18. Carefully observe the IR spectra depicted below and indicate if the following statements are true or false? **1 Mark**

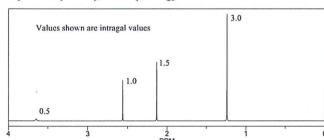|	True (T) or False (F)?	
(i) Is likely to be a symmetrical alkyne	(T)	✗
(ii) Has *sp* C-H bond	(T)	✓
(iii) Is devoid of any carbonyl group	(T)	✓
(iv) Has several *sp³* C-H bonds	(T)	✓
(v) May have a nitrile (-C≡N group) as well	(F)	✗
(vi) Has *sp²* C-H bonds	(F)	✓

19. Calculate the magnetic field (in tesla) require to flip an ^1H nucleus in an NMR spectrometer that operate at 600 MHz. (Given; $\gamma = 2.675 \times 10^8$ T^{-1} s^{-1} and $\pi = 3.14$) **0.5 Mark**
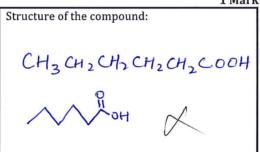
Magnetic field $B_o = \dfrac{2\pi\nu}{\gamma} = 14.086\,T$

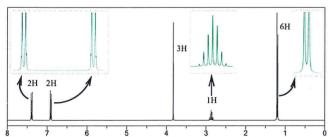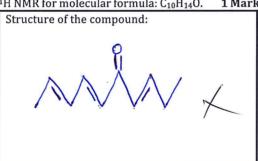**20.** If two signals differ by 90 Hz in a 400 MHz spectrometer, by how much do they differ in a 600 MHz spectrometer? **0.5 Mark**

135 Hz

21. Show the structure of the compound corresponding to the following ^1H NMR for molecular formula: $C_6H_{12}O_2$. IR (KBr cm^{-1}): 3500 (broad), 1715 (strong) **1 Mark**

Values shown are intragal values

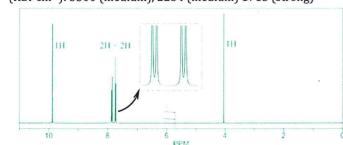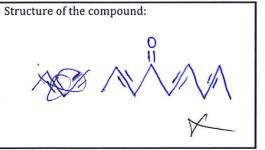Structure of the compound:

$CH_3\,CH_2\,CH_2\,CH_2\,CH_2\,COOH$

22. Give the structure of the compound corresponding to the following ^1H NMR for molecular formula: $C_{10}H_{14}O$. **1 Mark**

Structure of the compound:

23. Indicate the structure of the compound corresponding to the following ^1H NMR for molecular formula: C_9H_6O and IR (KBr cm^{-1}): 3300 (medium), 2234 (medium) 1715 (strong) **1 Mark**

Structure of the compound:
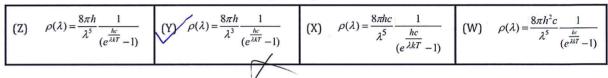
4

Answer only in this sheet. Only fully correct answers will be accepted. All questions are compulsory. Rough work is mandatory.

1. Given the Planck's radiation law, $\rho(\upsilon) = \dfrac{8\pi h\upsilon^3}{c^3}\dfrac{1}{e^{\frac{h\upsilon}{kT}}-1}$, the expression for $\rho(\lambda)$ would be, **2.0 Marks**

(Z) $\rho(\lambda) = \dfrac{8\pi h}{\lambda^5}\dfrac{1}{(e^{\frac{hc}{\lambda kT}}-1)}$	(Y) $\rho(\lambda) = \dfrac{8\pi h}{\lambda^3}\dfrac{1}{(e^{\frac{hc}{\lambda kT}}-1)}$	(X) $\rho(\lambda) = \dfrac{8\pi hc}{\lambda^5}\dfrac{1}{(e^{\frac{hc}{\lambda kT}}-1)}$	(W) $\rho(\lambda) = \dfrac{8\pi h^2 c}{\lambda^5}\dfrac{1}{(e^{\frac{hc}{\lambda kT}}-1)}$

2. If, $E_v = \left(v + \dfrac{1}{2}\right)\hbar\omega$ is the energy of a harmonic oscillator in the quantum state v, then the expression for $\langle x^2 \rangle$ is: **2.0 Marks**

(V) $\left(v+\dfrac{1}{2}\right)\dfrac{\hbar}{\sqrt{(\mu k)}}$	(U) $\left(v+\dfrac{1}{2}\right)\sqrt{\dfrac{\hbar}{\mu k}}$	(T) $\left(v+\dfrac{1}{2}\right)\dfrac{\sqrt{\mu k}}{\hbar}$	(S) $\left(v+\dfrac{1}{2}\right)\sqrt{\dfrac{\mu k}{\hbar}}$

3. If the wave function for an electron circulating on a ring could be written as $\Psi(\varphi) = Ae^{im\varphi}$, then the value of A would be, **2.0 Marks**

(R) $\sqrt{2\pi}$	(Q) $1/\sqrt{\pi}$	(P) $1/\sqrt{2\pi}$	(O) $\sqrt{2/\pi}$

4. A proton (1.67×10^{-27} kg) is confined in an infinite square well of width 10 fm (1 fm = 10^{-15} m). h = 6.62×10^{-34} Js; c = 3.0×10^8 ms^{-1}. The wavelength of the photon (in fm) emitted when the proton undergoes a transition from the first excited state (n = 2) to the ground state (n = 1) is: **2.0 Marks**

(N) 404	(M) 302	(L) 101	(K) 202

5. With the length of the box, L, the probability of finding an electron with, $\Psi(x) = \sqrt{\dfrac{2}{L}}\sin\dfrac{\pi x}{L}$ between x = 0.25 L and x = 0.75 L is, **2.0 Marks**

(J) 0.28	(I) 0.82	(H) 0.62	(G) 0.26

1

6. Draw the Lewis structure of XeO$_2$F$_2$ with appropriate molecular geometry. **1 Mark**

7. Using the VSEPR theory draw the most probable molecular geometry for ClF$_3$ **1 Mark**

8. Arrange the elements (Mg, Al, P and S) in the increasing order of their first ionization potential. **1 Mark**

Al < Mg < S < P ✓

9. The correct order of electronegativity of the following elements is. **1 Mark**

(F)	O < S < As < Ge	(E)	Ge < As < S < O	(D)	S < O < As < Ge	(C)	As < O < Ge < S

10. Arrange the following in the decreasing order of crystal field splitting energy Δ_o. **(1+1) Marks**
    (i) [Cr(NH$_3$)$_6$]$^{3+}$, [CrCl$_6$]$^{3-}$, [Cr(CN)$_6$]$^{3-}$
    (ii) [Co(H$_2$O)$_6$]$^{2+}$, [Rh(H$_2$O)$_6$]$^{3+}$, [Co(H$_2$O)$_6$]$^{3+}$

(i)	$[Cr(CN)_6]^{3-} > [Cr(NH_3)_6]^{3+} > [CrCl_6]^{3-}$ ✓
(ii)	$[Rh(H_2O)_6]^{3+} > [Co(H_2O)_6]^{3+} > [Co(H_2O)_6]^{2+}$ ✓

11. Use valence bond theory and complete the following table **(0.5+0.5+0.5+0.5) Marks**

Complex	Hybrid orbitals involved	Geometry	Magnetism
[Co(Cl)$_4$]$^{2-}$	SP^3 (4 coordinate)	tetrahedral	Paramagnetic
[Ni(CN)$_4$]$^{2-}$	dsP^2 (4 coordinate)	square Planar	diamagnetic
[CoF$_6$]$^{3-}$	SP^{3}d^2 (6 coordinate)	octahedral	Paramagnetic
[Co(CN)$_6$]$^{3-}$	d^{2}sP^3 (6 coordinate)	octahedral	diamagnetic

12. Which of the following is true when one compares the bond angles in CH$_2$F$_2$ and CH$_2$Br$_2$ **1 Mark**

13. I$_2$ has a lower boiling point than Br$_2$ **1 Mark**

(X)	True	(W)	False

14. Which of the following statements are true (T) and which are false (F). (Suppose the answer for the statements (i), (ii), (iii) and (iv) follows the order; True, True, False and True respectively, then the option is "TTFT") **1+ 1 Marks**

14a

	Tick the right option
(i) The pollution prevention hierarchy is: Dispose, Treat, Recycle, Prevent.	(V) FTFT
(ii) Turnover number tells about the productivity of a catalyst.	(U) FTTF ✓
(iii) In a cascade reaction, several components react together to give a single product.	(M) TTFT
(iv) E-factor of pharmaceuticals are worse than bulk chemicals.	(S) TFTT

14b

	Tick the right option
(i) Diels-Alder reaction goes with 100% atom economy.	(R) FTFT
(ii) Reaction having higher yields has always higher atom economy.	(Q) FTTF
(iii) Biorefinary converts biomass in to useful products.	(P) TTFT
(iv) Solvent CCl$_4$ is preferable over diethylether.	(O) TFTF ✓

15. Shown below are two quartz cuvettes of 1 cm path length. The first one is having capacity of 1 mL and the second 5 mL. If a compound of same concentration is filled and UV-Vis spectra is measured in both the cuvettes separately, what will be the effect of λ_{max}, absorbance (A) and extinction coefficient (ε). **1 Mark**

Statements
(i) λ_{max}, shall remain unchanged in both.
(ii) λ_{max}, shall remain same but ε for 2nd will be more than 1st cuvette.
(iii) Absorbance (A) for 2nd shall be 5 times more than the first.
(iv) λ_{max}, and ε shall remain same but (A) for 2nd shall be more than the 1st.
(v) λ_{max}, Absorbance (A) and ε all three shall remain unchanged.

The correct statements are

(N) i, ii and v only	(L) i and v only ✓
(M) i, ii, iii and v only	(K) ii, iii, iv only

16. Observe the given UV-Vis spectra carefully and answer the following: **1 Mark**

Statements
(i) SA-BP on gold spectra is most RED shifted.
(ii) All the compounds are likely to be coloured.
(iii) Electronic transition of Gold np requires lowest energy.
(iv) SA-BP on gold spectra is most blue shifted.
(v) All the three species have nearly equal extinction coefficient.
(vi) PB on gold have $\lambda_{max} \approx 545$ nm.

The correct statements are

(J) ii, iv and v only	(H) i, ii, iii, vi only ✓
(I) i, iii, iv and v only	(G) i, ii, v, vi only

17. From the context of IR spectroscopy, indicate if the following statements are true or false? **1 Mark**
True (T) or False (F)?

(i) Energy absorption will increase the amplitude and not the frequency.	(T) ✓
(ii) Frequency decreases with increasing molecular weight.	(T) ✓
(iii) Frequency increases with increasing bond energy.	(T) ✓
(iv) Region between 1400-4000 cm^{-1} is called finger print region.	(F) ✓
(v) Symmetrical alkyne will show intense peak at 2150 cm^{-1}	(F) ✓