TEST SERIES GATE 2017

BOOKLET SERIES B

Paper Code: PH **Test Type: TEST SERIES**

Duration: 3:00 Hours

PHYSICS

Date: 19-01-2017

Maximum Marks: 100

Read the following instructions carefully:

1. Attempt all questions.
2. This question paper consists of **2 sections**, General Aptitude (GA) for **15 marks** and the subject specific GATE paper for **85 marks**. Both these sections are compulsory. The GA section consists of **10** questions. Question numbers 1 to 5 are of 1-mark each, while question numbers 6 to 10 are of 2-mark each.
   The subject specific GATE paper section consists of **55** questions, out of which question numbers 11 to 35 are of 1-mark each, while question numbers 36 to 65 are of 2-mark each.
3. The question paper may consist of questions of **multiple choice type** (MCQ) and **numerical answer type**.
4. Multiple choice type questions will have four choices against (a), (b), (c), (d), out of which only **ONE** is the correct answer.
5. For numerical answer type questions, each question will have a numerical answer and there will not be any choices.
6. All questions that are not attempted will result in zero marks. However, wrong answers for multiple choice type questions (MCQ) will result in **NEGATIVE** marks. For all MCQ questions a wrong answer will result in deduction of $\frac{1}{3}$ marks for a **1-mark** question and $\frac{2}{3}$ marks for a **2-mark** question.
7. There is **NO NEGATIVE MARKING** for questions of **NUMERICAL ANSWER TYPE**.
8. Non-programmable type Calculator is allowed

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Q.1-Q. 5 carry ONE mark each.

1. If the sum of five consecutive integers is S, what is the largest of those integers in terms of S?

(a) $\frac{S-10}{5}$ (b) $\frac{S-10}{4}$ (c) $\frac{S+10}{5}$ (d) $\frac{S-10}{10}$

2. If the product of 4 consecutive integers is equal to one of them, what is the largest possible value of one of the integers?

(a) 0 (b) 3 (c) 4 (d) 6

3. Fill in the blank with appropriate word. He is ______ opponent, you must respect and fear him at all times.

(a) A redoubtable (b) A disingenuous
(c) C raven (d) An insignificant

4. $(0.55)^{150}$ is closest to

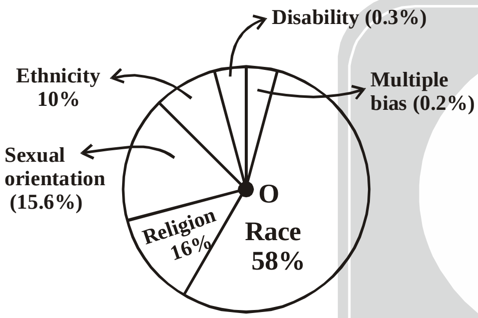
(a) 0.1 (b) 0 (c) 10 (d) 100

5. What is the Missing term in sequence ABC, A^2BC, A^2B^2C, _______, $A^3B^2C^2$.

(a) A^3B^2C (b) $A^2B^2C^2$ (c) $A^3B^3C^2$ (d) A^3BC

Q.6-Q. 10 carry TWO marks each.

6.



Percent– distribution of Bias – Motivated offenses in 1998 in USA.
If in 1998, there were 10, 000 bias motivated offenses based on ethnicity, how many more offenses were based on religion than on sexual orientation?

(a) 4 (b) 40 (c) 400 (d) 4000

7. A person moves 8 km west, 6 km north, 3 km east, and 6 more km north. How far is this person from his starting place

(a) 13 (b) 17 (c) 19 (d) 21

8. Fill in the blank by appropriate words?
The new computer system ____ next month.

(a) Is being installed by people (b) Is be installed
(c) Is being installed (d) Is been installed

9. Fill in the blank by appropriate words it's ______ disappointing.

(a) Very much (b) Very (c) Much (d) Much very

10. If Rout is related to Defeat then which pair is correctly matched

(a) Grief : Loss (b) Pathway : Ruin
(c) Memory : Oblivion (d) Ovation : Applause

Q.11-Q.35 carry one mark each.

11. If $\vec{A}$ and $\vec{B}$ are constant vectors, then $\vec{\nabla}\times\left[\left(\vec{A}\times\vec{B}\right)\times\vec{r}\right]$ can be expressed as $m\left(\vec{A}\times\vec{B}\right)$, where m is a scalar. The value of m is _________________

12. The laplace transform of

$$f(t) = 4t^3 + \cosh 2t - \sinh 2t$$

is

(a) $\frac{4}{s^4} + \frac{1}{s-2}$ (b) $\frac{24}{s^4} + \frac{1}{s+2}$ (c) $\frac{4}{s^4} + \frac{1}{s+2}$ (d) $\frac{24}{s^4} + \frac{1}{s-2}$

13. Consider the function,

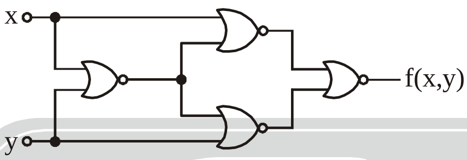
$$f(x) = 0 \quad \text{for } x < 2$$
$$= 1 \quad \text{for } x > 2$$

The derivative of the function $f(x)$ will be

(a) 0 (b) 1 (c) $\delta(x-2)$ (d) ∞

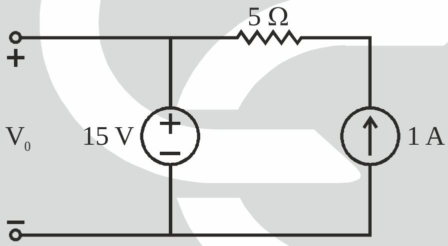
14. The number of distinct Boolean expression of 4 variables is ______________

15. Identify the logic function performed by the circuit shown in Fig.



(a) exclusive OR (b) exclusive NOR (c) NAND (d) NOR

16. In the circuit of figure the value of voltage v_o is



(a) 10 V (b) 15 V (c) 20 V (d) None of these

17. Two particles of masses m_1 and m_2 are placed along a straight line. They move due to their mutual gravitation force. If x_1 and x_2 be coordinates of particles then Lagrangian of the system is

(a) $L = \frac{1}{2}(m_1\dot{x}_1^2 + m_2\dot{x}_2^2) - \frac{Gm_1m_2}{x_1 + x_2}$ (b) $L = \frac{1}{2}(m_1\dot{x}_1^2 + m_2\dot{x}_2^2) - \frac{Gm_1m_2}{|x_2 - x_1|}$

(c) $L = \frac{1}{2}(m_1\dot{x}_1^2 + m_2\dot{x}_2^2) + \frac{Gm_1m_2}{|x_2 - x_1|}$ (d) $L = \frac{1}{2}(m_1\dot{x}_1^2 + m_2\dot{x}_2^2) - \frac{Gm_1m_2}{|x_2 - x_1|^2}$

18. A relativistic particle of mass *m* and charge '*e*' moves with speed v in electromagnetic potentials $(\vec{A}, \phi)$. Which of the following statements is correct?

(a) Lagrangian of particle is $L = -mc^2\sqrt{1 - \text{v}^2/c^2} - e\phi$

(b) Hamiltonian of particle is $H = \sqrt{(\vec{p} - e\vec{A})^2 + m^2c^4} + e\phi$

(c) Canonical momentum is $m\vec{\text{v}}$

(d) Canonical momentum is $m\vec{\text{v}} + e\vec{A}$

19. If $Q = \log\left(\frac{\sin\beta p}{q}\right)$, $P = q\cot\alpha p$ be a canonical transformation then value of α is _______________

20. The excitations of a three –dimensional solid are bosonic in nature with their frequency ω and wave-number k are related by $\omega \propto k$. If the chemical potential is zero, the behavior of the specific heat of the solid at low temperature is proportional to

(a) $T^{1/2}$ (b) $T^{3/2}$ (c) T^{3} (d) T

21. In the first –order phase transition which is/are continuous?

(a) Volume (b) chemical potential
(c) Entropy (d) All

22. If A and B are two Hermitian operators then among the following which is /are Hermitian.

(a) $\hat{A}\hat{B}\hat{A}$ (b) $i\left[\hat{A},\hat{B}\right]$
(c) $(1+i)\hat{A}\hat{B}+(1-i)\hat{B}\hat{A}$ (d) All

23. The dispersion for the 2p state of hydrogen atom is

(a) 4 a_0 (b) $\sqrt{5}$ a_0 (c) 5 a_0 (d) 0

24. The number of energy levels for a cubical box of side a in energy range $0 < E < \frac{15\pi^2\hbar^2}{2ma^2}$ is ______________.

25. An electron (mass = 9×10^{-31} kg, charge = 1.6×10^{-19} C) moving with a velocity 10^6 m/s, enters a magnetic field. If it describes a circle of radius 0.1 m, then strength of the magnetic field is equal to

(a) 4.5×10^{-5} T (b) 1.4×10^{-5} T (c) 5.6×10^{-5} T (d) 2.6×10^{-5} T

26. The number of transitions possible from $^3D_2$ state to $^3P_1$ state in presence of weak magnetic field is

(a) 7 (b) 8 (c) 9 (d) 10

27. In a cloud of electrons having 5×10^{28} electrons per m^3 , 80 % of the electrons drift along x-axis with a velocity 0.02 m/s and 20% of the electrons drift along y-axis with same speed. The current density is equal to

(a) $-3.2\times10^7\left(4\hat{i}+\hat{j}\right)$ A.m^{-2} (b) $3.2\times10^7\left(4\hat{i}+\hat{j}\right)$ A.m^{-2}
(c) $3.2\times10^7\left(\hat{i}+4\hat{j}\right)$ A.m^{-2} (d) $-3.2\times10^7\left(\hat{i}+4\hat{j}\right)$ A.m^{-2}

28. The Lande-g factor for $^3P_1$ level of an atom is equal to ___________

29. Consider current I flowing from $-\infty$ to $+\infty$ in wires laid along x-axis and y-axis. Magnetic field at (0, 0, d) is

(a) $\frac{\mu_0 I}{2\pi d}$ (b) $\frac{\mu_0 I}{\sqrt{2}\pi d}$ (c) $\frac{\mu_0 I}{\pi d}$ (d) 0

30. An electric field $\vec{E} = 2x^2\hat{x} + 3y^2\hat{y}$ exists in space. Let A(1, 1, 0) and B(0, 1, 1) be two points in the space. Potential difference between these two points is

(a) $\frac{4}{3}$ (b) $\frac{2}{3}$ (c) $-\frac{1}{3}$ (d) $-\frac{2}{3}$

31. In which of the following systems will the velocity of electron in the first Bohr orbit be maximum?
(a) Hydrogen atom (b) Deuterium atom
(c) Singly ionized helium (d) Doubly ionized lithium

32. The low temperature heat capacity in Graphite can be expressed as
(a) $AT + BT^3$ (b) $AT + BT^2$ (c) $(A + B)T^2$ (d) $A + BT^3$

33. The central wavelength of a $0.6\ \mu m$ wavelength laser corresponds to the m^{th} cavity mode of a resonator cavity of length 6 cm. The mode number *m* is
(a) 1000 (b) 2×10^4 (c) 2×10^5 (d) 200

34. In the nuclear reaction $p + p \rightarrow \pi^+ + n + \Lambda^0 + X$, the particle X stands for
(a) Σ^+-hypron (b) k^+-meson (c) proton (d) π^+-meson

35. The possible values of the spin of π^--meson by means of the reaction, $\pi^- + p \rightarrow n + \gamma$ is
(a) only 0 (b) 0 or 1 (c) only 1 (d) 0 or 1 or 2

Q.36-Q.65 carry TWO marks each.

36. The exponential of the matrix, $M = \begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix}$ will be

(a) $\frac{1}{2}\left(e+\frac{1}{e}\right)I+\frac{1}{2}\left(e-\frac{1}{e}\right)M$ (b) $\left(e+\frac{1}{e}\right)I+\left(e-\frac{1}{e}\right)M$

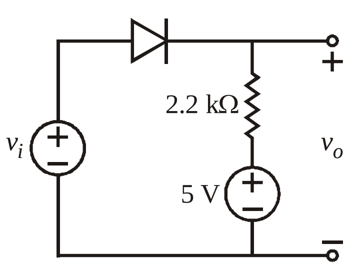
(c) $\left(e^2+\frac{1}{e^2}\right)I+\left(e^2-\frac{1}{e^2}\right)M$ (d) $\frac{1}{2}\left(e^2+\frac{1}{e^2}\right)I+\frac{1}{2}\left(e^2-\frac{1}{e^2}\right)M$

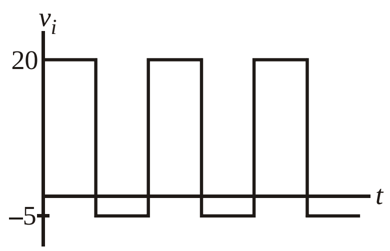
37. Which of the following functions cannot be be a real part of a complex analytic function of $z = x + iy$?
(a) $2xy$ (b) $\left(x^2 - y^2 - y\right)$ (c) $3x^2y - y^3$ (d) $3x^2y + y + y^3$

38. The generating function $G(x,t) = \sum_{n=0}^{\infty} H_n(x)\cdot\frac{t^n}{n!}$ for Hermite polynomial $H_n(x)$ is $G(x,t) = e^{2xt-t^2}$. The value of $H_{11}(x=0)$ is ____________________

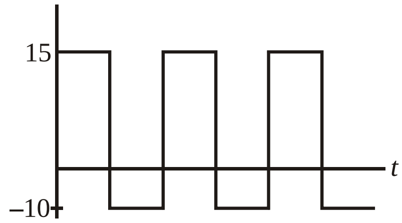
39. The AND function can be realized by using only n number of NOR gates. The value of n equal to __________

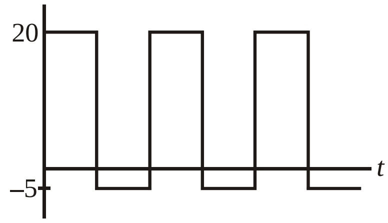
40. Consider the given a circuit and a waveform for the input voltage. The diode in circuit has cutin voltage $V_\gamma = 0$.

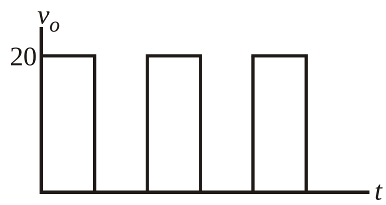


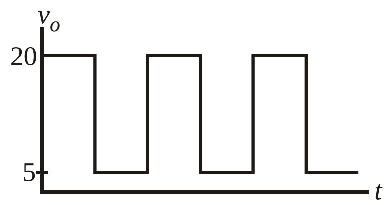


The waveform of output voltage v_o is

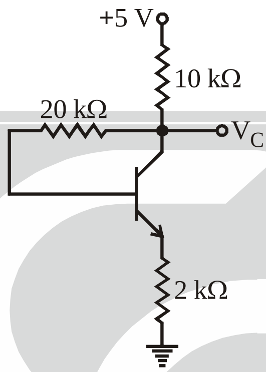
(a) 

(b) 

(c) 

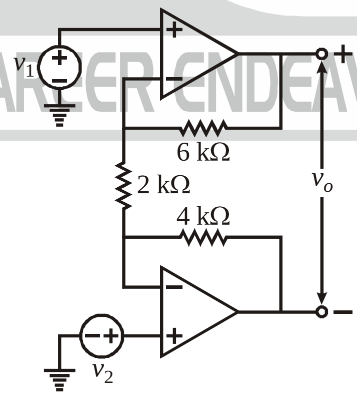
(d) 

41. The common-emitter current gain of the transistor is $\beta = 75$. The voltage V_{BE} in ON state is 0.7 V. The value of V_C is



(a) 1.49 V (b) 2.9 V (c) 1.78 V (d) 2.3 V

42. For the circuit shown below the voltage gain $A_{vd} = \dfrac{v_o}{(v_1 - v_2)}$ is



(a) 8 (b) –6 (c) 6 (d) –8

43. A particle of rest mass m_0 is moving +X direction in frame with momentum $\sqrt{3}\,m_0c$. What is energy of the particle in a frame S' which is moving along +Y direction with speed 4c/5, relate to S frame.

(a) $\frac{10}{3}m_0c^2$ (b) $\frac{5}{2}m_0c^2$ (c) $2m_0c^2$ (d) $\frac{7}{5}m_0c^2$

44. A thin annular ring of mass M and inner and outer radii R and 2R rolls on a horizontal surface such that centre of ring moves with speed v. Kinetic energy of the ring is

(a) $3Mv^2$ (b) $\frac{9}{8}Mv^2$ (c) Mv^2 (d) $\frac{3Mv^2}{4}$

45. A particle of mass 'm' is placed on the top of a smooth sphere of radius R. Particle is slightly displaced due to which it slides on the sphere before leaving contact with the sphere. Kinetic energy of the particle at the moment it leaves contact with the sphere is $\frac{mgR}{\alpha}$ then value of α is ________________

46. A particle of mass m is in a harmonic oscillator potential $V(x) = 2k\,x^2$ .Given that $\psi(x) = A\exp(-2ax^2)$ is an eigen function of energy. The value of constant a is

(a) $\frac{\sqrt{mk}}{\hbar}$ (b) $\frac{\sqrt{mk}}{2\hbar}$ (c) $\frac{\sqrt{mk}}{4\hbar}$ (d) $\frac{2\sqrt{mk}}{\hbar}$

47. In a particular metal at 300 K, the electrons each have chemical potential -2.03 eV. A certain quantum state has energy -2.00 eV, and it can contain no more than one electron.The probability that it is empty ____________

48. The Vander Wall's equation for 1 mole of a gas is $\left(P+\frac{a}{V^2}\right)(V-b) = RT$, where a, b are constants. If U is the internal energy of n moles of this gas, then the value of $\left(\frac{\partial U}{\partial V}\right)_T$ is

(a) $\frac{a}{V^2}$ (b) $\frac{a}{nV^2}$ (c) $\frac{a}{(nV)^2}$ (d) $\left(\frac{na}{V}\right)^2$

49. The average energy per particle for a Fermi gas at $T = 0$, in terms of Fermi energy ε_F, if density of states is proportional $\varepsilon^{-1/2}$ is given by

(a) $\frac{3}{5}\varepsilon_F$ (b) $\frac{1}{2}\varepsilon_F$ (c) $\frac{3}{2}\varepsilon_F$ (d) $\frac{1}{3}\varepsilon_F$

50. Consider a system of distinguishable particles with energy levels $0, \varepsilon, 2\varepsilon, 3\varepsilon, 4\varepsilon, ...$. For a system with 2 particles and energy $2\,\varepsilon$, the entropy of the system is

(a) kln3 (b) 2kln2 (c) 2kln3 (d) kln5

51. An electron is in state $\psi(r,\theta,\phi) = A\,f(r)\sin^2\theta\sin\phi$, where $f(r)$ is a function of r only and independent θ and ϕ and A is constant. If L represents orbital angular momentum and L_x, L_y , L_z its components. Which option is correct?

(a) $\langle L\rangle = \sqrt{20}\,\hbar$, $\langle L_z\rangle = 0$ (b) $\langle L\rangle = \sqrt{6}\,\hbar$, $\langle L_x\rangle = 0$

(c) $\langle L\rangle = \sqrt{6}\,\hbar$, $\langle L_x\rangle = 2\hbar$ (d) $\langle L\rangle = \sqrt{12}\,\hbar$, $\langle L_z\rangle = \hbar$

52. For a particle of mass m moving in the potential $V(x)=\frac{1}{2}m\omega^2x^2$, a small perturbation only for positive x, $H_p=\lambda x$ is applied with $\lambda>0$ constant. The first order correction to ground state energy is

(a) 0 (b) $\frac{\lambda}{2}\left(\frac{\hbar}{m\omega}\right)^{1/2}$ (c) $\frac{\lambda}{2}\left(\frac{\hbar}{\pi m\omega}\right)^{1/2}$ (d) $\lambda\left(\frac{\hbar}{m\omega}\right)^{1/2}$

53. At time $t=0$, the wavefunction for Hydrogen atom is

$$\psi(r,0)=\frac{1}{\sqrt{10}}\left(\psi_{100}+\psi_{200}+\sqrt{2}\psi_{211}+\sqrt{3}\psi_{21-1}\right)$$

where the subscripts are values of the quantum numbers n, l, m. Ignore spin and radiative transions. The expectation values of the energy of the system is $-x$ eV, then the value of x is ________________.

54. The interaction potential of two identical particle of spin-1/2 is $V(r)=V_0\left[3+\vec{\sigma}_1\cdot\vec{\sigma}_2\right]$, where are $\vec{\sigma}_i$ Pauli's spin operators. The contributions of this potential for singlet and triplet states respectively are

(a) $-3\ V_0$ and V_0 (b) V_0 and $-3V_0$ (c) V_0 and 4 V_0 (d) V_0 and $3V_0$

55. The density of copper is 8.94×10^3 kg/m^3, and its atomic mass is 63.5 amu. If resistivity of the copper at 20ºC is: $\rho=1.72\times10^{-8}\ \Omega-\text{m}$. What is relaxation time (τ) of electron? Each copper atom contributes one free electron to the metal.

(a) 2.5×10^{-16} sec. (b) 2.5×10^{-15} sec.

(c) 2.5×10^{-14} sec. (d) 2.5×10^{-13} sec.

56. A charge Q is uniformly distributed in the volume of a solid sphere of radius R. If potential at the surface is taken to be zero, potential at its centre will be

(a) zero (b) $\frac{Q}{4\pi\in_0 R}$ (c) $\frac{3Q}{8\pi\in_0 R}$ (d) $\frac{Q}{8\pi\in_0 R}$

57. The moment of inertia of the IR active molecule in the $v=0$ and $v=1$ levels is $15.2\times10^{-47}\,kg-m^2$. The wave number difference between the $R(1)$ and $P(1)$ lines of the fundamemtal band for that IR active molecule is

(a) 734 m^{-1} (b) 1101 m^{-1} (c) 1520 m^{-1} (d) 2049 m^{-1}

58. The lattice constant 'a' of a fcc solid is 2 Å. The number of atoms per cm^2 on (111) plane are

(a) 5.8×10^{15} (b) 2.9×10^{15} (c) 2.5×10^{15} (d) 2.5×10^{16}

59. The dispersion relation for electron in 3-dimensional lattice in tight binding approximation is given by

$$E(k)=E_0-A\left[\cos(k_xa)+\cos k_ya+\cos k_za\right]$$

where 'a' is a lattice constant and the value of A is 1 eV. The band width of the band along [111] direction is

(a) 1 eV (b) 3 eV (c) 6 eV (d) 8 eV

60. Consider a 20 μm diameter p-n junction fabricated in silicon. The donor density is 10^{16} per cm^3. The charge developed on the n-side is $1.6\times10^{-13}C$. Then the width (in μm) of the depletion region on the n-side of the p-n junction is ________________

61. The electric field due to an electric quadrupole radiation varies with distance r as

(a) $\frac{1}{r^2}$ (b) $\frac{1}{r^4}$ (c) $\frac{1}{r^3}$ (d) $\frac{1}{r}$

62. X-rays of 10 keV energy are used to determine the crystal lattice structure of fcc solid. The lattice constant of solid is a = 1.24Å. The angle of diffraction for (111) plane is _________________ degree.

63. The possible values of isospin I and its z-component I_3 for the system of particles $(\pi^+ + p)$ is

(a) $I = \frac{3}{2}, I_3 = \frac{3}{2}$ (b) $I = \frac{I}{2}, \frac{3}{2}, I_3 = \frac{3}{2}$ (c) $I = \frac{I}{2}, \frac{3}{2}, I_3 = \frac{1}{2}$ (d) $I = \frac{I}{2}, I_3 = \frac{3}{2}$

64. A 100 MeV k^+ particle decays as $k^+ \to \pi^+ + \pi^+ + \pi^-$. The measured value of kinetic energy of one π^+ particle is 68.6 MeV, that of other π^+ is 80.8 MeV. While the kinetic energy of π^- is 75.5 MeV. The Q-value of the above reaction is

(a) 124.9 MeV (b) 224.9 MeV (c) 324.9 MeV (d) 73.9 MeV

65. A freshly separated sample of P_0^{210} contains $1\times10^{-6}\ g$ of that nuclide. If the decay constant is 5.8×10^{-8} / sec , the number of disintegrations per second at the time of separation would be

(a) 1.6×10^{7} (b) 3.2×10^{8} (c) 1.6×10^{8} (d) 3.2×10^{7}

Space for rough work

PHYSICS-PH

Date: 19-01-2017

GATE TEST SERIES-B

ANSWER KEY

1. (c)	**2.** (b)	**3.** (a)	**4.** (a)	**5.** (b)
6. (c)	**7.** (a)	**8.** (c)	**9.** (b)	**10.** (d)
11. (2)	**12.** (b)	**13.** (c)	**14.** (65536)	**15.** (b)
16. (b)	**17.** (c)	**18.** (b)	**19.** (1)	**20.** (c)
21. (b)	**22.** (d)	**23.** (b)	**24.** (6)	**25.** (c)
26. (c)	**27.** (a)	**28.** (1.5)	**29.** (b)	**30.** (d)
31. (d)	**32.** (b)	**33.** (b)	**34.** (b)	**35.** (b)
36. (a)	**37.** (d)	**38.** (0)	**39.** (3)	**40.** (d)
41. (a)	**42.** (c)	**43.** (a)	**44.** (b)	**45.** (3)
46. (b)	**47.** (0.76)	**48.** (c)	**49.** (d)	**50.** (a)
51. (b)	**52.** (c)	**53.** (7.47)	**54.** (c)	**55.** (c)
56. (d)	**57.** (b)	**58.** (a)	**59.** (c)	**60.** (**0.3 to 0.33**)
61. (d)	**62.** (**120**)	**63.** (b)	**64.** (a)	**65.** (c)