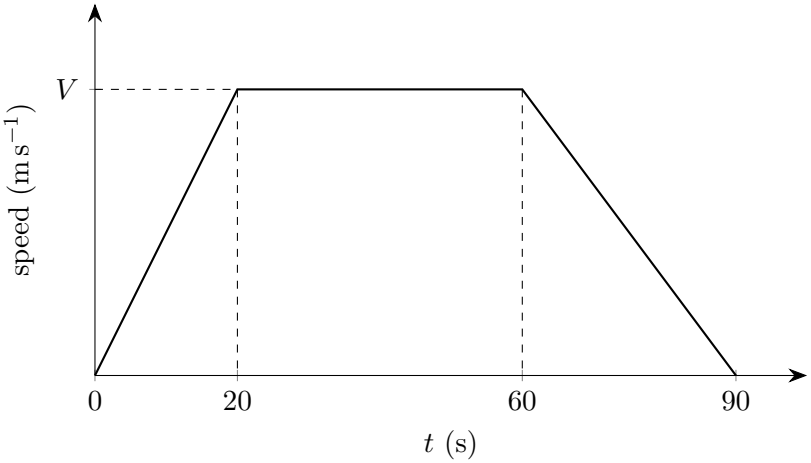
The car starts from rest at $t = 0$ and accelerates uniformly until it reaches a speed of $V\,\mathrm{m\,s^{-1}}$ at $t = 20$.

The car travels at this constant speed until $t = 60$.

It then decelerates uniformly and comes to rest at $t = 90$.

The total distance travelled by the car is 1.3 km.

At what value of t has the car travelled exactly half of the total distance?



A 32.5

B 37.5

C 40

D 42.5

E 45

F 47.5

Algebra

8. The maximum load L supported by a beam is directly proportional to the square of its width w and inversely proportional to its length ℓ.

A beam of width 4 cm and length 6 m supports a maximum load of 240 kg.

A second beam of the same type has width 6 cm and length 9 m.

What is the maximum load supported by the second beam?

A 160 kg

B 240 kg

C 360 kg

D 540 kg

E 810 kg

Number

9. A metal block has a mass of 0.72 kg, correct to the nearest 0.01 kg.
The volume of the block is 80 cm^3, correct to the nearest 10 cm^3.
What is the upper bound for the density of the metal, in g cm^{-3}?

A $\frac{143}{17}$

B $\frac{145}{17}$

C 9

D $\frac{143}{15}$

E $\frac{29}{3}$

F $\frac{73}{7}$

Sequences & Series

10. The nth term of a sequence is $an^2 + bn + c$, where a, b and c are constants.

The 2nd term of the sequence is 34.

The 3rd term of the sequence is 22.

The 4th term of the sequence is equal to the 7th term.

What is the smallest term of the sequence?

A 6

B 8

C 9.5

D 10

E 12

F 14

Algebra

11. A price is increased by $p\%$, and the new price is then decreased by $p\%$.
The final price is 1% less than the original price.
Given that $p > 0$, what is the value of p?

A 0.1

B 0.5

C 1

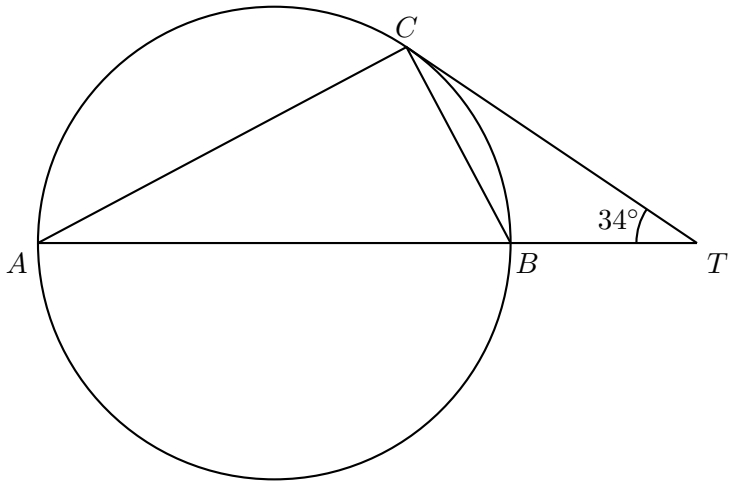
D 5

E 10

F 100

Geometry

12. Points A, B and C lie on a circle. The line segment AB is a diameter.
The tangent to the circle at C meets the line AB, extended beyond B, at T.
The angle BTC is 34°
What is the angle BAC?



A 17°

B 28°

C 34°

D 56°

E 62°

F 73°

Probability & Counting

13. A bag contains 4 red counters, 3 blue counters and 2 green counters.

Two counters are taken at random from the bag, without replacement.

The two counters are of different colours.

Given this, what is the probability that one of the two counters is green?

A $\frac{7}{26}$

B $\frac{7}{18}$

C $\frac{5}{12}$

D $\frac{7}{13}$

E $\frac{15}{26}$

Geometry

14. Rectangle $ABCD$ has $AB = 6$ cm and $BC = 8$ cm.
Vertex B is reflected in the line AC to the point B'.
What is the length BB'?

A $\frac{12}{5}$ cm

B $\frac{14}{5}$ cm

C $\frac{24}{5}$ cm

D $\frac{48}{5}$ cm

E 10 cm

F $\frac{96}{5}$ cm

Algebra

15. The variables a, b and c are non-zero and satisfy

$$\frac{2}{a} = \frac{3}{b} - \frac{4}{c}$$

Which one of the following is a rearrangement to make c the subject?

A $c = \dfrac{4ab}{2a - 3b}$

B $c = \dfrac{4ab}{2a + 3b}$

C $c = \dfrac{4ab}{3a - 2b}$

D $c = \dfrac{4ab}{3a + 2b}$

E $c = \dfrac{4ab}{2b - 3a}$

F $c = \dfrac{4ab}{3b - 2a}$

Coordinate Geometry

16. The points A and B have coordinates $(-2, 0)$ and $(8, 0)$.
The point P has coordinates (x, y), where $y > 0$.
The angle APB is $90°$.
What is the largest possible area of triangle APB?

A 12.5

B 20

C 25

D 40

E 50

Polynomials

17. A curve has equation $y = ax^2 + bx + c$, where a, b and c are constants.
The curve crosses the x-axis at the points $(-1, 0)$ and $(5, 0)$.
The curve also passes through the point $(1, -16)$.
What are the coordinates of the turning point of the curve?

A $(-2, -18)$

B $(2, -9)$

C $(2, -10)$

D $(2, -16)$

E $(2, -18)$

F $(2, 18)$

Trigonometry

18. A vertical tower stands on horizontal ground.

The points P and Q lie on the ground in a straight line with the foot of the tower, with Q between P and the foot of the tower.

$PQ = 10\,\text{m}$.

The angle of elevation of the top of the tower from P is $30°$.

The angle of elevation of the top of the tower from Q is $45°$.

What is the height of the tower, in metres?

A $5(\sqrt{3} - 1)$

B $5\sqrt{3}$

C $5(\sqrt{3} + 1)$

D $10\sqrt{3}$

E $5(3 + \sqrt{3})$

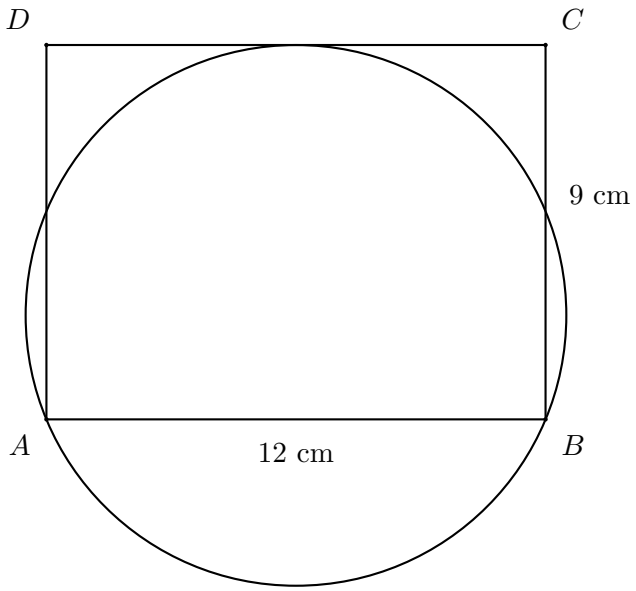
F $10(\sqrt{3} + 1)$

Geometry

19. $ABCD$ is a rectangle with $AB = 12$ cm and $BC = 9$ cm.

A circle passes through A and B, and touches the side DC at exactly one point.

What is the radius of the circle, in cm?



A 4.5

B 6

C 6.5

D 7.5

E 9

F 12.5

Number

20. Which of the following is a simplification of

$$\frac{\sqrt{18}}{\sqrt{6}-\sqrt{2}}$$

A $\dfrac{3\sqrt{3}-3}{2}$

B $\dfrac{\sqrt{3}+1}{2}$

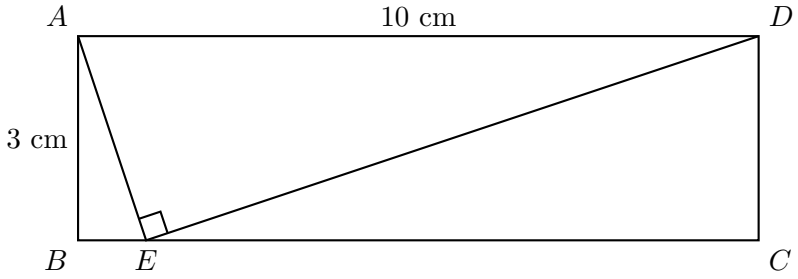
C $\dfrac{3\sqrt{3}+1}{2}$

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

E $3\sqrt{3}+3$

Geometry

21. $ABCD$ is a rectangle with $AB = 3$ cm and $AD = 10$ cm.
Point E lies on BC, and $\angle AED = 90°$
What is the value of $BE \times EC$?



A 9 cm^2

B 18 cm^2

C 41 cm^2

D 50 cm^2

E 82 cm^2

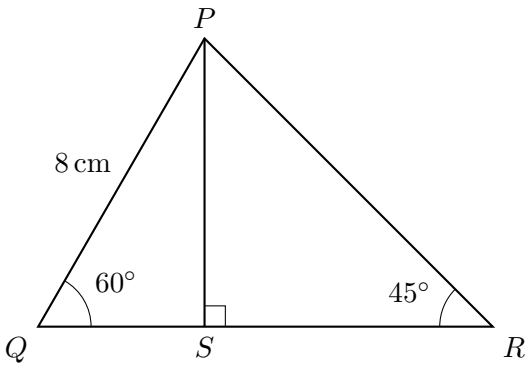
Trigonometry

22. In triangle PQR, the point S lies on QR and PS is perpendicular to QR.

$PQ = 8\,\text{cm}$.

Angle $PQR = 60°$ and angle $PRQ = 45°$.

What is the area of triangle PQR, in cm^2?



A $8 + 8\sqrt{3}$

B $24 + 8\sqrt{3}$

C $24\sqrt{2} + 8\sqrt{3}$

D $24 + 24\sqrt{3}$

E $48 + 16\sqrt{3}$

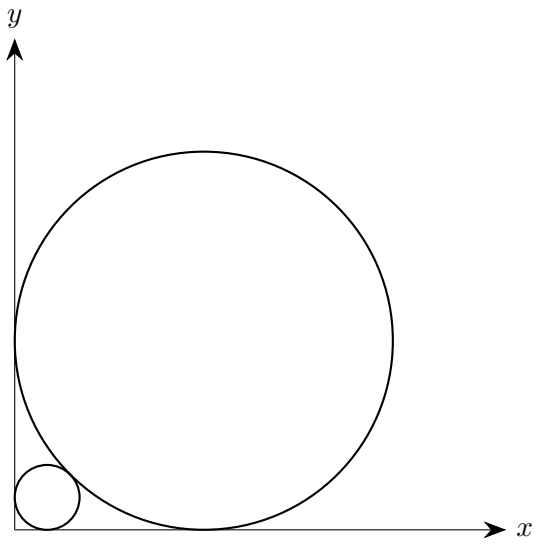
Geometry

23. A circle of radius 1 lies in the region where $x \geq 0$ and $y \geq 0$, and touches both axes.

A second, smaller circle also lies in this region, touches both axes, and touches the first circle at exactly one point.

The two circles do not overlap.

What is the radius of the smaller circle?



A $\frac{1}{3}$

B $3 - 2\sqrt{2}$

C $\sqrt{2} - 1$

D $\frac{\sqrt{2} - 1}{2}$

E $2 - \sqrt{2}$

F $17 - 12\sqrt{2}$

G $3 + 2\sqrt{2}$

Coordinate Geometry

24. The curve C has equation $y = \dfrac{k}{x}$, where k is a positive constant.

A straight line meets the positive x-axis at A and the positive y-axis at B

The line meets C at two points P and Q, both of which lie on the segment AB

$AP = PQ = QB$

The triangle with vertices O, A and B, where O is the origin, has area 36

What is the value of k?

A 4

B 8

C 9

D 12

E 16

F 18

G 24

Coordinate Geometry

25. The point A has coordinates $(-1, 3)$.

The point B has coordinates $(5, -1)$.

The line ℓ passes through the midpoint of AB and is perpendicular to AB.

The line ℓ meets the x-axis at the point P.

What is the x-coordinate of P?

A -2

B $\frac{1}{2}$

C $\frac{4}{3}$

D $\frac{8}{3}$

E $\frac{7}{2}$

F $\frac{13}{3}$

Probability & Counting

26. The cards numbered $1, 2, 3, 4, 5$ are placed in a random order, with every order equally likely. An adjacent pair of cards is called mixed if one number is odd and the other number is even. What is the probability that there is exactly one mixed adjacent pair?

A $\frac{1}{12}$

B $\frac{1}{10}$

C $\frac{1}{6}$

D $\frac{1}{5}$

E $\frac{1}{4}$

F $\frac{2}{5}$

Algebra

27. The line $y = mx + 4$ has positive gradient.

It meets the graph of $y = x^2$ at two points whose horizontal distance apart is 6.

What is the value of m?

A $\sqrt{5}$

B $2\sqrt{3}$

C $2\sqrt{5}$

D $4\sqrt{2}$

E $2\sqrt{13}$

F $8\sqrt{2}$