ROYAL CIVIL SERVICE COMMISSION
BHUTAN CIVIL SERVICE EXAMINATION (BCSE) 2023
EXAMINATION CATEGORY: <u>TECHNICAL</u>
PAPER II: GENERAL SUBJECT KNOWLEDGE PAPER FOR <u>ENGINEERING</u>

Date   : October 6, 2023
Total Marks   : 100
Examination Time : 90 minutes (1.5 hours)
Reading Time   : 15 Minutes (prior to examination time)

GENERAL INSTRUCTIONS:

1. Write your Registration Number clearly and correctly on the Answer Booklet.

2. The first 15 minutes is to check the number of pages of the Question Paper, printing errors, clarify doubts and to read the instructions. You are NOT permitted to write during this time.

3. This paper consists of **TWO parts: Part I & Part II.**

   Part I consists of 70 multiple choice questions of 1 (one) mark each, and
   Part II consists of 10 short answer questions of 3 (three) marks each.

4. All questions are COMPULSORY

5. All answers should be written on the Answer Booklet provided to you. Candidates are not allowed to write anything on the question paper. If required, ask for additional Answer Booklet.

6. All answers should be written with correct numbering of Part, Section and Question Number in the Answer Booklet provided to you. Note that any answer written without indicating correct Part, Section and Question Number will NOT be evaluated and no marks would be awarded.

7. Begin each Part on a fresh page of the Answer Booklet.

8. You are not permitted to tear off any sheet(s) of the Answer Booklet as well as the Question Paper.

9. Use of any other paper including paper for rough work is not permitted

10. **You must hand over the Answer Booklet to the Invigilator before leaving the examination hall.**

11. The Question paper has **13 printed pages,** including this Instruction Page.

GOOD LUCK!

PART I

Multiple Choice Questions [70 marks]

Choose the correct answer and write down the letter of the correct answer chosen in the Answer Booklet against the question number. e.g. 71 (a). Each question carries ONE mark. Any double writing, smudgy answer or writing more than one choice shall not be evaluated.

SECTION A: Mathematics

1. Let f: R → R be the functions defined by f(x) = x^3 + 5. Then $f^{-1}(x)$ is
   a) $(x + 5)^{1/3}$
   b) $(5 - x)^{1/3}$
   c) $5 - x$
   d) $(x - 5)^{1/3}$

2. The domain of the function defined by $f(x) = Sin^{-1}\sqrt{x - 1}$
   a) [1, 2]
   b) [-1, 1]
   c) [0, 1]
   d) None of these

3. Find the positive integer n in $\lim_{x \to 3} \frac{(x^n - 3^n)}{(x-3)} = 108$.
   a) 3
   b) 4
   c) -2
   d) 1

4. Find the value of $\sec^2 (\tan^{-1} 2) + \csc^2 (\cot^{-1} 3)$
   a) 12
   b) 5
   c) 15
   d) 9

5. If $\tan^{-1} 2x + \tan^{-1} 3x = \frac{\pi}{4}$, then x is
   a) $\frac{1}{6}$
   b) 1
   c) $(\frac{1}{6}, -1)$
   d) None of these

6. If $\begin{bmatrix} x + y & 2x + z \\ x - y & 2z + w \end{bmatrix} = \begin{bmatrix} 4 & 7 \\ 0 & 10 \end{bmatrix}$, then the values of x, y, z and w respectively are
   a) 2, 2, 3, 4
   b) 2, 3, 1, 2
   c) 3, 3, 0, 1
   d) None of these

7. If $A^2 - A + I = O$, then the inverse of A is
   a) $I - A$
   b) $A - I$
   c) A
   d) $A + I$

8. If the points (3, -2), (x, 2), (8, 8) are co-linear, find the value of x.
   a) 2
   b) 5
   c) 4
   d) 3

9. Using determinants, find the equation of the line joining the points (1, 2) and (3, 6).
   a) $x = 3y$
   b) $y = x$
   c) $y = 2x$
   d) $4x - y = 5$

10. If $x^y \cdot y^x = 16$, then the value of $\frac{dy}{dx}$ at (2, 2) is
    a) 0
    b) 1
    c) -1
    d) None of these

11. If $y = (\tan x)^{\sin x}$, then $\frac{dy}{dx}$ is equal to
    a) $\sec x + \cos x$
    b) $\sec x + \log \tan x$
    c) $(\tan x)^{\sin x}$
    d) None of these

12. It is given that at $x = 1$, the function $x^4 - 62x^2 + ax + 9$ attains its maximum value on the interval [0, 2]. Find the value of a.
    a) 120
    b) 100
    c) 140
    d) 160

13. The area of a right-angled triangle of the given hypotenuse is maximum when the triangle is
    a) Scalene
    b) Isosceles
    c) Equilateral
    d) None of these

14. The equation of the normal to the curves $y = \sin x$ at $(0, 0)$ is
    a) $x = 0$
    b) $y = 0$
    c) $x + y = 0$
    d) $x - y = 0$

15. Evaluate: $\int \tan(x - \theta) \tan(x + \theta) \tan 2x \, dx$
    a) $\frac{1}{2} \log|\cos 2x| - \log|\cos(x - \theta)| + \log|\cos(x + \theta)| + c$
    b) $-\frac{1}{2} \log|\cos 2x| + \log|\cos(x - \theta)| + \log|\cos(x + \theta)| + c$
    c) $-\frac{1}{2} \log|\cos 2x| - \log|\cos(x - \theta)| - \log|\cos(x + \theta)| + c$
    d) None of these

16. The solution of differential equation $(e^y + 1) \cos x \, dx + e^y \sin x \, dy = 0$ is
    a) $(e^y + 1) \sin x = c$
    b) $e^x \sin x = c$
    c) $(e^x + 1) \cos x = c$
    d) None of these

17. The vectors from origin to the points A and B are $\vec{a} = 2\vec{i} - 3\vec{j} + 2\vec{k}$ and $b = 2\vec{i} + 3\vec{j} + \vec{k}$, respectively then the area of triangle OAB is
    a) 340
    b) $\sqrt{25}$
    c) $\sqrt{229}$
    d) $\frac{1}{2} \sqrt{229}$

18. The area of the quadrilateral ABCD, where A(0, 4, 1), B(2, 3, -1), C(4, 5, 0) and D(2, 6, 2), is equal to
    a) 18 sq. units
    b) 27 sq. units
    c) 81 sq. units
    d) 9 sq. units

19. Maximize $Z = 11x + 8y$, subject to $x \leq 4$, $y \leq 6$, $x \geq 0$, $y \geq 0$.
    a) 44 at (4, 2)
    b) 62 at (4, 0)
    c) 48 at (4, 2)
    d) 60 at (4, 2)

20. The probability of a man hitting a target is $\frac{1}{4}$. How many times must he fire so that the probability of his hitting the target at least once is greater than $\frac{2}{3}$?
    a) 3
    b) 2
    c) 4
    d) 1

SECTION B: Chemistry

21. Which one of the following is acidic?
    a) Lemon juice
    b) Tomatoes
    c) Milk
    d) All of the above

22. The nature of calcium phosphate present in tooth enamel is
    a) Basic
    b) Amphoteric
    c) Acidic
    d) Neutral

23. Which of the following does not form an acidic salt?
    a) Phosphoric acid
    b) Carbonic acid
    c) Hydrochloric acid
    d) Sulphuric acid

24. Which one of the following will turn red litmus blue?
    a) Vinegar
    b) Baking soda solution
    c) Lemon juice
    d) Soft drinks

25. Rusting of iron takes place in
    a) ordinary water
    b) distilled water
    c) both ordinary and distilled water
    d) none of the above

26. Silver articles becomes black on prolonged exposure to air. This is due to the formation of
    a) AgS
    b) Ag_2S
    c) $AgSO_4$
    d) Ag_2O and Ag_2S

27. An element reacts with oxygen to give a compound with a high melting point. The compound is soluble in water. The element is likely to be
    a) calcium
    b) carbon
    c) iron
    d) silicon

28. In the decomposition of lead (II) nitrate to give lead (II) oxide, nitrogen dioxide and oxygen gas, the coefficient of nitrogen dioxide (in the balanced equation) is
    a) 1
    b) 2
    c) 3
    d) 4

29. On immersing an iron nail in $CuSO_4$ solution for few minutes, you will observe
    a) the colour of solution fades away.
    b) the surface of iron nails acquires a black coating.
    c) the colour of solution changes to green.
    d) no reaction takes place.

30. An element X on exposure to moist air turns reddish-brown and a new compound Y is formed. The substance X and Y are
    a) X = Fe, Y = Fe_2O_3
    b) X = Ag, Y = Ag_2S
    c) X = Cu, Y = CuO
    d) X = Al, Y = Al_2O_3

31. What is the molality of a solution formed when 58.5g of NaCl is dissolved in 2000mL water?
    a) 0.5000m
    b) 0.0005m
    c) 29.2500m
    d) 0.2925m

32. What type of bond do the transition elements form with themselves?
    a) Ionic bond
    b) Metallic bond
    c) Covalent bond
    d) Coordinate bond

33. The correct way of naming Co in $[CoCl_2(en)_2]^+$ is
    a) Cobaltate(II)
    b) Cobalt(II)
    c) Cobalt(III)
    d) Cobaltate(III)

34. Which of the following statement is **INCORRECT**?
    a) Vitamins can be produced by plants
    b) Vitamins contain amino groups
    c) Vitamin deficiency causes diseases
    d) Excess vitamin intake is harmful

35. What is the correct name of the following compound?

$$CH3 - CH - CH = CH$$
$$| $$
$$OH$$
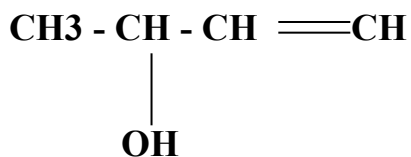
a) But-1-en-3-ol
b) But-3-enol
c) But-2-en-3-ol
d) But-3-en-2-ol

36. What characteristic of water accounts for its unique properties as a solvent?
a) Low viscosity
b) Cohesive
c) Polar
d) Flexible

37. Which of the following has the highest density?
a) CH_2Cl_2
b) $CHCl_3$
c) CH_3Cl
d) CCl_4

38. What effect does temperature have on the half-life of a first-order reaction?
a) It increases
b) It decreases
c) It remains the same
d) Both increases as well as decrease

39. Which solid structure has a definite and sharp melting point?
a) All types of solids
b) No type of solid
c) Amorphous solids
d) Crystalline solids

40. In a fuel cell, which of the following can be utilized as a fuel?
a) Nitrogen
b) Argon
c) Hydrogen
d) Helium

SECTION C: Physics

41. Which of the following is the weakest force?
a) Gravitational force
b) Nuclear force
c) Electromagnetic force
d) None of these

42. When we hold a book in our hand, we are balancing the gravitational force on the book due to
    a) Normal force provided by our hand
    b) Friction force provided by the book
    c) Parallel force between the book and hand
    d) None of these

43. The fuse in electrical circuits has:
    a) Low resistivity, high melting point
    b) High resistivity, low melting point
    c) Low resistivity, low melting point
    d) High resistivity, high melting point

44. The flux of the electrostatic field through the closed spherical surface is found to be four times that through the closed spherical surface S. Find the magnitude of the charge Q. The three charges are q1 = 1Uc, q2 = -4uC, q3 = 8.84uC.
    a) 5.84uC
    b) 31.32uC
    c) 17.52uC
    d) 38.52uC

45. Which of the following physical quantity has S.I. unit J/C?
    a) Electric flux
    b) Dipole moment
    c) Electric Potential
    d) Electric field intensity

46. An instrument that comprises of only a single convex lens is:
    a) Refracting telescope
    b) Compound telescope
    c) Simple telescope
    d) Reflecting telescope

47. A forward-biased PN junction acts as a/an
    a) Thyristor
    b) Closed switch
    c) Amplifier
    d) Chopper

48. A transformer has a primary coil with 1600 loops and a secondary coil with 1200 loops. If the current in the primary coil is 6 Ampere, then what is the current in the secondary coil of a transformer.
    a) 78 Ampere
    b) 98 Ampere
    c) 68 Ampere
    d) 58 Ampere

49. The efficiency of a transformer is maximum when
    a) Eddy current loss = iron loss
    b) Hysteresis loss = copper loss.
    c) Eddy current loss = hysteresis loss
    d) Iron loss = Copper loss

50. Point out the correct direction of magnetic field in the given figures.
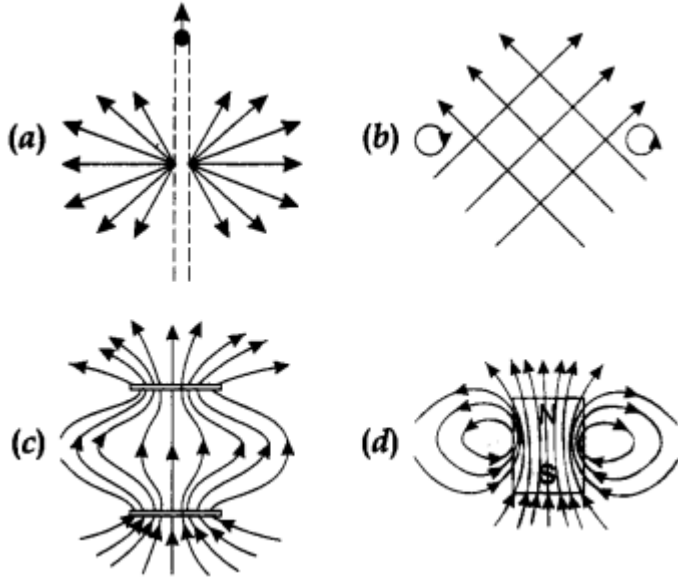
51. A capacitor has some dielectric between its plates, and the capacitor is connected to a dc source. The battery is now disconnected and then the dielectric is removed, then
    a) capacitance will increase.
    b) energy stored will decrease.
    c) electric field will increase.
    d) voltage will decrease.

52. Which of the following is correct for V-I graph of a good conductor?
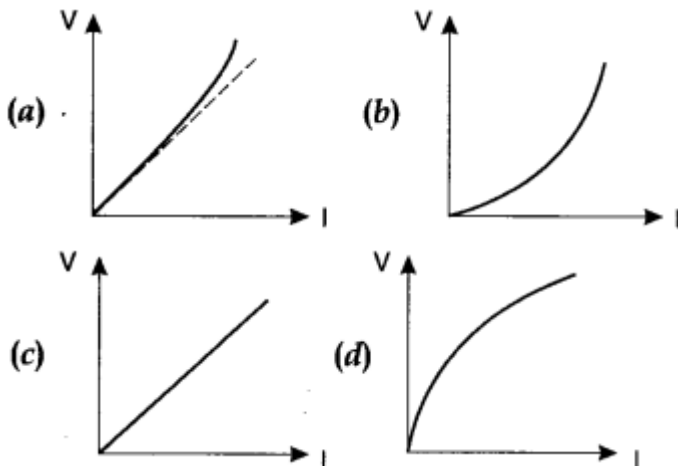
53. As body falls, its potential energy & kinetic energy
    a) decrease, increase
    b) increase, increase
    c) increase, decrease
    d) decrease, decrease

54. In an experiment to measure the internal resistance of a cell by a potentiometer, it is found that the balance point is at a length of 2 m when the cell is shunted by a 5Ω resistance and is at 3 m when the cell is shunted by a 10Ω resistance. The internal resistance of the cell is
    a) 10 Ω
    b) 15 Ω
    c) 1 Ω
    d) 1.5 Ω

55. A block of wood is placed on a surface. A force is applied parallel to the surface to move the body. The frictional force developed acts
    a) Normal to the surface upwards
    b) Normal to the surface downwards
    c) Along the direction of the applied force
    d) Opposite to the direction of the applied force

56. A bullet of mass 25g is moving with a velocity of 200cm/s is stopped within 5cm of the target. The average resistance offered by the target is
    a) 1 N
    b) 2 N
    c) 3 N
    d) 4 N

57. A body is sliding down a rough inclined plane which makes an angle of 30 degree with the horizontal. If the coefficient of friction is 0.26, the acceleration in m/s^2 is
    a) 1.95
    b) 2.78
    c) 3.47
    d) 4.6

58. A body of mass 10 kg is moved parallel to the ground through a distance of 2 m. The work done against the gravitational force is
    a) 196J
    b) -196J
    c) 20J
    d) Zero

59. A pump on the ground floor of a building can pump up water to fill a tank of volume 30m³ in 15 min. If the tank is 40 m above the ground, and the efficiency of the pump is 30%, how much electric power is consumed by the pump?
(Take g=10 ms−2)
a) 36.5 kW
b) 44.4kW
c) 52.5 kW
d) 60.5 kW

60. A student holds a 10kg stack of books 1.5m above the ground for 20s. How much power was used to hold the books during this time?
a) 15W
b) 0W
c) 300W
d) 7.35W

SECTION D: General IT Knowledge

61. Accuracy, purpose, relevance, validity and timeliness are the features of?
a) Data
b) Information
c) Knowledge
d) All of the above

62. ChatGPT is a large language model-based chatbot developed by Open AI. What does "T" in ChatGPT stand for?
a) Translator
b) Transducer
c) Transformer
d) Technology

63. The information that gets transformed in encryption is _____
a) Plain text
b) Parallel text
c) Encrypted text
d) Decrypted text

64. A technique in which a program attacks a network by exploiting IP broadcast addressing operations:
a) Smurfing
b) Denial of service
c) E-mail bombing
d) Ping storm

65. A program that runs in the background on your computer, sending information about your browsing habits to the company that installed it on your computer is called as
a) Pop-ups
b) Adware
c) Grayware
d) Spyware

66. Identify the different features of Big Data Analytics.
    a) Open source
    b) Scalability
    c) Data Recovery
    d) All of the above

67. What are modern computers based on?
    a) Microchip
    b) Micro processor
    c) I/O devices
    d) Both (a) & (b)

68. What technology is used to record cryptocurrency transactions?
    a) Mining
    b) Digital wallet
    c) Blockchain technology
    d) Token

69. Which company bought the popular video teleconferencing software 'Skype'?
    a) Google
    b) Accenture
    c) Oracle
    d) Microsoft

70. First web browser invented in 1990 is
    a) WorldWideWeb
    b) Internet Explorer
    c) Mosaic
    d) Nexus

Part II

Short Answer Questions [30 marks]

Answer ALL 10 short answer questions. Each question carries 3 marks.

1. Prove $\int secxdx = \log|secx + tanx| + c$ **(3 marks)**

2. Find those integral values of m for which the c-coordinate of the point of intersection of lines represented by y = mx + 1 and 3x + 4y = 9 is an integer. **(3 marks)**

3. Are the set C= {x:x-5=0} and E={x: x is an integral positive root of the equation x^2-2x-15 = 0} equal? **(3 marks)**

4. What is corrosion? Explain the electrochemical theory of rusting of iron and write the reactions involved in the rusting of iron. **(3 marks)**

5. Define the term solution. How many types of solutions are formed? Write briefly about each type with an example. **(3 marks)**

6. Calculate the amount of benzoic acid (C_6H_5COOH) required for preparing 250 mL of 0.15 M solution in methanol. **(3 marks)**

7. The circuit arrangement (in the figure) shows that when an alternating current pass through the coil A, the current starts flowing in the coil B. Answer the following questions. **(3 marks)**

Coil A   Coil B
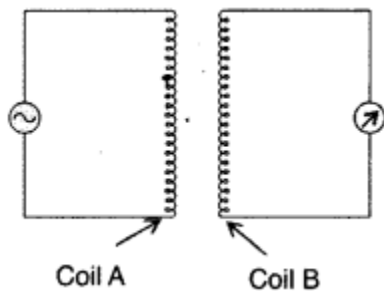
(i) State the underlying principle involved.
(ii) Mention two factors on which the current produced in the coil B depends.

8. Read each statement below carefully and state with reasons, if it is true or false. **(3 marks)**
   A particle in one-dimensional motion
   a) with zero speed at an instant may have non-zero acceleration at that instant.
   b) with constant speed must have zero acceleration.

9. A family uses 8 kW of power. (a) Direct solar energy is incident on the horizontal surface at an average rate of 200 W per square meter. If 20% of this energy can be converted to useful electrical energy, how large an area is needed to supply 8 kW? (b) Compare this area to that of the roof of a typical house. **(3 marks)**

10. How has artificial intelligence advanced? State the impact of artificial intelligence in the world today? **(3 marks)**

TASHI DELEK