2024-DSE
MATH CP
PAPER 1

THE 13TH HONG KONG DIPLOMA OF SECONDARY EDUCATION MOCK EXAMINATION 2024

MATHEMATICS PAPER 1

Question – Answer Book

(2¼ hours)

This paper must be answered in English

INSTRUCTIONS

1. After the announcement of the start of the examination, you should first write your appropriate information in the space provided on Page 1 and stick barcode labels in the spaces provided on Pages 1, 3, 5, 7, 9, 11 and 13.
2. This paper consists of THREE sections, A(1), A(2) and B.
3. Attempt ALL questions in this paper. Write your answers in the spaces provided in this Question-Answer Book. Do not write in the margins. Answers written in the margins will not be marked.
4. Graph paper and supplementary answer sheets will be supplied on request. Write your Candidate Name, mobile phone number, the question number and stick a barcode label on each sheet, and fasten them with string INSIDE this book.
5. Unless otherwise specified, all working must be clearly shown.
6. Unless otherwise specified, numerical answers should be either exact or correct to 3 significant figures.
7. The diagrams in this paper are not necessarily drawn to scale.
8. No extra time will be given to candidates for sticking on the barcode labels or filling in the question number boxes after the 'Time is Up' announcement.
9. Contents of the examination answered by students may be used for certain purposes such as teaching and data analysis.

Please stick the barcode label here.

(1) 考生英文姓名 Name of Candidate (English)	(3) 考生編號 Candidate Number
(2) 考生中文姓名 Name of Candidate (Chinese)	(4) 座位編號 Seat Number
(5) 考生手提電話號碼 Mobile Phone Number of Candidate	
(6) 學校中文名稱 School Name (Chinese)	

	Examiner's Use Only
Question No.	Marks
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SECTION A(1) (35 marks)

1. Simplify $\dfrac{(x^2y^{-3})^9}{(x^3y)^{-4}}$ and express your answers with positive indices. (3 marks)

2. Make q the subject of the formula $\dfrac{p(1+q)}{5} = \dfrac{qr}{2} + 1$. (3 marks)

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3. Factorize

(a) $2x^2 + 3xy - 35y^2$,

(b) $4x - 14y - 2x^2 - 3xy + 35y^2$.

(3 marks)

4. (a) Find the range of values of x which satisfy both $\frac{4(x-1)}{5} + 10 > 7(x-4)$ and $x + 3 \geq 0$.

(b) How many positive integers satisfy both inequalities in (a)?

(4 marks)

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5. A box of candies is shared among all the students in a class. If each student gets 4 candies, then 30 candies are left. If 4 of the students do not get any candies, then each of the remaining students gets 6 candies. Find the number of candies in the box. (4 marks)

6. The marked price of a robot is higher than its cost by $100. The robot is sold at a discount of 30% on its marked price. After selling the robot, the percentage loss is 20%. Find the marked price of the robot. (4 marks)

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7. A point P is rotated about the origin O through 180° to a point Q. $Q'(3, -4)$ is the reflection image of Q with respect to the x-axis.

(a) Write down the coordinates of P and Q.

(b) P is rotated clockwise about O through 90° to P'. Are O, P' and Q' collinear? Explain your answer.

(4 marks)

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8. In Figure 1, BCE, CDF and AFE are equilateral triangles.

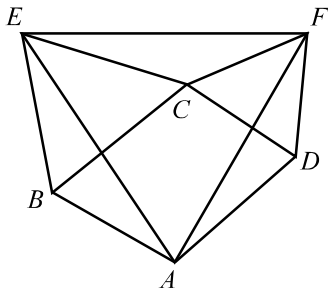

Figure 1

(a) Prove that $AB = DC$.

(b) It is given that $\angle ECF = 140^{\circ}$, find $\angle BAD$.

(5 marks)

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9. The following table shows the distribution of the numbers of the numbers of pens owned by some students.

Number of pens	0	1	2	3
Number of students	h	5	8	k

It is given that h and k are positive numbers.

(a) Write down the least possible value and the greatest possible value of the inter-quartile range of the distribution.

(b) If $h = 2k$ and the median of the distribution is 2, how many possible value(s) of k is/are there?

(5 marks)

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SECTION A(2) (35 marks)

10. It is given that f(x) is partly constant and partly varies as x^2. Suppose that f(14) = 79 and f(21) = 154.

(a) Find f(7). (3 marks)

(b) Suppose that $P(0, p)$ and $Q(7, q)$ are points lying on the graph of y = f(x). The horizontal line passing through Q cuts the y-axis at the point R. Find the area of ΔPQR. (3 marks)

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11. The score of 20 students in a Mathematics exam are presented in the following stem-and-leaf diagram.

Stem (tens)	Leaf (units)				
5	a	5			
6	1	3	6	6	6
7	0	6	7	b	9
8	1	1	1	2	
9	1	7	8	9	

It is given that the mean and the range of the marks are 76 and 46 respectively.

(a) Find a and b. (2 marks)

(b) If a student is chosen at random, find the probability that his score is higher than the median mark. (2 marks)

(c) If two students are chosen at random, given that each of their scores is higher than the median mark, find the probability that they have the same score. (2 marks)

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12. Let $f(x) = 2x^3 + g(x)$, where $g(x)$ is a quadratic polynomial. When $f(x)$ is divided by $(x-2)^2$ and when $f(x)$ is divided by $(x-2)(2x+1)$, the remainders are $x - 8 - k$ and $-\frac{3}{2}kx + 6$ respectively, where k is a constant.

(a) Find the value of k. (3 marks)

(b) Someone claims that all the roots of the equation $f(x) = -kx$ are rational. Is the claim correct? Explain your answer. (4 marks)

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13. Figure 2(a) shows an ice-cream cone which consists of a right cylinder and a frustum cut from a right circular cone. The base radius and the height of the cylinder are 1.5 cm and 3 cm respectively. The upper base radius and the height of the frustum are 3 cm and 5 cm respectively.

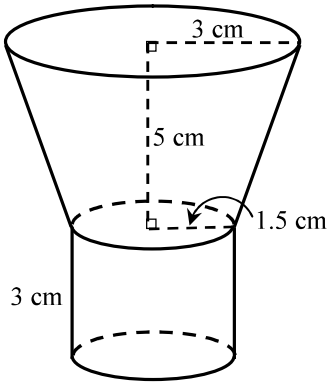

Figure 2(a)

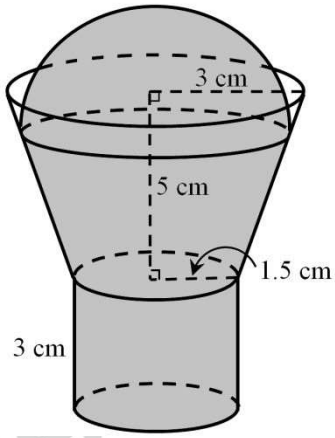

Figure 2(b)

(a) Find the capacity of the ice-cream cone in terms of π. (3 marks)

(b) In Figure 2(b), some ice-cream with the top in the shape of a hemisphere of radius 2.4 cm is put into the cone. If John puts 15 cm^3 of milk into the cone and stirs until the ice-cream has completely melted into a semi-liquid drink called 'milkshake', will the 'milkshake' be overflown? Explain your answer. (Assume the volume of the ice-cream does not change if it melts completely.) (4 marks)

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14. The coordinates of the points A and B are (8, –6) and (16, 6) respectively. Let P be a moving point in the rectangular coordinate plane such that P is equidistant from A and B. Denote the locus of P by Γ.

(a) (i) Describe the geometric relation between Γ and AB.

(ii) Find the equation of Γ.

(3 marks)

(b) G is a point on Γ. Circle C with centre G passes through the mid-point of AB. Denote the y-coordinate of G by k.

(i) Prove that the equation of C is $x^2 + y^2 - (24 - 3k)x - 2ky + 144 - 36k = 0$.

(ii) C passes through point $D(7, 5)$. Using (b)(i), or otherwise, find the area of the smallest circle which passes through B and G in terms of π.

(6 marks)

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SECTION B (35 marks)

15. A queue is randomly formed by 4 boys and 9 girls.

(a) How many different queues can be formed? (1 mark)

(b) Find the probability that no boys are next to each other in the queue. (3 marks)

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16. Suppose a, 27, b is a geometric sequence, where $b < 1 < a$.

(a) Express $\log_3 b$ in terms of $\log_3 a$. (2 marks)

(b) If $\log_b 27a$, $\log_a 27b$, $\log_{27} ab$ is an arithmetic sequence, find the common difference of the arithmetic sequence. (4 marks)

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17. Let $f(x) = -x^2 + 4kx - 13k^2 - 26$, where k is a real constant.

(a) Using the method of completing the square, find the coordinates of the vertex of the graph of $y = f(x)$ in terms of k. (2 marks)

(b) The graph of $y = g(x)$ is obtained by first reducing the graph of $y = f(x)$ to k of the original along the y-axis and then translating upward by $\frac{4-9k^2}{k}$ unit(s), where $0 < k < \frac{2}{3}$. If $g(x)$ is always negative for all real values of x, find the range of values of k. (5 marks)

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18. A straight line L: $8x + 15y - 485 = 0$ is the tangent to the circle C: $x^2 + y^2 - 4x - 24y + k = 0$ at P. Denote the centre of C by G.

(a) Find the value of k and the coordinates of P. (4 marks)

(b) It is given that $Q(25, q)$ is a point lying on the straight line L.

(i) Find the equation of the circumcircle of ΔPQG.

(ii) Someone claims that the ratio of the area of the circumcircle of ΔPQG to the area of the circle C is 1 : 2. Do you agree? Explain your answer.

(5 marks)

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19. In Figure 3(a), a piece of square thin metal sheet $ABCD$ with side 40 cm is divided into 16 little squares evenly. It is folded along AF, BF, FG, CG and DG to form a chopstick-stand as shown in Figure 3(b). Points A, B, C, D, E and H lie on the same horizontal plane. Points F and G are vertically above points E and H respectively.

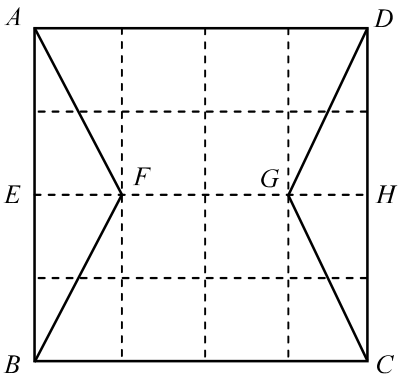

Figure 3(a)

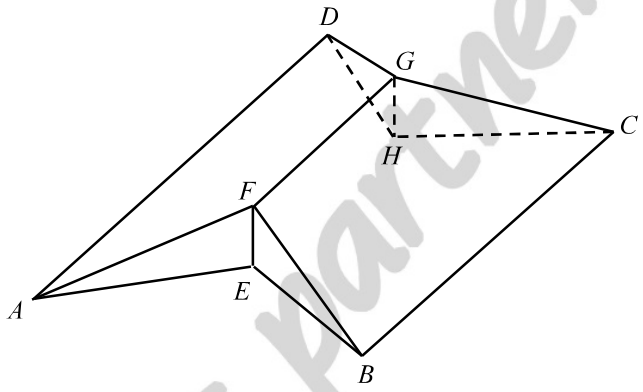

Figure 3(b)

Consider Figure 3(b), find

(a) (i) AB,

(ii) the angle between the planes AEF and BEF, and

(iii) CE.

(6 marks)

(b) Someone claims that the angle between the planes BEF and $BCGF$ is greater 75°. Do you agree? Explain your answer. (3 marks)

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Answers written in the margins will not be marked.

2024 – DSE

MATH

PAPER 2

MC

THE 13TH HONG KONG DIPLOMA OF SECONDARY EDUCATION MOCK EXAMINATION 2024

MATHEMATICS PAPER 2

(1¼ hours)

INSTRUCTIONS

1. Read carefully the instructions on the Answer Sheet. After the announcement of the start of the examination, you should first stick a barcode label and insert the information required in the spaces provided. No extra time will be given for sticking on the barcode label after the 'Time is Up' announcement.
2. When told to open this book, check that all the questions are there. Look for the words '**END OF PAPER**' after the last question.
3. All questions carry equal marks.
4. **ANSWER ALL QUESTIONS**. You are advised to use an HB pencil to mark all the answers on the Answer Sheet, so that wrong marks can be completely erased with a clean rubber. You must mark the answers clearly; otherwise you will lose marks if the answers cannot be captured.
5. You should mark **ONE** answer for each question. If you mark more than one answer, you will receive **NO MARKS** for that question.
6. No marks will be deducted for wrong answers.
7. Contents of the examination answered by students may be used for certain purposes such as teaching and data analysis.

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Not to be taken away from the examination centre

There are 30 questions in Section A and 15 questions in Section B.

The diagrams in this paper are not necessarily drawn to scale.

Choose the best answer for each question.

Section A

1. If $\frac{p}{2-p}=\frac{q}{4+q}$, then p =

   A. $-2q$.

   B. $\frac{q}{2+q}$.

   C. $\frac{q}{2-q}$.

   D. $\frac{q}{q-2}$.

2. $\frac{4}{3x+2}+\frac{3}{2-3x}=$

   A. $\frac{3x-2}{9x^2-4}$.

   B. $\frac{3x-14}{9x^2-4}$.

   C. $\frac{21x-2}{3x^2-2}$.

   D. $\frac{21x-14}{9x^2-4}$.

3. $\frac{7^y\cdot(7^y)^y}{7^{y+2}}=$

   A. 7^{2y-2}.

   B. 7^{y^2-2}.

   C. 7^{y^2-y}.

   D. 7^{2y^2-y-2}.

4. $a^2 - 9b^2 - 8a + 16 =$

A. $(a - 3b - 4)(a + 3b - 4)$.

B. $(a - 3b - 4)(a + 3b + 4)$.

C. $(a - 3b + 4)(a + 3b - 4)$.

D. $(a + 3b - 4)^2$.

5. If a and b are constants such that $(ax - 2)(2x + 3) + 3 \equiv bx^2 + (a + 2)x - 3$, $b =$

A. –6.

B. –3.

C. 3.

D. 6.

6. The solution of $2(15 - x) \le 2x + 6$ and $2x \le x + 6$ is

A. $x \le 6$.

B. $x \ge 6$.

C. $x = 6$.

D. $x \ne 6$.

7. If $10.9468 < x < 10.9537$, which of the following must be true?

A. $x = 10$ (correct to 2 significant figures)

B. $x = 10.9$ (correct to 3 significant figures)

C. $x = 10.95$ (correct to 4 significant figures)

D. $x = 10.950$ (correct to 5 significant figures)

8. Let $f(x) = 2x^2 + 1$, then $f(x - 1) =$

A. $2x^2$.

B. $2x^2 - 1$.

C. $2x^2 + 4x + 3$.

D. $2x^2 - 4x + 3$.

Go to the next page

9. Let p and q be constants. If the remainder is -1 when $x^2 + px + q$ is divided by $x + 2$, find $4p - 2q + 5$.

A. 5

B. 10

C. 15

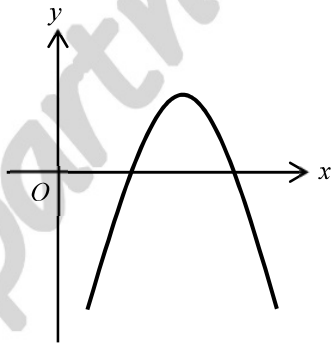
D. 20

10. The figure shows the graph of $y = ax^2 - bx + c$, where a, b and c are constants. Which of the following are true?

I. $ac > 0$

II. $\frac{b}{c} > 0$

III. $b + c < 0$



A. I and II only

B. I and III only

C. II and III only

D. I, II and III

11. The marked price of a bag is \$8 000. If the bag is sold at the marked price, then the percentage profit is 60%. If the bag is sold at a 20% discount on the marked price, then the profit is

A. \$1 400.

B. \$1 600.

C. \$2 667.

D. \$4 400.

12. The scale of a map is 1 : 5 000. If the area of a park on the map is 8 cm^2, then the actual area of the park is

A. 4 000 m^2.

B. 20 000 m^2.

C. 40 000 m^2.

D. 200 000 m^2.

13. If $\frac{bc}{a}$ is a non-zero constant, then

A. a varies directly as b and c.

B. a varies inversely as b and inversely as c.

C. a varies directly as b and inversely as c.

D. a varies directly as c and inversely as b.

14. Denote a pattern, which the 1st pattern consists of 2 dots. For any positive integers n, the $(n + 1)$th pattern is formed by adding 2^{n+2} dots to the nth pattern. Find the number of dots in the 8^{th} pattern.

A. 506

B. 508

C. 1016

D. 1018

15. A tank with base 14 cm × 16 cm contains water of height 6 cm. A long cylinder with diameter 2 cm is put into the tank such that it stands vertically without its top being covered by water. Find the rise in water level correct to 3 significant figures.

A. 0.357 cm

B. 0.171 cm

C. 0.0853 cm

D. 0.0427 cm

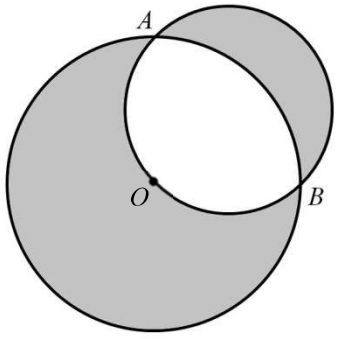
16. In the figure, a circle with centre O and radius 4 cm has points A and B on its circumference. Another circle with diameter AB is drawn such that O lies on its circumference. Find the area of the shaded region.

A. $(4\pi + 12)$ cm

B. $(4\pi + 16)$ cm

C. $(8\pi + 12)$ cm

D. $(8\pi + 16)$ cm



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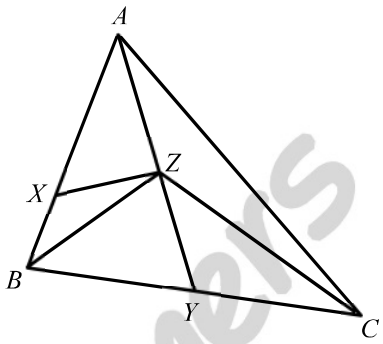
17. In the figure, Y is the mid-point of BC. Z is a point lying on AY. X is a point lying on AB such that $AX : XB = 5 : 2$.

If the area of ΔXBZ is 4 cm^2, then the area of ΔAZC is



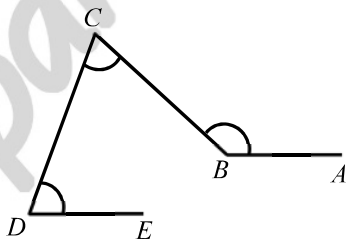
A. 10 cm^2.

B. 14 cm^2.

C. 25 cm^2.

D. 29 cm^2.

18. In the figure, AB // DE. If $\angle ABC = 4x - 98^\circ$, $\angle BCD = x + 10^\circ$ and $\angle CDE = x + 6^\circ$, find x.



A. 51°

B. 57°

C. 63°

D. 67°

19. Which of the following statements about a regular 24-sided polygon are true?

I. The number of folds of rotational symmetry is 24.

II. Each interior angle is 165°.

III. Each interior angle is 8 times the exterior angle.

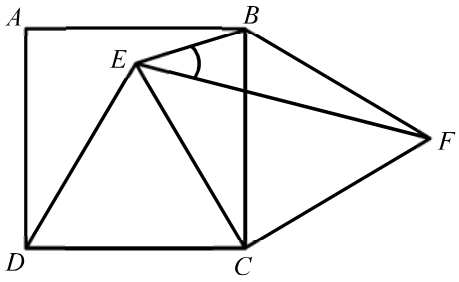
A. I and II only

B. I and III only

C. II and III only

D. I, II and III

20. In the figure, $ABCD$ is a square. ΔBFC and ΔCDE are equilateral triangles. Find $\angle BEF$.



A. 15°

B. 20°

C. 25°

D. 30°

21. $ABCD$ is a parallelogram. Let P, Q, R and S be the mid-points of AB, BC, CD and AD respectively. Which of the following must be true?

I. $AP = CR$

II. $\angle QPS = \angle SRQ$

III. $\Delta QCR \cong \Delta SDR$

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

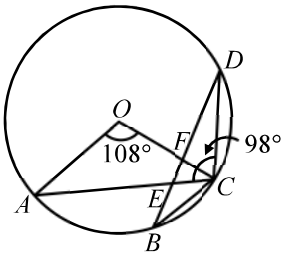
22. In the figure, BD cuts AC and OC at E and F respectively. $\angle AOC = 108°$ and $\angle ACD = 98°$. Find $\angle EBC$.

A. 20^o

B. 23^o

C. 25^o

D. 28^o



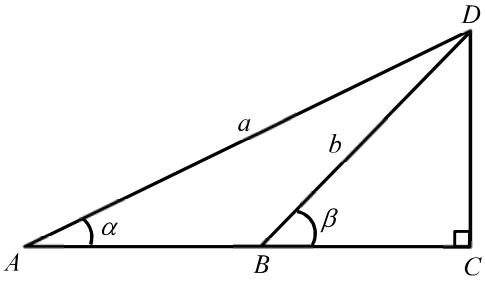
23. In the figure, ABC is a straight line. If $AD = a$ and $BD = b$, then $AB =$

A. $b\cos\alpha - a\cos\beta$.

B. $b\sin\alpha - a\sin\beta$.

C. $a\cos\alpha - b\cos\beta$.

D. $a\sin\alpha - b\sin\beta$.



24. The polar coordinates and the rectangular coordinates of a point P are $(r, 150°)$ and $(x, 1)$ respectively. Find the value of x.

A. –2

B. $-\sqrt{3}$

C. $\sqrt{3}$

D. 2

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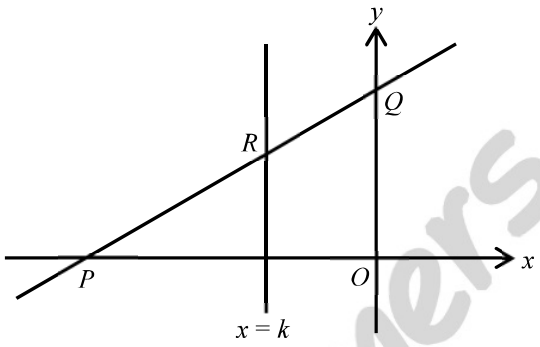
25. In the figure, $P = (-5, 0)$ and $Q = (0, 4)$. If the straight line PQ intersects the line $x = k$ at R, find the y-coordinate of R.

A. $\frac{20-4k}{5}$

B. $\frac{20+4k}{5}$

C. $\frac{25-5k}{4}$

D. $\frac{25+5k}{4}$



26. For ΔABC, it is given that the moving point P is equidistant from the straight lines AB and BC. Which of the following must be true?

I. The locus of P is the angle bisector of $\angle ABC$.

II. The locus of P is an altitude of ΔABC.

III. The locus of P is a median of ΔABC.

A. I only

B. II only

C. I and III only

D. I, II and III

27. It is given that the equation of the circle C_1 is $x^2 + y^2 - 8x - 6y + 20 = 0$ and the equation of the circle C_2 is $2x^2 + 2y^2 + 12x - 16y + 33 = 0$. Let G_1 and G_2 be the centres of C_1 and C_2 respectively. Denote the origin by O. Which of the following is/are true?

I. G_1O is perpendicular to G_2O.

II. The area of C_1 is greater than the area of C_2.

III. O is equidistant from G_1 and G_2.

A. I only

B. II only

C. I and III only

D. II and III only

28. John has 8 pens and only 1 of them is a black ball pen. He selects the pens one by one at random without replacement. Find the probability that he selects the black ball pen in more than 2 trials.

A. $\frac{1}{4}$

B. $\frac{3}{4}$

C. $\frac{1}{8}$

D. $\frac{5}{8}$

29. The stem-and-leaf diagram shows the distribution of a set of data.

Stem (tens)	Leaf (units)
1	1 5 7 9
2	0 1 3 5 6 9
3	2 7 7 8
4	0 4

Three numbers are added to the above set of data. The lower quartile, median and the upper quartile of the distribution become 19, 25 and 37 respectively. If the mean of the three numbers is 29, find the greatest number added.

A. 35

B. 37

C. 40

D. 43

30. Let a, b, c and d be the mean, the median, the mode and the range of the group of 8 numbers $\{x-5, x-1, x-1, x-1, x, x+2, x+4, x+6\}$ respectively. Which of the following must be true?

I. $a > b$

II. $a < d$

III. $c = \frac{a+b}{2}$

A. I only

B. I and II only

C. I and III only

D. II and III only

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Section B

31. $5 \times 2^8 + 17 - 48 \times 2^3 =$

A. 110001001_2.

B. 111001001_2.

C. 1100010001_2.

D. 1110010001_2.

32. The H.C.F. and L.C.M. of three expressions are a^2bc and $a^4b^3cd^2$ respectively. If the first and the second expressions are $a^2b^2cd^2$ and a^4bc respectively, which of the following can be the third expression?

I. a^3b^3c

II. a^4b^2cd

III. $a^2b^3cd^2$

A. III only

B. I and II only

C. I and III only

D. I, II and III

33. If the roots of the equation $(\log_9 x)^2 + \log_9 x^2 - 12 = \log_9 x$ are m and n, then $\log_3 m + \log_3 n =$

A. –2.

B. –3.

C. $\frac{1}{2}$.

D. $\frac{1}{9}$.

34. Let $f(x) = x^2 + bx + c$, where b and c are real numbers. One of the roots of $f(x) = 0$ is $4 - 3i$, where $i = \sqrt{-1}$. Find the value of $b - c$.

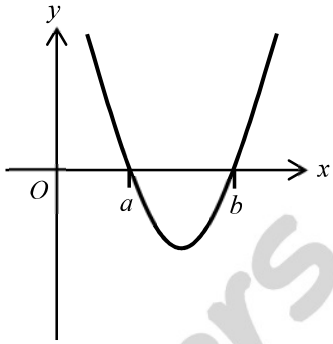
A. –33

B. –34

C. –35

D. –36

35. Solve $f(x) \leq 0$ and $f(x - a + b) \leq 0$.



A. $x = a$

B. $x = b$

C. $-a + b \leq x \leq b$

D. $b \leq x \leq a + b$

36. Let a_n be the nth term of a geometric sequence. If $a_2 = 4$ and $a_4 = 16$, which of the following must be true?

I $a_{n+1} > a_n$ for all integers n.

II. $a_n a_{n+3} = a_{n+1} a_{n+2}$ for all integers n.

III. The sum of the first 50 terms of the sequence is smaller than a_{51}.

A. I only

B. II only

C. II and III only

D. I, II and III

37. Consider the following system of inequalities:

$$\begin{cases} 8x + 3y \leq 23 \\ 5x - 9y \geq -40 \\ x + 4y \geq -8 \end{cases}$$

Let D be the region which represents the solution of the above system of inequalities. If (x, y) is a point lying in D, then the greatest value of $5x + 4y + c$ is 49. Find c.

A. 24

B. 25

C. 41

D. 49

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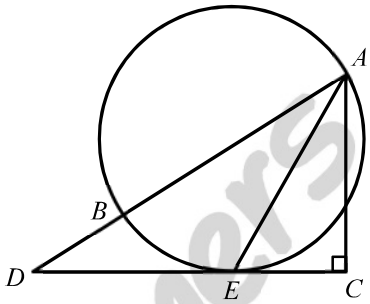
38. In the figure, AB is the diameter of the circle. ABD is a straight line and $\angle ACD = 90°$. CD is the tangent to the circle at E. Which of the following statements must be correct?

I. The in-centre of ΔACD lies on AE.

II. $\Delta ACE \sim \Delta AEB$

III. $AB \times AC = AE^2$



A. I and II only

B. I and III only

C. II and III only

D. I, II and III

39. The circle C_1: $x^2 + y^2 + 8x + 6y - 9 = 0$ intersects the line L: $y = -4x - 1$ at P and Q. If C_2 is another circle passing through P and Q such that the radius of C_2 is the same as that of C_1, then the coordinates of the centre of C_2 is

A. $(-\frac{11}{28}, \frac{121}{14})$.

B. $(\frac{96}{35}, \frac{12}{35})$.

C. $(\frac{76}{17}, -\frac{15}{17})$.

D. $(-\frac{6}{29}, -\frac{73}{58})$.

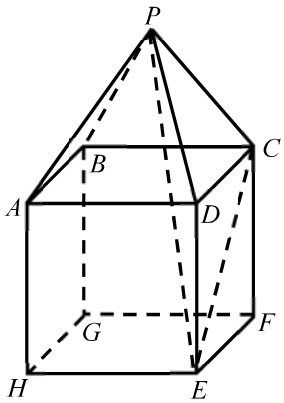
40. In the figure, $ABCDEFGH$ is a cube, and $PA = PB = PC = PD = AB$. Find $\angle PEC$, correct your answer to 3 significant figures.

A. 25.9°

B. 30.0°

C. 32.4°

D. 33.4°



41. Let a be a constant. The straight line L_1: $x - 3y - a = 0$ and L_2: $4x + 3y + a = 0$ cuts the x-axis at P and Q respectively. It is given that L_1 and L_2 intersect at R. If the coordinates of the orthocentre of ΔPQR is (0, 18), then $a =$

A. –24

B. –13.5

C. 13.5

D. 24

42. Consider all the six digit numbers that can be formed using the digits 1, 2, 3, 4, 5 and 6, each digit being used exactly once. Each of such six digit numbers have the property that for each digit, not more than two digits smaller than that digit appear to the right of that digit. How many different six digit numbers can be formed?

A. 120

B. 144

C. 162

D. 210

43. There are two bags each containing 13 balls marked from 1 to 13. There are three students and each one has to draw one ball from each bag at random without replacement. Find the probability that at least one student gets two same numbers.

A. $\frac{3}{13}$

B. $\frac{5}{11}$

C. $\frac{7}{33}$

D. $\frac{9}{52}$

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44. The mean, median and mode of real numbers 4, 4, 4, 6, 7, 18, x are not all equal. The mean, median and mode are arranged in ascending order, they form an arithmetic sequence. Find the sum of all possible values of x, correct to the nearest integer.

A. 6

B. 10

C. 14

D. 18

45. The variance of the 5 numbers $\{\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5\}$ is 8.5 and the variance of the 6 numbers $\{\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6\}$ is 5.2. It is given that the mean of the two sets of numbers are the same. Find the standard deviation of the 11 numbers $\{\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5, \beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6\}$ correct to 3 significant figures.

A. 2.38

B. 2.59

C. 5.66

D. 6.70

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