

**Suggested Solution for 2012 HKDSE Mathematics(core) Multiple Choice Questions**

1. C

$$\begin{aligned} & \frac{(2x^4)^3}{2x^5} \\ &= \frac{2^3 x^{4 \times 3}}{2x^5} \\ &= \frac{2^3 x^{12}}{2x^5} \\ &= 4x^7 \end{aligned}$$

2. D

$$\begin{aligned} & (4x + y)^2 - (4x - y)^2 \\ &= (4x + y + 4x - y)[4x + y - (4x - y)] \quad [a^2 - b^2 = (a + b)(a - b)] \\ &= 8x(4x + y - 4x + y) \\ &= 8x(2y) \\ &= 16xy \end{aligned}$$

3. C

$$\begin{aligned} \text{R.H.S.} &= x^2 + (2 + q)x + 2q + 10 \\ \text{By comparing the coefficients of } x, \\ 2 + q &= 0 \\ q &= -2 \\ \text{By comparing the constant terms,} \\ p &= 2(-2) + 10 \\ &= 6 \end{aligned}$$

Alternatively

$$\begin{aligned} & \text{Substitute } x = -2 \text{ to both sides of the identity,} \\ (-2)^2 + p &= (-2 + 2)(-2 + q) + 10 \\ 4 + p &= 10 \\ p &= 6 \end{aligned}$$

4. B

$$\begin{aligned} \text{Let } f(x) &= x^3 + 4x^2 + kx - 12. \\ \text{By Factor Theorem,} \\ f(-3) &= 0 \\ (-3)^3 + 4(-3)^2 + k(-3) - 12 &= 0 \\ k &= -1 \end{aligned}$$

5. B

$$\begin{cases} m + 2n + 6 = 7 \text{ i.e. } m + 2n = 1 \dots (1) \\ 2m - n = 7 \dots (2) \end{cases}$$

$$\begin{aligned} (1) \times 2 - (2), \\ 5n &= -5 \\ n &= -1 \end{aligned}$$

Alternatively

$$\begin{aligned} & \text{From (1), } m = 1 - 2n \dots (3) \\ & \text{Substitute (3) into (2),} \\ 2(1 - 2n) - n &= 7 \\ -5n &= 5 \\ n &= -1 \end{aligned}$$

6. D

The graph opens downwards.

$$\therefore a < 0$$

The equation of the axis of symmetry of the graph is  $x = -b > 0$ .

$$\therefore b < 0$$

7. C

$$15 + 4x < 3 \text{ or } 9 - 2x > 1$$

$$4x < -12 \text{ or } 8 > 2x$$

$$x < -3 \text{ or } x < 4$$

$$\therefore x < 4$$

8. D

Percentage required

$$= 37.5\% \times 80\% + (1 - 37.5\%) \times 60\%$$

$$= 67.5\%$$

9. A

$$\frac{6x+5y}{3y-2x} = 7$$

$$6x + 5y = 7(3y - 2x)$$

$$6x + 5y = 21y - 14x$$

$$20x = 16y$$

$$\frac{x}{y} = \frac{16}{20} = \frac{4}{5} \text{ i.e. } x : y = 4 : 5$$

10. D

Let  $y = kx^2 + \frac{k_1}{x}$  where  $k$  and  $k_1$  are constants. Then,

$$-4 = k(1)^2 + \frac{k_1}{1} \text{ i.e. } k + k_1 = -4 \dots (1)$$

$$5 = k(2)^2 + \frac{k_1}{2} \text{ i.e. } 8k + k_1 = 10 \dots (2)$$

$$(2) - (1),$$

$$7k = 14$$

$$k = 2$$

$$\text{and } k_1 = -6$$

When  $x = -2$ ,

$$y = 2(-2)^2 + \frac{-6}{-2}$$

$$= 11$$

11. C

Her average typing speed

$$= \frac{3 \times 63 + 4 \times 56}{7}$$

$$= 59 \text{ words per minute}$$

12. B

Let  $T(n)$  be the number of dots in the  $n$ th pattern. Then,

$$T(1) = 1$$

$$T(2) = 1 + 1 = 2$$

$$T(3) = 2 + 2 = 4$$

$$T(4) = 4 + 3 = 7$$

$$T(5) = 7 + 4 = 11$$

$$T(6) = 11 + 5 = 16$$

$$T(7) = 16 + 6 = 22$$

$$T(8) = 22 + 7 = 29$$

13. D

$$0.0322515$$

$$= 0.0323 \text{ (correct to 3 significant figures)}$$

$$= 0.0323 \text{ (correct to 4 decimal places)}$$

$$= 0.032252 \text{ (correct to 5 significant figures)}$$

$$= 0.032252 \text{ (correct to 6 decimal places)}$$

14. B

$$\frac{(25-0.5)m}{(5+0.5)cm} \leq n < \frac{(25+0.5)m}{(5-0.5)cm}$$

$$\frac{(25-0.5) \times 100cm}{(5+0.5)cm} \leq n < \frac{(25+0.5) \times 100cm}{(5-0.5)cm}$$

$$445\frac{5}{11} \leq n < 566\frac{2}{3}$$

$\therefore$  The greatest possible value of  $n$  is 566.

15. A

By Pythagoras' theorem,

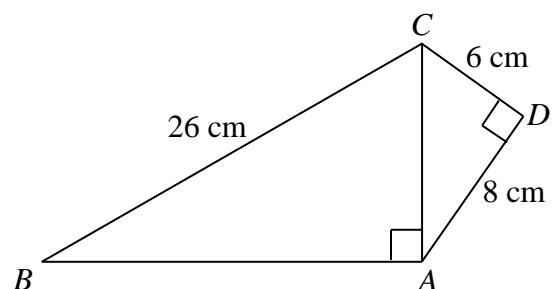
$$AC^2 = AD^2 + CD^2 = 6^2 + 8^2 = 100 \text{ i.e. } AC = 10 \text{ cm}$$

$$AB^2 + AC^2 = BC^2$$

$$AB^2 + 100 = 26^2$$

$$AB = 24 \text{ cm}$$

$$\text{Area of } ABCD = \frac{1}{2} \times 6 \times 8 + \frac{1}{2} \times 24 \times 10 = 144 \text{ cm}^2$$



16. B

$$\widehat{AB} = 2\pi \times OA \times \frac{\angle AOB}{360^\circ}$$

$$12\pi = 2\pi \times 30 \times \frac{\angle AOB}{360^\circ}$$

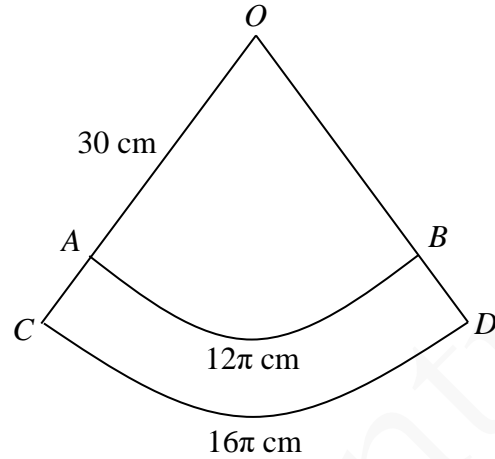
$$\angle AOB = 72^\circ$$

$$\widehat{CD} = 2\pi \times OC \times \frac{\angle AOB}{360^\circ}$$

$$16\pi = 2\pi \times OC \times \frac{72^\circ}{360^\circ}$$

$$OC = 40 \text{ cm}$$

$$AC = OC - OA = 40 - 30 = 10 \text{ cm}$$



17. B

Note that  $\triangle GDF \sim \triangle GAE$ .

$$\therefore GD : GA = 1 : 2$$

$$\frac{\text{Area of } \triangle GDF}{\text{Area of } \triangle GAE} = \left(\frac{GD}{GA}\right)^2$$

$$\frac{3}{\text{Area of } \triangle GAE} = \left(\frac{1}{2}\right)^2$$

$$\text{Area of } \triangle GAE = 12 \text{ cm}^2$$

$$\text{Area of } DAEF = 12 - 3 = 9 \text{ cm}^2$$

Draw  $FH$  such that  $DA \parallel FH$ .

Note that  $\triangle GDF \cong \triangle FHE$ .

$$\text{Area of } \triangle FHE = \text{area of } \triangle GDF = 3 \text{ cm}^2$$

$$\text{Area of parallelogram } DAHF = 9 - 3 = 6 \text{ cm}^2$$

$$\text{Area of } DAHF : \text{area of } FHBC = DF : FC$$

$$6 : \text{area of } FHBC = 3 : 4$$

$$\text{Area of } FHBC = 8 \text{ cm}^2$$

$$\text{Area of } ABCD$$

$$= \text{Area of } DAHF + \text{area of } FHBC$$

$$= 6 + 8$$

$$= 14 \text{ cm}^2$$

Alternatively

Construct a point  $H$  such that  $CDGH$  is a parallelogram.

$$\therefore GD : DA = 1 : 1$$

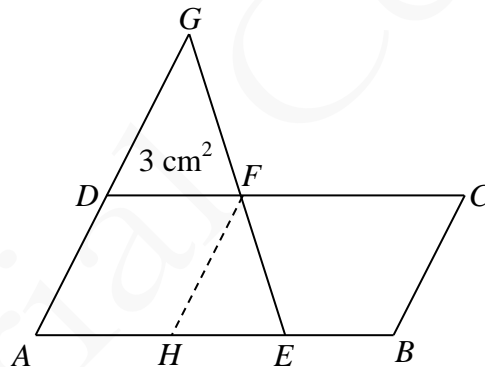
$$\therefore \text{Area of } ABCD = \text{area of } CDGH$$

$\therefore \triangle GDF$  and  $FCHG$  have the same height.

$$\therefore \text{Area of } FCHG : \text{area of } \triangle GDF = (4 + 7) : 3$$

$$\rightarrow \text{Area of } FCHG = 11 \text{ cm}^2$$

$$\therefore \text{Area of } CDGH = 3 + 11 = 14 \text{ cm}^2 \quad \text{i.e. Area of } ABCD = 14 \text{ cm}^2$$



Alternatively

$$\therefore DF : FC = 3 : 4 \text{ and } DF : AE = 1 : 2 = 3 : 6$$

$$\therefore AE : EB = 6 : 1$$

$$\text{Area of } DAEF : \text{area of } FEBC = (3 + 6) : (4 + 1)$$

[ $\because DAEF$  and  $FEBC$  have the same height.]

$$9 : \text{area of } FEBC = 9 : 5$$

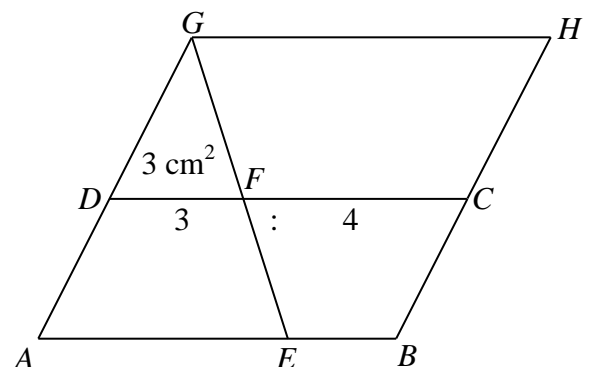
$$\text{Area of } FEBC = 5 \text{ cm}^2$$

$$\text{Area of } ABCD$$

$$= \text{Area of } DAEF + \text{area of } FEBC$$

$$= 9 + 5$$

$$= 14 \text{ cm}^2$$



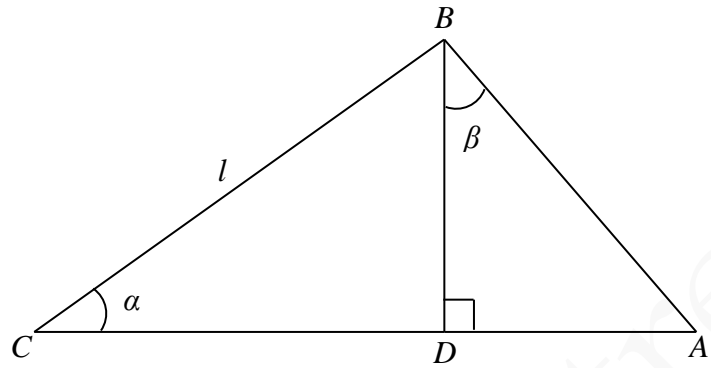
18. A

$$\frac{BD}{l} = \sin \alpha$$

$$BD = l \sin \alpha$$

$$\frac{BD}{AB} = \cos \beta$$

$$\begin{aligned} AB &= \frac{BD}{\cos \beta} \\ &= \frac{l \sin \alpha}{\cos \beta} \end{aligned}$$



19. C

$$\frac{\cos 60^\circ}{1 - \cos(90^\circ - \theta)} + \frac{\cos 240^\circ}{1 - \cos(270^\circ - \theta)}$$

$$= \frac{0.5}{1 - \sin \theta} + \frac{-0.5}{1 - (-\sin \theta)}$$

$$= \frac{0.5(1 + \sin \theta) - 0.5(1 - \sin \theta)}{(1 - \sin \theta)(1 + \sin \theta)}$$

$$= \frac{0.5 + 0.5 \sin \theta - 0.5 + 0.5 \sin \theta}{1 - \sin^2 \theta}$$

$$= \frac{\sin \theta}{\cos^2 \theta}$$

$$= \frac{\tan \theta}{\cos \theta}$$

20. C

Join AD.

$$\angle OAD = \angle ODA \text{ (base } \angle, \text{ isos. } \triangle)$$

$$\angle BAD + \angle BCD = 180^\circ \text{ (opp. } \angle\text{s, cyclic quad.)}$$

$$\angle OAD + \angle BAO + \angle BCD = 180^\circ$$

$$\angle OAD + 28^\circ + 114^\circ = 180^\circ$$

$$\angle OAD = 38^\circ$$

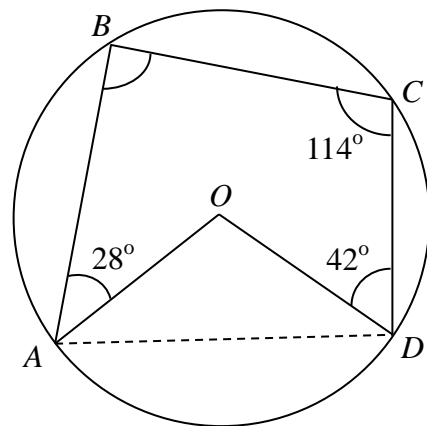
$$\therefore \angle ODA = \angle OAD = 38^\circ$$

$$\angle ABC + \angle ADC = 180^\circ \text{ (opp. } \angle\text{s, cyclic quad.)}$$

$$\angle ABC + \angle ODA + \angle CDO = 180^\circ$$

$$\angle ABC + 38^\circ + 42^\circ = 180^\circ$$

$$\angle ABC = 100^\circ$$



21. D

Let  $O$  be the centre of the circle. Then,

Radius =  $12 \div 2 = 6$  cm and  $OA = OB = OC = OD = CD = 6$  cm

$\therefore \triangle COD$  is an equilateral  $\triangle$  with  $\angle COD = 60^\circ$ .

Area of  $\triangle COD$

$$= \frac{1}{2} \times 6 \times 6 \times \sin 60^\circ$$

$$= 9\sqrt{3} \text{ cm}^2$$

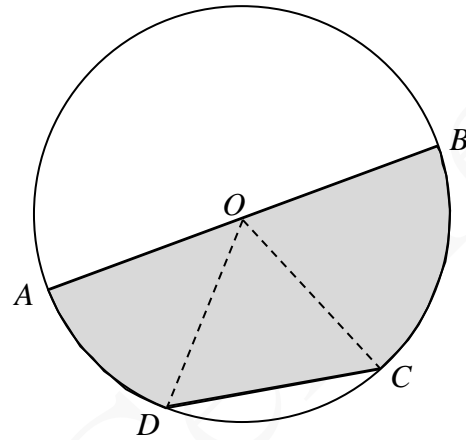
Note that  $\angle AOD + \angle BOC = 120^\circ$

$\therefore$  Area of sector  $AOD$  + area of sector  $BOC$

$$= \pi(6)^2 \times \frac{120^\circ}{360^\circ}$$

$$= 12\pi \text{ cm}^2$$

$\therefore$  Area of the shaded region =  $(12\pi + 9\sqrt{3}) \text{ cm}^2$



22. A

Each exterior angle

$$= \frac{360^\circ}{12}$$

$$= 30^\circ$$

$\therefore$  I is true.

Each interior angle

$$= 180^\circ - 30^\circ$$

$$= 150^\circ$$

$\therefore$  II is true.

$\therefore n = 12$

$\therefore$  The number of axes of reflectional symmetry of the polygon is 12.

$\therefore$  III is NOT true.

23. D

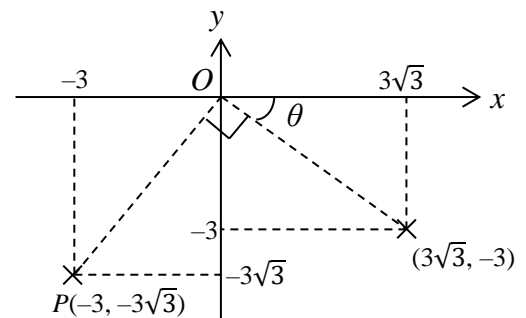
The rectangular coordinates of  $P$ 's image are  $(3\sqrt{3}, -3)$ .

$$r = \sqrt{(3\sqrt{3})^2 + (-3)^2} = 6$$

$$\tan \theta = \frac{3}{3\sqrt{3}}$$

$$\theta = 30^\circ$$

The polar coordinates of its image are  $(6, 360^\circ - 30^\circ)$  i.e.  $(6, 330^\circ)$ .



24. A

Let the coordinates of  $P$  be  $(x, y)$ .

$$\sqrt{(x-20)^2 + (y-12)^2} = 5$$

$$(x-20)^2 + (y-12)^2 = 5^2$$

The locus of  $P$  is a circle with centre  $(20, 12)$  and radius 5.

25. C

Rewrite  $L_1 : y = -ax + b$  and  $L_2 : y = -cx + d$ .

Then, for  $L_1$ , slope =  $-a$ , y-intercept =  $b$  and x-intercept =  $\frac{b}{a}$ .

For  $L_2$ , slope =  $-c$ , y-intercept =  $d$  and x-intercept =  $\frac{d}{c}$ .

From the figure, the slope of  $L_1 = -a > 0$ . i.e.  $a < 0$

$\therefore$  I is true.

From the figure, the slope of  $L_2 >$  the slope of  $L_1$ .

$\therefore -c > -a$  i.e.  $c < a$

$\therefore$  II is NOT true.

From the figure, y-intercept of  $L_1 >$  y-intercept of  $L_2$ .

$\therefore b > d$

$\therefore$  III is true.

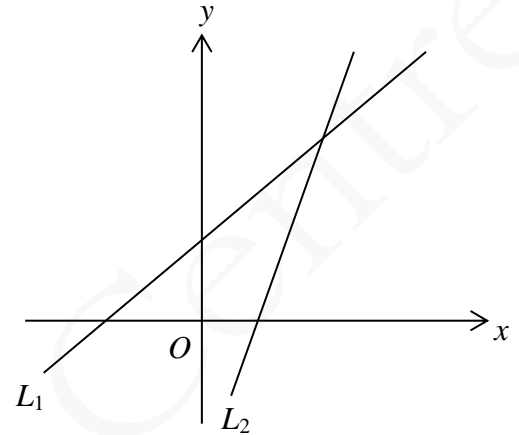
From the figure, x-intercept of  $L_2 >$  x-intercept of  $L_1$ .

$\therefore \frac{d}{c} > \frac{b}{a}$

$\frac{d}{c} \times ac > \frac{b}{a} \times ac$  [ $\because c < a < 0$ ]

i.e.  $ad > bc$

$\therefore$  IV is true.



26. A

From the figure,  $k > -h$  i.e.  $h + k > 0$

$\therefore$  I is true.

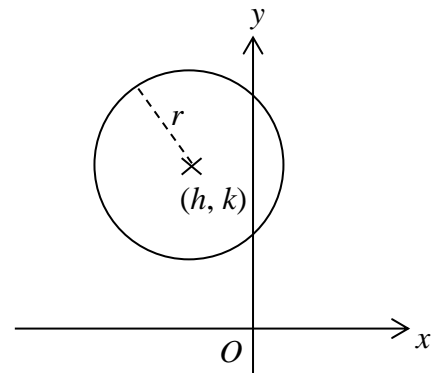
From the figure,  $h < 0$ .

$\therefore r - h > 0$

$\therefore$  II is true.

From the figure,  $k > r$ . i.e.  $r - k < 0$

$\therefore$  III is NOT true.



27. A

The 3-digit number is divisible by 5 only if  $\blacklozenge$  is 0 or 5 and  $\blackstar$  can be any integer from 0 to 9 inclusive.

The required probability

$$= \frac{2 \times 10}{10 \times 10}$$

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

28. B

Out of the 20 members, there are 6 members who are not under the age of 74.

The required probability

$$= \frac{6}{20}$$

$$= 0.3$$

29. B

$$\text{Mean} = \frac{1 \times 8 + 2 \times 4 + 3 \times 6 + 4 \times 2}{2 + 8 + 4 + 6 + 2}$$

$$= \frac{21}{11}$$

Standard deviation

$$= \sqrt{\frac{2\left(0 - \frac{21}{11}\right)^2 + 8\left(1 - \frac{21}{11}\right)^2 + 4\left(2 - \frac{21}{11}\right)^2 + 6\left(3 - \frac{21}{11}\right)^2 + 2\left(4 - \frac{21}{11}\right)^2}{2 + 8 + 4 + 6 + 2}}$$

$$\approx 1.16 \text{ (correct to 2 decimal places)}$$

30. D

$\therefore$  Median = 14

$\therefore m \geq 14$  and  $n \geq 14$

$\therefore$  I is true.

$$\text{Mean} = \frac{19 + 10 + 12 \times 2 + 13 \times 2 + 14 + 15 + 16 + m + n}{11} = 14$$

$\therefore m + n = 30$

$\therefore$  III is true.

$\therefore m + n = 30$  and  $m \geq 14$

$\therefore n = 30 - m \leq 30 - 14 = 16$

$\therefore$  II is true.



31. B

$a$  in the H.C.F. must come from the 3<sup>rd</sup> expression.

$b^5$  in the L.C.M. must come from the 3<sup>rd</sup> expression.

$\therefore$  The 3<sup>rd</sup> expression is  $ab^5$ .

32. C

$$y = mn^x$$

$$\log_3 y = \log_3(mn^x)$$

$$\begin{aligned} \log_3 y &= \log_3 m + \log_3 n^x \\ &= (\log_3 n)x + \log_3 m \end{aligned}$$

From the figure, the slope of the graph = 2.

$$\therefore \text{slope} = \log_3 n = 2$$

$$n = 3^2 = 9$$

Alternatively

From the figure, the slope of the graph = 2 and the  $\log_3 y$ -intercept = 4.

$$\text{Then, } \log_3 y = 2x + 4$$

$$y = 3^{2x+4}$$

$$y = 3^4(3^2)^x$$

$$y = 81(9)^x$$

$$\therefore n = 9$$

33. A

$$AD0000002012_{16}$$

$$= 10 \times 16^{11} + 13 \times 16^{10} + 2 \times 16^3 + 1 \times 16 + 2$$

$$= 10(16^{11}) + 13(16^{10}) + 8210$$

$16^{11}$	$16^{10}$	$16^9$	$16^8$	$16^7$	$16^6$	$16^5$	$16^4$	$16^3$	$16^2$	$16^1$	$16^0$
A	D	0	0	0	0	0	0	2	0	1	2

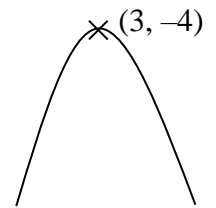
34. C

$\therefore (3, -4)$  is the vertex of the graph.

$$\therefore f(3) = -4 \text{ i.e. } f(3) + 4 = 0$$

$\therefore 3$  is a root of the equation  $f(x) + 4 = 0$ .

$\therefore$  The roots of the equation  $f(x) + 4 = 0$  are real numbers.



Note that the graph may open upwards or downwards with the vertex  $(3, -4)$ .

The equation  $f(x) = 0$  has no real roots if the graph opens downwards.  $\therefore$  A is not true.

The equation  $f(x) - 3 = 0$  has no real roots if the graph opens downwards.  $\therefore$  B is not true.

The equation  $f(x) + 5 = 0$  has real roots if the graph opens downwards.  $\therefore$  D is not true.

35. A

$$i^3(\beta i - 3)$$

$$= \beta i^4 - 3i^3$$

$$= \beta - 3(-i)$$

$$= \beta + 3i$$

36. D

Using  $(0, 0)$  as a testing point, it is not difficult to see that the constraints for the shaded region are:

$$\begin{cases} y \geq 3 \\ y \leq x + 3 \\ y \leq 6 - 2x \end{cases}$$

As  $(h, k)$  lies in the region,

$$k \geq 3$$

$$k \leq h + 3 \quad \text{i.e. } h - k \geq -3$$

$$k \leq 6 - 2h \quad \text{i.e. } 2h + k \leq 6$$

$\therefore$  I, II and III are true.

37. A

Let  $d$  be the common difference.

$$a_{18} = a_1 + 17d = 26 \dots (1)$$

$$a_{23} = a_1 + 22d = 61 \dots (2)$$

$$(2) - (1),$$

$$5d = 35$$

$$d = 7 \dots (3)$$

Substitute (3) into (1),

$$a_1 + 17(7) = 26$$

$$a_1 = -93$$

$$a_{14} = a_1 + 13d$$

$$= -93 + 13(7)$$

$$= -2$$

$$< 0$$

$\therefore$  I is true.

$$a_1 - a_2 = -d$$

$$= -7$$

$$< 0$$

$\therefore$  II is true.

$$a_1 + a_2 + a_3 + \dots + a_{27}$$

$$= \frac{(2a_1 + 26d) \times 27}{2}$$

$$= \frac{[2(-93) + 26(7)] \times 27}{2}$$

$$= -54$$

$$< 0$$

$\therefore$  III is NOT true.

38. C

$f(x - 2) + 1$  is a translation of  $f(x)$  by 2 units to the right followed by a translation of 1 unit upwards.

39. D

Let  $y = h + 3\cos kx^\circ$ , where  $h$  and  $k$  are constants.

From the figure, when  $x = 0$ ,  $y = 7$ ,

$$7 = h + 3\cos k(0)^\circ$$

$$h = 4$$

When  $x = 90$ ,  $y = 1$ ,

$$1 = 4 + 3\cos k(90)^\circ$$

$$\cos k(90)^\circ = -1$$

$$k(90)^\circ = 180^\circ$$

$$k = 2$$

$$\therefore y = 4 + 3\cos 2x^\circ$$

Alternatively

Comparing with  $y = \cos x$ , the graph is stretched 3 times in  $y$ -direction and translated 4 units upwards. In  $x$ -direction, it is compressed 2 times.

$$\therefore h = 4 \text{ and } k = 2.$$

$$\therefore y = 4 + 3\cos 2x^\circ$$

40. D

Let  $E$  be the foot of the perpendicular from  $A$  to  $BC$ . Then,  $E$  is also the foot of the perpendicular from  $D$  to  $BC$ .

The required angle is  $\angle AED(\theta)$ .

Let the length of one side of the tetrahedron be  $2x$ .

By Pythagoras' theorem,

$$AE^2 + EC^2 = AC^2$$

$$AE^2 + x^2 = (2x)^2$$

$$AE^2 = 3x^2$$

$$AE = \sqrt{3}x$$

Note that  $DE = AE = \sqrt{3}x$ .

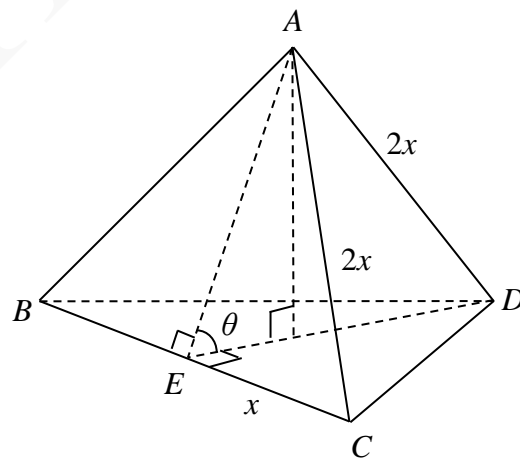
By cosine formula,

$$\cos \theta = \frac{AE^2 + DE^2 - AD^2}{2(AE)(DE)}$$

$$= \frac{(\sqrt{3}x)^2 + (\sqrt{3}x)^2 - (2x)^2}{2(\sqrt{3}x)(\sqrt{3}x)}$$

$$= \frac{1}{3}$$

$$\theta = 71^\circ \text{ (correct to the nearest degree)}$$



41. C

Join  $OC$  and  $OB$ .

$$\angle PBO = \angle BPQ = 12^\circ \text{ (base } \angle \text{s, isos. } \Delta \text{)}$$

$$\begin{aligned} \angle BOQ &= 2\angle BPQ \text{ (} \angle \text{ at centre twice } \angle \text{ at } \odot^{\text{ce}} \text{)} \\ &= 2 \times 12^\circ \\ &= 24^\circ \end{aligned}$$

$$\begin{aligned} \angle COP &= \angle PBO \text{ (} \angle \text{s in alt. segment)} \\ &= 12^\circ \end{aligned}$$

$$\angle COB + \angle COP + \angle BOQ = 180^\circ \text{ (adj. } \angle \text{s on st. line)}$$

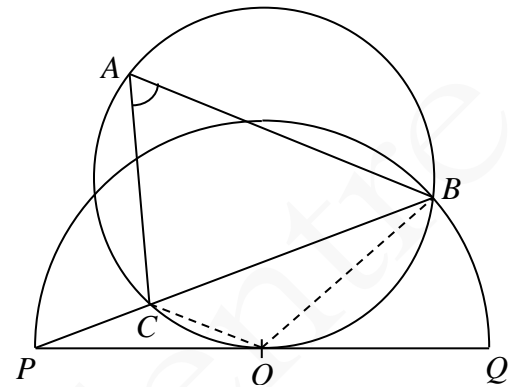
$$\angle COB + 12^\circ + 24^\circ = 180^\circ$$

$$\angle COB = 144^\circ$$

$$\angle BAC + \angle COB = 180^\circ \text{ (opp. } \angle \text{s, cyclic quad.)}$$

$$\angle BAC + 144^\circ = 180^\circ$$

$$\angle BAC = 36^\circ$$



42. B

$$\begin{cases} x - y + k = 0 \text{ i.e. } x = y - k \dots (1) \\ x^2 + y^2 + 2x - 4y - 13 = 0 \dots (2) \end{cases}$$

Substitute (1) into (2),

$$(y - k)^2 + y^2 + 2(y - k) - 4y - 13 = 0$$

$$y^2 - 2ky + k^2 + y^2 + 2y - 2k - 4y - 13 = 0$$

$$2y^2 - 2(k + 1)y + k^2 - 2k - 13 = 0$$

$$\Delta > 0$$

$$[-2(k + 1)]^2 - 4(2)(k^2 - 2k - 13) > 0$$

$$k^2 - 6k - 27 < 0$$

$$(k + 3)(k - 9) < 0$$

$$-3 < k < 9$$

43. B

Number of different teams that can be formed

= Total number of teams formed – number of teams with boys only

$$= C_5^{20} - C_5^{12}$$

$$= 14\,712$$

44. D

The required probability

$$= P(\text{"1st number is not 9"}) \times P(\text{"2nd number is not 9"}) \times P(\text{"3rd number is 9"})$$

$$= \frac{3}{6} \times \frac{2}{5} \times \frac{3}{4}$$

$$= \frac{3}{20}$$

45. A

$$m_1 = \frac{x_1 + x_2 + x_3 + \dots + x_{100}}{100}$$

$$m_2 = \frac{x_1 + x_2 + x_3 + \dots + x_{100} + m_1}{101}$$

$$= \frac{100m_1 + m_1}{101}$$

$$= m_1$$

∴ I is true.

∴ the minimum datum  $\leq m_1 \leq$  the maximum datum

∴  $r_1 = r_2$

∴ II is true.

∴  $m_1 = m_2$

∴ The second group of numbers are less dispersed.

∴  $v_2 < v_1$

∴ III is NOT true.

Alternatively

$$v_1 = \frac{(x_1 - m_1)^2 + (x_2 - m_1)^2 + (x_3 - m_1)^2 + \dots + (x_{100} - m_1)^2}{100}$$

$$v_2 = \frac{(x_1 - m_2)^2 + (x_2 - m_2)^2 + (x_3 - m_2)^2 + \dots + (x_{100} - m_2)^2 + (m_1 - m_2)^2}{101}$$

$$= \frac{(x_1 - m_1)^2 + (x_2 - m_1)^2 + (x_3 - m_1)^2 + \dots + (x_{100} - m_1)^2 + (m_1 - m_1)^2}{101}$$

[∵  $m_1 = m_2$ ]

$$= \frac{(x_1 - m_1)^2 + (x_2 - m_1)^2 + (x_3 - m_1)^2 + \dots + (x_{100} - m_1)^2}{101}$$

$< v_1$

∴ III is NOT true.