ESAT-style practice paper

Set A 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.

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Number

1. Which of the following is a simplification of

$$\sqrt{28} - \frac{4}{\sqrt{7} + \sqrt{3}}$$

A $\sqrt{7} - 2\sqrt{3}$

B $\sqrt{7} - \sqrt{3}$

C $\sqrt{7} + \sqrt{3}$

D $3\sqrt{7} - \sqrt{3}$

E $3\sqrt{7} + \sqrt{3}$

Probability & Counting

2. There are 120 students in a year group.

Of these students, 70 study French, 45 study Spanish and 20 study neither French nor Spanish.

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

What is the probability that this student studies French?

A $\frac{11}{24}$

B $\frac{11}{20}$

C $\frac{7}{12}$

D $\frac{14}{23}$

E $\frac{11}{17}$

F $\frac{11}{14}$

Algebra

3. Which one of the following is a simplification of the expression below, for all values of x for which the expression is defined?

$$\frac{x^2-9}{2x^2+5x-3} \div \frac{x^2-x-6}{4x^2-1}$$

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

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

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

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

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

F $\dfrac{(x-3)^2(x+2)}{(2x-1)^2(2x+1)}$

Algebra

4. u is inversely proportional to the square root of v, where u and v are positive.

The value of v is decreased by 36%.

What is the percentage increase in u?

A 20%

B 25%

C 36%

D 56.25%

E 80%

F 125%

Inequalities

5. A balance displays the actual mass of an object plus a fixed error, which may be positive, negative or zero.

Two boxes give readings of 10 kg and 16 kg on this balance.

The actual mass of the lighter box is at least half and at most three quarters of the actual mass of the heavier box.

Let T be the combined actual mass of the two boxes, in kilograms.

What is the complete range of possible values of T?

A $12 \leq T \leq 36$

B $12 \leq T \leq 42$

C $18 \leq T \leq 36$

D $18 \leq T \leq 42$

E $24 \leq T \leq 48$

Sequences & Series

6. The first four terms of a quadratic sequence are

$$4, \quad 9, \quad 18, \quad 31$$

One term of this sequence is equal to 381.
Which term of the sequence is equal to 381?

A the 12th term

B the 13th term

C the 14th term

D the 15th term

E the 16th term

F the 19th term

G the 20th term

Algebra

7. The variables t and x are related by the formula

$$t = \sqrt{\frac{3x + k}{x - 2}}$$

where k is a constant.

Which of the following is a rearrangement of this formula to make x the subject?

A $x = \dfrac{2t + k}{t - 3}$

B $x = \dfrac{k + 2}{t^2 - 3}$

C $x = \dfrac{2t^2 - k}{t^2 - 3}$

D $x = \dfrac{2t^2 + k}{t^2 - 3}$

E $x = \dfrac{2t^2 + k}{t^2 + 3}$

F $x = \dfrac{2t^2 + k}{3 - t^2}$

Algebra

8. The three faces of a cuboid that meet at one vertex have diagonals of lengths 5, $\sqrt{34}$ and $\sqrt{41}$. What is the length of a straight line joining two opposite vertices of the cuboid?

A $5\sqrt{2}$

B $\sqrt{66}$

C $6\sqrt{2}$

D $5\sqrt{3}$

E 10

F 12

Algebra

9. A rectangle has sides L and W, where L and W are positive.
Side L is increased by 25%. Side W is adjusted so that the area of the rectangle is unchanged.
The resulting perimeter is 5% less than the original perimeter.
What was the original ratio $W : L$?

A $1 : 2$

B $4 : 5$

C $1 : 1$

D $5 : 4$

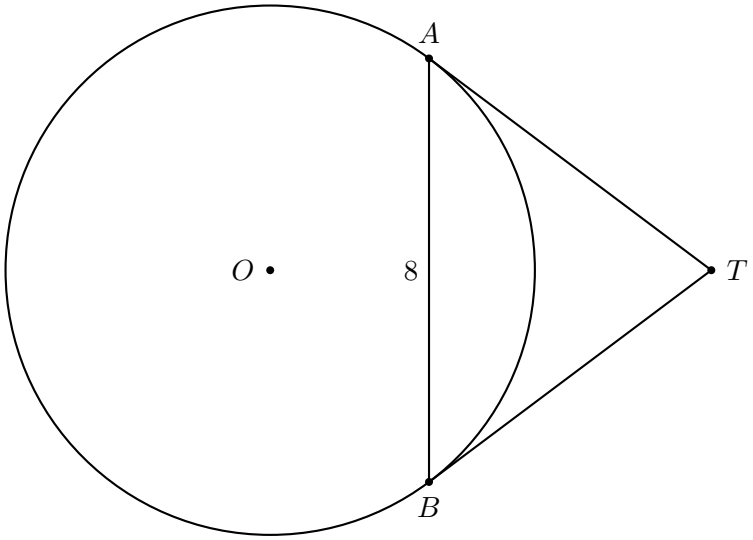
E $3 : 2$

F $2 : 1$

Geometry

10. A circle has centre O and radius 5. The chord AB has length 8. The tangents to the circle at A and B meet at T, as shown.

What is the area of triangle ATB?



A 12

B 16

C $\frac{64}{3}$

D $\frac{80}{3}$

E $\frac{100}{3}$

Polynomials

11. k is a constant.

The equation $x^2 + 5x + k = 0$ and the equation $x^2 + 3x - k = 0$ have a common solution.

This common solution is not zero.

What is the value of k?

A -4

B -2

C 0

D 2

E 4

F 8

Coordinate Geometry

12. Points A and B have coordinates $(0, 0)$ and $(6, 0)$ respectively.

A point P lies on the line $y = 2x$

The distances PA and PB are in the ratio $1 : 2$

There are two possible positions for P

What is the distance between these two positions?

A $\frac{8\sqrt{5}}{5}$

B $\frac{16}{5}$

C $\frac{32}{5}$

D $\frac{16\sqrt{5}}{5}$

E $\frac{16\sqrt{17}}{5}$

Geometry

13. A sector of a circle has radius 10 cm and angle 216°.

The two straight edges of the sector are joined, with no overlap, to form the curved surface of a cone.

The volume of a cone is $\frac{1}{3}\pi r^2 h$, where r is the radius of the base and h is the perpendicular height.

What is the volume of the cone, in cm^3?

A 96π

B 120π

C 128π

D 288π

E 360π

F 384π

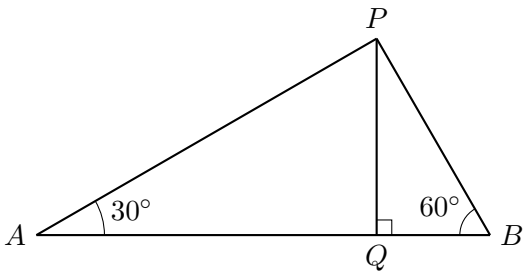
Trigonometry

14. A vertical pole PQ stands on horizontal ground.

The points A, Q and B lie in a straight line on the ground, with Q between A and B, and $AB = 40\,\text{m}$.

The angles of elevation of P from A and B are $30°$ and $60°$, respectively.

What is the height of the pole?



A $\dfrac{20\sqrt{3}}{3}\,\text{m}$

B $10\sqrt{3}\,\text{m}$

C $\dfrac{40\sqrt{3}}{3}\,\text{m}$

D $20\sqrt{3}\,\text{m}$

E $40\sqrt{3}\,\text{m}$

Number

15. A tank contains 620 litres of water, correct to the nearest 10 litres.

The tank is emptied at a constant rate of 13 litres per minute, correct to the nearest litre per minute.

What is the upper bound for the time, in minutes, taken to empty the tank?

A $45\frac{5}{9}$

B $47\frac{9}{13}$

C $48\frac{1}{13}$

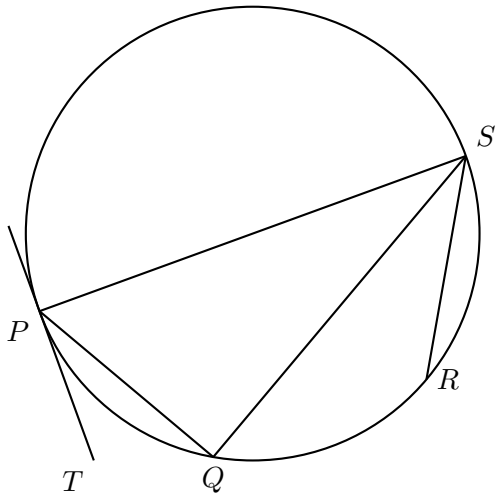
D $49\frac{1}{5}$

E $49\frac{3}{5}$

F 50

Geometry

16. In the diagram, P, Q, R and S lie on a circle, in that order going round the circumference.
The line through P and T is a tangent to the circle at P.
Angle $TPQ = 48°$ and angle $QSR = 41°$
Find angle PSR.



A 41°

B 65°

C 83°

D 89°

E 91°

F 137°

Probability & Counting

17. Bag A contains 3 red counters and 2 blue counters.

Bag B contains 2 red counters and 4 blue counters.

A fair six-sided die is rolled once.

If the die shows a 6, one counter is taken at random from bag A; otherwise, one counter is taken at random from bag B.

The counter taken is red.

What is the probability that it was taken from bag A?

A $\frac{1}{10}$

B $\frac{1}{6}$

C $\frac{9}{34}$

D $\frac{9}{25}$

E $\frac{17}{45}$

F $\frac{3}{5}$

G $\frac{25}{34}$

Coordinate Geometry

18. The points A and B have coordinates $(4, 4)$ and $(0, 2)$ respectively.
The point C lies on the straight line with equation $y = 2x + 3$.
The distance from A to C is equal to the distance from B to C.
What is the area of triangle ABC?

A $\frac{5}{2}$

B 5

C 6

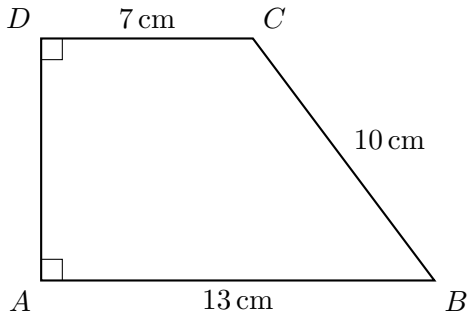
D $5\sqrt{2}$

E 10

F 12

Geometry

19. The trapezium $ABCD$ has parallel sides AB and CD.
Angles DAB and ADC are right angles.
The lengths are $AB = 13\,\text{cm}$, $CD = 7\,\text{cm}$ and $BC = 10\,\text{cm}$.
What is the area of the trapezium?



A $40\,\text{cm}^2$

B $52\,\text{cm}^2$

C $60\,\text{cm}^2$

D $80\,\text{cm}^2$

E $100\,\text{cm}^2$

F $104\,\text{cm}^2$

Number

20. A printer produces 2400 identical labels.
Each label uses 3.2×10^{-5} litres of ink.
The ink costs £12.50 per litre.
What is the total cost of the ink used?

A £0.0096

B £0.096

C £0.96

D £9.60

E £96

F £960

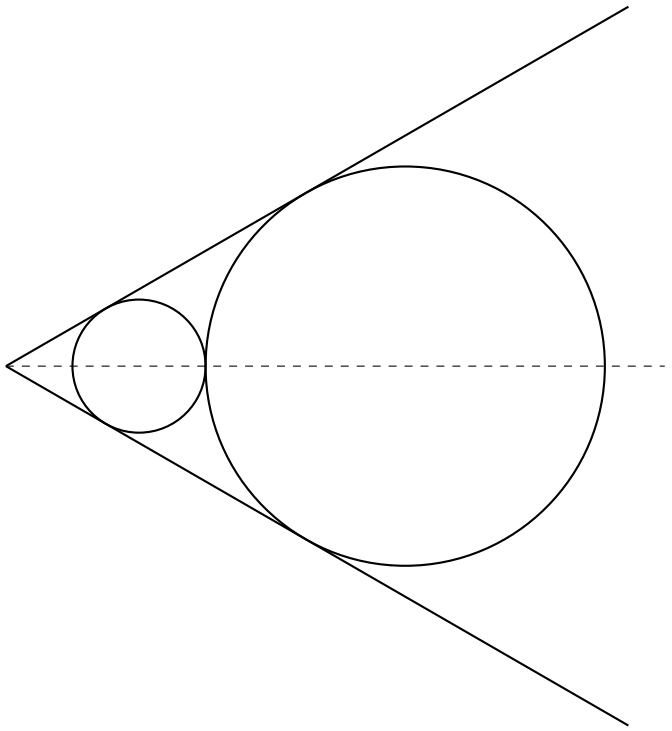
Geometry

21. Two circles lie inside an angle of 60°.

Each circle touches both arms of the angle, and the circles also touch each other.

The smaller circle is nearer the vertex of the angle and has radius 2 cm.

What is the radius of the larger circle?



A 3 cm

B 4 cm

C 6 cm

D 8 cm

E 12 cm

Probability & Counting

22. A bag contains 3 red counters and 5 blue counters.

Two counters are taken at random, one at a time, without replacement.

What is the probability that the two counters are different colours?

A $\frac{3}{28}$

B $\frac{15}{56}$

C $\frac{5}{14}$

D $\frac{13}{28}$

E $\frac{15}{32}$

F $\frac{15}{28}$

Algebra

23. A worker is paid a basic hourly rate for the first 32 hours worked each week.
Additional hours are paid at 1.5 times the basic hourly rate.
The worker earns £528 for working 40 hours in one week.
What is the basic hourly rate?

A £8.80

B £11.00

C £12.00

D £13.20

E £16.50

Geometry

24. A rectangle $ABCD$ has side lengths $AB = 2k$ and $AD = k$, where k is a positive constant.

The point E lies on the side AB such that $AE = x$

The point F lies on the side BC such that $BF = x$

What is the minimum possible area of triangle DEF as x varies?

A $\frac{1}{2}k^2$

B $\frac{5}{8}k^2$

C $\frac{3}{4}k^2$

D $\frac{7}{8}k^2$

E k^2

F $\frac{9}{8}k^2$

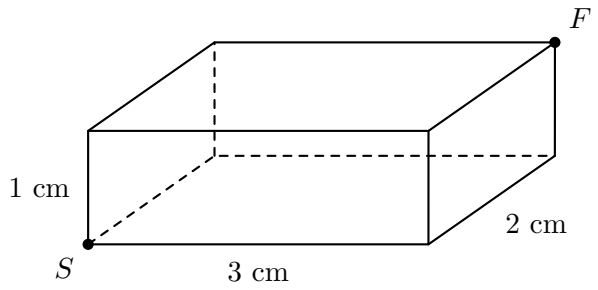
Geometry

25. A solid cuboid has edges of length 1 cm, 2 cm and 3 cm.

An ant starts at one corner S of the cuboid and crawls across the outside surfaces to the corner F furthest from it. That is, the corner not sharing any face with the starting corner.

The ant may cross any face but cannot pass through the inside of the cuboid.

What is the shortest possible distance the ant travels?



A $\sqrt{14}$ cm

B $3\sqrt{2}$ cm

C $2\sqrt{5}$ cm

D $1 + \sqrt{13}$ cm

E $\sqrt{26}$ cm

F 6 cm

Polynomials

26. The graph of $y = 2x^2 - 12x + k$, where k is a constant, has its turning point on the line $y = -x$.
The graph crosses the x-axis at two points.
What is the distance between these two points?

A $\frac{\sqrt{6}}{2}$

B $\sqrt{3}$

C $\sqrt{6}$

D $2\sqrt{3}$

E $2\sqrt{6}$

F $4\sqrt{6}$

Sequences & Series

27. Define a sequence a_n on the positive integers by $a_1 = 1$ and, for $n \geq 1$,

$$a_{n+1} = \begin{cases} 2a_n + 1 & \text{if } a_n \text{ is even,} \\ \dfrac{a_n - 1}{2} & \text{if } a_n \text{ is odd} \end{cases}$$

What is the value of a_{2025}?

A 0

B 1

C 2

D 3

E 4