THE ASSOCIATION OF MATHEMATICS TEACHERS OF INDIA

Screening Test – Bhaskara Contest

NMTC at JUNIOR LEVEL – IX & X Standards

Saturday, 26th August, 2017

Note:

1. Fill in the response sheet with your Name, Class and the institution through which you appear in the specified places.
2. Diagrams are only visual aids; they are NOT drawn to scale.
3. You are free to do rough work on separate sheets.
4. Duration of the test: 2 pm to 4 pm – 2 hours.

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PART – A

Note

- Only one of the choices A, B, C, D is correct for each question. Shade the alphabet of your choice in the response sheet. If you have any doubt in the method of answering, seek the guidance of the supervisor.
- For each correct response you get 1 mark. **For each incorrect response you lose $\frac{1}{2}$ mark.**

1. If m is a real number such that $m^2+1=3m$, the value of

$$\frac{2m^5-5m^4+2m^3-8m^2}{m^2+1}$$

is A. 1 B. 2 C. -1 D. -2

2. Consider the equation $\frac{7x}{2}-a=\frac{5x}{3}+9$. The least positive a for which the solution x to the equation is a positive integer is

A. 1 B. 2 C. 3 D. 4

3. If $x=2017$ and $y=\frac{1}{2017}$, the value of

$$\left\{\frac{\frac{x}{y}+2}{\frac{x}{y}+1}+\frac{x}{y}\right\}\div\left\{\frac{x}{y}+2-\frac{\frac{x}{y}}{\frac{x}{y}+1}\right\}$$

is A. 2017 B. 2017^2 C. $\frac{1}{2017^2}$ D. 1

4. The ratio of an interior angle of a regular pentagon to an exterior angle of a regular decagon is

A. 4 : 1 B. 3 : 1 C. 2 : 1 D. 7 : 3

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5. The smallest integer x which satisfies the inequality $\dfrac{x-5}{x^2+5x-14} > 0$ is

A. -8 B. -6 C. 0 D. 1

6. If x and y satisfy the equations

$$\sqrt{\frac{20y}{x}} = \sqrt{x+y} + \sqrt{x-y}$$
$$\sqrt{\frac{16x}{5y}} = \sqrt{x+y} - \sqrt{x-y}$$

the value of $x^2 + y^2$ is

A. 2 B. 16 C. 25 D. 41

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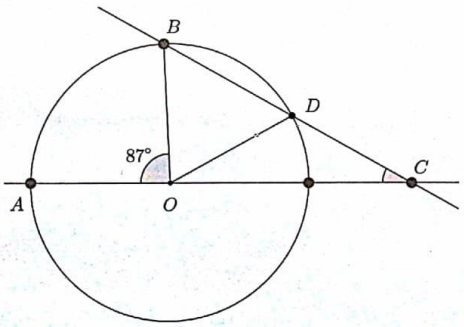
7. 125% of a number x is y. What percentage of $8y$ is $5x$?

A. 30% B. 40% C. 50% D. 60%

8. In the adjoining figure, O is the center of the circle and $OD = DC$. If $\angle AOB = 87°$, the measure of the angle $\angle OCD$ is

A. 27° B. 28° C. 29° D. 19°



9. a, b, c, d, e are real numbers such that

$$\frac{a}{b} = \frac{2}{3}, \quad \frac{b}{c} = \frac{1}{3}, \quad \frac{c}{d} = \frac{1}{4}, \quad e = \frac{ac}{b^2 + c^2}$$

The value of e is

A. $\frac{1}{9}$ B. $\frac{2}{9}$ C. $\frac{1}{5}$ D. $\frac{2}{5}$

10. The length and breadth of a rectangular field are integers. The area is numerically 9 more than the perimeter. The perimeter is

A. 24 B. 32 C. 36 D. 40

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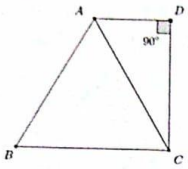


11. $ABCD$ is a trapezium in which ABC is an equilateral triangle with area $9\sqrt{3}$ square units. If $\angle ADC = 90°$, the area of the trapezium in square units is

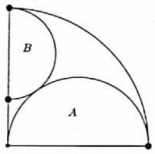
A. $12\sqrt{3}$ B. $\frac{15\sqrt{3}}{2}$ C. $\frac{27\sqrt{3}}{2}$ D. $\frac{35\sqrt{3}}{2}$

12. p is a prime number such that $p^2 - 8p - 65 > 0$. The smallest value of p is

A. 7 B. 11 C. 13 D. 17

13. The least positive integer n such that $2015^n + 2016^n + 2017^n$ is divisible by 10 is

A. 1 B. 3 C. 4 D. None of these



14. In a quadrant of a circle of diameter 4 units semicircles are drawn as shown. The radius of the smaller circle (B) is

A. $\frac{1}{2}$ B. $\frac{1}{3}$ C. $\frac{2}{3}$ D. $\frac{3}{4}$

15. The product of two positive integers is twice their sum; the product is also equal to six times the difference between the two integers. The sum of these integers is

A. 6 B. 7 C. 8 D. 9

PART – B

Note

- Write the correct answer in the space provided in the response sheet.
- For each correct response you get 1 mark. **For each incorrect response you lose $\frac{1}{4}$ mark.**

16. n is a natural number such that n minus 12 is the square of an integer and n plus 19 is the square of another integer. The value of n is ———

17. The number of there digit numbers which have odd number of factors is ———

18. The positive integers a, b, c are connected by the inequality

$$a^2 + b^2 + c^2 + 3 < ab + 3b + 2c$$

then the value of $a + b + c$ is ———

19. The sum of all roots of the equation $|3x - |1 - 2x|| = 2$ is ———

20. PQR is a triangle with $PQ = 15, QR = 25, RP = 30$. A, B are points on PQ and PR respectively such that $\angle PBA = \angle PQR$. The perimeter of the triangle PAB is 28, then the length of AB is ———

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21. A hare sees a hound 100 m away from her and runs off in the opposite direction at a speed of 12 KM an hour. A minute later the hound perceives her and gives a chase at a speed of 16 KM an hour. The distance at which the hound catches the hare (in meters) is ———

22. Two circles touch both the arms of an angle whose measure is $60°$. Both the circles also touch each other externally. The radius of the smaller circle is r. The radius of the bigger circle (in term of r) is ———

23. a, b are distinct natural numbers such that $\frac{1}{a}+\frac{1}{b}=\frac{2}{5}$. If $\sqrt{a+b}=k\sqrt{2}$, the value of k is ———

24. The side AB of an equilateral triangle ABC is produced to D such that $BD=2AC$. The value of $\frac{CD^2}{AB^2}$ is ———

25. D and E trisect the side BC of a triangle ABC. DF is drawn parallel to AB meeting AC at F. EG is drawn parallel to AC meeting AB at G. DF and EG cut at H. Then the numerical value of $\frac{\text{Area }(ABC)}{\text{Area }(DHE)+\text{Area }(AFHG)}$ is ———

26. In an examination 70% of the candidates passed in English, 65% passed in Mathematics, 27% failed in both the subjects and 248 passed in both the subjects. The total number of candidates is ———

27. In a potato race, a bucket is placed at the starting point, which is 7 m from the first potato. The other potatoes are placed 4 m a part in a straight line from the first one. There are n potatoes in the line. Each competitor starts from the bucket, picks up the nearest potato, runs back with it, drops in the bucket, runs back to pick up the next potato, runs to the bucket and drops it and this process continues till all the potatoes are picked up and dropped in the bucket. Each competitor ran a total of 150 m. The number of potatoes is ———

28. A two digit number is obtained by either multiplying the sum of its digits by 8 and adding 1, or by multiplying the difference of its digits by 13 and adding 2. The number is ———

29. The inradius of a right angled triangle whose legs have lengths 3 and 4 is ———

30. a, b are positive reals such that $\frac{1}{a}+\frac{1}{b}=\frac{1}{a+b}$. If $\left(\frac{a}{b}\right)^3+\left(\frac{b}{a}\right)^3=2\sqrt{n}$, where n is a natural number, the value of n is ———

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PART - A

Note

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- For each correct response you get 1 mark. **For each incorrect response you lose $\frac{1}{2}$ mark.**

1. If m is a real number such that $m^2 + 1 = 3m$, the value of $\frac{2m^5 - 5m^4 + 2m^3 - 8m^2}{m^2 + 1}$ is

(A) 1 (B) 2 (C*) – 1 (D) – 2

Sol. $\frac{2m^5 + 2m^3 - 5m^4 - 8m^2}{m^2 + 1}$

$\frac{1}{3}[2m^4 + 2m^2 - 5m^3 - 8m]$

$\frac{1}{3}[2m^2 \times 3m - 5m^3 - 8m]$

$\frac{m}{3}[m^2 - 8] = \frac{m}{3}[3m - 9] = \frac{3m^2 - 9m}{3} = \frac{-3}{3} = -1.$

2. Consider the equation $\frac{7x}{2} - a = \frac{5x}{3} + 9$. The least positive a for which the solution to the equation is a positive integer is

(A) 1 (B*) 2 (C) 3 (D) 4

Sol. $\frac{7x}{2} - \frac{5x}{3} = 9 + a$

$\frac{11x}{6} = 9 + a$

$11x + 54 + 6a$

$\therefore a = 2.$

3. If $x = 2017$ and $y = \frac{1}{2017}$, the value of $\left\{\frac{\frac{x}{y} + 2}{\frac{x}{y} + 1} + \frac{x}{y}\right\} \div \left\{\frac{x}{y} + 2 - \frac{\frac{x}{y}}{\frac{x}{y} + 1}\right\}$ is

(A) 2017 (B) 2017^2 (C) $\frac{1}{2017^2}$ (D) 1

Sol. $y = \frac{1}{x}$

$$\therefore \left(\frac{x^2+2}{x^2+1}+x^2\right) \div \left(x^2+2-\frac{x^2}{x^2+1}\right)$$

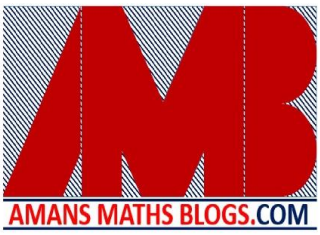
$$\left(\frac{x^2+2+x^4+x^2}{x^2+1}\right) \times \frac{x^2+1}{x^4+2x^2+x^2+2-x^2}$$

$$\frac{x^4+2x^2+2}{x^4+2x^2+2} = 1$$

4. The ratio of an interior angle of a regular pentagon to an exterior angle of a regular decagon is

(A) 4:1 (B) 3:1 (C) 2:1 (D) 7:3

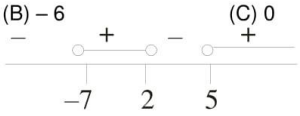
Sol. $$\text{Req ratio} = \frac{\frac{(5-2)180^\circ}{5}}{\frac{360^\circ}{10}} = \frac{3}{1}$$



5. The smallest integer x which satisfies the inequality $\frac{x-5}{x^2+5x-14} > 0$ is

(A) – 8 (B) – 6 (C) 0 (D) 1

Sol. $\frac{x-5}{(x+7)(x-2)} > 0$



smallest integer – 6

6. If x and y satisfy the equations $\sqrt{\frac{20y}{x}} = \sqrt{x+y}+\sqrt{x-y}$ $\sqrt{\frac{16x}{5y}} = \sqrt{x+y}-\sqrt{x-y}$ the value of $x^2 + y^2$ is

(A) 2 (B) 16 (C) 25 (D*) 41

Sol. Multiply

$$\sqrt{\frac{20\times16}{5}} = x + y - (x - y)$$

$8 = 2y$

$y = 4$

Add $\sqrt{\frac{20y}{x}}+\sqrt{\frac{16x}{5y}} = 2\sqrt{x+y}$.

$$\frac{20}{x}+\frac{x}{5} = x \quad \Rightarrow \quad x = 5$$

$\therefore \quad x^2 + y^2 = 41$

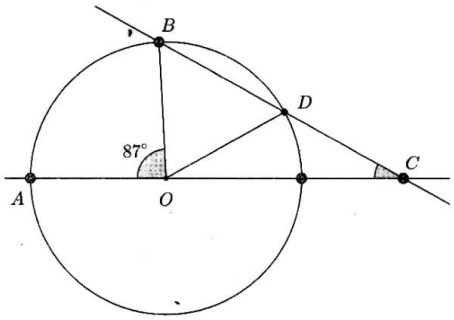
7. 125% of a number x is y . What percentage of 8y is 5x?

(A) 30% (B) 40% (C*) 50% (D) 60%

Sol. $\frac{125}{100}x = y \quad \Rightarrow \quad 5x = 4y \quad \Rightarrow \quad \frac{x}{y} = \frac{4}{5}$

$$\frac{5x}{8y}\times100 = \frac{5}{8}\times\frac{4}{5} \times 100 = 50\%.$$

8. In the adjoining figure, 0 is the center of the circle and OD = DC. If ∠AOB = 87º, the measure of the angle ∠OCD is



(A) 27° (B) 28° (C*) 29° (D) 19°

Sol. As OD = DC $\Rightarrow$ $\angle DOC = \angle DCO = \theta$

$\Rightarrow$ $\angle ODC = 180 - 2\theta$

$\Rightarrow$ $\angle ODB = \angle OBD = 2\theta$

$\Rightarrow$ $\angle BOD = 93 - \theta$

In ΔBOD

$93 - \theta + 2\theta + 2\theta = 180°$

$3\theta = 87$

$\theta = 29.$

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9. a, b, c, d, e are real numbers such that $\frac{a}{b}=\frac{2}{3},\frac{b}{c}=\frac{1}{3},\frac{c}{d}=\frac{1}{4},e=\frac{ac}{b^2+c^2}$. The value of e is

(A) $\frac{1}{9}$ (B) $\frac{2}{9}$ (C*) $\frac{1}{5}$ (D) $\frac{2}{5}$

Sol. $\frac{a}{b}=\frac{2}{3},\ \frac{b}{c}=\frac{1}{3},\ \frac{c}{d}=\frac{1}{4} \Rightarrow \frac{a}{c}=\frac{2}{9}.$

$$e=\frac{ac}{b^2+c^2}=\frac{1}{\frac{b}{a}\cdot\frac{b}{c}+\frac{c}{a}}=\frac{1}{\frac{3}{2}\times\frac{1}{3}+\frac{9}{2}}=\frac{1}{\frac{1}{2}+\frac{9}{2}}=\frac{2}{10}=\frac{1}{5}.$$

10. The length and breadth of a rectangular field are integers. The area is numerically 9 more than the perimeter. The perimeter is

(A) 24 (B) 32 (C) 36 (D) 40

Sol. $\ell b = 9 + 2(\ell + b)$

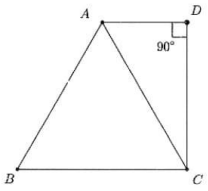
$\ell b - 2\ell - 2b = 9$

$(\ell - 2)(b - 2) = 13 \times 1$

$\ell = 15, b = 3$

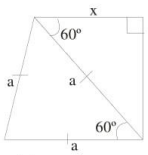
Perimeter = 2(15 + 3) = 36

11. ABCD is a trapezium in which ABC is an equilateral triangle with area $9\sqrt{3}$ square units. If ∠ADC = 90º, the area of the trapezium in square units is



(A) $12\sqrt{3}$ (B) $\frac{15\sqrt{3}}{2}$ (C) $\frac{27\sqrt{3}}{2}$ (D) $\frac{35\sqrt{3}}{2}$

Sol.



$\frac{\sqrt{3}}{4}a^2 = 9\sqrt{3}$

$a = 6$

$\cos 60° = \frac{x}{a}$

$x = \frac{a}{2}$

Area Trap $= \frac{1}{2}\left(a + \frac{a}{2}\right)\frac{\sqrt{3}a}{2} = \frac{3\sqrt{3}\,a^2}{8}$

$= \frac{3\sqrt{3} \times 36}{8} = \frac{27\sqrt{3}}{2}$

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12. p is a prime number such that $p^2 - 8p - 65 > 0$. The smallest value of p is

(A) 7 (B) 11 (C) 13 (D*) 17

Sol. $p^2 - 8p - 65 > 0$

$(p - 13)(p + 5) > 0$

$p \in (-\infty, -5) \cup (13, \infty)$

$p = 17$.

13. The least positive integer n such that $2015^n + 2016^n + 2017^n$ is divisible by 10 is

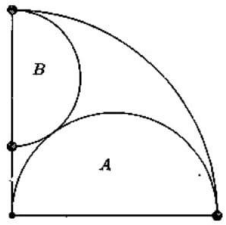
(A) 1 (B) 3 (C) 4 (D*) None of these

Sol. As cyclicity of 5 and 6 is 1.

So, $2015^n + 2016^n$ always ends with 1.

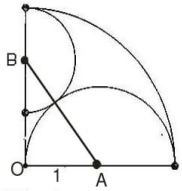
For 10 divisible unit digit of 2017^n should be 9. So $n = 4k + 2$.

14. In a quadrant of a circle of diameter 4 units semicircles are drawn as shown. The radius of the smaller circle (B) is



(A) $\frac{1}{2}$ (B) $\frac{1}{3}$ (C*) $\frac{2}{3}$ (D) $\frac{3}{4}$

Sol.



$AB = 1 + r$

$OB = 2 - r$

$AB^2 = OA^2 + OB^2$

$(1 + r)^2 = (2 - r)^2 + 1^2$

$1 + r^2 + 2r = 4 + r^2 - 4r + 1$

$6r = 4$

$r = \frac{2}{3}$.

15. The product of two positive integers is twice their sum; the product is also equal to six times the difference between the two integers. The sum of these integers is

(A) 6 (B) 7 (C) 8 (D*) 9

Sol. $xy = 2(x + y)$

$xy = 6(x - y)$

$\frac{xy}{2} + \frac{xy}{6} = 2x$

$8y = 24 \quad \Rightarrow \quad y = 3$

$3x = 2x + 6$

$x = 6$

So, $x + y = 6 + 3 = 9$.

PART – B

Note

- Write the correct answer in the space provided in the response sheet.
- For each correct response you get 1 mark. **For each incorrect response you lose $\frac{1}{4}$ mark.**

16. n is a natural number such that n minus 12 is the square of an integer and n plus 19 is the square of another integer. The value of n is _____

Sol. $n - 12 = m^2$

$n + 19 = x^2$

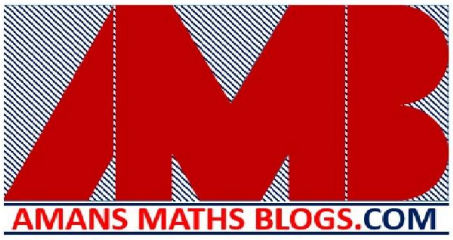
$31 = x^2 - m^2$

$(x + m)(x - m) = 31 \times 1$

$2x = 32 \quad \Rightarrow \quad x = 16$

$m = 15$

$n - 12 = 225 \quad \Rightarrow \quad n = 237.$



17. The number of three digit numbers which have odd number of factors is _____

Sol. Perfect square have odd no of factor

$\therefore 10^2, 11^2, 12^2, 13^3, \ldots\ldots\ldots\ldots, 31^2$

Total no. = 22.

18. The positive integers a, b, c are connected by the inequality $a^2 + b^2 + c^2 + 3 < ab + 3b + 2c$ then the value of $a + b + c$ is_____

Sol. $\left(a - \frac{b}{2}\right)^2 + (c-1)^2 + \frac{3}{4}(b-2)^2 - \frac{1}{2} < 0$

As all three terms should be less than $\frac{1}{2}$

so by putting $a = b = c = 1$

We get $\frac{1}{4} + 0 + \frac{3}{4} - \frac{1}{2} < 0$

$\frac{1}{2} < 0$ not true

So we try a= 1 , c = 1 , b = 2

$0 + 0 + 0 - \frac{1}{2} < 0$. Its true

$\therefore a = 1, c = 1, b = 2$

$\therefore a + b + c = 1 + 2 + 1 = 4$

19. The sum of all roots of the equation $|3x - |1 - 2x|| = 2$ is _____

Sol. $\left|3x - \left|1 - 2x\right|\right| = 2$

$3x - \left|1 - 2x\right| = \pm 2$

Case – I

$3x - 2 = 1 - 2x$

$5x = 3$

$x = 0.6$

But $x \geq \frac{2}{3}$

Case – I

$3x + 2 = 1 - 2x$

$5x = -1$

$x = -\frac{1}{5}$

$= -0.2$

So no solution.

Case – II

$-3x + 2 = 1 - 2x$

$x = 1$

Case – II

$-3x + 2 = 1 - 2x$

$-3 = x$

But $x > \frac{-2}{3}$

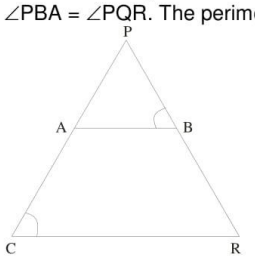
No solution.

So, $x_1 = 1, x_2 = \frac{-1}{5}$

$x_1 + x_2 = 1 - \frac{1}{5} = \frac{4}{5}$.

20. PQR is a triangle with PQ = 15, QR = 25, RP = 30. A, B are points on PQ and PR respectively such that $\angle PBA = \angle PQR$. The perimeter of the triangle PAB is 28, then the length of AB is_____

Sol.



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Per $\Delta PAB = 28$

Per $\Delta POR = 70$

QR =

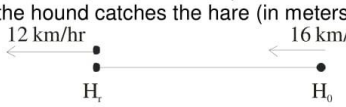
$\Delta PAB \sim \Delta PRQ$

$\frac{AB}{QR} = \frac{Per\,\Delta PAB}{Per\,\Delta PQR}$

$AB = \frac{25 \times 28}{70} = 10$

21. A hare sees a hound 100 m away from her and runs off in the opposite direction at a speed of 12 KM an hour. A minute later the hound perceives her and gives a chase at a speed of 16 KM an hour. The distance at which the hound catches the hare (in meters) is _____

Sol.



Distance traveled by hare in 1 minute $= 12 \times \frac{5}{18} \times 60$ = 200 meter

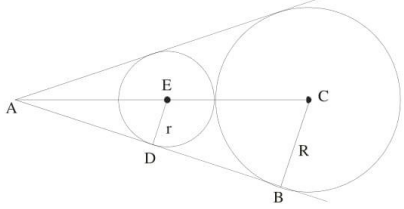
Now there is a gap of 200 + 100 = 300 meter between hare and hound.

So required time to chase hare = $t = \frac{300}{(16-12)\frac{5}{18}}$ = 270 seconds.

Distance traveled by hound = $270 \times 16 \times \frac{5}{18}$ = 1200 meter.

22. Two circles touch both the arms of an angle whose measure is 60° . Both the circles also touch each other externally. The radius of the smaller circle is r . The radius of the bigger circle (in term of r) is____

Sol.



$\sin 30° = \frac{R}{AC} = \frac{r}{AE}$

AC = 2R

AE = 2r
AC = AE + EC
2R = 2r + r + R
R = 3r

23. a, b are distinct natural numbers such that $\frac{1}{a}+\frac{1}{b}=\frac{2}{5}$. If $\sqrt{a+b}=k\sqrt{2}$, the value of k is _____

Sol. $\frac{1}{a}+\frac{1}{b}=\frac{2}{5}$

2ab – 5a = 5b

$a(2b-5)=\frac{5(2b-5)+25}{2}$

2a(2b–5) = 5(2b–5) + 25

(2b–5) (2a –5) = 25

2a – 5 = 25	1	5
2b–5 = 1	25	5
2b = 30	6	10
2a = 6	30	10
b = 15	3	5
a = 3	15	5
a + b	18	18 10

as a & b are distinct so we take a + b = 18

$\sqrt{a+b}=k\sqrt{2}$

$\sqrt{18}=k\sqrt{2}$

$\therefore K = 3$

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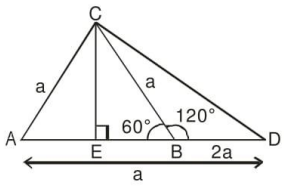
24. The side AB of an equilateral triangle ABC is produced to D such that BD = 2AC.The value of $\frac{CD^2}{AB^2}$ is_____

Sol.

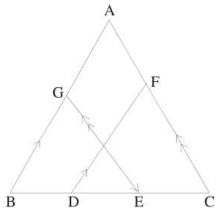


$CD^2 = CE^2 + ED^2 = \frac{3}{4}a^2+\left(2a+\frac{a}{2}\right)^2 = \frac{3a^2}{4}+\frac{25a^2}{4} = 7a^2$

$\frac{CD^2}{AB^2} = \frac{7a^2}{a^2} = 7.$

25. D and E trisect the side BC of a triangle ABC. DF is drawn parallel to AB meeting AC at F. EG is drawn parallel to AC meeting AB at G. DF and EG cut at H. Then the numerical value of $\frac{\text{Area}(ABC)}{\text{Area}(DHE)+\text{Area}(AFHG)}$ is

Sol.



HDE ~ ABC

$\frac{ar\ HDE}{ar\ ABC}=\left(\frac{x}{3x}\right)^2=\frac{1}{9}$

GBE ~ ABC

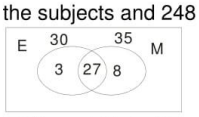
$\frac{ar\ GBE}{ar\ ABC}=\left(\frac{2x}{3x}\right)^2=\frac{4}{9}$

$$\text{ar AFHG} = \left\{1-\left[\frac{4}{9}+\frac{4}{9}-\frac{1}{9}\right]\right\} ABC = \frac{2}{9}\ \text{ABC} \Rightarrow \frac{\text{Area(AFHG)}}{\text{Area(ABC)}} = \frac{2}{9}$$

$$\therefore \frac{ar\ \Delta ABC}{ar\,\Delta DHE + ar\ AFHG} = \frac{1}{\frac{\text{Area DHE}}{\text{Area ABC}} + \frac{\text{Area AFHG}}{\text{Area ABC}}} = \frac{1}{\frac{1}{9}+\frac{2}{9}} = 3.$$

26. In an examination 70% of the candidates passed in English, 65% passed in Mathematics, 27% failed in both the subjects and 248 passed in both the subjects. The total number of candidates is_____

Sol.



38% are failed either of the subject

$\therefore$ 62% pass both subject.

$\frac{62}{100} \times x = 248$

$x = 400$

27. In a potato race, a bucket is placed at the starting point, which is 7 meter from the first potato. The other potatoes are placed 4 m a part in a straight line from the first one. There are n potatoes in the line. Each competitor starts from the bucket, picks up the nearest potato, runs back with it, drops in the bucket, runs back to pick up the next potato, runs to the bucket and drops it and this process continues till all the potatoes are picked up and dropped in the bucket. Each competitor ran a total of 150 m. The number of potatoes is._____.

Sol. Let the number of competitor are m and the number of potatoes are n.

$\frac{n}{2}$ (28 + (n – 1) 8) = 150 m

$\frac{n}{2}$ (10 + 4n) = 150 m

$2n^2 + 5n = 75$ m

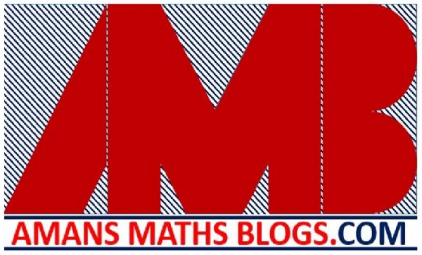
$n = \frac{-5 \pm \sqrt{25+600m}}{4}$ and $7 + 4n \le 75$

$4n \le 68$

$n \le 17$

As m > 1.

By putting m = 3, n = 15.



28. A two digit number is obtained by either multiplying the sum of its digits by 8 and adding 1, or by multiplying the difference of its digits by 13 and adding 2. The number is _____ .

Sol. $10x + y = 8(x + y) + 1 \Rightarrow 10x + y = 8x + 8y + 1$

$2x = 7y + 1$ .....(i)

$10x + y = 13\ (x – y) + 2 = 13x – 13y + 2$

$14y = 3x + 2$ .....(ii)

By solving (i) and (ii) we get

x = 4, y = 1

Number = 41.

29. The in radius of a right angled triangle-whose legs have lengths 3 and 4 is _____.

Sol. $\Delta = rs$

$\frac{1}{2} 3 \times 4 = r\left(\frac{3+4+5}{2}\right)$

$r = 1$

30. a, b are positive reals such that $\frac{1}{a}+\frac{1}{b}=\frac{1}{a+b}$ if $\left(\frac{a}{b}\right)^3+\left(\frac{b}{a}\right)^3 = 2\sqrt{n}$ where n is a natural number, the value of n is

Sol. $(a + b)^2 = ab$

$a^2 + 2ab + b^2 = ab \Rightarrow a^2 + ab + b^2 = 0$

there is no such positive real a, b for which $a^2 + ab + b^2 = 0$.