B.Sc.(Honours) Examination, 2019

Semester-IV (CBCS)
Physics (Honours)
Core Course: CC-9 (Theory)
(Elements of Modern Physics)

Time: Three Hours **Full Marks: 40**

Questions are of value as indicated in the margin.
Answer ***any four*** questions.

1. (a) What is black body and black body radiation?
   (b) What is the Planck's postulate to explain the distribution of black body radiation?
   (c) Write down the Planck's distribution law and hence obtain the Wien's displacement law $\lambda_m T$=constant.
   (d) The surface temperature of sun is 6000K what is the value of λ_m?
   ((0.5+0.5)+1+(1+5)+2)

2. (a) What are the characteristics of phto-emission?
   (b) Define threshold frequency and work-function.
   (c) What is the relation between threshold frequency and work-function?
   (d) Draw the schematic diagram for black body radiation for T = 1500K, 6000K, 10000K and 10^6K.
   (e) Draw the schematic diagram for the variation of energy of the emitted photo-electron with the frequency of the incident photon.
   (3+(1+1)+1+(2+2))

3. (a) How do you distinguish Einstein's theory of specific heat of a solid with that of Debye theory?
   (b) Obtain an expression for the specific heat of solid in Einstein's theory.
   (c) Show explicitly that at high temperature Dulong-Petit's law comes automatically from Einstein's model. (3+5+2)

4. (a) Consider α decay from an α-active nucleus. Write down the decay reaction
   (b) Obtain the energy released in the process.
   (c) Show that for a massive nucleus, almost the whole amount of energy released will be carried off by the emitted α particle.
   (d) Why a third particle is needed in nuclear β-decay?
   (e) Why this third particle is a fermion and also is an anti-particle?
   (1+2+3+2+2)

P.T.O.

5. (a) Show that the energy in eV of a photon of wavelength 1Åis approximately 12412.5.

   (b) Show that the ratio of the de Broglie wavelength to the Compton wavelength of a particle is $\left(\left(\frac{c}{v}\right)^2 - 1\right)^{1/2}$.

   (c) If A, B, C and D are four commuting Hermitian operators, what is the value of$(ABCD)^\dagger$.

   (d) Using the uncertainty relation show that and electron can not stay in a real nucleus of radius a few fm. (2+2+2+4)

6. (a) What do you mean by the parity operator (P), charge conjugation operator (C) and the time reversal operator (T).

   (b) What is the effect of time reversal operator on Schröodinger equation?

   (c) What is CPT theorem and the consequences of CPT invariance. ((1+1+1)+4+(1+2))

7. (a) Obtain the solution for Schröodinger equation for a particle in an one-dimensional infinite potential well. Hence also show that the solution is exactly like a classical vibrational plucked string.

   (b) Draw the Feynman diagram for the decay processes (i) $\mu^- \rightarrow e^- + \overline{\nu_e} + \nu_\mu$ and (ii) $n \rightarrow p + e^- + \overline{\nu_e}$. Use also the quark level diagram in the second case. (5+(1+2+2))
