Name: .....

Roll No: .....

Indian Institute of Science Education and Research Mohali

CHM 201: Spectroscopy and other physical methods

Mid-sem Examination, 21st OCT, 2021

Total marks: 20; Time: 9.00 AM – 09.40 AM

Objective type:

1. Radiative decay from an excited state is called as:
   a. Stimulated emission
   b. Fluorescence
   c. Absorbance
   d. Reflectance **(1 marks)**
2. ~~You~~ Calculate the wavelength of Sodium D-line (l= 588.89 nm) as light from this source passes through a medium with refractive index of 1.33.
   a. 527 nm
   b. 443 nm
   c. 886 nm
   d. 1054 nm **(1 marks)**
3. Convert the absorbance of 1.145 OD to transmittance.
   a. 72.00 %
   b. 14.40 %
   c. 7.20 %
   d. 1.44 % **(1 marks)**
4. In an FTIR spectrometer, what length of a movable mirror drive provide resolution of 0.2 cm^{-1}
   a. 2.5 cm
   b. 5.0 cm
   c. 7.5 cm
   d. 10.0 cm **(1 marks)**
5. Which of the following molecule is NOT microwave active;
   a. H_2O
   b. NH_3
   c. BF_3
   d. SF_6 **(1 marks)**

Subjective type (short answer): MAXIMUM 60 WORDS PER QUESTION!

6. Why a constant slit-width provides a constant bandwidth in a grating monochromator? **(2 marks)**
7. Write ONE similarity and ONE difference between spontaneous and stimulated emission? **(2 marks)**
8. Does rotational zero-point energy is available for molecular Hydrogen? How? **(2 marks)**

[PTO]

Name: .....

Roll No: .....

Numerical problems: 1 PAGE PER QUESTION

9. The following is the specification for an infrared spectrometer: 95.0 lines/mm with a 14.0 mm illumination area. (a) Find the first-order resolution of the grating. (b) What will be separation between the two lines centered at 1200 cm^{-1} to resolve them? **(2 marks)**

10. A space prober of NASA equipped with microwave detector designed to seek CO in the atmosphere of Saturn. If the bond length of ^{12}CO is 102.8 pm, at what wavelength do the first three lines appears in the rotational transitions? What resolution you need to separate ^{13}CO isotope rotational lines? How does the rotational states will help to understand the isotope abundance? [$m^{12}C = 19.94 \times 10^{-27}$ Kg, $m^{13}C = 21.58 \times 10^{-27}$ Kg and $mO = 26.57 \times 10^{-27}$ Kg] **(3 marks)**

Descriptive type: MAXIMUM 2 PAGES

11. Derive the energy of a non-rigid rotor and show this gives the Kratzer formula for D (centrifugal distortion constant). Show the non-rigid rotational energy diagram of HF. Which transition will give rise to maximum population if B (rotational constant) = 41.122 cm^{-1} for HF. **(4 marks)**

(T = 298 K)

$K_B = 1.38 \times 10^{-23}\ m^2\ kg\ s^{-2}\ K^{-1}$

$C = 3 \times 10^8\ m/s$

$h = 6.626 \times 10^{-34}\ m^2\ kg/s$