ROYAL CIVIL SERVICE COMMISSION
BHUTAN CIVIL SERVICE EXAMINATION (BCSE) 2021
EXAMINATION CATEGORY: TECHNICAL

PAPER II: GENERAL SUBJECT KNOWLEDGE PAPER FOR ENGINEERING

Date : October 30, 2021
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 **14 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. If A, B and C are the three sets such that A ∩ B = A ∩ C and A ∪ B = A ∪ C, then
   a) A = B
   b) A = C
   c) B = C
   d) A ∩ B = ϕ

2. The range of the function f(x) = $\sqrt{(x-1)(3-x)}$ is
   a) [1, 3]
   b) [0, 1]
   c) [-2, 2]
   d) None of the above

3. Simplified form of $\cos^{-1}(4x^3 - 3x)$ is
   a) $3\sin^{-1}x$
   b) $3\cos^{-1}x$
   c) $\pi - 3\sin^{-1}x$
   d) None of the above

4. If $\begin{bmatrix} 1-x & 2 \\ 18 & 6 \end{bmatrix} = \begin{bmatrix} 6 & 2 \\ 18 & 6 \end{bmatrix}$, then x =
   a) ±6
   b) 6
   c) -5
   d) 7

5. If y = log $\left(\frac{1-x^2}{1+x^2}\right)$, then $\frac{dy}{dx}$ is equal to
   a) $\frac{4x^3}{1-x^4}$
   b) $\frac{-4x}{1-x^4}$
   c) $\frac{1}{4-x^4}$
   d) $\frac{-4x^3}{1-x^4}$

6. Solution of differential equation *x*dy – yd*x* = Q represents
   a) a rectangular hyperbola.
   b) a parabola whose vertex is at origin.
   c) a straight line passing through origin.
   d) a circle whose centre is at origin.

7. If $\vec{a} = \overrightarrow{2\iota} - \overrightarrow{5j} + k$ and $\vec{b} = \overrightarrow{4\iota} + \overrightarrow{2j} + \vec{k}$, then $\vec{a} \cdot \vec{b}$ =
   a) 0
   b) -1
   c) 1
   d) 2

8. The equation of the plane through point (1, 2, -3) which is parallel to the plane 3x- 5y + 2z = 11 is given by
   a) 3x – 5y + 2z – 13 = 0
   b) 5x – 3y + 2z + 13 = 0
   c) 3x – 2y + 5z + 13 = 0
   d) 3x – 5y + 2z + 13 = 0

9. A pair of dice are rolled. The probability of getting an even prime number on each dice is
   a) $\frac{1}{36}$
   b) $\frac{1}{12}$
   c) $\frac{1}{6}$
   d) 0

10. The solution of the following limit is

$$\lim_{x \to 2} \frac{3x^2 - x - 10}{x^2 - 4}$$

   a) $\frac{11}{4}$
   b) $\frac{8}{4}$
   c) $\frac{2}{4}$
   d) $\frac{4}{6}$

11. The maximum value of slope of the curve $y= -x^3+ 3x^2 + 12x - 5$ is
   a) 15
   b) 12
   c) 9
   d) 0

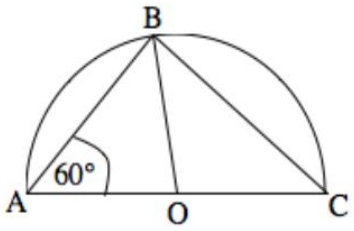
12. The value of $\sin^{-1}\left(\cos\frac{3\pi}{5}\right)$ is
    a) $\frac{\pi}{10}$
    b) $\frac{3\pi}{5}$
    c) $\frac{-\pi}{10}$
    d) $\frac{-3\pi}{5}$

13. $\int_0^{\pi/8}\tan^2(2x)$ is equal to
    a) $\frac{4-\pi}{8}$
    b) $\frac{4+\pi}{8}$
    c) $\frac{4-\pi}{4}$
    d) $\frac{4-\pi}{2}$

14. A tank can be filled by pipe A in 5 hours and by pipe B in 8 hours, each pump working on its own. When the tank is full and a drainage hole is open, the water is drained in 20 hours. If initially the tank was empty and someone started the two pumps together but left the drainage hole open, how long does it take for the tank to be filled?
    a) 2.5 hours
    b) 3.6 hours
    c) 7 hours
    d) 6 hours

15. Tashi drives a distance of 200 km to reach the town. If the car speed is increased by 10 km/hr than its usual speed, Tashi will take 1 hour less to cover the same distance. What is the usual speed of the car?
    a) 40 km/hr
    b) 50 km/hr
    c) 30 km/hr
    d) 60 km/hr

16. In the given semi-circle, center O, <BAO = 60°. The triangle ABC is



a) Right-angled
b) Isosceles
c) Equilateral
d) Scalene

17. The expression $\frac{50}{\sqrt[3]{5}}$ may be simplified to

a) 10
b) $2\left(5^{5/3}\right)$
c) $2\left(5^{7/3}\right)$
d) $5\sqrt{5}$

18. The addition of a rational number and an irrational number is equal to
a) Rational number
b) Irrational number
c) Both
d) None of the above

19. If the lines representing the pair of linear equations $a_1x + b_1y + c_1 = 0$ and $a_2x + b_2y + c_2 = 0$ are coincident, then
a) $a_1/a_2 = b_1/b_2$
b) $a_1/a_2 = b_1/b_2 = c_1/c_2$
c) $a_1/a_2 \neq b_1/b_2$
d) $a_1/a_2 = b_1/b_2 \neq c_1/c_2$

20. A quadratic equation $ax^2 + bx + c = 0$ has no real roots, if
a) $b^2 - 4ac < 0$
b) $b^2 - 4ac = 0$
c) $b^2 - 4ac > 0$
d) $b^2 - ac < 0$

SECTION B: Chemistry

21. The essential element for batteries used in electric cars is
a) Magnesium
b) Lithium
c) Sodium
d) Bromine

22. Which of the following is not part of Dalton's atomic theory?
    a) All matter is composed of indivisible atoms.
    b) Atoms of the same element can be different.
    c) Compounds are formed when atoms combine in whole number ratios.
    d) A chemical reaction involves rearrangement of atoms.

23. _____ is the unit of the scale used for measurement of the spicy heat of a chilli pepper?
    a) Smith
    b) Scoville
    c) Wright
    d) Orville

24. The most suitable method for ore concentration when the ore is soluble in some suitable solvent is
    a) Hydraulic Washing
    b) Magnetic Separation
    c) Froth floatation
    d) Leaching

25. Choose the correct statement about the modern periodic table:
    a) Elements in any one group contain the same number of valence electrons.
    b) Elements in any one period contain the same number of shells.
    c) Both a) and b)
    d) None of the above

26. The chemical formula of rust is
    a) $Fe_2O_3. nH_2O$
    b) $Fe_2Cl_3. nH_2O$
    c) $FeCO_2. nH_2O$
    d) $FeO. nH_2O$

27. Which of the following gas is responsible for burning of eyes when we cut an onion?
    a) Chlorine
    b) Sulphur
    c) Helium
    d) Methane

28. The correct increasing order of pH values of the following substances is
    a) Gastric Juice < Milk Of Magnesia < Citric Juice < Pure Water
    b) Citric Juice < Gastric Juice < Pure Water < Milk Of Magnesia
    c) Gastric Juice < Citric Juice < Pure Water < Milk Of Magnesia
    d) Gastric Juice < Citric Juice < Milk Of Magnesia < Pure Water

29. Which of the following has the longest wavelength?
    a) X rays
    b) Microwaves
    c) Green light
    d) UV light

30. Which substance is oxidised in the reaction represented by the ionic equation below?

$Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$

a) Copper because it gains electrons.
b) Zinc because it gains electrons.
c) Zinc because it loses electrons.
d) Copper because it loses electrons.

31. The hydrocarbon C_4H_8 was burnt in air and the incomplete combustion was occurred. Which equation correctly represents the incomplete combustion reaction?
a) $C_4H_8 + 4O \rightarrow 4CO + 4H_2$
b) $C_4H_8 + 4O_2 \rightarrow 4CO + 4H_2O$
c) $C_4H_8 + 6O_2 \rightarrow 4CO_2 + 4H_2O$
d) $C_4H_8 + 8O \rightarrow 4CO_2 + 4H_2$

32. Which statement best describes the chemistry of soaps?
a) They contain both a nonpolar group and a polar group.
b) They contain only a nonpolar group.
c) They contain only a charged group.
d) They are highly polar, charged compounds.

33. _____ compound is the most acidic.
a) $ClCH_2CO_2H$
b) FCH_2CO_2H
c) $BrCH_2CO_2H$
d) ICH_2CO_2H

34. All of the following are reducing sugar EXCEPT
a) D-fructose
b) D-ribose
c) Sucrose
d) Cellobiose

35. _____ is the least active metal.
a) Aluminum
b) Iron
c) Platinum
d) Magnesium

36. Mayonnaise is
a) a coalescent solution.
b) a hydrogenated oil.
c) an emulsion.
d) a covalent solution.

37. The element that is expected to behave most like magnesium is
    a) Sodium
    b) Calcium
    c) Aluminum
    d) Scandium

38. _____ represents the correct formula of the compound formed by fluorine and aluminum.
    a) Al_3F_7
    b) Al_5F
    c) AlF_3
    d) Al_7F_3

39. _____ is most likely to lose electrons in an ionic compound.
    a) Oxygen (O)
    b) Hydrogen (H)
    c) Carbon (C)
    d) Lead (Pb)

40. The 2021 Nobel Prize in Chemistry has been awarded to German scientist Benjamin List of the Max Planck Institute and Scotland-born scientist David W.C. MacMillan of Princeton University for
    a) the development of a method for genome editing.
    b) the development of lithium-ion batteries.
    c) the development of asymmetric organocatalysis.
    d) the directed evolution of enzymes.

SECTION C: Physics

41. This is one-atom-thick layer of carbon atoms arranged in a hexagonal lattice. The groundbreaking experiments regarding its two-dimensional material resulted in winning the Nobel Prize in Physics in 2010. The "wonder material" is
    a) Silicene
    b) Graphene
    c) Stanene
    d) All of the above

42. The pulling sensation when we stand near a running train can be explained on the basis of
    a) Archimedes Principle
    b) Bernoulli's law
    c) Avogadro's Hypothesis
    d) Newton's Third Law of motion

43. You are sitting inside an open vehicle moving with uniform speed. When you throw a stone vertically upwards, the stone will fall
    a) Ahead of you
    b) Behind you
    c) Over you
    d) Either ahead or behind of you

44. The X-ray crystallography mainly uses which among the following properties of electromagnetic radiation?
    a) Reflection
    b) Interference
    c) Diffraction
    d) Refraction

45. What is the charge of a p-type semiconductor?
    a) Positive
    b) Negative
    c) Neutral
    d) None of the above

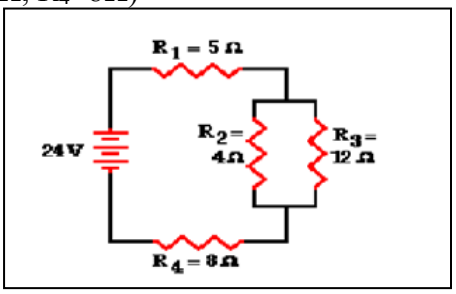
46. What is the eye defect when a person can see nearby objects clearly but cannot see distant objects distinctly?
    a) Cataract
    b) Hypermetropia
    c) Myopia
    d) Presbyopia

47. _____ is the S.I unit of Latent heat of fusion.
    a) $J\ kg^{-1}\ K^{-1}$
    b) $J\ kg^{-1}$
    c) $J\ kg^{-2}$
    d) $J\ kg\ K^{-1}$

48. What happens to the time period of the simple pendulum if the solid bob is replaced by a hollow sphere of same radius but half the mass?
    a) Time period remains unchanged.
    b) Time period becomes double.
    c) Time period becomes half.
    d) Time period becomes four times.

49. Which of the following instruments is used to measure the relative density of a liquid?
    a) Hygrometer
    b) Lactometer
    c) Gravitometer
    d) Hydrometer

50. Determine the current (I_4) across resistor 4 (R_4) in the following electric circuit. The circuit is powered by a 24-volt source. (R_1=5Ω, R_2=4Ω, R_3= 12Ω, R_4=8Ω)
    a) 1.0A
    b) 1.12A
    c) 1.50A
    d) 0.38 A



51. A 4.0 kg object is moving across a friction-free surface with a constant velocity of 2 m/s. Which one of the following horizontal forces is necessary to maintain this state of motion?
    a) 0 N
    b) 0.5 N
    c) 2.0 N
    d) 8.0 N

52. A charged particle after being accelerated through a potential difference 'V' enters in a uniform magnetic field and moves in circle with radius 'r'. If V is doubled, the radius of the circle becomes
    a) 2r
    b) 4r
    c) $r/\sqrt{2}$
    d) $\sqrt{2}r$

53. The phase difference between the current and voltage in series LCR circuit at resonance is
    a) π
    b) $\pi/2$
    c) $\pi/3$
    d) 0

54. What is the density of a block of metal which weighs 60N in air and 40N under water?
    a) 1000 kg/m^3
    b) 3000 kg/m^3
    c) 5000 kg/m^3
    d) 7000 kg/m^3

55. The potential difference across a 4 ohm resistor is 20 volts. Assuming that all of the energy dissipated by this resistor is in the form of heat, how many joules of heat are radiated in 10 seconds?
    a) 1000 J
    b) 800 J
    c) 2000 J
    d) 100 J

56. A girl throws a 0.1kg ball at a wall. The ball hits the wall perpendicularly with a velocity of 5 m/s and then bounces straight back with a velocity of 4 m/s. The change in the momentum of the ball is
    a) 0.1 kgm/s
    b) 0.4 kgm/s
    c) 0.5 kgm/s
    d) 0.9 kgm/s

57. How many times more intense is 80 decibel sound than a 40-decibel sound?
    a) 2
    b) 40
    c) 1000
    d) 10000

58. What is the weight of a 70 kg astronaut in space, far from any planets?
    a) 0 kg
    b) 140 kg
    c) 35kg
    d) 210 kg

59. In AC circuit theory, the term that replaces the resistance is
    a) Inductance
    b) Capacitance
    c) Impedance
    d) Reactance

60. An object is located 1m in front of a converging lens having a focal length of 20 cm. At what distance behind the lens (whose thickness is negligible) will the image be formed?
    a) 18 cm
    b) 20 cm
    c) 25 cm
    d) 22 cm

SECTION D: General IT Knowledge

61. Which programming language is exclusively used for artificial intelligence?
    a) Java
    b) J2EE
    c) Prolog
    d) C

62. Which one of the following operating systems is produced by IBM?
    a) OS-2
    b) Windows
    c) DOS
    d) UNIX

63. Which of the following is NOT the function of an Operating System?
    a) Memory Management
    b) Input/Output Management
    c) Job Scheduling
    d) Database Management

64. Facebook has expanded far beyond its original social networking platform since its inception. It has made following business acquisitions EXCEPT
    a) WhatsApp
    b) Snapchat
    c) Instagram
    d) Oculus VR

65. System software is an interface between
    a) Hardware and Application Software
    b) Application software and Use.
    c) RAM and ROM
    d) CPU and UPS

66. IM technology is a type of online chat allowing real-time text transmission over the Internet or another computer network. What does IM stands for?
    a) Inter Message
    b) Instant Messaging
    c) Inter Modulation
    d) Internal Messaging

67. Which one of the following represents the binary equivalent of the decimal number 23?
    a) 01011
    b) 10111
    c) 10011
    d) 11011

68. The term used to describe a memory location whose value changes during program execution is
    a) Constant
    b) Variable
    c) Volatile
    d) Dynamic

69. Errors that occur in a program when the rules of programming language are NOT obeyed are called
    a) Syntax errors
    b) Run-time errors
    c) Logical errors
    d) Execution errors

70. The name of the interface used by blind persons to operate a computer is
    a) Sensor
    b) Touchscreen
    c) Braille
    d) Icon

Part II

Short Answer Questions [30 marks]

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

1. If $a^{2-x} \cdot b^{5x} = a^{x+3} \cdot b^{3x}$, show that x log (b/a) = (1/2) log a. (3 marks)

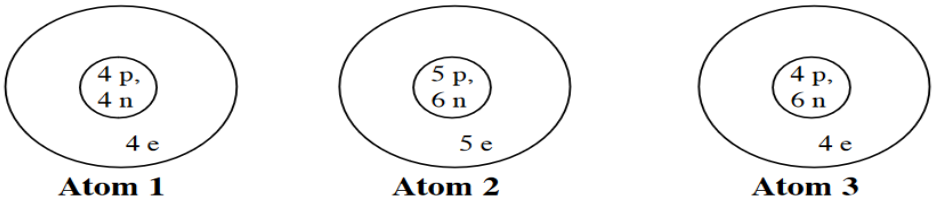
2. The coefficient of x in the equation $x^2 + px + q = 0$ was taken as 17 in place of 13 and thus its roots were found to be -2 and -15. Find the roots of the original equation. (3 marks)

3. Answer the following questions:

   a) If $4 \sin^{-1} x + \cos^{-1} x = \pi$, then find the value of x. (2 marks)

   b) Factorize: $x^2 + y^2$ (1 mark)

4. Use the models below for this question. (p= protons; n = neutrons; e = electrons)



   a) What is the relationship between Atom 1 and Atom 3? (1 mark)

   b) Write each of the atoms above in the shorthand notation that describes the most common isotope of hydrogen as H-1. (1 mark)

   c) How many valence electrons does Atom 2 have? (1 mark)

5. Identify the oxidation-reduction reactions below and circle the material undergoing oxidation. (3x1=3 marks)

   a) $HCl + NaOH \rightarrow H_2O + NaCl$

   b) $PbCl_2 + KI \rightarrow KCl + PbI_2$

   c) $CuO + H_2 \rightarrow Cu + H_2O$

6. A closed vessel contains 52 g of C_2H_2 and 200 g of O_2, which react to form CO_2 and H_2O.

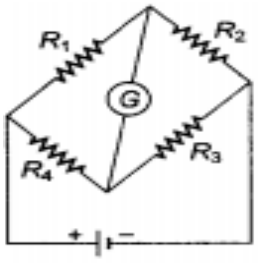
   a) How many molecules of C_2H_2 are in the vessel? (2 marks)

   b) Write a balanced equation for the reaction. (1 mark)

7. A ball is dropped into a tray filled with sand. When it hits the sand, it has a velocity of 6.2 m/s and a momentum of 0.46 kg m/s. The ball takes 0.17 s to come to rest after it hits the sand.
   a) Calculate the mass of the ball. (1.5 marks)
   b) Calculate the average impact force. (1.5 marks)

8. Mention the function of the following used in communication system. (3x1=3 marks)
   a) Transducer
   b) Repeater
   c) Transmitter

9. For the circuit diagram of a Wheatstone bridge shown in the figure, use Kirchhoff's laws to obtain its balance condition. (3 marks)



10. Answer the following questions on cryptocurrency:
    a) What is cryptocurrency? (1 mark)
    b) Mention one major difference between digital currency and cryptocurrency. (1 mark)
    c) Name two types of cryptocurrency. (1 mark)

TASHI DELEK