Entrance Examinations 2019
Ph.D. (ACRHEM)

Marks: 70
**Time: 2.00 hours**

Hall Ticket no: [   ]

1. Write your hall ticket number on the OMR answer sheet given to you. Also write the hall ticket number in the space provided above.

2. Read the following instructions carefully before answering the questions.

3. This question paper has TWO parts: PART 'A' and PART 'B'.

   Part 'A': It consists of 35 objective type questions of 1.0 (ONE) mark each. <u>There is a negative marking of 0.33 marks for every wrong answer.</u>

   Part 'B: It consists of 35 objective type questions of 1.0 (ONE) mark each with no negative marking.

4. All questions are to be answered. Answers for these questions are to be entered on the OMR sheet, filling the appropriate circle against each question. For example, if the answer to a question is D, it should be marked as below:

   (A)   (B)   (C)   ●
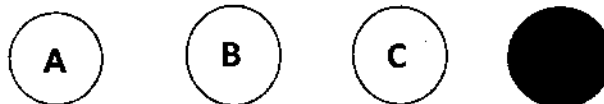
5. No additional sheets will be provided. Rough work can be done in the question paper itself.

6. Hand over the OMR answer sheet at the end of the examination to the invigilator.

7. Mobile phones, log tables and programmable calculators are NOT permitted

8. Values of some physical constants: $\epsilon_o = 8.85 \times 10^{-12}\ F/m$; mass of an electron = 9.11×10^{-31} kg; charge of an electron = 1.6×10^{-19} Coulumbs; Planck's constant $h = 6.63 \times 10^{-34}$ joule·second; Boltzman's constant k = 1.38×10^{-23} J/K.

9. This book contains **18 (eighteen)** pages including this cover sheet and **2 (two)** blank pages for rough work.

Part A (35 Questions)

The following graph shows the literacy rates of some of the states/union territories (here referred to as states). Answer the questions **1)-3)** based on this graph –
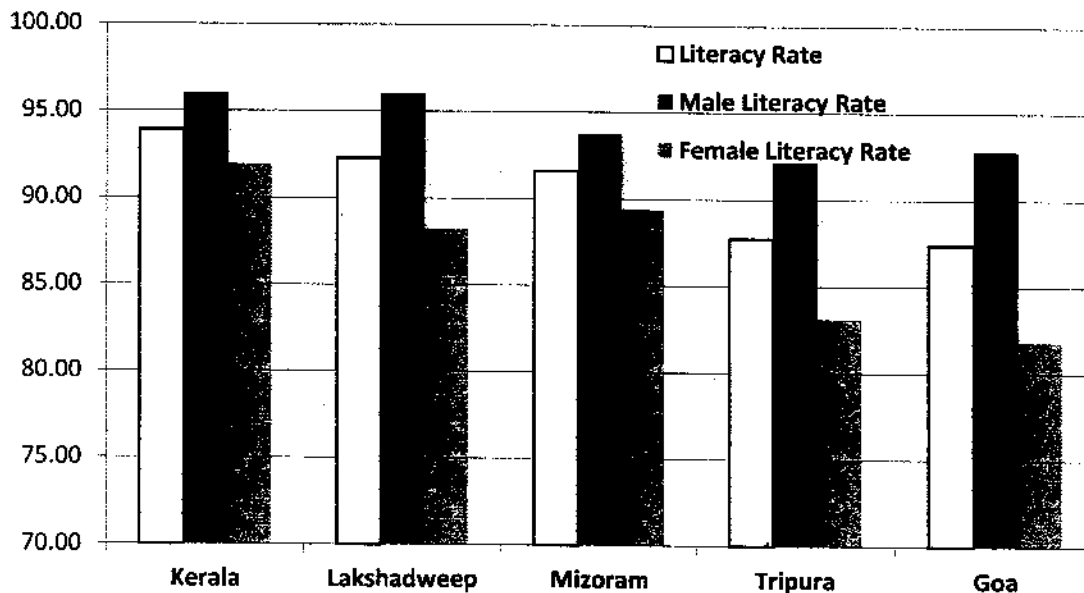
1) Which state has the lowest male literacy rate?

   [A] Kerala
   [B] Mizoram
   [C] Tripura
   [D] Goa

2) What is the female literacy rate in Kerala?

   [A] 90.5
   [B] 91.9
   [C] 91.1
   [D] 95.2

3) Which two states have almost same literacy rate?

   [A] Goa and Tripura
   [B] Mizoram and Goa
   [C] Mizoram and Tripura
   [D] Kerala and Lakshawdeep

Read this passage carefully and answer the questions **4)-6)** based on this:

An endangered species is a species which has been categorized as very likely to become extinct. Endangered (EN), as categorized by the International Union for Conservation of Nature (IUCN) Red List, is the second most severe conservation status for wild populations in the IUCN's schema after Critically Endangered (CR). In 2012, the IUCN Red List featured 3,079 animal and 2,655 plant species as endangered (EN) worldwide. The

figures for 1998 were 1,102 and 1,197, respectively. Many nations have laws that protect conservation-reliant species: for example, forbidding hunting, restricting land development or creating preserves. The conservation status of a species indicates the likelihood that it will become extinct. Many factors are considered when assessing the status of a species; e.g., such statistics as the number remaining, the overall increase or decrease in the population over time, breeding success rates, or known threats. The IUCN Red List of Threatened Species is the best-known worldwide conservation status listing and ranking system. Over half of the world's species are estimated to be at risk of extinction. Internationally, 199 countries have signed an accord to create Biodiversity Action Plans that will protect endangered and other threatened species. Though labelled a list, the IUCN Red List is a system of assessing the global conservation status of species that includes "Data Deficient" (DD) species – species for which more data and assessment is required before their status may be determined – as well species comprehensively assessed by the IUCN's species assessment process. Those species of "Near Threatened" (NT) and "Least Concern" (LC) status have been assessed and found to have relatively robust and healthy populations, though these may be in decline. Unlike their more general use elsewhere, the List uses the terms "endangered species" and "threatened species" with particular meanings: "Endangered" (EN) species lie between "Vulnerable" (VU) and "Critically Endangered" (CR) species, while "Threatened" species are those species determined to be Vulnerable, Endangered or Critically Endangered.

4) Which is the most severe conservation status for wild populations in the IUCN's scheme?

[A] Endangered
[B] Critically Endangered
[C] Vulnerable
[D] Threatened

5) Approximately how many of world's species are estimated to be at risk of extinction?

[A] 20%
[B] 5%
[C] 35 %
[D] 55%

6) Which of the following has been assessed and found to have relatively robust and healthy populations?

[A] Endangered
[B] Critically Endangered
[C] Vulnerable
[D] Near threatened

7) Re-organise the following steps of a research problem in a suitable/logical sequence

(i) Analysing/interpreting the collected research data
(ii) Preparing the final research report
(iii) Identification and selection of an appropriate research problem
(iv) Articulating the research design/process
(v) Collecting the experimental/theoretical data

[A] (iii), (iv), (i), (ii) and (v)
[B] (iii), (iv), (i), (v) and (ii)
[C] (iii), (v), (iv), (i) and (ii)
[D] (iii), (iv), (v), (i) and (ii)

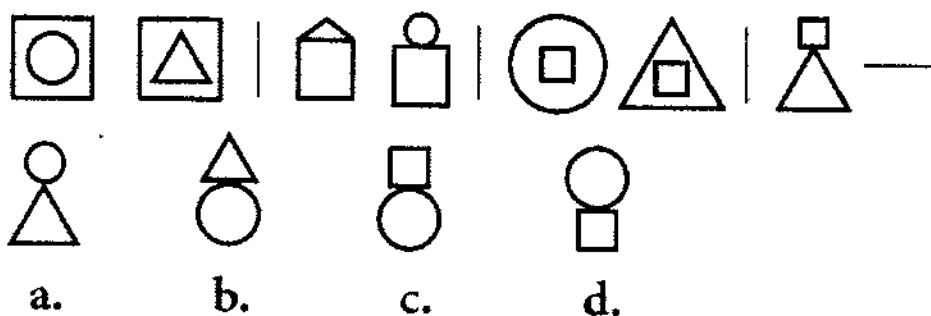8) Complete the missing item in the following sequence: AZ, GU, MP, ?, YF

    [A] KF
    [B] RX
    [C] SK
    [D] TS

9) Find the missing number in the following series: 11, 13, 17, 19, 23, 29, 31, 37, 41, ?

    [A] 45
    [B] 47
    [C] 49
    [D] 43

10) Fill in the missing figure from below options a, b, c, or d

    a.   b.   c.   d.

    [A] a
    [B] b
    [C] c
    [D] d

11) Three coins (unbiased) are tossed. The probability of obtaining at most two heads is

    [A] 1/2
    [B] 3/8
    [C] 7/8
    [D] 1/4

12) Find the odd one out in this series: 242, 482, 551, 263, 323, 362, 284

    [A] 551
    [B] 323
    [C] 284
    [D] 263

13) Present ages of Raju and Rani are in the ratio of 5:4, respectively. Three years later, the ratio of their ages will be 11:9, respectively. What is Raju's present age in years?

[A] 24
[B] 27
[C] 40
[D] Cannot be determined with the data provided

14) **Statements:** All politicians are dishonest. All dishonest are unfair.
Conclusions:
   I. Some dishonest people are politicians.
   II. No dishonest person is a politician.
   III. Some unfair people are politicians.
   IV. All unfair people are politicians.
   Based on the above data which one of the following options is correct.

[A] None follows
[B] Only I and IV follows
[C] Only I and II follows
[D] Only I and III follows

15) Find the missing in the series: AB_2CDE, _____, $ABCD_6E$, $ABCDE_8$, $ABC_{10}DE$

[A] A_2BCDE
[B] ABC_4DE
[C] $ABCD_3E$
[D] A_3BCDE_4

16) Suppose today is Saturday. After 661 days, it will be a

[A] Sunday
[B] Monday
[C] Tuesday
[D] Wednesday

17) A grocer has a sale of INR 6000, INR 6500, INR 7000, INR 7500 and INR 8000 for 5 consecutive months. How much sale must the grocer have in the sixth month so that he gets an average sale of INR 7500?

[A] INR 8000
[B] INR 8500
[C] INR 10000
[D] INR 12000

18) In a code language MEDICINE is written as EOJDJEFM, then COMPUTER will be

[A] RFUVQNPC
[B] CFUVQNPR
[C] RPNQVUFC
[D] CPNQVUFR

19) How many 8's are there preceded by 7 but not followed by 3?

5 9 3 2 1 7 8 2 6 9 7 8 6 1 3 2 8 7 8 1 3 8 3 2 5 6 7 8 3 9 5 8 2 0 1
8 7 8 6 3 4

[A] Five (5)
[B] Four (4)
[C] Six (6)
[D] Three (3)

20) AA is BB's sister. CC is BB's mother. DD is CC's father. EE is DD's mother. Then, how is AA related to DD?

[A] Grandfather
[B] Grandmother
[C] Daughter
[D] Granddaughter

21) Raj walked 20 m towards north direction. Then he turned right and walked 40 m. Then he turned right and walked 35 m. Then he turns left and walks 20 m. Finally he turns left and walks 15 m. In which direction and how many metres is he from the starting position?

[A] 30 m West
[B] 45 m East
[C] 60 m West
[D] 60 m East

22) If × stands for 'addition', ÷ stands for 'subtraction', + stands for 'multiplication' and - stands for 'division', then 200 × 80 ÷ 8 - 4 + 2 = ?

[A] 272
[B] 284
[C] 276
[D] 286

23) Find the total number of triangles in the figure provided below:
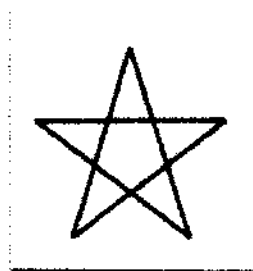
[A] 6
[B] 10
[C] 8
[D] 12

24) A man has USD 960 in the denominations of one dollar, five dollar, and ten dollar notes. The number of each denomination is equal. What is the total number of notes that he has?

[A] 90
[B] 150
[C] 180
[D] 240

25) The probability that it is Friday and that a student is absent is 0.03. If there are five working days in a week, what is the probability that a student is absent given that today is Friday?

[A] 10%
[B] 15%
[C] 12%
[D] 20%

26) 10 liters of water is added to 50 liters of solution containing 20% of alcohol in water. What is the strength (percentage) of alcohol in the solution now

[A] 20.00%
[B] 16.66%
[C] 12.50%
[D] 33.33%

27) A certain data obeys normal distribution. What percentage of the data falls within three standard deviations (σ) from the mean?

[A] 68.2
[B] 99.7
[C] 91.6
[D] 74.1

28) Find the mean, median, mode, and range for the following list of values: 13, 18, 13, 14, 13, 16, 14, 21, 13

[A] 15,13,14,9
[B] 15,13,14,8
[C] 15,14,13,9
[D] 15,14,13,8

29) $A = x(x^2)^4$ while $B = (x^3)^3$; For $x > 1$ which of the following is true?

[A] A > B
[B] B > A
[C] A = B
[D] Cannot determine the relation between A and B.

30) What day comes three days after the day which comes two days after the day which comes immediately after the day which comes two days after Monday?
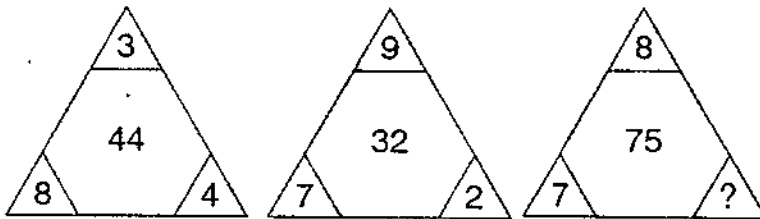
    [A] Tuesday
    [B] Wednesday
    [C] Monday
    [D] Sunday

31) Which one does not belong to this sequence
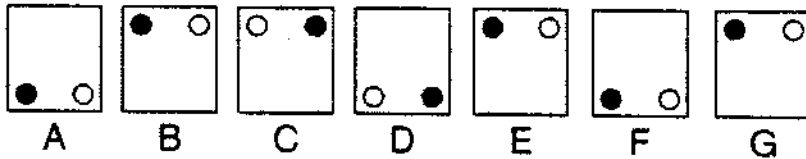
    [A] A
    [B] D
    [C] G
    [D] E

32) What numbers should be in the '?' place?

    [A] 5
    [B] 2
    [C] 6
    [D] 8

33) A and B are racing around a race track. Together they begin at the starting line, and A's car completes one lap every 88 seconds, while B's car completes one lap every 80 seconds. How many seconds after they begin the race will A and B first reach the starting line at the same time?

    [A] 400 seconds
    [B] 880 seconds
    [C] 600 seconds
    [D] 440 seconds

34) Find the pair of words analogous to Sound: Cacophony

    [A] Taste: Style
    [B] Smell: Stench
    [C] Touch: Massage
    [D] Speech: Oration

35) Find the odd one out amongst the following

    [A] Triangle
    [B] Sphere
    [C] Circle
    [D] Oval

End of Part A

Space for rough work

Part B (35 Questions)

36) The value of electron Bohr Magneton in units of eV/G is

[A] 0.3×10^{-11}
[B] 0.9×10^{-9}
[C] 1.2×10^{-11}
[D] 0.6×10^{-8}

37) For the operator $\hat{Q} \equiv i \frac{d}{d\emptyset}$ where $\emptyset$ is the usual polar coordinate in two dimensions, the spectrum of this operator is

[A] Set of all even integers and non-degenerate
[B] Set of all odd integers and non-degenerate
[C] Set of all integers and non-degenerate
[D] Set of all integers and degenerate

38) The Eigen values of the matrix $\begin{pmatrix} 2 & 0 & -2 \\ -2i & i & 2i \\ 1 & 0 & -1 \end{pmatrix}$ are

[A] $1, -1, i$
[B] $0, -1, -i$
[C] $-1, 0, \pm i$
[D] $0, 1, i$

39) Following the Ehrenfest's theorem $\frac{d\langle p \rangle}{dt} =$ ⎯⎯⎯ (where p is the momentum)

[A] $\langle \frac{\partial V}{\partial x} \rangle$
[B] $\langle -\frac{\partial V}{\partial x} \rangle$
[C] $\langle \frac{dV}{dx} \rangle$
[D] $\pi/2$

40) The bandwidth associated with an optical pulse of 1 ps duration is

[A] 1 THz
[B] 500 GHz
[C] 630 GHz
[D] 100 GHz

41) Ray matrix approach of geometrical optics cannot be used to calculate which of the following aberrations?

[A] Chromatic aberration
[B] Astigmatism
[C] Coma
[D] Spherical aberration

42) Following the consequences of the symmetries of the Hamiltonian $\mathcal{H}$, the following statements are true

   [A] If $\mathcal{H}$ is invariant under the infinitesimal canonical transformation generated by a variable $g(q, p)$, then g is conserved.
   [B] If $\mathcal{H}$ is invariant under the infinitesimal canonical transformation generated by a variable $g(q, p)$, then g is not conserved.
   [C] If $\mathcal{H}$ is invariant under the infinitesimal canonical transformation generated by a variable $g(q', p')$, then g is conserved.
   [D] If $\mathcal{H}$ is invariant under the infinitesimal canonical transformation generated by a variable $g(q', p')$, then g is not conserved.

43) An electron is in the state with $S_z = \hbar/2$ at t=0. A steady state $\vec{B} = B\hat{i}$, B = 100 G is turned on. How many seconds will it take for the spin to flip?

   [A] 7×10^{-14}
   [B] 2×10^{-9}
   [C] 3×10^{-15}
   [D] 3×10^{-11}

44) Poincare sphere is a geometrical representation of

   [A] Jones vectors
   [B] Ray vectors
   [C] Stokes vectors
   [D] Ray-pulse vectors

45) The reflection coefficient for scattering of a potential $V(x) = V_0 a \delta(x)$ is

   [A] $\dfrac{(maV_0)^2}{\hbar^4 k^2 + (maV_0)^2}$
   [B] $\dfrac{maV_0^2}{\hbar^2 k^2 + maV_0^2}$
   [C] $\dfrac{maV_0^2}{\hbar^4 k^2 + maV_0^2}$
   [D] $\dfrac{maV_0}{\hbar^2 k^2 + maV_0}$

46) A laser light falls on a transparent dielectric slab of thickness 3 mm with normal incidence. The refractive index of the dielectric is 1.5. The approximate percentage of transmitted light is:

   [A] 4
   [B] 8
   [C] 92
   [D] 96

47) The electric field of an EM wave travelling in free space is given by $\vec{E} = E_0(\hat{\imath} + \hat{\jmath})exp[i(\vec{k}.\hat{z} - \omega t)]$. What is the corresponding magnetic field?

[A] $\vec{B} = \frac{E_0}{c}(-\hat{\imath} - \hat{\jmath})exp[i(\vec{k}.\hat{z} - \omega t)]$

[B] $\vec{B} = \frac{E_0}{c}(-\hat{\imath} - 5\hat{\jmath})exp[i(\vec{k}.\hat{z} - \omega t)]$

[C] $\vec{B} = \frac{E_0}{c}(-\hat{\imath} + \hat{\jmath})exp[i(\vec{k}.\hat{z} - \omega t)]$

[D] $\vec{B} = \frac{E_0}{c}(-5\hat{\imath} - \hat{\jmath})exp[i(\vec{k}.\hat{z} - \omega t)]$

48) The speed of an electromagnetic wave in free space is given by -

[A] $\sqrt{\mu_0 \epsilon_0}$

[B] $\mu_0 \epsilon_0$

[C] $\frac{1}{\sqrt{\mu_0 \epsilon_0}}$

[D] $\frac{1}{\mu_0 \epsilon_0}$

49) A certain monochromatic light falls on a dielectric medium. The reflected light is found to be zero intensity at a particular angle, when the angle was changed. What can be said about the incident light? It is

[A] plane polarized
[B] circularly polarized
[C] elliptically polarized
[D] partially polarized

50) The photoelectric work function W for Lithium is 2.3 eV. If an ultraviolet light of wavelength 200 nm is incident on the Lithium surface, the maximum kinetic energy of the photoelectrons is

[A] 3.90 eV
[B] 7.80 eV
[C] 1.95 eV
[D] 5.85 eV

51) If U is the internal energy of an ideal gas, then $(\partial U/\partial V)_T =$.

[A] RT/V
[B] PV/RT
[C] 0
[D] V/RT

52) For an ideal diatomic gas, the ratio of c_v/c_p is

[A] 5/7
[B] 5/3
[C] 3/2
[D] 1/2

53) A gas expands adiabatically and its volume is doubled. However, its temperature (in degrees kelvin) is decreased by a factor of 1.32. The number of degrees of freedom for such gas molecules is.

[A] 6
[B] 3
[C] 4
[D] 5

54) If $\psi(x) = N/(x^2+a^2)$, the value of normalization constant N is

[A] $(2a/\pi)$
[B] $(2a^2/\pi)$
[C] $(2a^3/\pi)^{1/2}$
[D] $(2a^3/\pi)^{3/2}$

55) Given that the complete wave function of a hydrogen like atom in a particular state is $\psi(r,\theta,\varphi) = N \times r^2 \times \exp(-Zr/3a_0) \times \sin^2\theta \times \exp(2i\varphi)$ the Eigen value of L_z, the third component of the angular momentum operator is

[A] $2\hbar$
[B] $5\hbar$
[C] $\hbar$
[D] $6\hbar$

56) The wavelength of the Mo(Z=42) K_α X-ray line given that the ionization energy of the hydrogen atom is 13.6 eV and $\sigma = 1.0$ is.

[A] 6.9324 Å
[B] 3.2865 Å
[C] 7.2116 Å
[D] 0.7238 Å

57) An electron subjected to an electric field of 20 V/m has an inter-collision time of 10 femtoseconds. The drift velocity of the electron is

[A] 8.62 cm/s
[B] 2.50 cm/s
[C] 3.51 cm/s
[D] 6.50 cm/s

58) The density of states function for electrons in a metal is given by $Z(E)dE = 13.6 \times 10^{27} E^{1/2}\, dE$. The Fermi level at a temperature few degrees above absolute zero for copper (8.5×10^{22} electrons/cc) is located at

[A] 4.445 eV
[B] 7.296 eV
[C] 2.135 eV
[D] 3.896 eV

V-64

59) According to the BCS theory the energy gap for Indium whose critical temperature (T_c) being 3.4^0 K is

[A] 2.895×10^{-5} eV
[B] 6.249×10^{-8} eV
[C] 1.035×10^{-3} eV
[D] 4.289×10^{-6} eV

60) The separations of the sets of planes which produce strong X-ray diffraction patterns at angles 4^0 and 8^0 in the first order is: (Assume X-rays wavelength is 0.2 nm)

[A] 1.434 nm and 0.718 nm
[B] 8.231 nm and 5.851 nm
[C] 2.581 nm and 9.312 nm
[D] 7.032 nm and 11.236 nm

61) The deviation of the second order diffraction image formed by an optical grating with 5000 lines/cm is 32^0. The wavelength of the light in nm is

[A] 633 nm
[B] 530 nm
[C] 400 nm
[D] 785 nm

62) Which of these statements is incorrect in the case of common mode differential operational amplifier?

[A] Most of undesirable pickups are common mode.
[B] Connecting wires on input work as antenna.
[C] Interference is in the form of an electromagnetic signal.
[D] It amplifies all types of signals.

63) In a double slit experiment distance between the slits is d = 0.1 mm and the screen is placed at D = 1 m. A light source with a wavelength of $\lambda = 600$ nm is used for the experiment. The spacing between the adjacent bright fringes is

[A] 3 mm
[B] 4 mm
[C] 5 mm
[D] 6 mm

64) In the field of radio astronomy hydrogen atoms are observed. For these, radiative transitions from n = 109 to n = 108 occur. The frequency and wavelength of the radiation emitted in this transition, respectively, are:

[A] 5.15 GHz, 5.83 cm
[B] 6.72 GHz, 7.63 cm
[C] 5.83 GHz, 5.15 cm
[D] 7.63 GHz, 6.72 cm

65) A solid insulating sphere, a solid conducting sphere and a hollow conducting sphere are each given identical charge +Q. The spheres all have the same radius 'r'. At a distance 'a' $>r$ from the center of the spheres, the electric field is

[A] greatest for the solid insulating sphere.
[B] greatest for the solid conducting sphere.
[C] greatest for the hollow conducting sphere.
[D] a non-zero value but the same for all three spheres.

66) A Capacitor C and a resistance R are connected in series across a battery as shown. At the instant just after the switch is closed,
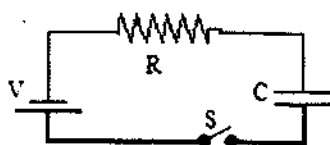
[A] the voltage across C equals V.
[B] the voltage across R equals V.
[C] the voltage across R is zero
[D] the current is zero.

67) Which of the following is NOT a correct consequence of the Heisenberg uncertainty principle:

[A] The shorter the lifetime of an excited state of an atom, the less accurately can its energy be measured
[B] An electron in an atom cannot be described by a well-defined orbit.
[C] The momentum of an electron cannot be measured exactly.
[D] Measurement of one variable in an atomic system can affect subsequent measurements of other variables.

68) The benzene molecule C_6H_6 has _____ vibrational modes

[A] 16
[B] 20
[C] 24
[D] 30

69) The solution of the differential equation $\frac{dy}{dt^2} + \frac{dy}{dt} - 12y = 0$ with $y(0) = 0, y'(0) = 1$ is

[A] $y(t) = \frac{-1}{7}e^{4t} + \frac{1}{7}e^{-3t}$
[B] $y(t) = \frac{1}{7}e^{4t} - \frac{1}{7}e^{3t}$
[C] $y(t) = \frac{-1}{7}e^{-4t} + \frac{1}{7}e^{3t}$
[D] $y(t) = \frac{1}{7}e^{4t} + \frac{1}{7}e^{3t}$

70) Which of the following is a Hermitian matrix?

[A] $\begin{vmatrix} 1 & i \\ i & 1 \end{vmatrix}$

[B] $\begin{vmatrix} 1 & i \\ -i & 1 \end{vmatrix}$

[C] $\begin{vmatrix} 1 & -i \\ -i & 1 \end{vmatrix}$

[D] $\begin{vmatrix} -1 & i \\ i & i \end{vmatrix}$

End of Part B

Space for rough work

University of Hyderabad
Entrance Examinations - 2019

School/Department/Centre : ACRHEM (School of Physics)
Course/Subject : ACRHEM Ph.D. Exam

Q.No.	Answer	Q.No.	Answer	Q.No.	Answer	Q.No.	Answer
1	C	26	B	51	C		
2	B	27	B	52	A		
3	A	28	D	53	D		
4	B	29	C	54	C		
5	D	30	A	55	A		
6	D	31	D	56	D		
7	D	32	A	57	C		
8	C	33	B	58	A		
9	D	34	B	59	C		
10	C	35	A	60	A		
11	C	36	D	61	B		
12	B	37	C	62	D		
13	—	38	D	63	D		
14	D	39	B	64	A		
15	B	40	B	65	D		
16	C	41	C	66	B		
17	C	42	A	67	C		
18	A	43	B	68	D		
19	B	44	C	69	C		
20	D	45	A	70	B		
21	D	46	C				
22	C	47	C				
23	B	48	C				
24	C	49	A				
25	B	50	A				

Note/Remark: For Q.No-13, benefit to be given to all.

J.Venugopal Rao
03/05/19

Signature V.Kusware
School/Department/Centre