ENTRANCE EXAMINATION, JUNE 2018

QUESTION PAPER

Ph.D. (ACRHEM)

Marks: 80

Time: 2.00 Hrs

Hall ticket no.

Please confirm that

(a) This booklet has all 20 pages (including two blank pages) printed clearly and numbered.

(b) You are given a clean and clear OMR answer sheet.

Read carefully all the instructions given below and on the OMR sheet -

1. Write your hall ticket number on page 1 of this booklet without fail.
2. Write your hall ticket number on the OMR answer sheet without fail.
3. All answers are to be marked on the OMR answer sheet following the instructions provided there upon.
4. Handover the OMR answer sheet at the end of the examination without fail.
5. No additional sheets will be provided. Rough work is to be done in the question paper itself in the space provided on pages 18- 20.
6. Question paper has two parts: Part - A and Part - B.
7. Part - A consists of 20 objective type questions of two marks each.
8. Part - B consists of 40 objective type questions of one mark each.
9. Non- programmable calculators are permitted.
10. All the symbols used in the text have their usual meaning, unless otherwise specified.

Part - A

Read the following paragraph and answer the questions 1-3 based on this -

Countries in the European Union (EU) announced their support for a proposal to ban the outdoor use of neonicotinoids, widely used pesticides that have been linked to declines in pollinators — especially bees. Their decision tightens restrictions on this group of pesticides enacted in 2013, and follows the publication of research earlier this year finding that three neonicotinoids compounds — imidacloprid, clothianidin and thiamethoxam — are harmful to bees, according to a statement released by the European Commission, the branch of the EU that proposes and enforces legislation and policies. Neonicotinoid pesticides, also known as "neonics," get their name from their chemical similarity to nicotine. First approved for use in the EU in 2005, neonicotinoids are highly toxic to insects and other invertebrates — far more so than to mammals, birds or reptiles — and they affect insects by targeting their central nervous system, paralyzing and then killing them, according to the EC.

1. Which statement is true

   A. Neonicotinoids are harmful only to bees

   B. Neonicotinoids are more harmful to insects than to birds

   C. Neonicotinoids are harmful only to mammals

   D. Neonicotinoids are more harmful to birds than to insects

2. Countries in the European Union (EU) have –

   A. Banned the use of Neonicotinoids

   B. Banned the outdoor use of Neonicotinoids

   C. Supported a proposal to ban Neonicotinoids

   D. Banned the indoor use of Neonicotinoids

3. Which statement is true –

   A. Imidacloprid is more harmful than Clothianidin and Thiamethoxam

   B. Imidacloprid is less harmful than Clothianidin and Thiamethoxam

   C. Imidacloprid, Clothianidin and Thiamethoxam are Neonicotinoid compounds

   D. Clothianidin is less harmful than Thiamethoxam and Imidacloprid

4. Scientific method refers to

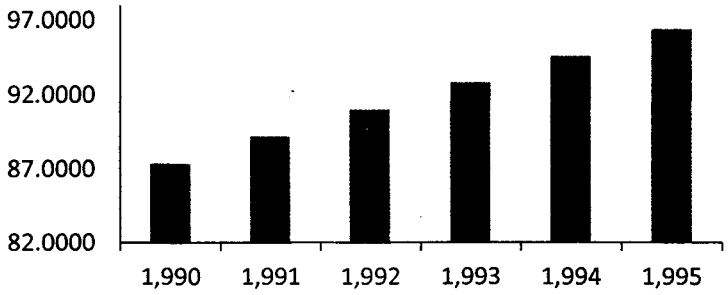
   A. A process of research used to explore observations and answer questions

   B. A process of expressing research ideas

   C. A process of publication of data

   D. A process of assessing the quality of individual researcher

5. The following bar chart shows the population of India in crores during 1990-1995. Based on this data what would have been the estimated population in the year 2004.



A. 112.5 crores
B. 100.2 crores
C. 113.6 crores
D. 110.3 crores

6. Given the following two equations $x^2 + 2x - 3 = 0$ and $x^2 + 4x - 5 = 0$, what is the value of x?
A. 1
B. -3
C. -5
D. -1

7. In a mixture the ratio of oil and water is 6:1. In this mixture another 7 liters of water is added. Then the quantity of oil and water in the original mixture, respectively, is
A. 7, 7/6
B. 6, 1
C. 6, 6/7
D. 7, 7/3

8. If '*chennai*' is coded as '*dgfmozj*' then '*Hyderabad*' is coded as
A. *ixedszcze*
B. *jafgtcdcf*
C. *gxcdqzazc*
D. *izefsbcbe*

9. In research, plagiarism refers to

   A. Wrong publication of data

   B. Stealing and publication of another author's work, thoughts or ideas

   C. Publication of unverified data

   D. Quantification of the quality of research work

10. Assume the cost of one unit of commercial electricity is Rs 3. If an 18 W LED bulb glows for an average of 8 hours/day, what is the cost of electricity consumed by this bulb in a month of 30 days?

    A. Rs 9.87

    B. Rs 24.34

    C. Rs 12.96

    D. Rs 6.14

11. Find the number on the dice opposite to the number 2.

    A. 6

    B. 5

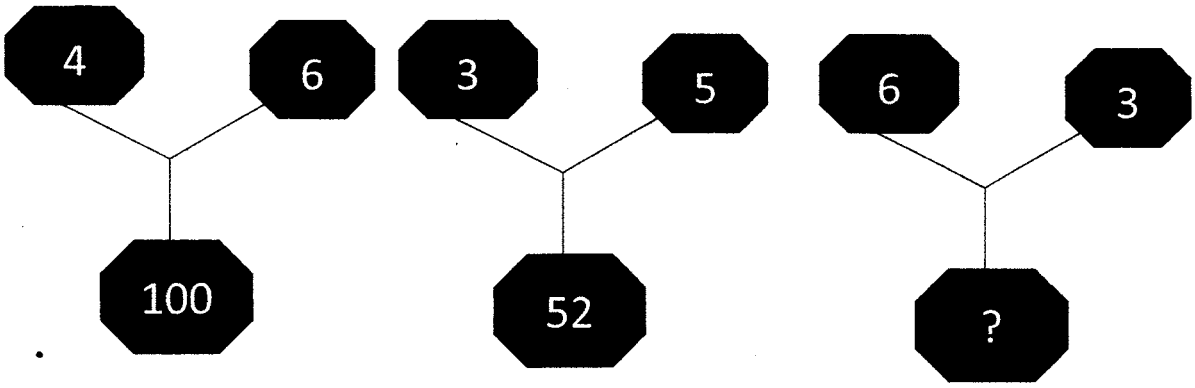
    C. 4

    D. 3

12. From the below figures, find the number at the bottom when top is 5?

A. 6
B. 4
C. 3
D. 2

13. Which number will replace the question mark symbol?

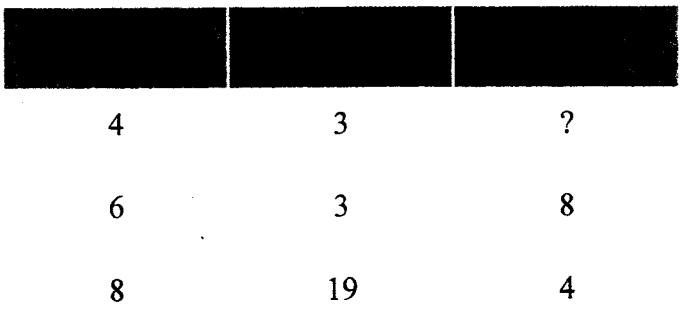


A. 81
B. 84
C. 250
D. 225

14. The professor is one of the most Erudite in our college. The statement means that professor is

A. Boring
B. Pleasant
C. Learned
D. Demanding

15. Which number will replace the question mark ?



4	3	?
6	3	8
8	19	4

A. 8
B. 6
C. 4
D. 2

16. What alpha numeric will replace the question mark?

B16	G21	K26
C27	H32	?

A. M37
B. N36
C. O37
D. M36

17. A thin convex lens images an object located at a very large distance compared to its focal length. This lens broke into pieces accidentally. Only one of the pieces, rougly half the area of the original lens was usable. If this piece is now used to image the same object –

A. Only half of the object will be imaged
B. No image is formed
C. The entire object is imaged with diminished intensity
D. No change in the imaging

18. A large number of measurements, free from systematic errors from a Gaussian distribution with standard error of 11 ^{O}C were made to measure the absolute zero temperature. What is the probability that a single measurement lies in the range of -284 to -262 ^{O}C?

A. 0.92

B. 0.68

C. 0.82

D. 0.33

19. Given two statements

I. All boys are honest

II. Virat is honest

And conclusions

I. Virat is a boy
II. All honest persons are boys

Which of the following statements follow?

A. Only conclusion I
B. Only conclusion II
C. Either conclusion I or II
D. Neither conclusion I nor II

20. What is the probability of getting a sum 9 from two throws of dice?

A. 1/6

B. 1/9

C. 2/9

D. None of these

Part - B

21. In a phase diagram what does the critical point signify?
    A. Point (pressure versus temperature) where solid, liquid and gas phase coexist.
    B. Point (pressure versus temperature) where liquid and gas phase coexist.
    C. Point (pressure versus temperature) where solid and gas phase cannot be distinguished.
    D. Point (pressure versus temperature) where liquid and gas phase cannot be distinguished.

22. The absolute temperature (T) and total number of accessible states (Ω) in statistical physics are related through the following equation
    A. $1/kT = \partial\Omega / \partial E$
    B. $kT = \partial \log(\Omega) / \partial E$
    C. $1/kT = \partial \log(\Omega) / \partial E$
    D. $kT = \frac{\partial \Omega}{\partial E}$

23. Which of these quantum numbers describes the orientation or the space occupied by one pair of electrons in its orbital?
    A. n, the principle quantum number.
    B. l, the azimuthal quantum number.
    C. m, the magnetic quantum number.
    D. s, the spin quantum number.

24. In a thermodynamic process of free expansion
    A. Work done is zero.
    B. Energy transfer is zero.
    C. Heat transfer is zero
    D. both (a) and (c)

25. Carnot cycle efficiency depends on
    A. Property of the medium and/or substances used
    B. Effectiveness of the insulation around the engine
    C. Condition of the engine used
    D. Temperature range of operation

26. Using 600 nm light a Young's double slit experiment is set up. The fringe width was found to be 30 mm. The whole apparatus is immersed in a liquid of refractive index 1.5. The new fringe width is

A. 30 mm

B. 20 mm

C. 60 mm

D. 45 mm

27. Using a 5 cm grating with 6000 lines/cm you need to resolve two lines at 400 nm with a separation of 0.01 nm. Which order of the grating will be able to do this?

A. first order

B. second order

C. third order

D. fourth order

28. The intensity at a point where two waves with intensities I and 4I interfere with a phase difference of π

A. 2I

B. 4I

C. I

D. 3I

29. μ_o, μ_e of a calcite crystal are 1.658 and 1.486, respectively. What thickness of this crystal is required to convert linearly polarized light at 589 nm to circularly polarized light?

A. 0.86 μm

B. 0.96 μm

C. 0.76 μm

D. 0.80 μm

30. The numerical aperture of an optical fiber is 0.4 and the core refractive index is 1.5. The refractive index of the cladding is

A. 1.65

B. 1.35

C. 1.45

D. 1.55

31. An electric field due to a monopole and dipole on a plane is proportional to

A. $1/r^{1.5}$ and $1/r^2$

B. $1/r^2$ and $1/r^3$

C. $1/r$

D. $1/r$ and $1/r^2$

32. The joule heating phenomenon (electrical currents and heat transfer) in a resistor can be explained by the following equations:

A. $\nabla.(-\sigma\nabla V) = 0$ *and* $\nabla.(-k\nabla T) = Q_T$

B. $\nabla.(-\sigma\nabla V) = Q_T$ *and* $\nabla.(-k\nabla T) = 0$

C. $\nabla.(-\sigma\nabla.V) = 0$ *and* $\nabla.(-k\nabla T) = 0$

D. $\nabla.(-\sigma\nabla.V) = Q_T$ *and* $\nabla.(-k\nabla.T) = 0$

33. The electric field with components $E_x = E_0 \cos(kz - \omega t)$ and $E_y = E_0 \cos(kz - \omega t + \pi/4)$ represent which state of polarization?

A. Linear

B. Elliptical

C. Left Circular

D. Right Circular

34. A boundary-value problem is defined by $\frac{d^2y}{dx} + y + 1 = 0, 0 \leq x \leq 1$ where $y(0) = y(1) = 0$. With $h = 0.5$ the value of $y(0.5)$ using finite-difference method and cubic spline method, is respectively

A. 0.14311 and 0.13949

B. 0.14301 and 0.13636

C. 0.15321 and 0.16594

D. 0.13636 and 0.13949

35. The correct order (increasing) of speed of sound in Mercury, Air, and Aluminium is
    A. Aluminium>Air>Mercury
    B. Aluminium>Mercury>Air
    C. Air>Aluminium>Mercury
    D. Mercury>Aluminium>Air

36. A parallel plate capacitor is made from two plates of area 2000 cm^2 separated by 1 cm. It is charged to a potential difference of 3 kV. When a dielectric is introduced by completely filling the space between them, the voltage dropped to 1 kV. What is the capacitance of the capacitor after the dielectric is introduced?
    A. 107 pF
    B. 832 pF
    C. 531 pF
    D. 485 pF

37. A mass of 5Kg is attached to a spring whose spring constant is 5 Nm^{-1}. It is set into motion with an initial displacement of 2 m and initial speed of 5 ms^{-1}.What will be the amplitude of the motion
    A. 2.0 m
    B. 25.2 m
    C. 2.5 m
    D. 5.3 m

38. A uniform magnitude field of 0.5 T exists along the x-axis. A proton enters this region with a velocity $v_x = 2\times10^5$ m/s, $v_y = 0$ and $v_z = 2\times10^5$ m/s. What will be the pitch of the helical path taken by the proton?
    A. 19.71 mm
    B. 51.23 mm
    C. 2.50 mm
    D. 1.25 mm

39. The probability of a random variable X with space $R_X = \{1, 2, 3, ..., 12\}$ is given by $f(x) = k(2x - 1)$. What is the value of the constant k?

A. 1/16

B. 1/12

C. 1/144

D. 1/132

40. A beam of electrons with kinetic energy 1 keV is diffracted as it passes through a poly crystalline metal foil. The metal has a cubic crystal structure with a spacing of 1 Å. Calculate the wavelength of the electron?

A. 1 Å

B. 0.39 Å

C. 0.5 nm

D. 0.8 Å

41. An electric field strength created by charge Q is measured to be 40 N/C at a distance of 0.2 m from the center of charge. What is the new field strength when the distance from the center of Q is changed to 0.4 m away with twice the charge Q?

A. 10 N/C

B. 20 N/C

C. 40 N/C

D. 80 N/C

42. Which of these magnetic fields can exist?

i] $\vec{B}(\vec{r}) = e^{-y^2}\,\vec{x}$ ii] $\vec{B}(\vec{r}) = e^{-x^2}\,\vec{x}$ iii] $\vec{B}(\vec{r}) = Sin(kr)\,\vec{r}$ iv] $\vec{B}(\vec{r}) = r\,\vec{\theta}$

A. i and iv

B. iii and ii

C. i and iii

D. iii, ii and iv

43. The nearest neighbour distance in the case of bcc structure

A. $\frac{a\sqrt{3}}{2}$

B. $\frac{a\sqrt{2}}{2}$

C. $\frac{2\,a}{\sqrt{3}}$

D. $\frac{2\,a}{\sqrt{2}}$

44. If the stiffness constants of elasticity $C_{11} = C_{12} = k$ for a cubic crystal, then bulk modulus is

A. 2k/3

B. k

C. 1/k

D. 3/2 k

45. The potential energy representing the interaction between two atom is $u(r) = \frac{-2}{r^4} + \frac{3}{r^6}$, the equilibrium distance is

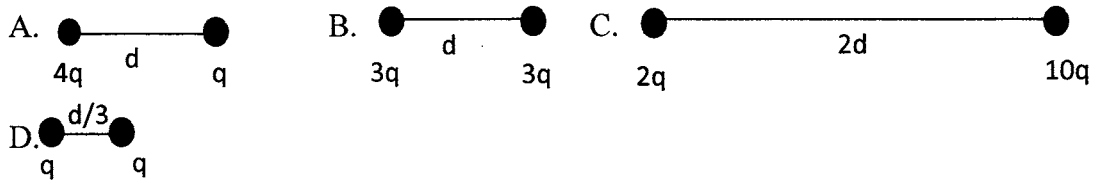
A. 1.5

B. $\sqrt{1.5}$

C. 2

D. $\sqrt{2}$

46. In each of these four scenarios listed below, the two charges remain fixed in place as shown. Rank the electric potential energies of the four system from the greatest to least



A. B = D > C > A

B. C > B > A> D

C. C > B = D >A

D. D> A = B > C

47. Let C be the curve $x = 1 - y^2$ from (0, -1) to (0,1). Evaluate the integral $\int y^3\,dx + x^2 dy$

A. 4/15

B. 2/15

C. 15/2

D. 15/4

48. Let $L_{\pm} = L_x \pm iL_y$,where L is angular momentum then the commutator $[L_+, L_-] =$

A. $2\hbar L_z$

B. $-i\hbar$

C. $\hbar L_y$

D. $\frac{1}{2}\hbar L_z$

49. Find the permittivity of the surface when a wave incident at an angle 60 is reflected by the surface at 45 in air

A. 1.41

B. 3.5

C. 2.2

D. 1.73

50. Let 'R' be the region in space defined by $4 \leq x^2 + y^2 + z^2 \leq 9$ and $Z \geq 0$. The value of the integral $\iiint x^2 + y^2\,dV$ is

A. $13/844\pi$

B. $844\pi/15$

C. $824\pi/15$

D. $13/824\pi$

51. What is the surface density of atoms for Si on the (1 0 0) plane? (lattice constant is 5.43 Å)

A. $6.78 \times 10^{14}\ atoms/cm^2$

B. $6.78 \times 10^{-14}\ atoms/cm^2$

C. $5.78 \times 10^{14}\ atoms/cm^2$

D. $5.78 \times 10^{-14}\ atoms/cm^2$

52. Estimate the probability of an electron tunneling through a rectangular barrier with a barrier height V_0 of 1eV and a barrier width of 15 Å. The electron energy is 0.20 eV.

A. 3×10^8

B. 1

C. 2.76×10^{-6}

D. 0

53. Assume the fermi energy level is exactly in the centre of band gap energy of a semiconductor at T = 300 K. Calculate the probability that an energy state in the bottom of the conduction band is occupied by an electron for Si. (take band gap of silicon as 1.12 eV)

A. 5.3×10^{10}

B. 4.07×10^{-10}

C. 0

D. 1

54. At what distance from a long, straight wire carrying a current of 5.0 A is the magnetic field due to the wire equal to the strength of Earth's field approximately $5.0 \times 10^{-5}\ T$?

A. 2 m

B. 2 cm

C. 3 m

D. 3 cm

55. For a one-dimensional wave function $\psi_{p_y}(y) = ce^{i\frac{p_y y}{\hbar}}$ the normalization constant 'c' according to p-normalizing condition is

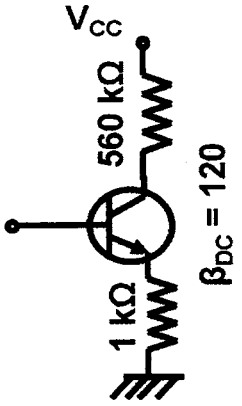
A. $\frac{1}{\sqrt{2\pi\hbar}}$

B. $\sqrt{\frac{\hbar}{2\pi}}$

C. $\sqrt{2\pi\hbar}$

D. $\hbar\sqrt{2\pi\hbar}$

56. Determine the value of dc input resistance (R_{IN}) looking in at the base of the BJT shown in figure, assuming that the transistor is biased in active region.

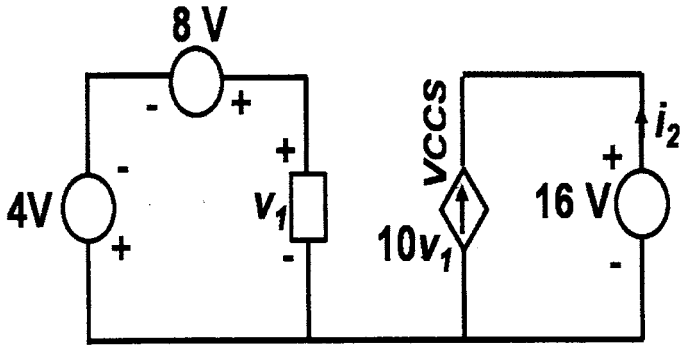


A. 120 kΩ
B. 120 Ω
C. 1 kΩ
D. 560 kΩ

57. Consider a practical Operational Amplifier (Op-Amp) with open loop gain of A_{OL} = 200,000, input impedance of $Z_{in[OL]}$ = 1 MΩ and output impedance of $Z_{out[OL]}$ = 100 Ω. Determine the values of effective input impedance ($Z_{in[VF]}$) and output impedance ($Z_{out[VF]}$) of a voltage follower that is constructed using this Op-Amp.

A. 1 MΩ and 100 Ω
B. 200 GΩ and 500 μΩ
C. 100 MΩ and 500 MΩ
D. Infinity and Zero

58. A Voltage Controlled Current Source (VCCS) shown in the circuit is designed such that it supplies the current in mA range. Then the current i_2 is



A. 40 mA
B. -40 mA
C. 1.6 mA
D. – 120 mA

59. The Q-value of the decay $^{233}U \rightarrow ^{229}Th + \alpha$ is 4.909 MeV. Calculate the kinetic energy of α-particle emitted in this decay if the daughter nucleus is in ground state.

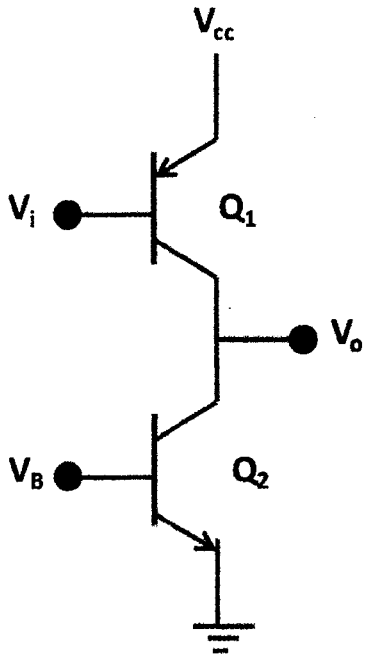
A. 4.909 MeV

B. 49.09 MeV

C. 4.82 MeV

D. 2.45 MeV

60. Identify the circuit topology shown in figure below, If Q1 and Q2 are biased in active region.



A. Common Emitter amplifier

B. Common Collector amplifier

C. Common Base amplifier

D. Cascade amplifier