Yashwantrao Chavan College of Science Karad
B.Sc. Part –III
Physics Paper XV: Atomic and Molecular Physics and Astrophysics
Question Bank 2023-24

Q1) Select the correct alternative for the following. **(1 mark each)**

1) Right vertical axis of the H-R diagram represents ………………….

   a) temperature   b) spectral class   c) luminosity   d) absolute magnitude

2) According to the condensation theory, during this period of aggregation of small bodies called .... continued to form the planets.

   a) asteroids   b) meteorites   c) planetismals   d) comets

3) Raman spectra can be produced only when the sources have...................intensity.

   a) high   b) weak   c) zero   d) very weak

4) In case of vibration rotational transitions of the molecule, the group $\Delta v = +1$ and $\Delta J = +1$ represents ……………..

   a) P-branch   b) Q-branch   c) R-branch   d) S-branch

5) In the presence of weak magnetic field or no field, orbital angular momentum and spin angular momentum precess with .... period about their resultant angular momentum.

   a) inverse   b) same   c) different   d) none of these

6) Sun-spots always occurs in ……………

   a) triplets   b) pairs   c) single   d) none of these

7) If the light has the finite velocity, more distant galaxy refers to....................time.

   a) later   b) earlier   c) infinite   d) none of these

8) Raman effect is related to following optical phenomenon.

   a) scattering   b) reflection   c) refraction   d) total internal reflection

9) In case of vibration rotational transitions of the molecule, the group $\Delta v = +1$ and $\Delta J = -1$ represents ……………..

   a) P-branch   b) Q-branch   c) R-branch   d) S-branch

10) The spectral lines which are close doublets are called …………..

   a) fine structure   b) diffused structure   c) fine series   d) diffused series

11) The device which measures Zeeman splitting of spectral lines and automatically converts into magnetic field is known as …………………..

a) solar magnetograph   b) lunar magnetograph

c) magnetostat   d) heliograph

12) The best fit estimated value of Hubble constant is............................Km/s/million ly.

a) 14   b) 17   c) 22   d)26

13) To observe Raman effect molecule must be ………….

a) polar   b) non-polar   c) a or b   d) none of these

14) Pure vibrational spectra ocure in …………………………

a) UV region   b) IR region   c) microwave region d) radio region

15) Which of two series have same convergence limits. i.e. 3P state.

a) sharp and diffuse   b) diffuse and principle

c) diffuse and fundamental   d) principle and sharp

16) Sun-spots in pairs has...............................polarities.

a) same   b) opposite   c) neutral   d) none of these

17) According to this theory, the universe will end in to darkness.

a) big-bang   b) steady state   c) oscillating   d) condensation

18) Which of the following made optical system is used to study Raman effect.

a) wood   b) metal   c) glass   d) all

19) If the wavefunction ψa is antisymmetric, stable molecular system................be formed.

a) can   b) cannot   c) always   d) none of these

20) The electron configuration for alkali atom is that of............................ as core, which is surrounded by an e-electron which is responsible for optical spectra.

a) metals   b) halogens   c) transition metals   d) inert gas

21) Total number of sun-spots counted at any time is not constant but varies almost periodically with the period of.................................. years.

a) 10   b) 11   c) 12   d) 13

22) The state of universe when all the matter in the universe is concentrated into a small region is called ……………..

a) big bang   b) nucleus   c) protostar   d) ylem

23) Intensity of raman lines compared to corresponding Rayleigh's lines is ………..

a) almost equal   b) very high   c) very low   d) zero

24) Quantum mechanically, the probability of tunnelling decreases with increase in …………………

a) charge q   b) mass m   c) distance R   d) velocity v

25) The transitions which can be excited easily give rise to .... series.

    a) sharp   b) principle   c) diffuse   d) fundamental

26) For a given principle quantum number (n), the levels with smaller l-value ………

    a) lie higher   b) lie deeper   c) lie at same level   d) none of these

27) Each sun-spot consists of a dark central area called …………………………

    a) umbra   b) penumbra   c) granule   d) none of these

28) The astronomer who first observed the red shift in the spectra of distant galaxies was …………..

    a) Issac Newton   b) Albert Einstein   c) Edwin Hubble   d) V M Slipher

29) Which of the following is generally lies in infra-red region,

    a) blue shift   b) red shift   c) rayleigh shift   d) raman shift

30) In case of H2 molecule, it there are two protons from two boxes with wall between them, then.................................there is a certain probability that the electron can tunnel through the wall and enter the other box.

    a) chemically   b) classically   c) logically   d) quantum mechanically

31) The rotational transitions are governed by selection rule ………….

    a) $\Delta J = 1$ b) $\Delta J = \pm 1$ c) $\Delta J = 0$ d) $\Delta J = -1$

32) Sun's surface is not uniformly bright but shows a number of dark regions called ……………..

    a) flares   b) prominences   c) corona   d) sun spots

33) The observation of red shift in the spectra of galaxies shows that the galaxies are …………….

    a) moving away from us   b) moving towards us

    c) at rest   d) none of these

34) Raman shift for anti-Stoke's Lines is …………………..

    a) positive   b) negative   c) zero   d) none of these

35) The molecular bond involved in the NaCl molecule is ………………

    a) ionic bond   b) covalent bond   c) no bond   d) none of these

36) A region of the H–R diagram running from upper left to lower right corner is known as ……...…..

    a) main sequence   b) spectral class

    c) absolute magnitude   d) luminosity

37) The transitions from nS levels to the lowest P-level give rise to a series of spectral lines in series called ……………..

a) sharp   b) principle   c) diffuse   d) fundamental

38) Temperature of the sun at the center is much higher than the surface therefore edge appears darker than center and this phenomenon is called as ……………….

a) sun spot   b) grannules   c) limb darkening   d) flares

39) According to this theory, the statistical distribution of matter and motion are uniform in time as well as in space

a) big-bang   b) steady state   c) oscillating   d) condensation

40) Raman shift for Stoke's Lines is …………………..

a) positive   b) negative   c) zero   d) none of these

41) If one or more pair of electrons are shared by two interacting atoms, it forms ….......................bond between them.

a) ionic   b) covalent   c) no   d) both a and b

42) Anomalous Zeeman pattern is converted to normal Zeeman pattern when Lande's g factor is ………………

a) 1   b) 1.2   c) 1.5   d) 1.7

43) The energy produced in the core of the sun reaches to the surface in the form of ….....................in the plasma.

a) corona   b) photosphere   c) convection current   d) radiation

44) The ………………………….theory reconciles with the concept of eternal and self-renewing universe

a) big-bang   b) steady state   c) oscillating   d) condensation

45) Raman shift Δv is given by …………………….., if v_i is incident frequency and v_s is scattered frequency.

a) $\Delta v = v_i + v_s$ b) $\Delta v = v_i - v_s$ c) $\Delta v = v_s - v_i$ d) $\Delta v = v_i . v_s$

46) In case of rotational spectra, only the molecules which possess.......................can absorb or emit electromagnetic radiations.

a) moment of inertia   b) electric dipole moment

c) angular momentum   d) none of these

47) If the coupling between l* and s* is not broken in an external magnetic field, then we observe ………..

a) normal zeeman effect   b) anomalous zeeman effect

c) paschen back effect   d) stark effect

48) The surface of the sun having an average temperature of about 6000 degree kelvin is known as …………….

a) corona   b) photosphere   c) sun spot   d) none of these

49) H-H fusion reaction were took place, when the temperature of matter reached to …....................degree kelvin.

a) 6000   b) 50000   c) 4.6 million   d) 10 million

50) Raman lines are situated ....with respect to undisplaced (incident) line.

a) only on one side   b) symmetrically on both sides

c) asymmetrically on both sides   d) none of these

Q. 2 Long answer type questions.   **(8 marks each)**

1) What is normal Zeeman effect? Explain normal Zeeman effect with the help of vector atom model.

2) What is anomalous Zeeman effect? Explain anomalous Zeeman effect with the help of vector atom model.

3) Explain in detail vibration-rotation spectra of a diatomic molecule. Describe how it can be used to estimate moment of inertia and thereby bond length.

4) Get an expression for vibrational energy levels of a diatomic molecule and hence discuss the pure vibrational spectra.

5) Get an expression for rotational energy levels of a diatomic molecule and hence discuss the pure rotational spectra.

6) How H_2^+ molecular ion becomes stable by sharing an electron by two protons ? Discuss the nature of wave function of H_2^+ molecular ion.

7) Discuss the quantum theory of Raman effect and explain the rotational –Raman spectra.

8) Discuss the quantum theory of Raman effect and explain the vibrational –Raman spectra.

9) Give the classical theory of Raman effect and show that Raman shift is equal to (i) frequency of vibration of molecule and (ii) double the frequency of rotation of the molecule.

10) Discuss the origin of solar system with special reference to condensation theory. What are the supporting evidences and objections to the condensation theory.

11) Explain Big-bang, oscillating and steady state theories of universe. Draw conclusion about most acceptable theory.

12) Describe H-R diagram. Explain birth of star, ageing of star and thereby its conversion to neutron star and blackhole.

13) Explain, how the strong, local magnetic field regions are created on the Sun's surface and thereby explain the observed features of sunspots.

14) Describe different stages of stellar evolution with the help of H-R diagram.

15) How death of star occurs? Explain in detail white dwarf, neutron star and blackholes. Describe their positions in H-R diagram.

Q. 3 Short answer type questions.   **(4 marks each)**

1) Give a brief account of spectral notations and optical spectral series due to alkali atoms.

2) Explain the spectrum of sodium and its doublet structure with the help of energy level diagram.

3) Explain when a molecular bond can be formed and also types of molecular bonds.

4) How H_2^+ molecular ion becomes stable by sharing an electron by two protons ?

5) Write a note on Frank-Condon principle.

6) Write a note on electronic spectra of diatomic molecules.

7) Qualitatively discuss the nature of wave function of H_2^+ molecular ion.

8) Obtain an expression for rotational energy level of a diatomic molecule.

9) Discuss the pure rotational spectra of diatomic molecule.

10) Obtain an expression for vibrational energy level of a diatomic molecule.

11) Discuss the pure vibrational spectra of diatomic molecule.

12) Explain the coarse structure of vibrational bands and the terms band system, band sequence and band progression.

13) Write a note on Raman effect. What are stokes and antistokes lines ?

14) List the characteristic properties of Raman lines.

15) Give the difference between Raman spectra and infrared spectra.

16) What is Hubble law? Define Hubble constant. Explain how Hubble law can be used to test correctness of cosmological theory.

17) What is Hubble law? Define Hubble constant. Explain how approximate age and range of universe can be estimated from Hubble constant.

18) 'As we look outward in space, we look backward in space'. Explain this statement and how this is used to test the correctness of cosmological theories.

19) Write a note on Big-bang theory of universe.

20) Write a note on Oscillating theory of universe.

21) Write a note on Steady state theory of universe.

22) State and explain any three test to verify the correctness of cosmological theories.

23) What is Milky-way galaxy? Describe in detail.

24) Explain the formation of protostar and the changes that occur till it forms a normal star.

25) When does star feels aged? Explain the formation of red-giant and then helium flash.

26) Explain how a small star forms a white dwarf. What is the maximum mass limit for the formation of white dwarf.

27) Explain the supernova explosion and formation of neutron star and finally the formation of a blackhole.

28) What is blackhole? Whether sun can form blackhole? Explain with reasons.

29) What are sun-spots? Give prominent features of sun-spots.

30) Why sun-spot regions are dark? Explain.