# OPSC PGT

## Previous Year Paper

## 2017 (Mathematics)

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Test Booklet Series

**A**

T. B. C. : PGT – 6/17

# TEST BOOKLET

PART – B

(MATHEMATICS)

Serial No. 6209

*Time Allowed : 2 Hours*

*Maximum Marks : 100*

## : INSTRUCTIONS TO CANDIDATES :

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5. This Test Booklet contains **100** items (questions). Each item (question) comprises four responses (answers). You have to select the correct response (answer) which you want to mark (darken) on the Answer Sheet. In case, you feel that there is more than one correct response (answer), you should mark (darken) the response (answer) which you consider the best. In any case, choose **ONLY ONE** response (answer) for each item (question).
6. You have to mark (darken) all your responses (answers) **ONLY** on the **separate Answer Sheet** provided by **using BALL POINT PEN (BLUE OR BLACK)**. See instructions in the Answer Sheet.
7. All items (questions) carry equal marks. All items (questions) are compulsory. Your total marks will depend only on the number of correct responses (answers) marked by you in the Answer Sheet. **There will no negative markings for wrong answers.**
8. Before you proceed to mark (darken) in the Answer Sheet the responses to various items (questions) in the Test Booklet, you have to fill in some particulars in the Answer Sheet as per the instructions sent to you with your **Admission Certificate.**
9. After you have completed filling in all your responses (answers) on the Answer Sheet and after conclusion of the examination, you should hand over to the Invigilator the *Answer Sheet* issued to you. You are allowed to take with you the candidate's copy / second page of the Answer Sheet along with the **Test Booklet**, after completion of the examination, for your reference.
10. Sheets for rough work are appended in the Test Booklet at the end.

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SEAL

1. The set of non-zero complex numbers form a group under :

(A) Addition

(B) Multiplication

(C) Addition as well as multiplication

(D) None of the above

2. If S is a subset of the finite group G under multiplication, then S is a subgroup of G if and only if S is nonempty and a, b ∈ S implies that :

(A) $ab \in S$

(B) $ab = 1$

(C) $ab^{-1} \in S$

(D) $ab^{-1}, a^{-1}b \in S$

3. The set of integers is a group under addition. The number of its elements of finite order are :

(A) None

(B) Infinite

(C) 1

(D) 2

4. An ideal P is a prime ideal, if :

(A) Order of P is prime

(B) $ab \in P \Rightarrow a, b \in P$

(C) $ab \in P \Rightarrow (a, b) \in 1$

(D) $ab \in P \Rightarrow$ either $a \in P$ or $b \in P$

5. M is a maximal ideal of the commutative ring R if and only if :

(A) R / M is a normal subgroup

(B) $R \cap M$ is an ideal

(C) R/M is a field

(D) $R \cap M$ is a proper ideal

6. $X^2 + 1$ is the minimal polynomial of i over :

(A) Field **R** as well as **Q**

(B) Field **Q** only

(C) Field of complex numbers only

(D) Neither **R** nor **Q**

7. If $f \in F[X]$ and degree of $f$ is n, then $f$ has a splitting field K over F with :

(A) $[K : F] < n!$

(B) $[K : F] < n$

(C) $[K : F] \leq n!$

(D) $[K : F] \leq n$

8. The number of primes not exceeding x, for indefinitely large x, can be approximated by :

(A) $\frac{x}{\log x}$

(B) $\frac{\exp x}{x}$

(C) $\frac{\cos x}{x}$

(D) $\frac{\cosh x}{x}$

9. For integers a, b & m, $a \equiv b \pmod{m}$ $\Rightarrow f(a) \equiv f(b) \pmod{m}$, when $f()$ is :

(A) A function over set of integers

(B) A polynomial

(C) A polynomial with integer coefficients

(D) A continuous function

10. The number of solutions of $5x + 3y = 52$ in positive integers are :

(A) Two

(B) Three

(C) Infinite

(D) Five

11. Let $f(x)$ is continuous on $[-1, 1]$, then it is :

(A) Differentiable on [0, 1]

(B) Differentiable at $x = -1$ and $x = 1$

(C) Uniformly continuous on [–1, 1]

(D) Uniformly continuous on (–1, 1)

12. Heine-Borel property ensures that :

(A) An open cover of a compact set has a finite sub-cover

(B) An open subset of a compact set has a bounded sub-cover

(C) Uniformly continuous function is differentiable.

(D) Uniformly continuous is Riemann integrable

13. A curve defined by mapping $g : [a, b] \rightarrow R^k$ is rectifiable, if g is :

(A) Continuous on [a, b]

(B) Has derivative continuous on [a, b]

(C) Is integrable on [a, b]

(D) Is monotonically increasing

14. In a complete metric space :

(A) Every infinite series is convergent

(B) Every subset is compact

(C) Every function is closed

(D) Every Cauchy sequence is convergent

15. The value of integral $\int_{2\Pi}^{0} \sin^2 x dx$ is :

(A) 0

(B) $-\pi$

(C) $\pi/2$

(D) $-\pi/2$

16. The domain of function $f(x) = \sin^{-1}[\log_2(x/2)]$ is :

(A) [–1, 4]

(B) [1, –4]

(C) [1, 4]

(D) None of the above

17. A function, uniformly continuous on an interval [a, b] :

(A) Is piecewise continuous on real line

(B) Is differentiable on [a, b]

(C) Is Riemann integrable on [a, b]

(D) Can be subjected to mean value theorem

18. A curve defined by mapping $\gamma : [a, b] \to R^k$ is called an arc, if :

(A) $\gamma(a) = \gamma(b)$

(B) $\gamma$ is one-one

(C) $\gamma$ is differentiable

(D) $\gamma$ is one-one and onto

19. $f(x) = \dfrac{\sqrt{2}\cos x - 1}{\cot x - 1}$, for $x \neq \pi/4$; and $f(x) = \alpha$, at $x = \pi/4$. What should be the value of $\alpha$ to make $f(x)$ continuous at $x = \pi/4$ ?

(A) $-1/2$

(B) $\sqrt{2}$

(C) $1/2$

(D) 2

20. The function $f(x) = |x - 1| + |x - 2|$ is :

(A) Continuous at x = 1 only

(B) Continuous at x = 1 and x = 2

(C) Differentiable at x = 1 and x = 2

(D) Not differentiable on (1, 2)

21. Pole of a function is a point where the function becomes :

(A) Maximum

(B) Zero

(C) Unbounded

(D) Discontinuous

22. For a complex number z, the value of $\sin^2 z + \cos^2 z$ is :

(A) i

(B) 1

(C) 1 + i

(D) 1 – i

23. Cauchy's residue theorem is used to solve :

(A) Initial value problems

(B) Boundary value problems

(C) Integral in complex domain

(D) Integral equations

24. Complex valued function $f(z) = |z|^2$, for complex z, is analytic :

(A) Nowhere in complex plane

(B) At z = 0 only

(C) In entire complex plane

(D) In complex plane except at z = 0

25. For analytic $f(z) = u + iv$, Cauchy-Riemann equations in polar coordinates are given by :

(A) $u_r = v_\theta, u_\theta = -v_r$

(B) $rv_r = u_\theta, v_\theta = -ru_r$

(C) $u_r = v_r, u_\theta = -v_\theta$

(D) $ru_r = v_\theta, u_\theta = -rv_r$

26. The complex valued function $f(z) = u(x, y) + iv(x, y)$, for $z = x + zy$, is analytic if and only if :

(A) v is derivative of u

(B) v is integral of u

(C) u and v are harmonic

(D) v is harmonic conjugate of u

27. For $z = x + iy$, $x > 0$, the integral

$\int_0^\infty e^{-zt}\,dt$ is equal to :

(A) $z$

(B) $\frac{1}{z}$

(C) $\log z$

(D) $e^{-z}$

28. Necessary condition for an arc $z = z(t)$ $(a \le t \le b)$ to be smooth, is a :

(A) Continuous $z'(t)$

(B) Integrable $z(t)$

(C) Differentiable $z(t)$

(D) Harmonic $z(t)$

29. Residue of complex valued function $z\cos\left(\frac{1}{z}\right)$ at $z = 0$ is :

(A) $-\frac{1}{4}$

(B) $-\frac{1}{3}$

(C) $-\frac{1}{2}$

(D) $-1$

30. The transformation $w = \frac{az+b}{cz+d}$ with complex constants a, b, c, d makes a bilinear transformation when :

(A) $ad - bc = 0$

(B) $ad - bc \neq 0$

(C) $\frac{a}{d} = \frac{b}{c}$

(D) $\frac{a}{d} = \frac{-b}{c}$

31. Which of the following shape does not make a convex region ?

(A) Rectangle

(B) Ellipse

(C) Triangle

(D) Star

32. Maximum value of $2x_1 + 3x_2$ subject to the conditions $x_1, x_2 \ge 0$, $x_1 - x_2 \le 1$, $x_1 + x_2 \ge 3$ is :

(A) Infinite

(B) 15

(C) 28

(D) 65

33. An unbalanced assignment problem can be solved by converting into a balanced assignment problem by introducing dummy person or a dummy job with :

(A) Minimum Cost

(B) Maximum Cost

(C) Zero Cost

(D) Mean Cost

34. In VED classification to enhance the inventory control efficiency, alphabet D stands for :

(A) Demand

(B) Desirable

(C) Delivery

(D) Decoupling

35. EPQ model of inventory associates mainly with :

(A) Manufacturing environment

(B) Price discounts

(C) Larger consumption

(D) Cheaper transportation

36. A saddle point of a game is that place in the payoff matrix where :

(A) Minimum of the row maxima = minimum of the column maxima

(B) Maximum of the row minima = maximum of the column minima

(C) Maximum of the row minima = minimum of the column maxima

(D) Minimum of the row maxima = maximum of the column minima

37. The function to be maximized (or minimized) in linear programming procedure is called :

(A) Target function

(B) Optimised function

(C) Subjective function

(D) Objective function

38. The main basic function of inventory is to :

(A) Increase the manufacturing

(B) Increase the profitability

(C) Increase the consumption

(D) Construct the marketing support

39. If a standard problem and its dual are both feasible, then both are called :

(A) Bounded feasible

(B) Dual feasible

(C) Co-feasible

(D) Optimum feasible

40. Maximum of $5x + 2y + z$ for $x, y, z \geq 0$ and $x + 3y - z \leq 6$ ; $y + z \leq 4$ ; $3x + y \leq 7$, comes from

(A) $x = 7/3, y = 1, z = 3$

(B) $x = 1/3, y = 3, z = 0$

(C) $x = 2/3, y = 3, z = 1$

(D) $x = 7/3, y = 0, z = 4$

41. For Simpson rule to solve a definite integral, each section of the curve is replaced by :

(A) A secant chord

(B) A tangent to curve

(C) A second degree curve

(D) A spline arc

42. Gauss elimination method solves :

(A) A system of linear equations

(B) A cubic equation

(C) An algebraic equation of degree 4

(D) An integral equation

43. Gauss-Siedel method represents :

(A) A matrix inversion

(B) An interative procedure

(C) An integral evaluation

(D) An interpolation technique

44. Newton-Raphson method is applied to solve :

(A) An algebraic equation

(B) A transcendental equation

(C) A system of simultaneous equations

(D) Any of these

45. Runge-Kutta methods are used to solve the differential equation of :

(A) Upto second order

(B) Upto order three

(C) First order only

(D) Any order

46. Cramer's rule is used to solve :

(A) An integral

(B) A system of linear equations

(C) An algebraic equation

(D) None of these

47. Jacobi's method requires the coefficient matrix in system of equations to be :

(A) Symmetric

(B) Hermitian

(C) Sparse

(D) Diagonally dominant

48. Order to convergence of secant method is approximately :

(A) 1.427

(B) 1.618

(C) 1.84

(D) 2.0

49. When performing Gaussian elimination, the pivot represents the :

(A) Largest element in column

(B) Largest element in row

(C) Largest element in matrix

(D) Diagonal element

50. Shooting method is used to solve :

(A) Any differential equation

(B) Only initial value problems

(C) Only boundary value problems

(D) System of differential equations

51. If a function $f$ is measurable then :

(A) $|f|$ is always measurable

(B) $|f|$ is bounded but not measurable

(C) $f$ may be measurable subject to some conditions

(D) Then $f$ should be a limit to sequence of functions

52. In the definition of Reimann-Stieltjes integral, given by $\int_a^b f(x)\, d\alpha(x)$, the function $\alpha(x), x \in [a, b]$ must be a :

(A) Continuous function

(B) Monotonically decreasing function

(C) Monotonically increasing function

(D) Differentiable function

53. If $f$ is a non-negative measurable function and $\int_s f dm = 0$ then $f$ is :

(A) A constant

(B) Zero everywhere

(C) A periodic function

(D) Zero, almost everywhere

54. For metric space X with metric d, the map $\phi : X \to X$ is a contraction of X, if, for $x, y \in X$ :

(A) $d(\phi(x), \phi(y)) \leq cd(x, y)$ with finite positive c

(B) $d(\phi(x), \phi(y)) \leq cd(x, y)$ with real $c \leq 1$

(C) $d(\phi(x), \phi(y)) \leq cd(x, y)$ with $0 < c < 1$

(D) $d(\phi(x), \phi(y)) \leq cd(x, y)$ with real $c < 1$

55. A real valued function defined on a measurable space is called a simple function if :

(A) The domain of the function is finite

(B) The range of the function is finite

(C) Measurable space is a vector space

(D) Function is a contraction map

56. The series $\Sigma(n + 1)^{1/3} - (n)^{1/3}$ is :

(A) Convergent

(B) Divergent

(C) Oscillatory

(D) A power series

57. If $\{ f_n \}$ is a monotone increasing sequence of non-negative measurable functions from S to **R** then $\int_s f dm = \lim_{n\to\infty} \int_s f_n dm$. This theorem is known as :

(A) Bounded Convergence Theorem

(B) Dominated Convergence Theorem

(C) Monotone Convergence Theorem

(D) Monotone Measure Theorem

58. What is the length of an arc of the curve y = 1 – ln(cos x) intercepted between x = 0 and x = π/4 ?

(A) $\ln(\sqrt{2}+1)$

(B) $\ln(\sqrt{2}+2)$

(C) $1-\ln\sqrt{2}$

(D) None of these

59. The value of $\int_0^{\pi/2} \sin x \log(\sin x)\, dx$ is :

(A) $\log(\pi/2)$

(B) $\log(e/2)$

(C) $\log(2/\pi)$

(D) $\log(2/e)$

60. The value of integral $\int_{-1}^{1} ([x]-x)\, dx$ is :

(A) – 1

(B) 2

(C) 1

(D) 0

61. A norm on a vector space X is a function, whose range is a set of :

(A) Rational numbers

(B) Positive real numbers

(C) Real numbers

(D) Non-negative real numbers

62. According to Banach's criterion, a normed vector space X is complete if and only if every :

(A) Absolutely convergent series in X is convergent

(B) Convergent series in X is uniformly convergent

(C) Series in X is uniformly convergent

(D) Series in X is absolutely convergent

63. Given a vector space X with a subspace M. The codimension of M is the :

(A) g.c.d. of dimension of X and M

(B) Number of functions from X to M

(C) Dimension of quotient space X/M

(D) Dimension of largest normed subspace of X

64. A preorder ≤ on a set is a binary relation that satisfies the properties of :

(A) Reflexivity

(B) Reflexivity and Transitivity

(C) Transitivity

(D) Symmetry and Reflexivity

65. A bounded (linear) operator from X to Y is a linear transformation $T : X \to Y$ such that the operator norm $\|T\|$ is :

(A) Finite

(B) Zero

(C) Infinite

(D) Unity

66. Let E and F are Banach spaces. $T \in B(E, F)$ becomes an open map when it is :

(A) Bijective

(B) Injective

(C) Surjective

(D) Neither injective nor surjective

67. Closed-graph theorem is used to give a proof of :

(A) Open-mapping lemma

(B) The principle of uniform boundedness

(C) Urysohns lemma

(D) Parseval's identity

68. Let $(H, \langle \cdot,\cdot \rangle)$ be an inner product space, then for $a, b \in H$, the relation $\|x+y\|^2 + \|x-y\|^2 = 2\|x\|^2 + 2\|y\|^2$ is known as :

(A) Pythagorean theorem

(B) Law of convexity

(C) Reisz-Fischer theorem

(D) Parallelogram Law

69. Let H be a separable Hilbert space. All orthonormal bases of H are :

(A) Countable

(B) Dense in H

(C) Proper closed subspaces

(D) Separable

70. For an orthonormal subset $\beta$ of H, which of the following are equivalent ?

(1) $\beta$ is a basis.

(2) $\beta$ is complete.

(3) Span $\beta = H$.

(A) (1) and (2)

(B) (2) and (3)

(C) (1) and (3)

(D) All of these

71. Linear operator A on a finite-dimensional vector space X is one-to-one if and only if :

(A) The range of A is all of X

(B) The domain of A is subset of X

(C) The domain and range of A is subset of X

(D) The domain of A is all of X

72. If A is a $n \times n$ non singular matrix, then adj(adj A) is equal to :

(A) $|A|^{n-2}$

(B) $|A|^{n-1}A$

(C) $|A|^{n-1}$

(D) $|A|^{n-2}A$

73. A square matrix A is singular if and only if its :

(A) Columns are linearly independent

(B) Rows are linearly independent

(C) Columns are linearly dependent

(D) Eigenvalues are non-zero

74. If $\alpha$ is an eigenvalue of a nonsingular matrix A then corresponding eigenvalue of adjoint of A will be :

(A) $|A|\alpha$

(B) $|A|/\alpha$

(C) $|A|$

(D) $|A|^{-1}$

75. Of a square matrix, the product of its eigenvalues is equal to :

(A) Sum of its diagonal elements

(B) Product of its diagonal elements

(C) Its determinant

(D) Determinant of its adjoint

76. What value of k makes the vectors (1, – 1, 3), (1, 2, –2), (k, 0, 1) linearly dependent ?

(A) $3/4$

(B) $1/2$

(C) $1/4$

(D) $-3/4$

77. Which of the following maps are linear transformations ?

(1) $T : R^2 \to R$ defined by $T(x, y) = |2x - 3y|$

(2) $T : R^2 \to R$ defined by $T(x, y) = xy$

(3) $T : R^3 \to R^2$ defined by $T(x, y, z) = (z, x + y)$

(A) All of these

(B) 1 and 2 only

(C) 3 only

(D) 2 and 3 only

78. The rank of $T : R^2 \to R^3$, defined as $T(x, y) = (x + y, x - y, y)$, is :

(A) 3

(B) 2

(C) 1

(D) 0

79. The eigenvalues for $T : R^3 \to R^3$ defined by $T(x, y, z) = (3x + y + 4z, 2y + 6z, 5z)$ are :

(A) 2, 3 and 5

(B) 3, 4 and 5

(C) 2, 3 and 4

(D) 1, 2 and 3

80. The dimension of the vector space C over the field of real numbers is :

(A) 1

(B) Infinite

(C) 2

(D) 4

81. Let p denotes the statement "Rahul is rich" and q denotes the statement "Rahul is happy". Then the statement "Rahul is poor or he is both rich and unhappy" is expressed as :

(A) $\sim p \vee (p \wedge \sim q)$

(B) $p \vee (p \wedge \sim q)$

(C) $\sim p \vee (p \wedge q)$

(D) $p \vee (p \wedge q)$

82. In terms of $\downarrow$, $p \rightarrow q$ is expressed as :

(A) $(p \downarrow q) \downarrow (q \downarrow p)$

(B) $(\sim p \downarrow q) \downarrow (\sim q \downarrow p)$

(C) $(\sim p \downarrow q) \downarrow (\sim p \downarrow q)$

(D) $(p \downarrow q) \downarrow (p \downarrow q)$

83. A poset $(L, \leq)$ becomes a lattice when every non-empty finite subset of L has :

(A) A supremum

(B) An infimum

(C) A supremum as well as an infimum

(D) Neither supremum nor infimum

84. In the lattice L = {1, 2, 3, 5, 6, 10, 15, 30} ordered by divisibility, the atoms are :

(A) 1, 2, 3, 5

(B) 2, 3, 5

(C) 1, 2, 3

(D) 3, 5

85. In recurrence relation $a_{r+2} - 2a_{r+1} + a_r$, $a_0 = 2$, $a_1 = 1$, the $a_r$ is given by :

(A) $1 + 2r + 2^r$

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

(C) $1 - 2r - 2^r$

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

86. The dual of $a + a'b = a + b$ is :

(A) $a(a' + b) = ab$

(B) $a(a' + b) = a'b$

(C) $a(a + b) = ab$

(D) $a'(a + b) = ab$

87. For every pair of elements a and b, DeMorgan's laws in Boolean algebra are :

(A) $(a + b)' = a' + b'$ & $(a * b)' = a' * b'$

(B) $(a + b)' = b' + a'$ & $(a * b)' = b * a$

(C) $(a + b)' = a' * b'$ & $(a * b)' = a' + b'$

(D) $(a + b)' = a * b$ & $(a * b)' = a + b$

88. In minimal form, the function $f(x, y, z) = xyz + xy'z + x'yz + x'y'z$ is written as :

(A) $f = z'$

(B) $f = z$

(C) $f = x + z$

(D) $f = y + z$

89. Let a simple graph of 15 edges, 3 vertices of degree 4 and all other vertices of degree 3. The number of edges in this graph are :

(A) 6

(B) 8

(C) 9

(D) 10

90. Nullity of a complete graph of 7 vertices is :

(A) 7

(B) 8

(C) 14

(D) 21

91. Frobenius' method is used to find the power series solution of :

(A) Integral equations

(B) Ordinary differential equations with variable coefficients

(C) Partial differential equations

(D) Integro-differential equations

92. The differential equation $(1 - x^2)\frac{d^2y}{dx^2} - 2x\frac{dy}{dx} + m(m + 1)y = 0$ is known as :

(A) Bessel's equation

(B) Hermite's equation

(C) Kelvin's equation

(D) Legendre's equation

93. For $J_n(x)$ being Bessel's function of first kind, $\frac{d}{dx}\left[x^n J_n(x)\right]$ is equal to :

(A) $x^n J_{n+1}(x)$

(B) $x^{n-1} J_{n+1}(x)$

(C) $x^n J_{n-1}(x)$

(D) $x^{n-1} J_n(x)$

94. For $x \to 0$, $J_n(x)$ is approximated as :

(A) $\frac{1}{\Gamma(n+1)}\left(\frac{x}{2}\right)^n$

(B) $\frac{1}{\Gamma(n)}\left(\frac{x}{2}\right)^n$

(C) $\frac{1}{\Gamma(n+1)} x^n$

(D) $\frac{1}{\Gamma(n)} x^n$

95. Heat conduction equation is classified as :

(A) Hyperbolic equation

(B) Parabolic equation

(C) Elliptic equation

(D) Harmonic equation

96. Laplace transform of $\frac{\sinh t}{t}$ is :

(A) $\frac{1}{2}\log\left(\frac{s-1}{s+1}\right)$

(B) $\frac{1}{2}\log\left(\frac{s+1}{s-1}\right)$

(C) $-\frac{1}{2}\log\left(\frac{s-1}{s+1}\right)$

(D) $-\frac{1}{2}\log\left(\frac{s+1}{s-1}\right)$

97. Inverse Laplace transform of $\frac{1}{2s-5}$ is :

(A) $\frac{1}{2}\exp\left(\frac{3}{2}t\right)$

(B) $\frac{5}{2}\exp\left(\frac{1}{3}t\right)$

(C) $\frac{2}{5}\exp\left(\frac{3}{2}t\right)$

(D) $\frac{1}{3}\exp\left(\frac{5}{2}t\right)$

98. For a function, given by $f(x) = 1$ for $|x| < a$ but $f(x) = 0$ for $|x| > a$, the Fourier transform is given by :

(A) $\frac{i}{s}\cos(sa)$

(B) $\frac{2}{s}\sin(sa)$

(C) $\frac{i}{a}\cos(sa)$

(D) $\frac{2}{a}\sin(sa)$

99. If $f(s)$ denotes the Fourier transform of F(x), then the Fourier transform of F(ax) is given by :

(A) $af\left(\frac{s}{a}\right)$

(B) $\frac{1}{a}f(sa)$

(C) $af(sa)$

(D) $\frac{1}{a}f\left(\frac{s}{a}\right)$

100. The equation $\frac{\partial^2 u}{\partial x^2} + i\frac{\partial u}{\partial t} = 0$, is known as :

(A) Burger's equation

(B) Transport equation

(C) Schrodinger's equation

(D) Maxwell's equation

■■■■■■■■■■■■■■■

## SPACE FOR ROUGH WORK

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