Name:_____ Roll No:_____ Tutorial Gr:_____

Signature of Invigilator

Duration: 8.00 - 8.45 AM   **Full marks:** 15   **Date:** 27/08/2019 (Tuesday)

Answer all the questions and write the answers inside the box. Only fully correct answers will be accepted and there will be no partial marks.

1. Given the Planck's radiation law expressed in wavelength, $\rho(\lambda)d\lambda = \dfrac{8\pi hc}{\lambda^5}\dfrac{1}{(e^{\frac{hc}{\lambda kT}}-1)}d\lambda$ and considering $\lambda << \dfrac{hc}{kT}$, the wavelength at which the radiation would be maximum (λ_{max}) is,   **(2.5 Marks)**

(**Tick inside the appropriate box**)

(A) $\dfrac{8hc}{5kT}$ [ ] ;   (B) $\dfrac{hc}{kT}$ [ ] ;   (C) $\dfrac{5hc}{kT}$ [ ] ;   (**D**) $\dfrac{hc}{5kT}$ [✓]

2. For a particle-in-a-box of length L = 6.63 Å, the wave function can be written as $\Psi(x) = \sqrt{\dfrac{2}{L}}\sin\dfrac{n\pi x}{L}$. The value of linear momentum in the 3rd excited state (ground state is the lowest energy state) (in the unit of kg m s^{-1}) would be, (Use   h = 6.63×10^{-34} Js). (**Tick inside the appropriate box**)   **(2.5 Marks)**

(A) 0.2×10^{-24} [ ] ;   (**B**) **2.0×10^{-24}** [✓] ;   (C) 2.0×10^{-34} [ ] ;   (D) 0.2×10^{-34} [ ]

3. Draw the Lewis structures of IF_4^- and ClF_4^+ with appropriate molecular geometry.   **(1.0 Mark)**
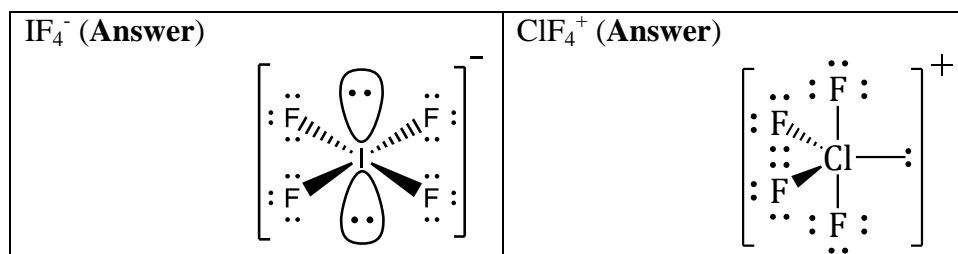
4. Arrange the following complexes in the decreasing order of crystal field splitting energy Δ_o.

Answers   **(1.0 Mark)**

(i) $[Cr(NH_3)_6]^{3+}$, $[CrCl_6]^{3-}$, $[Cr(CN)_6]^{3-}$

(ii) $[Co(H_2O)_6]^{2+}$, $[Rh(H_2O)_6]^{3+}$, $[Co(H_2O)_6]^{3+}$

(i) $[Cr(CN)_6]^{3-} > [Cr(NH_3)_6]^{3+} > [CrCl_6]^{3-}$

(ii) $[Rh(H_2O)_6]^{3+} > [Co(H_2O)_6]^{3+} > [Co(H_2O)_6]^{2+}$

5. Using Slater's rules, calculate the effective nuclear charge for $3d$ electron in copper. **(1.0 Mark)**

Answer | 8.85

6. State whether the following statements are True (T) or False (F) **(1.0 Mark)**

| Statements	T / F
(i) N_2 has a very high electron affinity	F
(ii) For the isoelectronic pair Br^- and Rb^+, the one with the larger radius is Br^-	T
(iii) For the Compounds EH_3 (E = As, N and P), the increasing order of their H-E-H bond angles is $AsH_3 < PH_3 < NH_3$	T

7. Using CFT indicate the correct d-orbital splitting pattern for a square planar complex.
(Tick inside the appropriate box) **(1.0 Mark)**

(i) $d_{z^2} < d_{x^2-y^2} < d_{xy} < d_{xz} < d_{yz}$		**(ii)** $d_{xy} < d_{z^2} < d_{x^2-y^2} < d_{xz} < d_{yz}$	
(iii) $d_{xz}=d_{yz} < d_{z^2} < d_{x^2-y^2} < d_{xy}$		**(iv)** $d_{xz}=d_{yz} < d_{z^2} < d_{xy} < d_{x^2-y^2}$	√

8. Do the following structure pairs represent identical molecules, a pair of enantiomers or a pair of diastereoisomers? **(3.0 Marks)**

a)
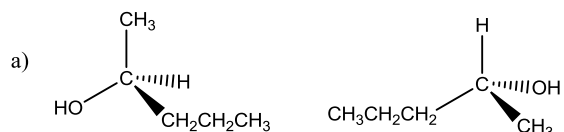
Answers

Enantiomers

b)

Identical Molecules

c)

Identical Molecules

9. Enantiomerically pure 2-Butanol (25.00 g) is dissolved in 20.0 mL of ethanol. 5.00 mL of this solution is placed in a 200 mm polarimeter tube at 25 °C. The observed rotation is 60° counter-clockwise. The optical rotation of a sample of 2-Butanol (10 g in 20 mL of ethanol) was measured in the same polarimeter under identical conditions. The observed rotation was found to be + 19°. What is the enantiomeric excess of the sample?

Answer | 79.0 -79.2 % **(2.0 Marks)**