

## Physics Paper III

## Time Allowed : 2½ Hours][Maximum Marks : 150Note : This Paper containsSeventy Five (75) multiple choice questions, each<br/>question carrying Two (2) marks. Attempt All questions.

1.	The eigenvalues of $(2 \times 2)$ matrix	4.	The room temperature measured by different instruments gave the
	$\begin{bmatrix} 2 & 3 \\ 1 & 0 \end{bmatrix}$ are :	5.	following results :
			37°C, 70°F, 311°K, 35°C
			The average temperature would
			be :
	(A) <b>0</b> , <b>2</b>		(A) 113°K
	(B) 1, 3		(B) 37°C
	(C) 3, -1		(C) 35°C
	(D) $1 + i, 1 - i$		(D) 70.5°F
2.			$\lim x^x$ is .
	The asymptotic behaviour of the		$\lim_{x\to 0} x^x $ is :
	curve $y = e^{-x^2} \sin x$ is :		(A) 0
	(A) oscillatory		(B) 1
	(B) goes to zero		(C) <i>i</i>
	(C) not defined		(D) ∞
3.	(D) goes to unity	6.	The particular integral of the
	Five boys and three girls are to		inhomogeneous linear differential equation :
	stand in a line for a photograph, in		equation .
	such a way that no two girls are		$\frac{dy}{dx} - y = x$
	adjacent. Number of ways in which this can be done is :		<i>u</i> x
	(A) 720		is given by :
			(A) $e^x$
	(B) 360		(B) $x e^x$
	(C) 14400		(C) $-x - 1$
	(D) 11600		(D) $x + 1$

FEB - 32313/III

7. Masses m and 3m are attached to the two ends of a spring of spring constant k. What is the period of oscillation ?

(A) 
$$4\pi \sqrt{\frac{m}{k}}$$
  
(B)  $2\pi \sqrt{\frac{k}{m}}$   
(C)  $2\pi \sqrt{\frac{m}{2k}}$   
(D)  $\pi \sqrt{\frac{3m}{k}}$ 

8. The mutual potential energy v of two particles depends on their mutual distance r as follows :

$$v = \frac{a}{r^2} - \frac{b}{r}$$

where a and b are positive constants. For what separation r are the particles in static equilibrium ?

(A) 
$$r = a + b$$

(B) 
$$r = ab/a + b$$

(C) 
$$r = 2a/b$$

(D) 
$$r^2 = a^2 + b^2$$

- 9. The captain of a boat becalmed in the equatorial doldrum moves the anchor vertically upwards with velocity v. Will the boat start moving ? Which way ?
  - (A) Yes, northwards
  - (B) Yes, eastwards
  - (C) Yes, westwards
  - (D) no.
- 10. An empty cylindrical can and a can tightly packed with wheat flour, both start rolling down on inclined plane at the same instant. Which can reaches the bottom first ?
  - (A) Empty can
  - (B) Filled can
  - (C) Both arrive at the same time
  - (D) Sizes of the cans must be known to answer this question



- 11. For attractive inverse square forcesthe shape of the orbit will be :
  - (A) Elliptic
  - (B) Parabolic
  - (C) Hyperbolic
  - (D) All of the above
- 12. A cork is submerged in a pail of water by a spring attached to the bottom of the pail. The pail is held by a child in an elevator. During the initial acceleration as the elevator travels to the next lower floor, the length of the spring will :
  - (A) increase
  - (B) decrease
  - (C) remain the same
  - (D) any one of the above depending on the spring constant

- - (A)  $\overline{0}$

(B) 
$$\frac{1}{4\pi\epsilon_0} \frac{q^2}{d^2} \hat{z}$$

(C) 
$$\frac{1}{16\pi\epsilon_0} \frac{q^2}{d^2} \hat{z}$$

(D) 
$$\frac{-1}{16\pi \in_0} \frac{q^2}{d^2} \hat{z}$$

14. The dimensions of a quantity  $\in_0 E^2$ are ...... (A) MLT<sup>-2</sup> (B) ML<sup>2</sup>T<sup>-2</sup> (C) ML<sup>-1</sup>T<sup>-2</sup> (D) ML<sup>-2</sup>T<sup>2</sup> [P.T.O.

15. The direction of propagation of electromagnetic wave is given by .....

(A)  $\overline{E}$ 

(B)  $\overline{B}$ 

- (C)  $\overline{\mathbf{E}} \times \overline{\mathbf{B}}$
- (D)  $\overline{B} \times \overline{E}$

16. Electric field at large distance r, from

the electric quadrupole  $\mathbf{is}$ proportional to ......

(A)  $r^{-2}$ 

- (B)  $r^{-3}$
- (C)  $r^{-4}$

(D)  $r^3$ 

StudentBounty.com 17. An electron enters a uniform magnetic field region with its velocity perpendicular to the direction of the field. In the field region, the trajectory of the electron is .....

(A) linear

- (B) circular
- (C) parabolic
- (D) hyperbolic
- 18. An infinitely long straight wire carrying current I. The is magnetic field at a distance r from it is .....

(A) 
$$\frac{\mu_0 I}{r}$$
  
(B)  $\frac{\mu_0 I}{\pi r}$   
(C)  $\frac{\mu_0 I}{2\pi r}$ 

(D) 
$$\frac{\mu_0 I}{\pi r^2}$$

FEB - 32313/III

- 19. The parity of wave function  $\psi$  is associated with which of the following transformation ?
  - (A) Space inversion
  - (B) Space rotation
  - (C) Space translation
  - (D) Space exchange of two particles
- 20. The energy levels of the deuterium atom are given in terms of the principal quantum number n and a positive constant A by the expression :
  - (A)  $A(n + \frac{1}{2})$
  - (B)  $A\left(-\frac{1}{4}+\frac{1}{n^2}\right)$
  - (C)  $-A/n^2$

(D) An<sup>2</sup>

21. A one-dimensional harmonic oscillator is perturbed by a perturbation potential  $\alpha x^3$ . The ground state energy of the oscillator to a first order perturbation is :

(A) 
$$\frac{\hbar\omega}{2}$$
  
(B)  $\frac{\hbar\omega}{2} + \alpha$   
(C)  $\frac{3}{2}\hbar\omega + \alpha$   
(D)  $\frac{\hbar\omega}{2} + \alpha^{3}$ 

22. The configuration of three electrons 1s2p3p has which of the following as the value of its maximum possible total angular momentum quantum number ?

(B)  $\frac{5}{2}$ (C) 3 (D)  $\frac{3}{2}$ 

(A)  $\frac{7}{2}$ 

5

23. A freely moving electron is localized in space to within  $\Delta x$  at  $x_0$ , its wave function can be described by a wave packet :

$$\Psi(x, t) = \int_{-\infty}^{\infty} e^{i(kx - wt)}f(k)dk,$$

where f(k) is peaked around a central value  $k_0$ . Which of the following is most nearly the width of the peak in k?

(A)  $\Delta k = \frac{1}{x_0}$ (B)  $\Delta k = \frac{1}{\Lambda r}$ (C)  $\Delta k = \frac{\Delta x}{x_0^2}$ (D)  $\Delta k = (\Delta x) \frac{k_0}{x_0}$ 

StudentBounty.com 24.  $\psi_1$  and  $\psi_2$  are two orthonormal wave functions for an electron. Which of the following can describe a state of two electrons ?

(A) 
$$\psi_1(x_1) \psi_2(x_2)$$
  
(B)  $\frac{\left[\psi_1(x_1) + \psi_2(x_2)\right]}{\sqrt{2}}$ 

(C) 
$$\frac{1}{\sqrt{2}} \{ \Psi_1(x_1) \Psi_2(x_2) + \Psi_1 \}$$

(D) 
$$\frac{1}{\sqrt{2}} \left\{ \Psi_1(x_1) \Psi_2(x_2) - \Psi_1 \\ (x_2) \Psi_2(x_1) \right\}$$

- 25. Consider distributing 2 identical particles over 3 energy levels. Treating the particles as indistinguishable Fermi-Dirac particles, the number of ways of distributing is :
  - (A) 9
  - (B) 6
  - (C) 3
  - (D)  $2^3$



26. The energy density of the photon gas maintained at a temperature 'T' is proportional to  $T^n$ , where 'n' is :

(A) 1

- (B) 2
- (C) 3
- (D) 4
- 27. The average value  $\overline{v}$  (non-relativistic) of the velocity of a gas of molecules maintained at a temperature 'T' is given by :
  - (A)  $\frac{1}{2}k_{\rm B}T$ (B) zero
  - (C)  $\frac{3}{2}k_{\rm B}T$ (D)  $\frac{k_{\rm B}T}{m}$

- 28. In the canonical ensembles the system :
  - (A) is not maintained at a fixed temperature
  - (B) can exchange energy with the surroundings
  - (C) can exchange the number of particles with the surroundings
  - (D) is completely isolated from the surroundings
- 29. The entropy of the universe in a reversible process is :
  - (A) is constant
  - (B) is increasing
  - (C) is decreasing

(D) becomes infinite

[P.T.O.



- 30. For a system in thermodynamic equilibrium the following must be necessarily constant throughout the system :
  - (A) Temperature and pressure
  - (B) Temperature and not pressure
  - (C) Pressure and chemical potential
  - (D) Temperature, pressure, chemical potential
- 31. Noise voltage varies in a resistor as :
  - (A)  $4kTR_B$
  - (B)  $\sqrt{4k\text{TR}_{B}}$
  - (C)  $\sqrt{2eI_PB}$
  - (D)  $\sqrt{2eI_PB.R}$

- 32. G.M. counter is used for the detection of :
  - (A) only alpha particles
  - (B) only beta particles
  - (C) only gamma radiation
  - (D) alpha, beta and gamma radiations
- 33. In a photomultiplier if each stageemits 4 secondaries per primary andthere are ten stages the gain is ofthe order of :
  - (A) 4<sup>10</sup>
  - (B) 10<sup>4</sup>
  - (C) 40

(D)

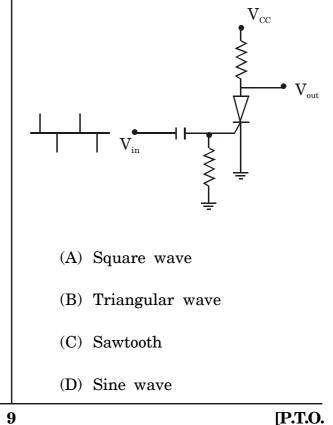
10!

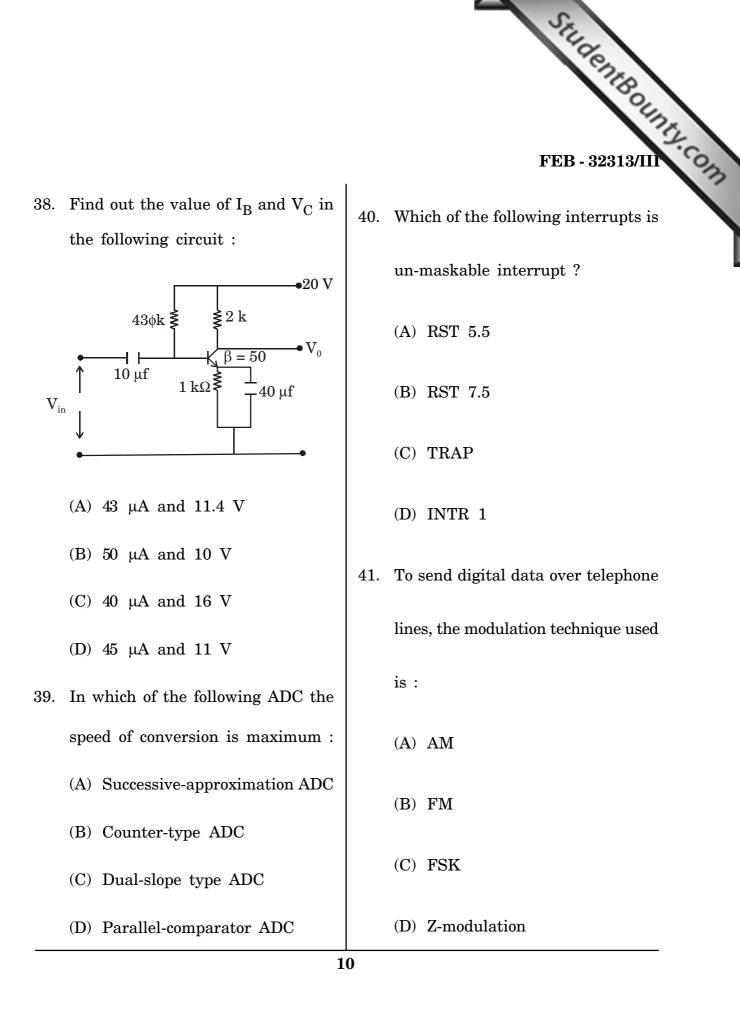
4!

FEB - 32313/III

- 34. A thin and hollow electrode is tapered and open at the end. The electrode is filled with an electrolyte. The electrode is put in an electrolyte bath. The tip will have :
  - (A) A very high resistance only
  - (B) A very low resistance only
  - (C) A high resistance with capacitance
  - (D) A low resistance with capacitance
- 35. Best vacuum that can be obtained with a rotary pump is :
  - (A) 10<sup>-3</sup> Torr
  - (B) 10 Torr
  - (C) 10<sup>-6</sup> Torr
  - $(D) \quad 10^{-10} \ Torr$

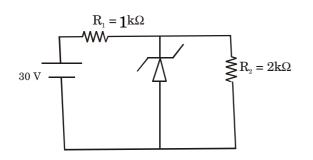
- 36. Precise value of *e*/*h* can be obtainedby :
  - (A) Millikan's oil drop method
  - (B) Compton effect
  - (C) Michelson interferrometer
  - (D) Superconducting quantum interference device
- 37. What is the output for the following circuit ?



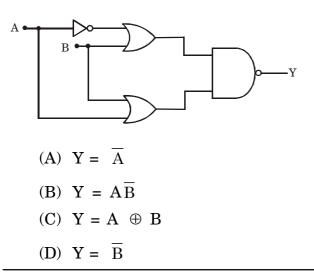


www.StudentBounty.com

42. In the given circuit the current through resistor  $R_2(2 \ k\Omega)$  is :

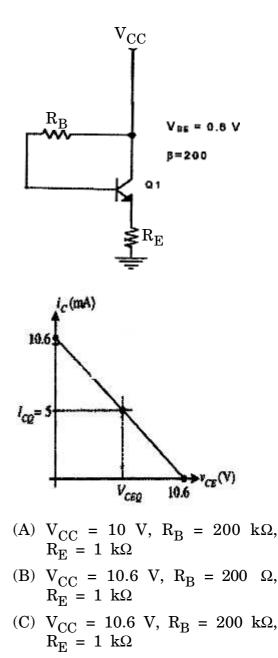


- (A) 2 mA
- (B) 15 mA
- (C) 10 mA
- (D) 6 mA
- 43. In the given digital logic circuit, A and B form the inputs. The output Y is :



11

**FEB - 32313/III** 44. Find the values of V<sub>CC</sub>, R<sub>B</sub> and R<sub>E</sub> in the following circuit :



- StudentBounty.com 45. In op-amp zero crossing detector : 47. Consider a planar ion  $CO_3^{2-}$ . How many normal modes of vibration this (A) output of comparator is zero ion will exhibit ? (B)  $-V_{CC} = 0$ (A) 6 (C) Reference voltage is zero
  - (D)  $+V_{CC} = 0$
- The following circuit acts as : 46.
  - $+V_{\rm CC}$  $R_L$ A• -Kŀ ۶Y B•---K (A) AND (B) OR (C) NOT (D) NAND

- (B) 7
- (C) 4
- (D) 12
- For 1s and 2s states of the hydrogen 48. atom, the all points is space at which the corresponding wave functions vanish is :

and $\infty$
∞

FEB - 32313/III

- 49. Give functional form of the variation of the potential energy with the separation *r* between a neutral atom and an ion :
  - (A)  $\frac{-1}{r}$
  - (B)  $\frac{1}{r^{12}} \frac{1}{r^6}$ (C)  $\frac{-1}{r^2}$
  - (D)  $\frac{-1}{r^3}$
- 50. A molecule can be infrared active provided a mode of vibration produces :
  - (A) a change in magnetic dipole moment
  - (B) a change in polarizability
  - (C) a change in electric dipole moment
  - (D) a change in quadrupole moment

- 51. A light source of wavelength 4358 Å is used to irradiate an organic liquid giving 3 Raman lines at 4400, 4419 and 4447 Å. The 'Raman Shift' of 4447 Å line will be :
  - $(A) \ \ 219 \ \ cm^{-1}$
  - $(B) \ \ 316.8 \ \ cm^{-1}$
  - (C)  $345.2 \text{ cm}^{-1}$
  - (D)  $459.2 \text{ cm}^{-1}$
- 52. Distance between two protons in a hydrogen molecule is :
  - (A) 1 nm
  - (B) 0.1 nm
  - (C) 0.01 nm
  - $(D) \ 0.001 \ nm$
- 53. State the quantum numbers for the ground state of neutral boron (atomic number 5).

(A) 
$${}^{2}P_{1/2}$$
  
(B)  ${}^{1}S_{0}$   
(C)  ${}^{2}S_{0}$   
(D)  ${}^{3}D_{1/2}$ 

 $\mathbf{13}$ 

- 54. Give the formula and the numerical value in meters, for the radius of the first Bohr orbit in hydrogen atom :
  - (A)  $\frac{\hbar}{mc} = 3.8 \times 10^{-13}$  meters
  - (B)  $\frac{\hbar}{mc} = 1.4 \times 10^{-15}$  meters

(C) 
$$\frac{\hbar^2}{me^2} = 5.3 \times 10^{-11}$$
 meters

(D) 
$$\frac{\hbar}{p} = 2 \times 10^{-17}$$
 meters

- 55. Alpha particles and protons of the same kinetic energy are passed through a gold foil. What is the ratio of their Coulomb scattering intensity ?
  - (A) 2
  - (B) 3
  - (C) 3/2
  - (D) 4
- 56. What is the ground state binding energy of an atom consisting of an electron and a positron bound to each other by their Coulomb interaction ? (A) 13.6 eV (B) 6.8 eV
  - (C) 8 eV
  - (D) 20.2 eV

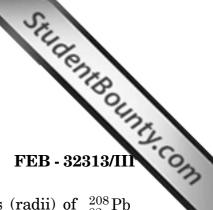
- StudentBounty.com If the first reflection from an  $f_{cc}$ 57. crystal has a Bragg angle  $\theta$  of 21.5°, the second reflection will have an angle  $\theta$  of :
  - (A) 18.5°
  - (B) 25.0°
  - (C) 31.0°
  - (D) 47.13°
- 58. One of the following is a non-polar molecule :
  - (A) HCl
  - $(B) CO_2$
  - (C)  $H_2O$
  - (D) HF
- 59. A rare earth ion has a ground state described by a basic level  ${}^{5}I_{8}$ . The maximum value of the orbital angular momentum L according to Hund rules is :
  - (A) 3
  - (B) 4
  - (C) 5
  - (D) 6

- 60. For Al, critical magnetic field at absolute zero is 105 gauss. The stabilization energy density of the superconducting Al wire in  $erg/cm^3$  is :
  - (A) 530.00
  - (B) 320.00
  - (C) 439.00
  - (D) 100.00
- 61. In a semiconductor the effective mass of a hole near the top of valence band is :
  - (A) positive
  - (B) negative
  - (C) zero
  - (D) pure imaginary
- 62. The plot of the energy momentum relation for free electrons has the shape of :
  - (A) A rectangular hyperbola
  - (B) An ellipse
  - (C) A circle
  - (D) A parabola

- StudentBounty.com The magnetisation of inside a type I 63. superconductor at temperatures T below the critical temperature  $T_c$ behaves :
  - (A) linearly as a function of the applied field H, upto the critical field H<sub>C</sub>
  - (B) is a non-zero constant as a function of H, upto the critical field H<sub>C</sub>
  - (C) is identically zero upto the critical field H<sub>C</sub>
  - (D) shows parabolic behaviour upto H<sub>C</sub> and shows a gap above H<sub>C</sub>
- 64. In an experiment of photoelectric effect, monochromatic X-rays are incident on the surface of a metal. Some of the resulting photoemitted electrons do not lose energy in escaping the surface and they leave the metal surface with a certain kinetic energy. If  $\phi$  is the workfunction of the metal, hv the photon energy and E is the binding energy (depth below the Fermi level from which the electron originates), the kinetic energy of the electron will be :

(A) K.E. = 
$$h\upsilon + E - \phi$$
  
(B) K.E. =  $h\upsilon - E + \phi$   
(C) K.E. =  $h\upsilon - E - \phi$   
(D) K.E. =  $h\upsilon + E + \phi$ 

15



- 65. When a beam of electron is reflected from a solid Aluminum surface, it is found that the electrons lose energy in discrete amounts of 15, 31 and 46 eV. Assuming the ideal electron gas model to be valid, the losses must be due to :
  - (A) plasma oscillations
  - (B) valence electron excitations
  - (C) core electron excitations
  - (D) generation of photoelectrons
- 66. Which of the following is *not* true in connection with the nuclear force ?
  - (A) Nuclear force is short-ranged
  - (B) Nuclear force is charge independent
  - (C) Nuclear force is spin-dependent
  - (D) The proton-proton force is stronger than the neutronneutron force

- 67. The ratio of sizes (radii) of  ${}^{208}_{82}$ Pb and  ${}^{26}_{12}$ Mg is approximately.
  - (A) 2
  - (B) 4
  - (C) 8
  - (D) 7
- 68. Which of the following is *not* a doubly magic nucleus ?
  - (A)  $^{16}_{8}O$
  - (B)  ${}^{40}_{20}$ Ca
  - (C)  $\frac{208}{82}$  Pb
  - (D)  ${}^{238}_{92}$ U
- 69. A nucleus with mass number 204 decays by α-emission. The Q-value of the reaction is 5.26 MeV. The kinetic energy of the α-particle is :
  (A) 5.26 MeV
  (B) 2.63 MeV
  (C) 5.26 × 200/204 MeV

(D) 5.26 × 
$$\frac{4}{204}$$
 MeV

## FEB - 32313/III

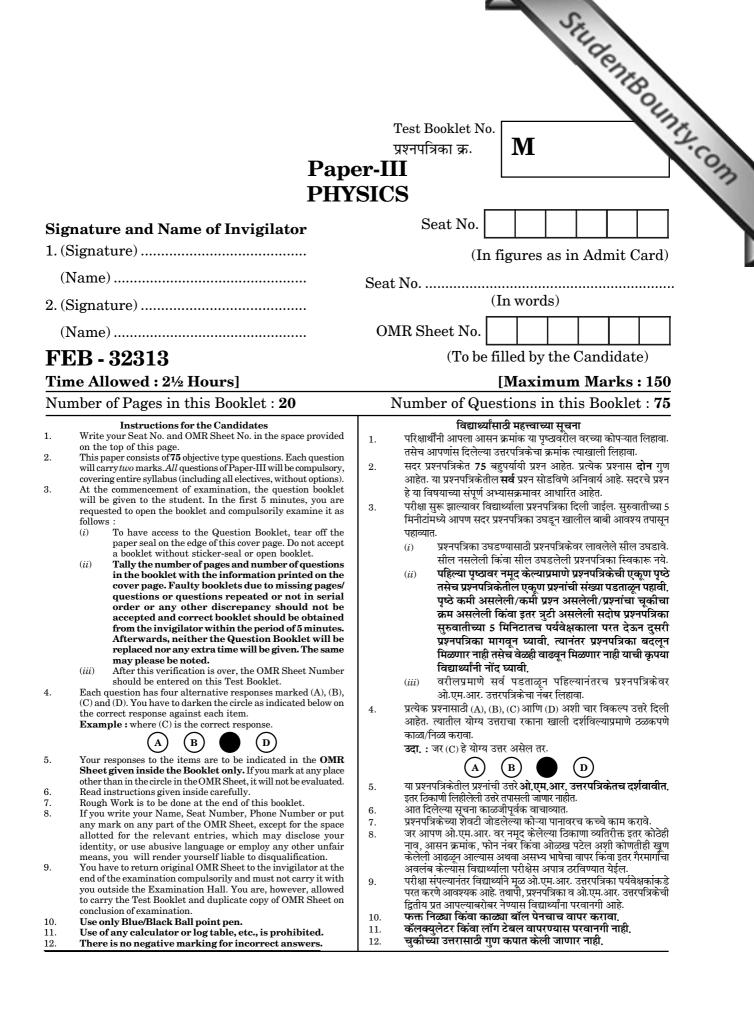
- 70. Which of the following is violated by
  - a  $\beta$ -decay phenomenon ?
  - (A) Energy conservation
  - (B) Momentum conservation
  - (C) Angular momentum conservation
  - (D) Parity conservation
- 71. The nuclear fission due to an absorption of a slow neutron is an example of :
  - (A) Compound nuclear reaction
  - (B) Direct reaction
  - (C) Neutron scattering reaction
  - (D) Quantum mechanical tunneling
- 72. Which of the following reactions is allowed one ?
  - (A) P + P  $\rightarrow$  k<sup>+</sup> +  $\Sigma^+$
  - (B)  $P + P \rightarrow k^+ + P + \wedge^0$
  - (C)  $\pi^- + P \rightarrow \Sigma^+ + K^0$
  - (D)  $\pi^- + P \rightarrow \pi^0 + \Lambda^0$

- 73. The quark structure of  $\pi^+$  is :
  - (A) *uu*
  - (B)  $\overline{u}d$
  - (C) dd
  - (D)
- 74. The symmetry term in the semiempirical mass formula is due to :
  - (A) non-equality of proton number Z and neutron number N
  - (B) non-spherical shape of nuclei
  - (C) charge-independence of nuclear force
  - (D) non-zero value of quadrupole moment of nuclei
- 75. α-particles of energy 5 MeV passing through an ionisation chamber completely lose their energy. Assuming that 35 eV of energy is required to produce one ion pair, find the height of the output pulse, if the capacity of the system is 10 µµf.
  - (A)  $2.85 \times 10^{-3}$  volts (B)  $3.2 \times 10^{-3}$  volts (C)  $2.24 \times 10^{-3}$  volts (D)  $3.4 \times 10^{-3}$  volts

17



## **ROUGH WORK**



www.StudentBounty.com