Sikkim Public Service Commission
Main Written Examination for the Post of Sub Inspector
PAPER - II PHYSICS

Time allowed: 3.00 Hrs

Maximum Marks: 250

INSTRUCTION TO CANDIDATES

Read the instructions carefully before answering the questions: -

1. IMMEDIATELY AFTER THE COMMENCEMENT OF THE EXAMINATION, YOU SHOULD CHECK THAT THIS BOOKLET DOES NOT HAVE ANY UNPRINTED OR TORN OR MISSING PAGES OR ITEMS ETC. IF SO, GET IT REPLACED BY A COMPLETE TEST BOOKLET.
2. Use only Black Ball Point Pen to fill the OMR Sheet.
3. Do not write anything else on the OMR Answer Sheet except the required information.
4. This Test Booklet contains 50 questions in MCQ Mode in Part I to be marked in OMR Sheet. Part II and Part III are Subjective Questions which have to be written on separate answer sheet provided to you.
5. Before you proceed to mark in the Answer Sheet (OMR), you have to fill in some particulars in the Answer Sheet (OMR) as per given instructions.
6. After you have completed filling in all your responses on the Answer Sheet (OMR) and the examination has concluded, you should hand over the Answer Sheet (OMR) and separate answer sheet to the Invigilator only. You are permitted to take with you the Test Booklet.
7. **Marking Scheme**

   THERE WIL BE NEGATIVE MARKING FOR WRONG ANSWERS MARKED BY A CANDIDATE IN THE OBECTVE TYPE QUESTIONS

   i. There are four alternatives for the answer to every question. For each question for which a wrong answer has been given by the candidate, one-third of the marks assigned to the question will be deducted as penalty.
   ii. If a candidate gives more than one answer, it will be treated as a wrong answer even if one of the given answers happens to be correct and there will be same penalty as above to the question.
   iii. If a question is left blank. i.e., no answer is given by the candidate; there will be no penalty for that question.

> DO NOT OPEN THIS TEST BOOKLET UNTIL YOU ARE ASKED TO DO SO

Choose the correct answer for the following questions: (3x50=150)

1. Law which states that square of period of any planet is proportional to cube of semi major axis of its orbit is

    A. Kepler's first law
    B. Kepler's second law
    C. Kepler's third law
    D. Newton's Second Law

2. Number of independent ways in which a molecule possesses transnational, rotational or vibratory motion without violation of constraints is called
    A. Degree of angle
    B. Degree of steradian
    C. Degree of transition
    D. Degree of freedom

3. If three sets of streamlines A, B and C are considered across section 1-2, which set will represent accelerated flow from 1 to 2?
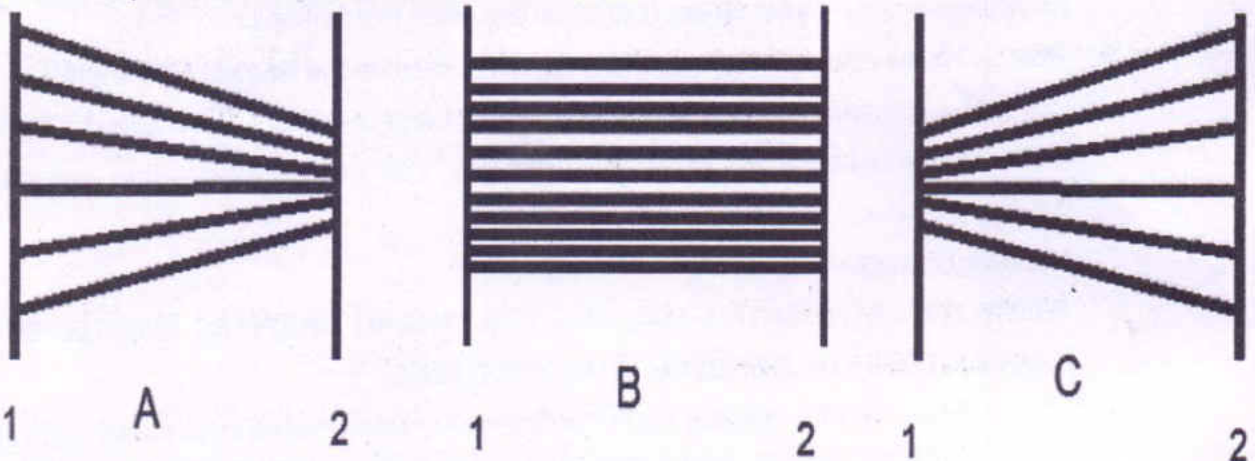
    A. A
    B. B
    C. C
    D. None of the sets

4   A particle of mass 'm_0' moves with speed 0.8c, where 'c' is the speed of light in vacuum. The relativistic kinetic energy of the particle is nearly
    A. $1.66m_0c^2$
    B. m_0c^2
    C. $0.32m_0c^2$
    D. $0.66\,m_0c^2$

5. The ratio of intensities of two waves is 1:9. If these waves produce interference, the ratio of maximum to the minimum intensities will be.
   A. 1:4
   B. 4:1
   C. 1:3
   D. 3:1

6. A convex lens and a concave lens each having same focal length of 30 cm are put in contact to form a combination of lenses. The power of this combination in dioptres is

   A. 60
   B. infinite
   C. Zero
   D. 30

7. What is the speed of light in glycerin (n = 1.47) expressed in terms of the speed of light in a vacuum?

   A. 2.04c
   B. 1.47c
   C. 0.680c
   D. 3.00c

8. In Michelson's interferometer 100 fringes cross the field view when the movable mirror is displaced through 0.02948 mm. Calculate the wavelength of monochromatic light used

   A. 5896 A^0
   B. 5890 A^0
   C. 4000 A^0
   D. 4890 A^0

9. Resolving power of grating is given by

   A. $\lambda/2$
   B. $\lambda/d\lambda$
   C. $d\lambda/\lambda$
   D. none of these

10. Particles which were deflected backwards in Rutherford's experiment were hit upon by

   A. Nucleus
   B. empty space
   C. electrons
   D. protons

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11. **Mass is best given by** _____

    A. Product of volume and density
    B. Ratio of mass to density
    C. Addition of mass and density
    D. Subtraction of mass and density

12. **If total kinetic energy and momentum of a system becomes zero after collision, then collision is**
    A. elastic
    B. inelastic
    C. conserved
    D. not conserved

13. **The modulus of rigidity and Poisson's ratio of the wire are 2.87×10^{10} N/m² and 0.379 respectively. What is the value of young's modulus of the material of the wire.**

    A. 1.08773×10^{10} N/m²
    B. 7.915×10^{10} N/m²
    C. 7.5725×10^{10} N/m²
    D. 0.1403×10^{10} N/m²

14. **Which of the following have highest elasticity?**
    A. Steel
    B. Copper
    C. Rubber
    D. Aluminium

15. **A change in observed frequency of a wave when source or detector moves relative to transmitting medium is called**

    A. Doppler effect
    B. Thermal effect
    C. Newton's effect
    D. Elastic effect

16. **Length contraction happens only**

    A. perpendicular to direction of motion
    B. along the direction of motion
    C. parallel to direction of motion
    D. both A and B

17. **Oscillations become damped due to**

    A. normal force
    B. friction
    C. tangential force
    D. parallel force

18. In a Young's double-slit experiment the centre of a bright fringe occurs wherever waves from the slits differ in the distance they travel by a multiple of:

A. a fourth of a wavelength
B. a half a wavelength
C. a wavelength
D. three-fourths of a wavelength

19. If the angle between the axes of polarizer and analyzer is 30 degree, the intensity of light transmitted by the analyzer is --------times the intensity by the polarizer.

A. 1/2
B. 3/4
C. 1/4
D. Zero

20. A beam of light is propagating in the x direction. The electric field vector

A. can oscillate in any direction in space.
B. must oscillate in the z-direction
C. must oscillate in the x direction
D. must oscillate in the yz plane

21. The active medium in He-Ne laser is

A. He
B. Ne
C. He-Ne
D. All correct

22. The critical temperature above which the ferromagnetic materials loose their magnetic property is known as :

A. Hysteresis
B. Transition Temperature
C. Standard temperature
D. Curie Temperature

23. In a series resonance circuit if bandwidth is 1 MHz and inductance is 1 mH, then what is the resistance value?

A. 1 Ohm
B. 10 Ohm
C. 100 Ohm
D. 1000 Ohm

24. In RLC series circuit, at resonance condition the value of current is

A. Maximum
B. Minimum
C. Zero
D. None of the above

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25. Kirchhoff's 2nd law is consequence of law of conservation of

   A. Power
   B. charge
   C. momentum
   D. energy

26. What is the frequency of the EM wave with a wavelength of 12cm?

   A. 2.4Ghz
   B. 2.6Ghz
   C. 2.5 Ghz
   D. 2.3Ghz

27. As a radiator, the black body emits the maximum possible thermal Radiation

   A. at a constant single wavelength
   B. at the maximum wavelength
   C. at all wavelengths
   D. none of the above

28. The relationship (Wavelength) $_{MAX}$ T = constant, between the temperature of a black body and the wavelength at which maximum value of monochromatic emissive power occurs is known as

   A. Planck's law
   B. Kirchhoff's law
   C. Lambert's law
   D. Wein's law

29. For any irreversible process, net entropy change is

   A. Negative
   B. zero
   C. positive
   D. infinite

30. Maxwell's equations can be written in

   A. integral form
   B. differential form
   C. logical form
   D. either in integral or differential form

31. In a lab, a student heats up a chemical from 10 ℃ to 25 ℃ which requires thermal energy of 30000 J. If mass of object is 40 kg, specific heat capacity of chemical would be

A. 05 J kg^{-1} ℃$^{-1}$
B. 10 J kg^{-1} ℃$^{-1}$
C. 15 J kg^{-1} ℃$^{-1}$
D. 50 J kg^{-1} ℃$^{-1}$

32. Uncertainty principle can be easily understandable with help of

A. Dalton's effect
B. electron effect
C. rhombic effect
D. Compton's effect

33. Splitting of spectral lines due to magnetic effect is called

A. Zeeman effect
B. spark effect
C. condensation effect
D. electromagnetic effect

34. A positron has a mass number of _____, a charge of _____, and a mass equal to that of a(an) _____.

A. 0, 1+, proton
B. 1, 2+, proton
C. 0, 1+, electron
D. 1, 2+, electron

35. A moderator is used to slow

A. protons
B. alpha particles
C. neutrons
D. beta particles

36. Particles that participate in the strong nuclear interaction are called

A. neutrinos
B. hadrons
C. leptons
D. electrons

37. Rutherford's experiments, in which he bombarded a very thin gold foil with alpha particles, showed that is

A. all of the α particles passed through the foil without significant deflection.
B. none of the α particles were able to penetrate the foil.
C. all of the α particles passed through the foil and were deflected through   large angles.
D. most of the α particles passed through the foil with negligible deflection but some were deflected through large angles.

38. What is the meaning of the term "critical mass"?

A. This refers to the mass of the "critical" elements in a reactor, i.e., the uranium or plutonium.
B. This refers to the minimum amount of fissionable material required to sustain a chain reaction.
C. This is the amount of mass needed to make a power reactor   economically feasible.
D. This is the material which is just on the verge of becoming radioactive.

39. The fuel for nuclear fusion in the centre of the Sun is

A. H
B. He
C. U
D. any radioactive material

40. An n-type semiconductor is ....
A. Positively charged
B. Negatively charged
C. Electrically neutral
D. One of the above

41. The random motion of holes and free electrons due to thermal agitation is called
....
A. Diffusion
B. Pressure
C. Ionisation
D. None of the above

42. In a transistor, the base current is about .... of emitter current
A. 25%
B. 20%
C. 35 %
D. 5%

43. In a transistor, I_C = 100 mA and I_E = 100.2 mA. The value of β is ..
A. 100
B. 50
C. about 1
D. 500

44. The power gain in a transistor connected in .... arrangement is the highest
   A. common emitter
   B. common base
   C. common collector
   D. none of the above

45. If the value of α is 0.9, then value of β is ....
   A. 9
   B. 0.9
   C. 900
   D. 90

46. The magnetic lines of force cannot penetrate the body of a superconductor, a phenomenon is known as
   A. Isotopic effect
   B. BCS theory
   C. Meissner effect
   D. London theory

47. The temperature at which conductivity of a material becomes infinite is called
   A. Critical temperature
   B. Absolute temperature
   C. Mean temperature
   D. Crystallization temperature

48. Minimum interplanar spacing required for Bragg's diffraction is:

   A. $\lambda/4$
   B. $\lambda/2$
   C. λ
   D. 2λ

49. Which of the following is not an amorphous material?

   A. Glass
   B. Plastics
   C. Lead
   D. Rubbers

50. The response of a material due to the function of heat is known as ___

   A. Mechanical property
   B. Electrical property
   C. Chemical property
   D. Thermal property

PART - II

Attempt ANY TWO questions.   (25 X 2 = 50)

1. A. Explain the lasing action of He-Ne laser using energy level diagram and

   describe the operation of He-Ne laser experimental set-up.   (15)

   B. Discuss the application of lasers in communication and medicine.   (10)

2. A. Explain the four thermodynamic relations of Maxwell. Using the same obtain the Clausius-Clapeyron equation.

$$\frac{dP}{dT} = \frac{L}{T(V_2 - V_1)}$$

                                                                                (18)

   B. Using Maxwell-Boltzmann distribution law prove that there cannot be any negative absolute temperature.   (7)

3. A. Show that the Young's modulus Y, modulus of rigidity $\Box$ and Poisson's ratio σ are related by the equation $Y=2\Box(1+\sigma)$ (15)

   B. Calculate the percentage contraction in the length of a rood in a frame of reference, moving with velocity 0.8c in a direction (i) parallel to its length and (ii) at an angle of 30^0 with its length.   (10)

4. A. How does one explain the approximate constancy of average binding energy per nucleon (BE/A) of nuclei in the region $30 \leq A \leq 170$ in the plot of BE/A versus mass number A?   (15)

   B. Write the semi-empirical mass formula pointing out the role of volume term, surface energy term, coulomb and symmetry energy correction terms.   (10)

5. A. A 10.0V battery is connected at t=0 to a series combination of a register $R=15.0\Omega$ and an inductor L = 6.0H. At what rate is energy being stored in the inductor when the current in the circuit is 0.3A?   (10)

   B. Two solenoids have 600 and 200 turns of wire and are placed co-axially close to each other. A current of 7.0 A in the first solenoid produces an average flux of 200 μWb through its each turn and flux of 100 μWb through each turn of the second solenoid. Find the self-inductance of the first solenoid and the mutual inductance of the solenoids.   (15)

PART - III

1. A. What are the salient features of nuclear forces?
   B. What does high viscosity mean.

2. A. What do you mean by Raman effect.
   B. Compare JFET and MOSFET.

3. A. Write on conservation laws for elementary particle reaction.
   B. What is the principle of Oscillator.

4. A. What is the difference between reduced mass and center of mass.
   B. What is phase reversal Zone Plate.

5. A. Is momentum conserved in Special relativity.
   B. What does negative temperature mean.

6. A. Write the three applications of Fiber optics.
   B. Distinguish between normal and anomalous dispersion.

7. A. Write on the basic principal of Holography.
   B. Write on the significance of Lamb Sift.

8. A. Write on the properties of Pauli spin matrices.
   B. What on the is a transistor switch?