MALLA REDDY ENGINEERING COLLEGE (AUTONOMOUS)

B.Tech I YEAR II SEMESTER (MR15)

Applied Physics – II- Question bank

(Common for ALL)

MODULE-1

Magnetism and Superconductivity

1. Materials do not having permanent magnetic dipoles are _____ [ ]
   a) Paramagnetic
   b) Ferromagnetic
   c) Ferri magnetic
   d) Diamagnetic
2. Magnetic susceptibility 'χ' is equal to _____ [ ]
   a) The ratio of the magnetic induction in the sample to the applied magnetic field intensity
   b) Magnetic moment per unit volume
   c) The ratio of the intensity of magnetization produced in the sample to the magnetic field intensity producing it
   d) The ratio of the magnetic field intensity to the intensity of magnetization
3. Relative permeability is related to magnetic susceptibility by_____ [ ]
   a) $\mu_r = 1 - \chi$
   b) $\mu_r = \chi - 1$
   c) $\mu_r = 1 + \chi$
   d) $\mu_r = 1/\chi$
4. Ferromagnetic susceptibility is _____ [ ]
   a) Very large, positive
   b) Small , positive
   c) Large, negative
   d) Small, negative
5. Antiferromagnetic susceptibility is _____ [ ]

a) Large, negative
b) Small , positive
c) Large, positive
d) Small, negative

6. Ferrimagnetic susceptibility is _____ [ ]
   a) Very large, positive
   b) Large, positive
   c) Small, positive
   d) Small, negative
7. The transition from the ferromagnetic to the paramagnetic state is named after _____ [ ]
   a) Curie
   b) Curie-Weiss
   c) Neel
   d) Debye
8. The area of hysteresis loop of a ferromagnetic material gives_____ [ ]
   a) The coercive force
   b) The remnant flex density
   c) The intensity of magnetization of the material
   d) The energy that is consumed in taking the material through a cycle of magnetization
9. The number of critical magnetic fields for a Type – I superconductor is_____ [ ]
   a) 1
   b) 2
   c) 3
   d) 4
10. SQUID stands for_____ [ ]
    a) Semi conducting Quantum Interference Device
    b) Superconducting Quantum Interference Device
    c) Small Quantum Interference Device
    d) Self induced Quantum Interference Device
11. The most characteristic feature of an antiferromagnetic material is_____ [ ]

a) Appearance of magnetic domains
b) Hysteresis behavior
c) A sharp minimum in the susceptibility Vs. Temperature curve
d) A sharp maximum in the susceptibility Vs. Temperature curve

12. The magnetization retained by the specimen when the magnetizing field is reduced from saturation value to zero is known as_____ [ ]
a) Coercivity
b) Hysteresis
c) Remnant Magnetization
d) Spontaneous magnetization

13. The dimension of ferromagnetic domains is in the order of _____ [ ]
a) 10^{6} meters
b) 10^{-9} meters
c) 10^{-6} meters
d) 10^{-3} meters

14. Alkali metals are examples of_____ [ ]
a) Paramagnetic
b) Ferromagnetic
c) Antiferromagnetic
d) Ferromagnetic

15. The example of ferromagnetic material is_____ [ ]
a) Ferrites
b) Salts of transition elements
c) Cobalt
d) None

16. The unit of magnetic susceptibility is _____ [ ]
a) Tesla
b) Am^{-1}
c) Hm^{-1}
d) No units

17. Below transition temperature ,a superconducting material exhibits_____ [ ]
a) Only zero resistance

b) Only diamagnetic property
c) Zero resistance and perfect diamagnetism
d) Zero resistance and ferromagnetism

18. The magnetization of a superconductor is_____ [ ]
a) 0
b) H
c) 1
d) -H

19. Examples of type-1 superconductors are_____ [ ]
a) Al, Nb & Ta
b) Al, Zn & Hg
c) Ta, V & Nb
d) None of these

20. In a superconducting state_____ [ ]
a) Entropy alone changes
b) Electronic specific heat alone changes
c) Both entropy and electronic specific heat change
d) None of these

21. Which among the following materials exhibits Hysteresis, similar to Ferromagnetic materials? _____ [ ]
a) Diamagnetic
b) Paramagnetic
c) Ferrimagnetic
d) None of these

22. When a material becomes superconductor_____ [ ]
a) The properties of lattice structure do not change
b) The properties of lattice structure do change
c) It becomes ferromagnetic in nature
d) Magnetic property does not change

23. A superconductor is a perfect _____ [ ]
a) Dielectric
b) Paramagnet
c) Resistor
d) Diamagnet

24. The magnetic susceptibility of a superconductor is _____ [ ]

a) -1
b) 0
c) +1
d) Infinity

25. Basic principle involved in Maglev vehicles _____ [ ]
a) Piezo electric effect
b) Magnetostriction
c) Meissner effect
d) Compton effect

26. Type – II superconductors are characterized by _____ number of critical magnetic fields. [ ]
a) 1
b) 2
c) 3
d) 4

27. The region between low critical field and upper critical field in type –II superconductor is called _____ [ ]
a) Superconducting state
b) Space charge region
c) Normal state
d) Vortex state or mixed state

28. Theory which explains superconductivity is_____ [ ]
a) Lattice theory
b) Lorentz theory
c) BCS theory
d) Sommerfield theory

29. A superconductor exhibits --------resistance [ ]
a) Small
b) Large
c) Zero
d) Infinite

30. In type –II superconductors _____ [ ]
a) The magnetic flux does not pass through the material
b) The magnetic flux passes through the material
c) The magnetic flux oscillates

d) The magnetic flux does not suddenly drop to zero but decreases exponentially

31. Type-1 superconductors are _____ [ ]
    a) Hard superconductors
    b) Soft Superconductors
    c) Either (a) and (b)
    d) None
32. The critical field strength of a superconductor_____ [ ]
    a) Is inversely proportional to temperature
    b) Varies with temperature
    c) Is proportional to temperature
    d) Is independent of temperature
33. In Anti-ferromagnetic substances, the magnetic dipoles of the adjacent atoms are_____ [ ]
    a) Equal and anti parallel
    b) Equal and parallel
    c) Unequal and parallel
    d) Unequal and anti parallel
34. In any magnetic domain of a ferromagnetic material, the magnetic dipoles of the adjacent atoms are_____ [ ]
    a) Equal and anti parallel
    b) Equal and parallel
    c) Unequal and parallel
    d) Unequal and anti parallel
35. The relative permeability for vacuum is_____ [ ]
    a) 0
    b) 1
    c) 1.22
    d) None
36. The relation between B and H is_____ [ ]
    a) $B=\mu/A$
    b) $H=\mu B$
    c) $\mu=HB$
    d) $B=\mu H$
37. In Ferromagnetic materials, the spin alignment is_____ [ ]

a) Regular
b) Irregular
c) No alignment
d) None

38. The magnetic moment of an atom is due to_____ [ ]
a) Orbital motion of electrons only
b) Spin motion of electron
c) Both orbital and spin motion
d) None of these

39. Which of the following substances can have positive permeability and negative susceptibility? _____ [ ]
a) Diamagnetic
b) Ferromagnetic
c) Paramagnetic
d) None of these

40. The value of susceptibility of a ferromagnetic substance is of the order of_____ [ ]
a) 10^{5}
b) 10^{6}
c) 10^{-7}
d) -10^{-6}

41. The number of states in Type – II superconductor is_____ [ ]
a) 1
b) 2
c) 3
d) 4

42. Equal number of opposite spins with same magnitude present in_____ [ ]
a) Ferromagnetic materials
b) Paramagnetic materials
c) Anti ferromagnetic materials
d) None of these

43. Equal number of opposite spins with different magnitude present in_____ [ ]
a) Ferromagnetic materials

b) Paramagnetic materials
c) Anti ferromagnetic materials
d) Ferri magnetic materials

44. In case of ferromagnetic materials_____ [ ]
a) $B_{out} >> B_{in}$
b) $B_{in} >> B_{out}$
c) $B_{in} = B_{out}$
d) None

45. The susceptibility of antiferromagnetic material is_____ [ ]
a) $\chi = 1/T$
b) $\chi = C/T-\Theta$
c) $\chi = C/T+\Theta$
d) None

46. The susceptibility of ferromagnetic material is_____ [ ]
a) $\chi = 1/T$
b) $\chi = C/T-\Theta$
c) $\chi = C/T+\Theta$
d) None

47. Bohr magneton=_____ [ ]
a) eh/2m
b) eħ/2m
c) eh/8m
d) eħ/8m

48. The conductivity of a superconductor is_____ [ ]
a) Infinite
b) Zero
c) Finite
d) None

49. The superconducting transition temperature of Mercury is_____ [ ]
a) 4.172°c
b) 4.172°F
c) 4.172 K

d) None

50. Resistivity of metals decreases with_____ [ ]
    a) Increasing temperature
    b) Decreasing temperature
    c) Independent of temperature
    d) None

KEY

1. d
2. c
3. c
4. a
5. b
6. a
7. a
8. d
9. a
10. b
11. d
12. c
13. c
14. a
15. c
16. d

17.c

18.d

19.b

20.c

21.c

22.b

23.d

24.a

25. c

26. b

27. d

28. c

29. c

30. d

31. b

32. b

33. a

34. b

35. b

36. d

37. a

38. c

39. a

40. b

41. c

42. c

43. d

44. b

45. c

46.b

47.b

48.a

49.c

50.b

Module – II: Quantum mechanics

1) Quantum theory successfully explains _____ [ ]
(a)Interference and diffraction
(b) Polarization and Black body radiation
(c) Photoelectric effect and Compton effect
(d) all

2) Dual nature (particle and wave) of matter was proposed by _____ [ ]

(a) de Broglie
(b) Planck
(c) Einstein
(d) Newton

3) The wavelength associated with the particle of mass m and velocity v is _____[ ]
(Note: h is Planck's constant)
(a) hmv
(b) h/mv
(c) mv/h
(d) 1/mvh

4) The wavelength of de Broglie's wave associated with an electron when accelerated in a potential difference V is (h is Planck's constant and e is charge of electron) ___ [ ]
(a) h / meV
(b) h / 2meV
(c) $h / (2meV)^{½}$
(d) $h / (2meV)^{2}$

5) When an electron is accelerated in a potential difference V, then the de Broglie wavelength associated with it in Angstrom is _____ [ ]
(a) 1.227/V
(b) $1.227/ (V)^{½}$
(c) 12.27/V
(d) $12.27/ (V)^{½}$

6) Quantum mechanics is different from classical mechanics in that _____ [ ]
a) there is a probabilistic approach
b) a particle without energy to pass over a potential barrier may still tunnel through
c) there is a wave function approach
d) all of these.

7) The existence of matter waves is proposed by _____ [ ]
(a) Davisson and Germer
(b) G.P.Thomson
(c) O.Stern

(d) all

8) The eigen value of an eigen function is its _____ [ ]

a) probabilistic value
b) characteristic value
c) wave value
d) potential energy value

9) The operator d^2 / dx^2 when operated on e^{2x} gives an eigen value of _____ [ ]

a) 1 b) 2 c) 3 d) 4

10) The target material in Davisson and Germer experiment is_____ [ ]

(a) Gold
(b) Nickel
(c) Tungsten
(d) Copper

11) The spurt in the curve drawn between the number of electrons collected against the angles of galvanometer with incident beam in Davisson and Germer experiment is more clear for a anode voltage of _____ [ ]

(a) 40 volts
(b) 44 volts
(c) 54 volts
(d) 68 volts

12) The diffraction angle for Nickel crystal in Davisson and Germer experiment is_____ [ ]

(a) 50^o
(b) 65^o
(c) 25^o
(d) 130^o

13) Schrodinger's wave equation for a particle with mass m and energy E, moving along X-axis is _____ [ ]

(a) $d^2\Psi / dx^2 + (2m / \hbar^2)(E-V)\Psi = 0$
(b) $d\Psi / dt + 2m / \hbar^2(E-V)\Psi = 0$
(c) $dy / dx + 2m / \hbar^2(E-V)\Psi = 0$
(d) $d^2\Psi / dx^2 + 2m/\hbar^2 (V-E)\Psi = 0$

14) The wave function 'Ψ' associated with a moving particle _____ [ ]

(a) Is not an observable quantity
(b) Does not have direct physical meaning
(c) Is complex quantity
(d) All

15) The solution of particle in one dimensional infinite potential well problem gives ___ [ ]

(a) Quantum numbers
(b) Discrete values of energy and zero point energy
(c)Wave function associated with the particle
(d) All

(16) The energy possessed by a particle of mass 'm' in n^{th} quantum state in a one dimensional infinite potential well of width 'L' is _____ [ ]

(a) $n^2 h^2 / 8mL^2$
(b) $n h / 8mL^2$
(c) $n^2 h^2 / 8mL$
d) $8mL^2 / n^2 h^2$

(17) In the measurement of energy and time of a process, the uncertainity is given by_____ [ ]

(a) $\Delta E. \Delta t \geq h/4\prod$
(b) $\Delta E. \Delta t \leq h/4\prod$
(c) $\Delta E. \Delta t = h/4\prod$
(d) None

(18) In photoelectric effect absorption or emission of energy takes place_____ [ ]
(a) In the form of packets of energy called quanta
(b) Continuously
(c) Both a and b
(d) None

(19) When an electron is accelerated through a potential difference of 100V, then it is associated with a wave of wave length equal to_____ [ ]

(a) 0.112nm
(b) 0.1227nm
(c) 1.227nm
(d) 12.27nm

(20) _____proposed matter waves but he did not prove it experimentally. [ ]
(a) Thomson
(b) Davission and Germer
(c) de Broglie
(d) Schrodinger

(21) The original aim of Davission and Germer experiment was to find the_____ by a metal target. [ ]

(a) Intensity of scattered electrons
(b) Electron diffraction
(c) To find interplanar spacing
(d) None

(22) The de Broglie wave length of electrons obtained from Davission and Germer experiment is _____ [ ]

(a) 0.0165nm
(b) 0.165nm
(c) 1.65nm
(d) 16.5nm

(23) Schrodinger's wave equation was derived based on_____ idea of matter waves.[ ]
(a) De Broglie's
(b) Schrodinger's
(c) Thomson's
(d) Newton's

(24) If ψ (x, y, z, t) represent wave function associated with a moving particle then $|\psi (x, y, z, t)|^2$ represent _____ [ ]

(a) Intensity
(b) Amplitude
(c) Probability density
(d) None

(25) If E_1 is the ground state energy of a particle, then the increase in energy from n^{th} energy level to next higher level is _____ [ ]

(a) $(2n+1)\ E_1$.
(b) $2n\ E_1$
(c) $(2n-1)\ E_1$
(d) $(3n+1)\ E_1$

(26) The normalized wave function of a particle in a one dimensional infinite potential well of width 'L' is _____ [ ]
(a) $\frac{2}{L} Sin \frac{n\pi x}{L}$
(b) $\frac{L}{2} Sin \frac{n\pi x}{L}$
(c) $\sqrt{\frac{L}{2}} Sin \frac{n\pi x}{L}$
(d) $\sqrt{\frac{2}{L}} Sin \frac{n\pi x}{L}$

(27) The most probable position of a particle in one dimensional infinite potential well of width 'L' in the first quantum state is_____ [ ]
(a) L / 4
(b) L / 3
(c) L / 2
(d) 2L / 3

28) Calculate the de Broglie wavelengths of an electron which has been accelerated from rest on application of potential of 400 volts _____ [ ]
a) 0.613 Å

b) 0.0613Å
c) 6.13Å
d) none

29) Calculate the wavelength associated with an electron raised to potential of 1600 V _____ [ ]

a) 0.3065Å
b) 0.0365 Å
c) 3.065 A°
d) none

30) If Δx and ΔP are the uncertainties in the position and momentum measurements then, According to uncertainty principle _____ [ ]

a) Δx. ΔP ≥h / 4∏
b) Δx. ΔP =h / 4∏
c) Δx. ΔP ≤h / 4∏
d) none

31) An electron is moving under a potential field of 15 kV. Calculate the wavelength of the electron waves. _____ [ ]

a) 0.1 Å
b) 0.01 Å
c) 1 Å
d) None

32) For a particle at rest, de Broglie wavelength is _____ [ ]

a) Infinite
b) Finite
c) Constant
d) None

33)Heisenberg's uncertainty principle supports the fact that_____ [ ]

a) Proton cannot exist in the nucleus
b) Electron cannot exist in the nucleus
c) Neutron cannot exist in the nucleus
d) Positron cannot exist in the nucleus

34) Uncertainty principle was proposed by_____ [ ]

a) Planck
b) G.P. Thomson
c) Heisenberg
d)Davisson & Germer

35) de Broglie waves are .....waves [ ]

a) Sound waves
b) Electromagnetic waves
c) Ultrasonic
d) None

36) The physical interpretation given by _____ to the wave function is presently accepted by all [ ]

a) Schroedinger b) Pauli c) Heisenberg d) Max Born

37) Louis de Broglie proposed the dual nature by comparing matter with ___ [ ]

a) radiation b) momentum c) both d) none

38) Fermat's principle of least time appears in the branch of physics called ___ [ ]

a) Mechanics b) Optics c) Thermodynamics d) none of these

39) Maupertius principle of least action appears in the branch of Physics called ___ [ ]

a) Mechanics b) Optics c) Thermodynamics d) none of these

40) Matter waves are associated with___ [ ]

a) Moving particle
b) stationary particle
c) neutral particle
d) all the above

41) As per the Einstein's mass energy equivalence, ___ [ ]

a) $E = m^2C$ b) $E = mC^2$ c) $E = m^3C$ d) $E = mC^3$

42) As per the Planck's quantum hypothesis ___ [ ]

a) $E = h\nu^2$ b) $E = h\nu$ c) $E = h^2\nu$ d) $E = h\nu^3$

43) The value of Planck's constant is ___Joule Second [ ]

a) 1.6×10^{-19} b) 9.1×10^{-31} c) 6.6×10^{-34} d) 3×10^{10}

44) The value of charge of electron is ___ coulomb [ ]

a) 1.6×10^{-19} b) 9.1×10^{-31} c) 6.6×10^{-34} d) 3×10^{10}

45) The value of mass of electron is ___ kg [ ]

a) 1.6×10^{-19} b) 9.1×10^{-31} c) 6.6×10^{-34} d) 3×10^{10}

46) In Davisson and Germer's experiment _____ is used to heat Tungsten filament for producing electrons. [ ]

a) Low Tension Battery b) High Tension Battery
c) High resistance voltage source d) AC source

47) In Davisson and Germer's experiment _____ is used to make the fine pencil beam of electrons. [ ]

a) Low Tension Battery b) High Tension Battery
c) High resistance voltage source d) AC source

48) Who among the following first tried to give a physical interpretation to wave function?[ ]

a) Millikan b) Schroedinger c) Max Born d) Dirac

49) Who among the following interpreted that wave function talks about the particle density?[]

a) Millikan b) Schroedinger c) Max Born d) Dirac

50) Which of the following is called Normalization condition? [ ]

a) $\iiint_{-\infty}^{\infty} \boldsymbol{\psi}^* \boldsymbol{\psi} \, dV = 0$
b) $\iiint_{-\infty}^{\infty} \boldsymbol{\psi}^* \boldsymbol{\psi} \, dV = 1$
c) $\iiint_{-\infty}^{\infty} \boldsymbol{\psi}^* \boldsymbol{\psi} \, dV < 0$
d) $\iiint_{-\infty}^{\infty} \boldsymbol{\psi}^* \boldsymbol{\psi} \, dV < 1$

Module-II Answers:

1. d 2. a 3. b 4. c 5. b 6. d 7. d 8. b 9. d 10. b 11. c 12. b
13. a 14. d 15. d 16. a 17. a 18. a 19.b 20. c 21. a 22. b 23. a 24. c
25. a 26. d 27. c 28. a 29.a 30 .a 31.a 32) a 33) b 34) c 35.b 36. d 37. a 38. b
39.a 40. a 41. b 42. b 43. c 44. a 45. b 46. a 47. b 48. a 49. b 50. b

Module – III A: Band Theory of Solids

1. According to the Band theory, Potential of the solid varies ---[ ]
    a) Periodically
    b) Constant
    c) Zero
    d) None
2. Band theory is also called -----[ ]
    a) Zone theory
    b) Quantum theory
    c) Classical theory
    d) None
3. While electron is moving through positive ion core in crystal lattice, the potential is ------ at the positive ion sites[ ]
    a) Minimum
    b) Maximum
    c) Optimum
    d) None
4. While electron is moving through positive ion core in crystal lattice, the potential is ------ in between the positive ion sites[ ]
    a) Minimum
    b) Maximum
    c) Optimum
    d) None
5. In Kronig-Penny model, to simply the mathematical calculations the potential curve or well is taken as ---- instead of parabola [ ]
    a) Rectangle
    b) Circle
    c) Both a and b
    d) None
6. Variation of velocity with k shows that the velocity of a free electron is zero when. [ ]

a) k= 0
b) k=π/a
c) Both a & b
d) None

7. In E – K diagram, [ ]
   a) Each portion of the curve represents allowed band of energies
   b) The curves are horizontal at the top and bottom
   c) The curves are parabolic near the bottom with curvatures in opposite directions
   d) All
8. The effective mass of an electron is maximum when it is: [ ]
   a) In the lower energy levels of an allowed band
   b) In the higher energy levels of an allowed band
   c) In the energy level corresponding to a point of inflection (k_0) in a allowed band
   d) None
9. In kronig-Penney model, as the scattering power of the potential barrier, P → ∞ then the allowed energy bands: [ ]
   a) Reduce to single energy levels
   b) Reduce to smaller bands
   c) Increase to bigger bands
   d) None
10. In kronig-Penney model, as the scattering power of the potential barrier, P → 0 then: []
    a) All the energies are allowed to the electrons
    b) All the energies are not allowed to the electrons
    c) The forbidden band reduces to smaller size
    d) None
11. In kronig-penny model, the width of allowed bands ----------and the width of forbidden bands ----------with increase of αa[ ]
    a) Increases, decreases
    b) Increases, increases
    c) Decreases, decreases
    d) Decreases, increases
12. The discontinuities in the energies of free electrons of a metal occur at the -------of the Brillouin zones. [ ]
    a) Middle
    b) Boundaries
    c) Both a and b
    d) None
13. The effective mass of a free electron is ----------, when it occupies lower energy levels of allowed band of energies: [ ]
    a) Negative

b) Positive
c) Low negative
d) None

14. The effective mass of a free electron is----------, when it occupies higher energy levels of allowed band of energies, [ ]
    a) Negative
    b) Positive
    c) Low positive
    d) High positive
15. Classical free electron theory is proposed by -----[ ]
    a) Drude and Lorentz
    b) Sommerfield
    c) Bloch
    d) None
16. The cause for electrical resistance in a metal is[ ]
    a) Impurities and crystal defects
    b) Thermal vibrations
    c) Electron scattering and non-periodicity of lattice potentials
    d) All
17. When an electron in a periodic potential is accelerated by an electric field or magnetic field, then the mass of the electron is called _____[ ]
    a) Effective mass
    b) Rest mass
    c) Both a & b
    d) None
18. According to Free Electron theory, the potential in between electrons and positive ions in the lattice is ---------[ ]
    a) Zero
    b) Constant
    c) Infinite
    d) None
19. According to Bloch, the periodicity of periodic potential in lattice is _____.[ ]
    a) Inter-atomic distance
    b) Zero
    c) Both a and b
    d) None
20. Band theory is proposed by---------[ ]
    a) Somerfield
    b) Bloch
    c) Thomson

d) All

21. At any temperature other than 0K, the probability of finding an electron at Fermi level is…[ ]
    a) 1
    b) 0.5
    c) 0
    d) Any positive value
22. According to Fermi-Dirac statistics the probability of an electron occupying an energy level E is given by_____ [ ]
    a) $F(E) = \frac{1}{1-\exp\left(\frac{E-E_F}{K_BT}\right)}$
    b) $F(E) = 1 + \exp\left(\frac{E-E_F}{K_BT}\right)$
    c) F(E) = $\frac{1}{1+\exp\left(\frac{E-E_F}{K_BT}\right)}$
    d) F(E)= $1 - \exp\left(\frac{E-E_F}{K_BT}\right)$
23. When the valence and conduction bands are overlapped then that solid is called[ ]
    a) Conductor
    b) Semiconductor
    c) Insulator
    d) None
24. When there is a small gap in between valence and conduction bands, then that solid is called_____[ ]
    a) Conductor
    b) Semiconductor
    c) Insulator
    d) None
25. At absolute zero, semiconductor have the band structure similar to _____[ ]
    a) Insulator
    b) Conductor
    c) Neither a nor b
    d) Both a and b

Key:

1. a
2. a
3. a
4. b

5. a
6. a
7. d
8. c
9. a
10. a
11. a
12. b
13. b
14. a
15. a
16. d
17. a
18. b
19. a
20. b
21. b
22. c
23. a
24. b
25. a