

Supplementary Information

Synthesis of a new class of pyrazole embedded spirocyclic scaffolds using magnetically separable $\text{Fe}_3\text{O}_4@\text{SiO}_2\text{-SO}_3\text{H}$ nanoparticles as recyclable solid acid support

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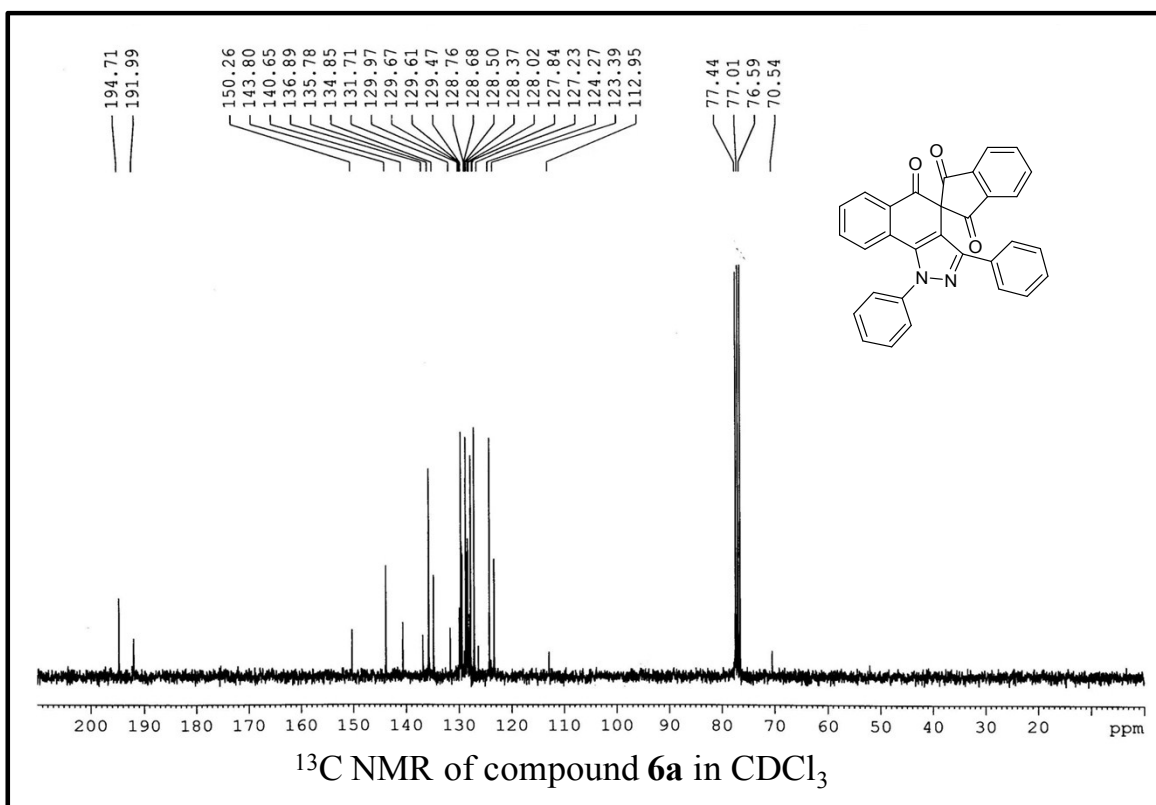
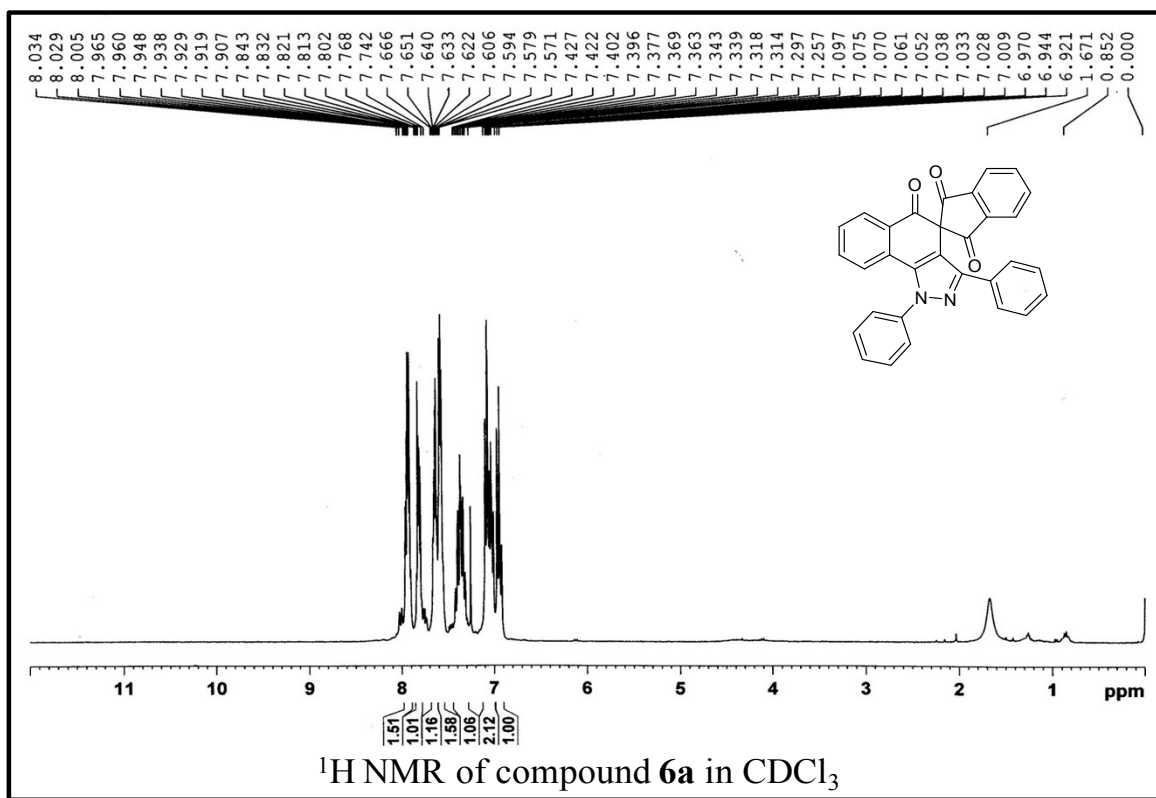
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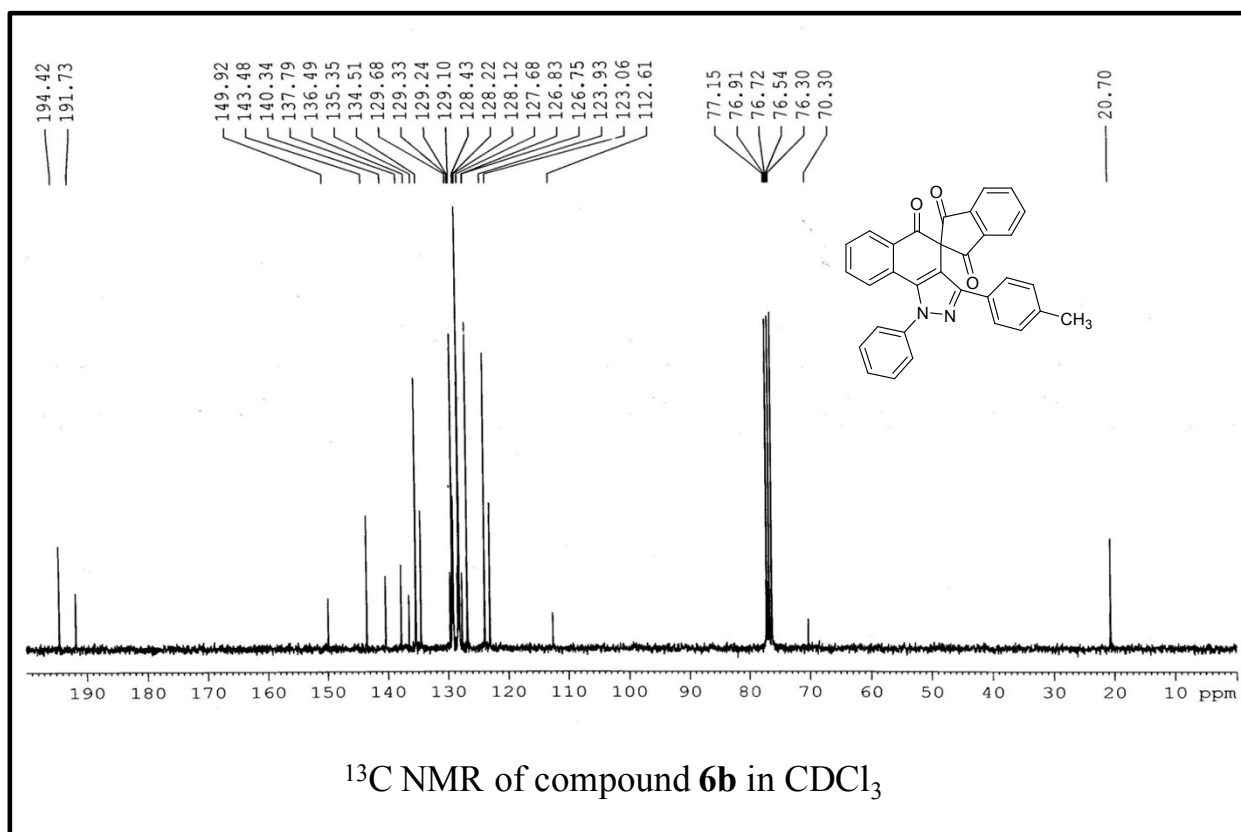
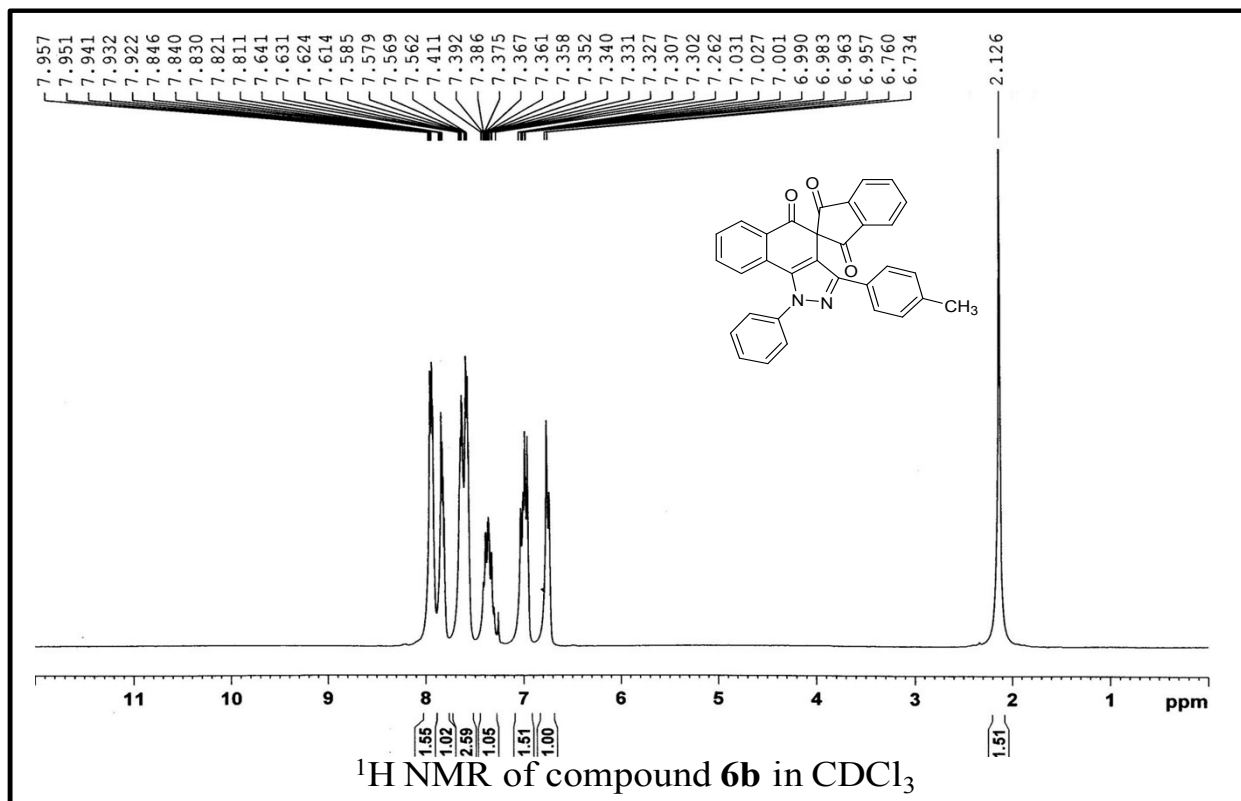
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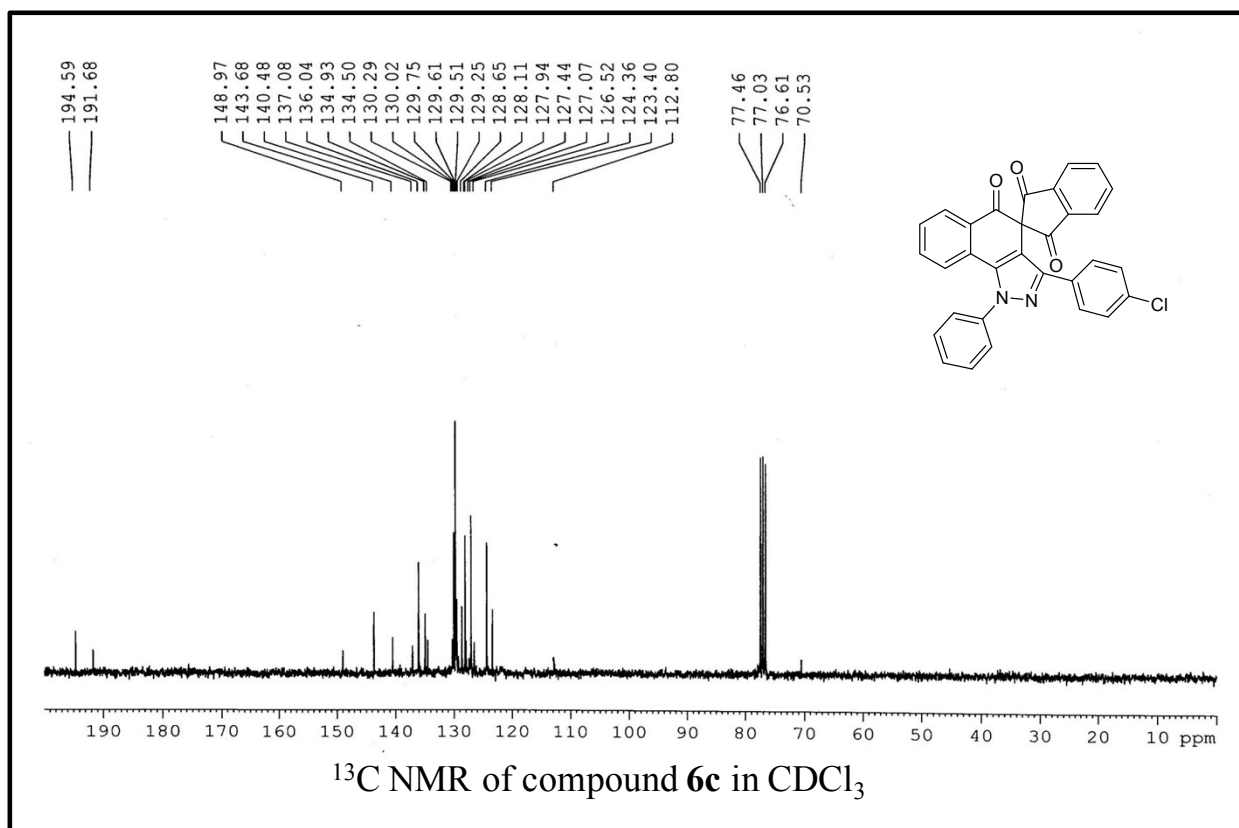
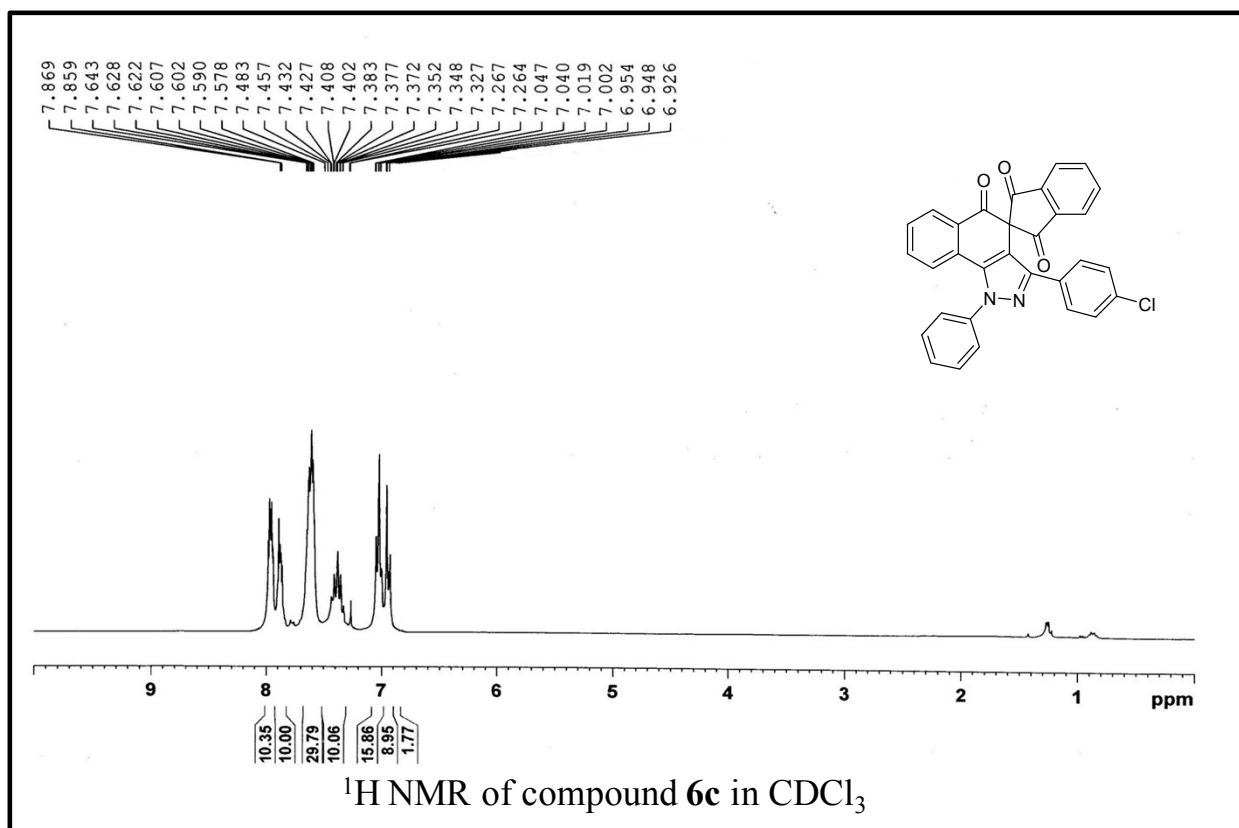
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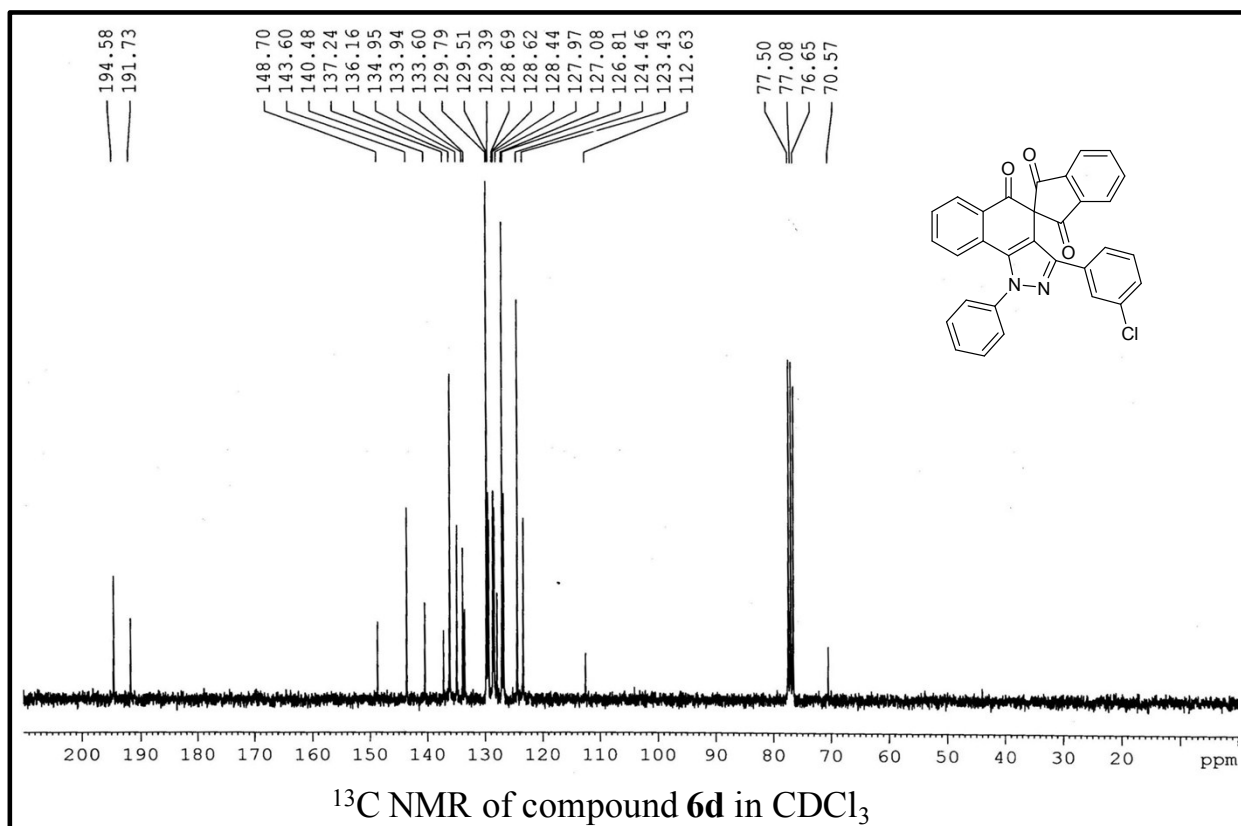
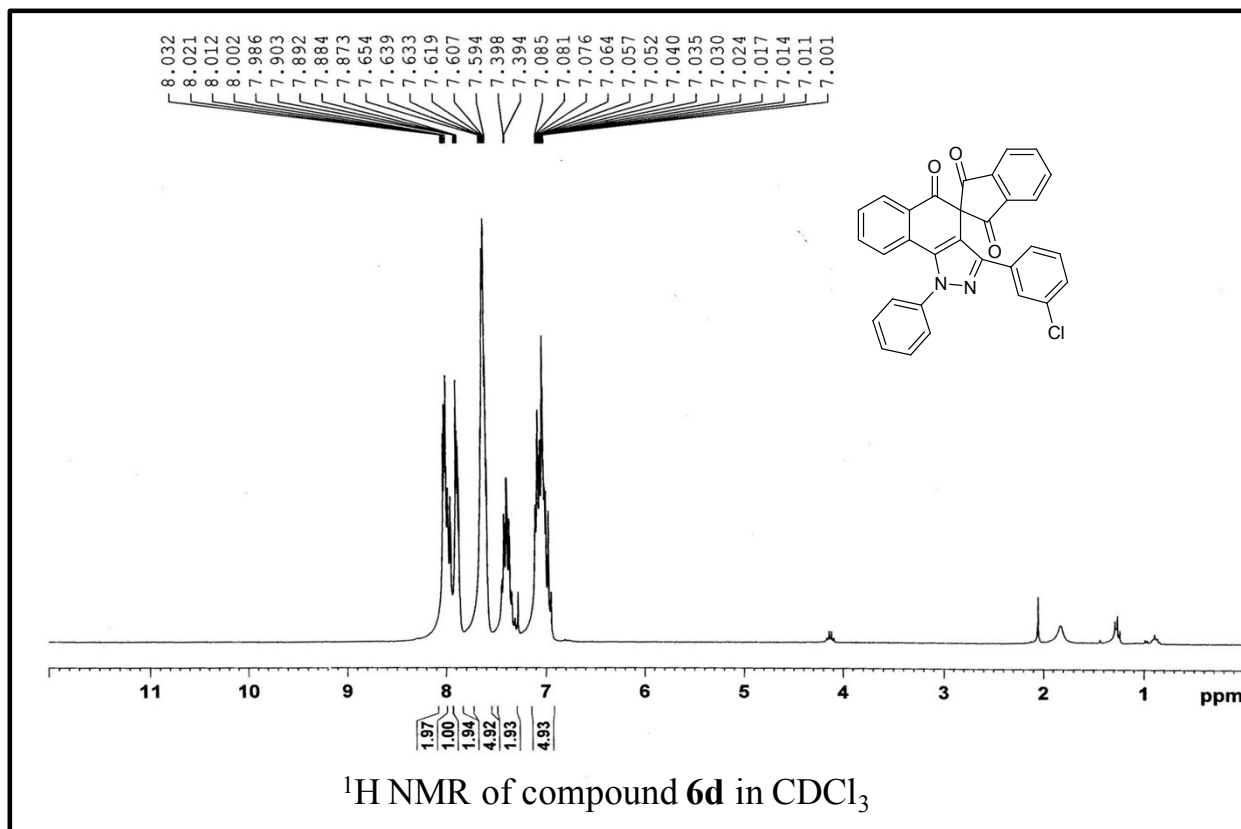
- A. Copies of ^1H and ^{13}C NMR Spectra ----- S2-S21
- B. IR spectrum of the catalyst ----- S22-S23

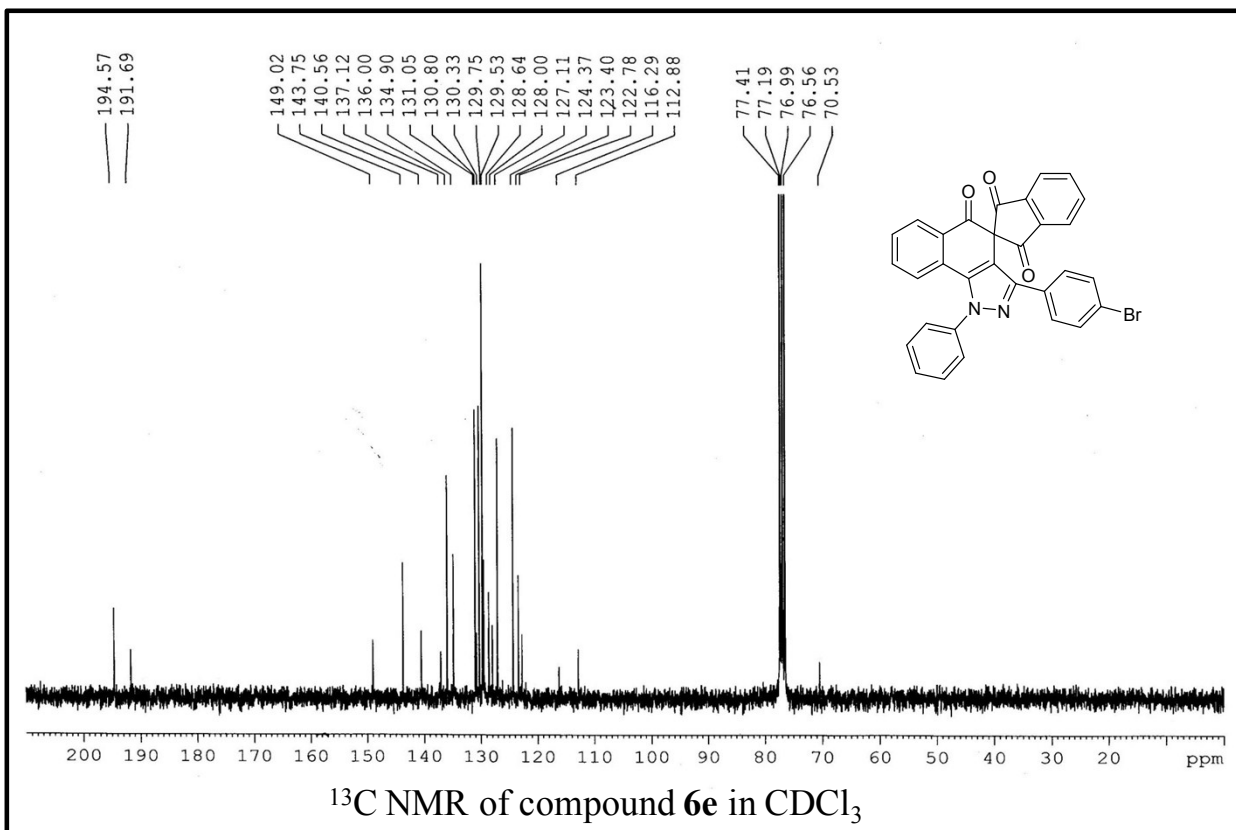
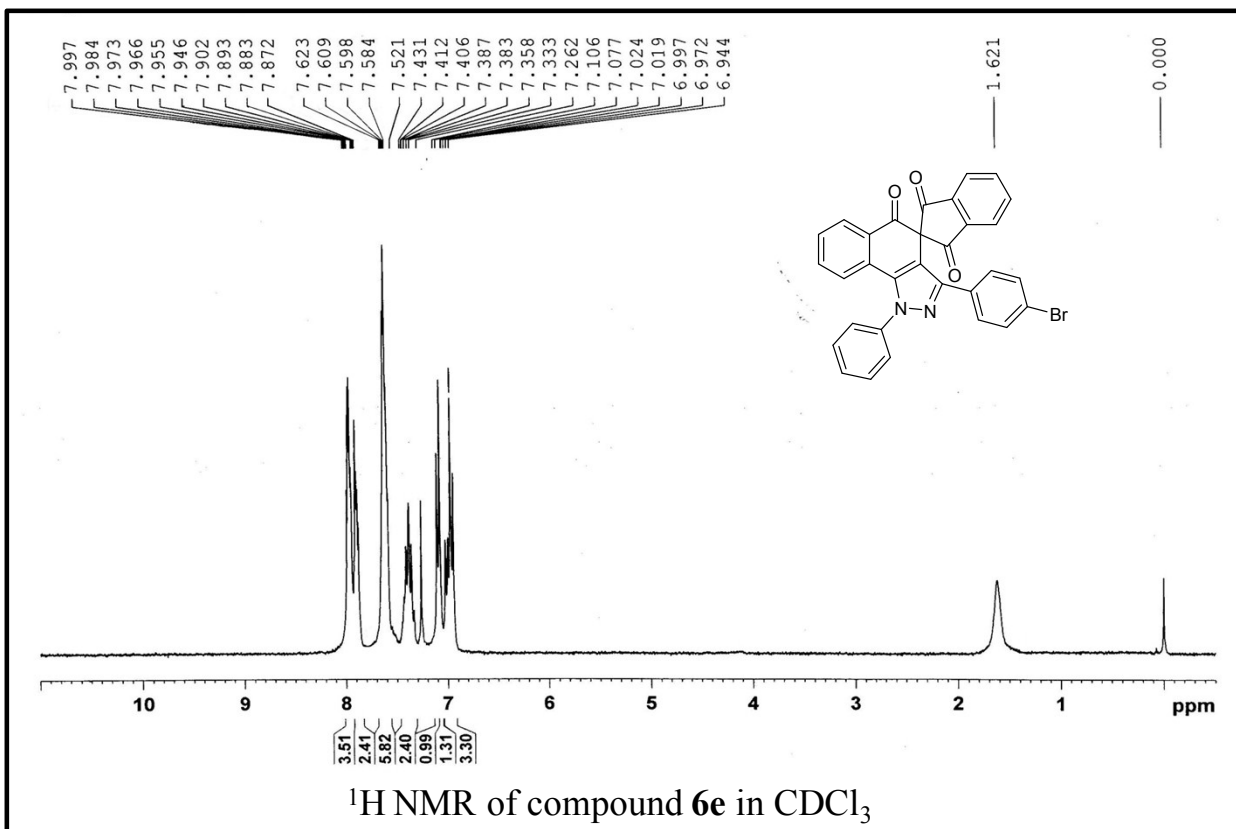
B. Copies of ^1H and ^{13}C NMR Spectra of synthesized compounds:

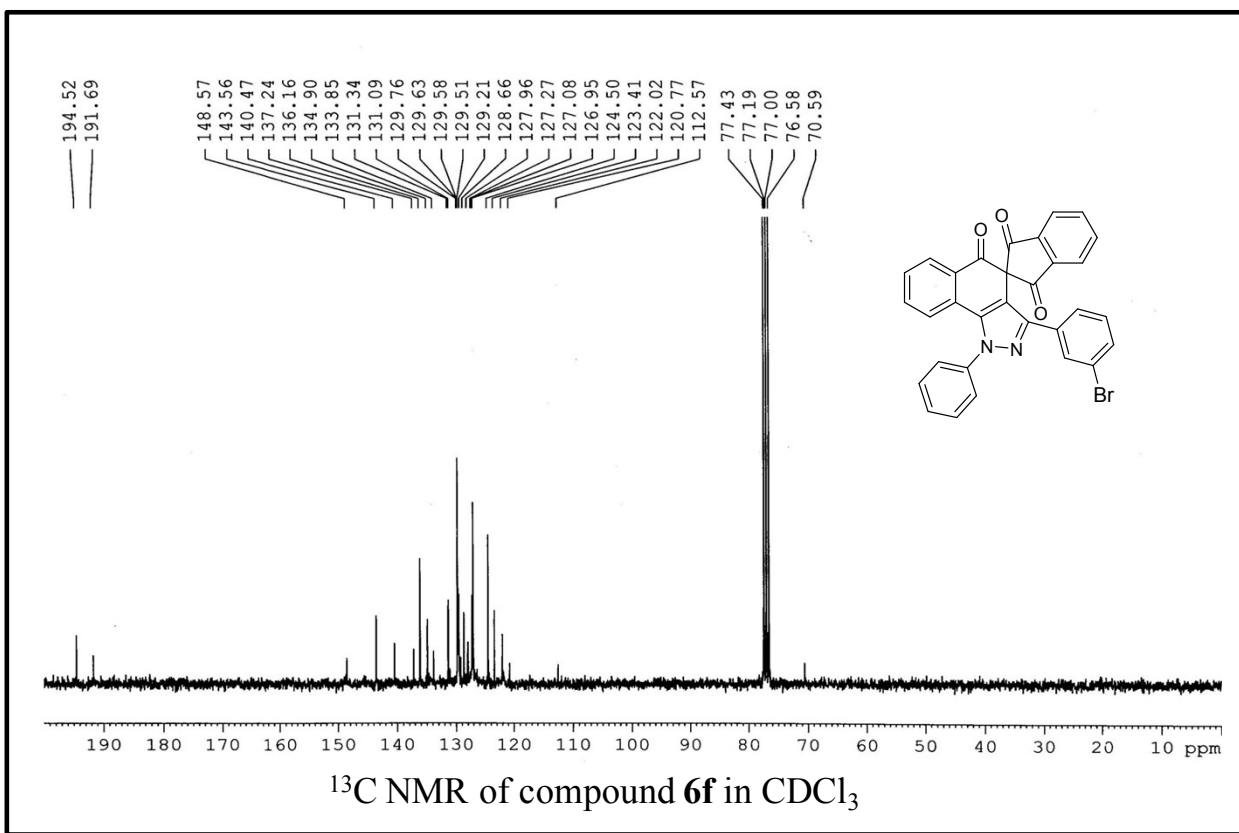
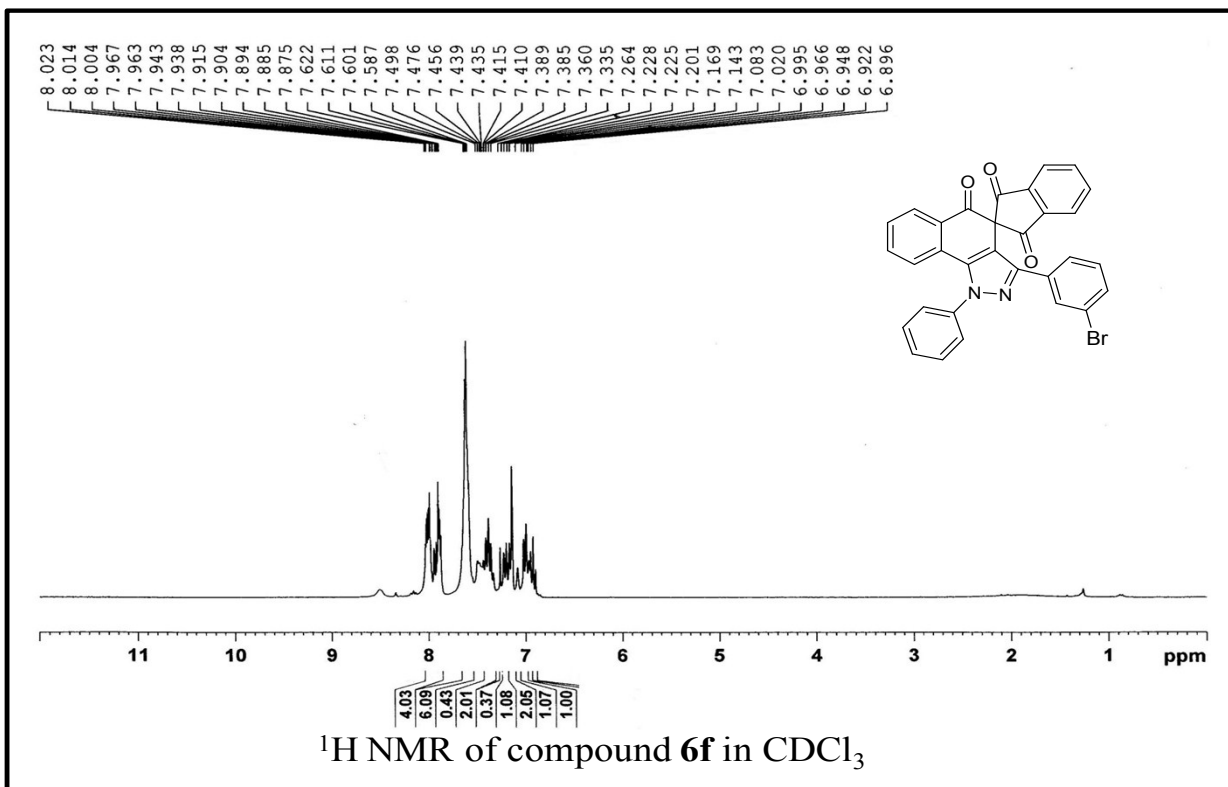


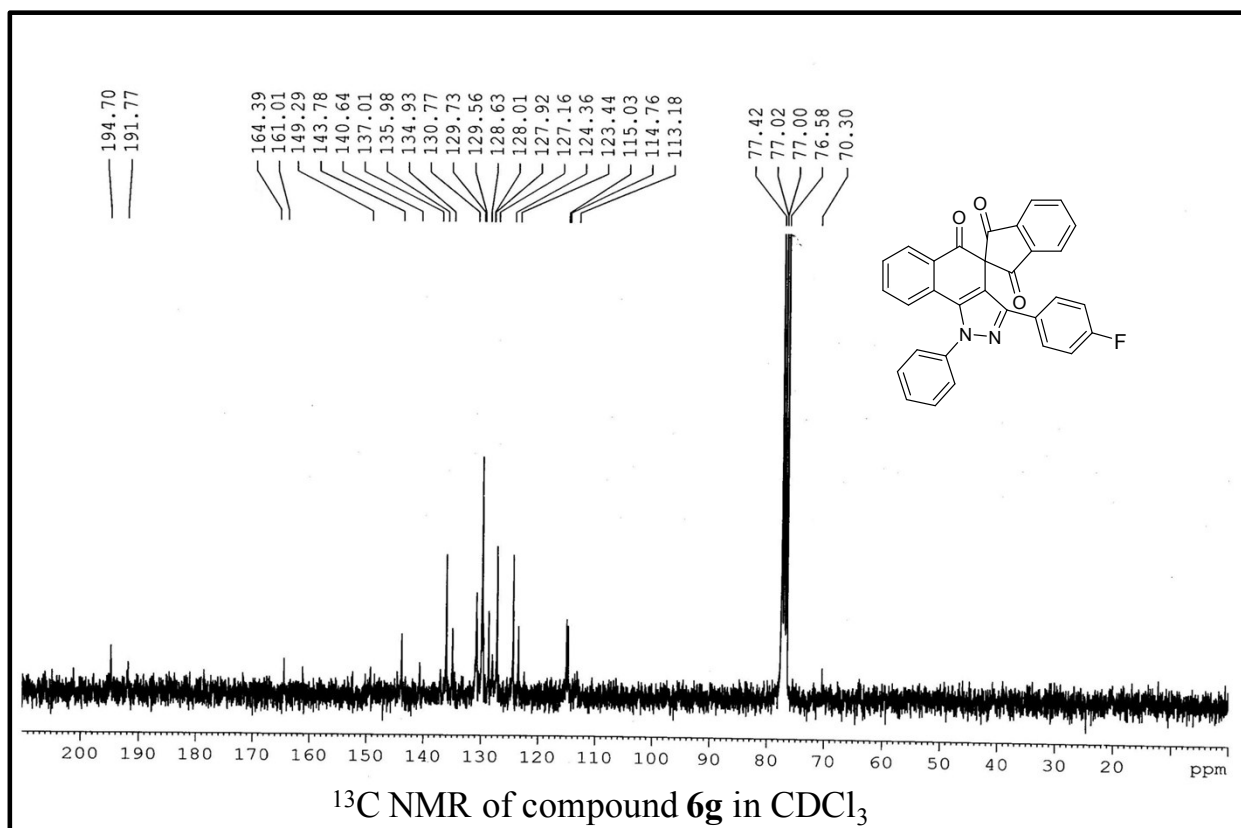
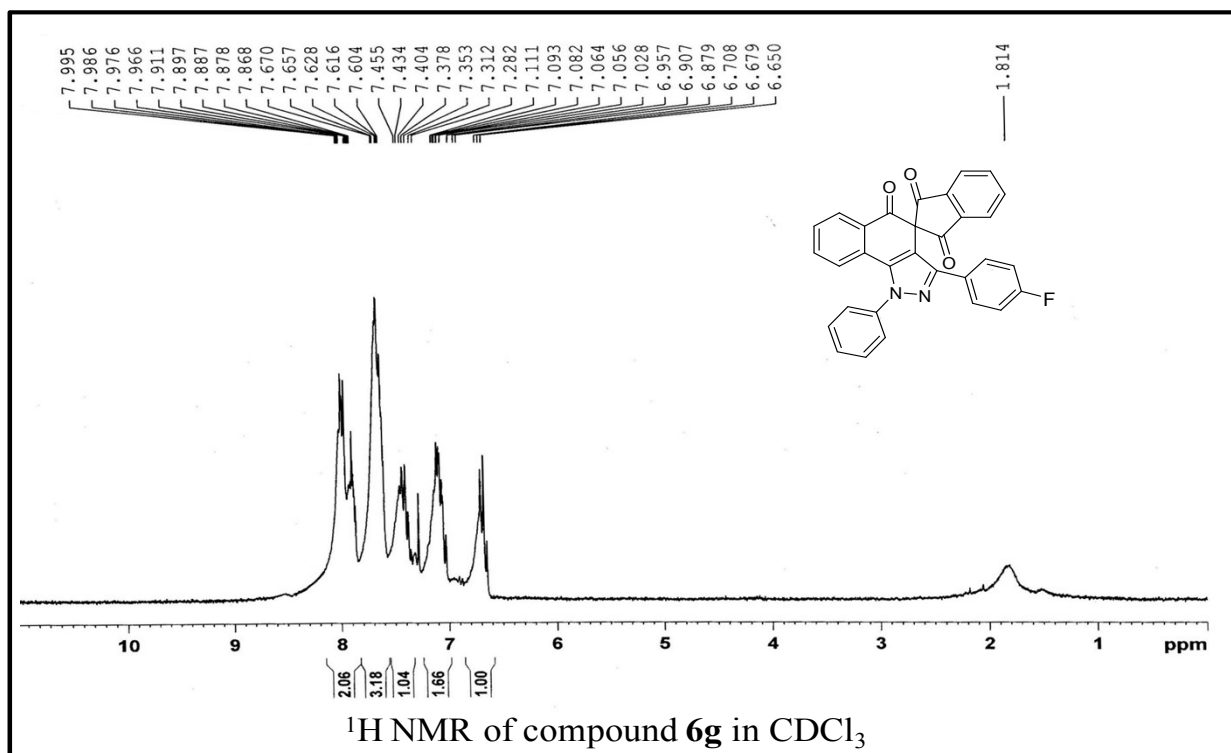


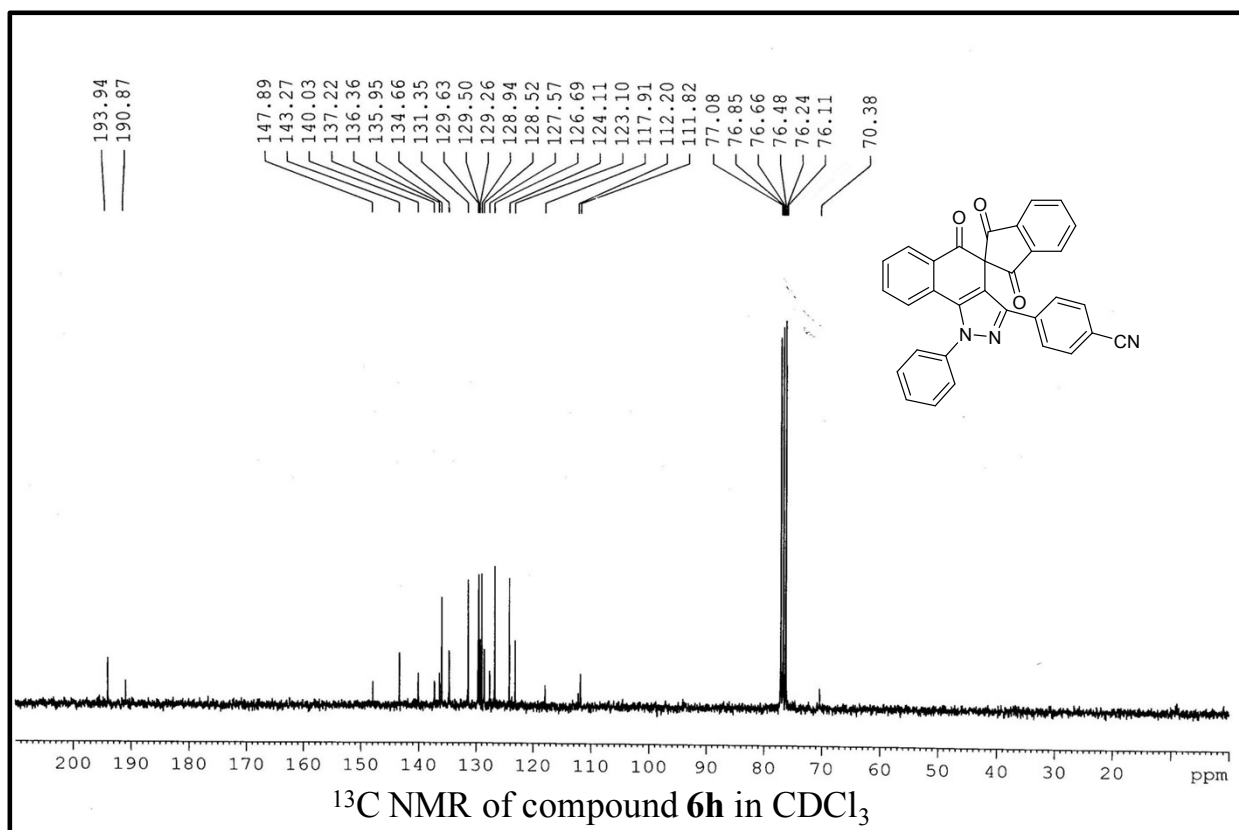
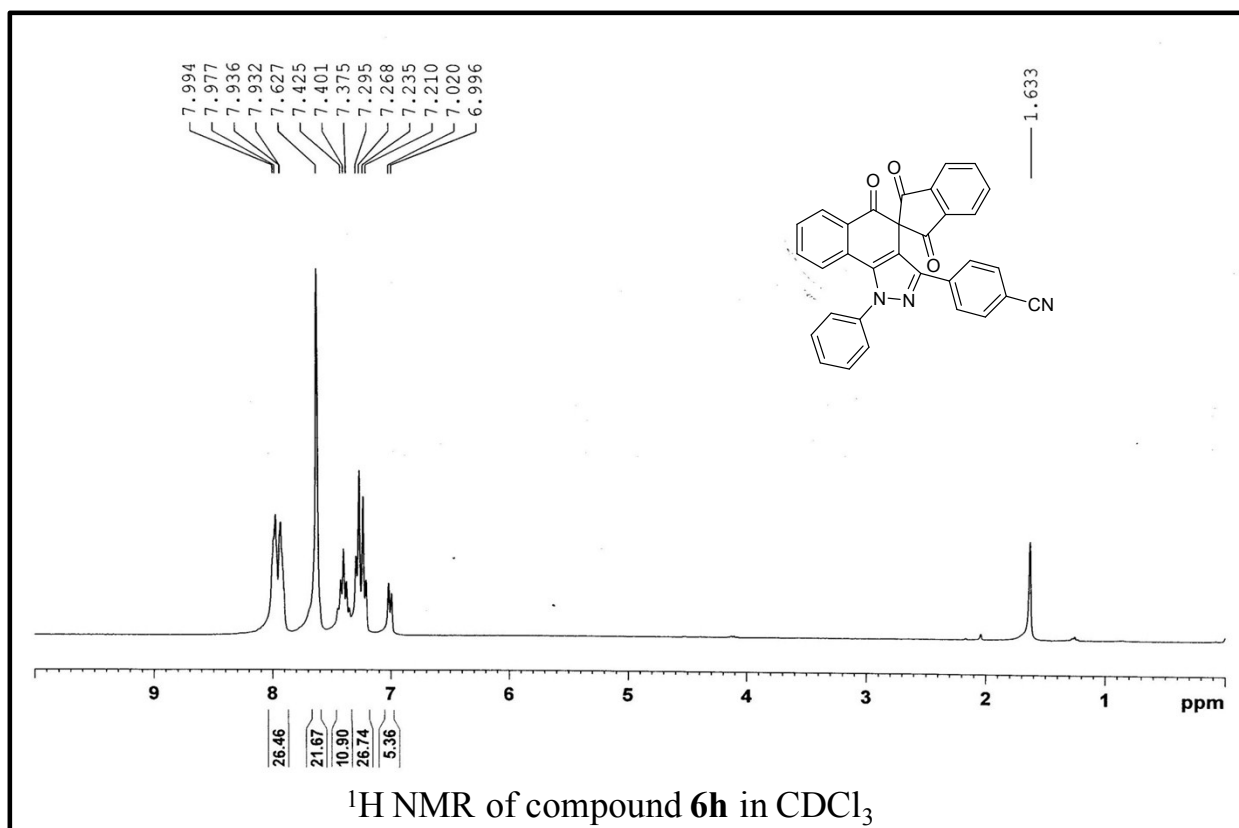


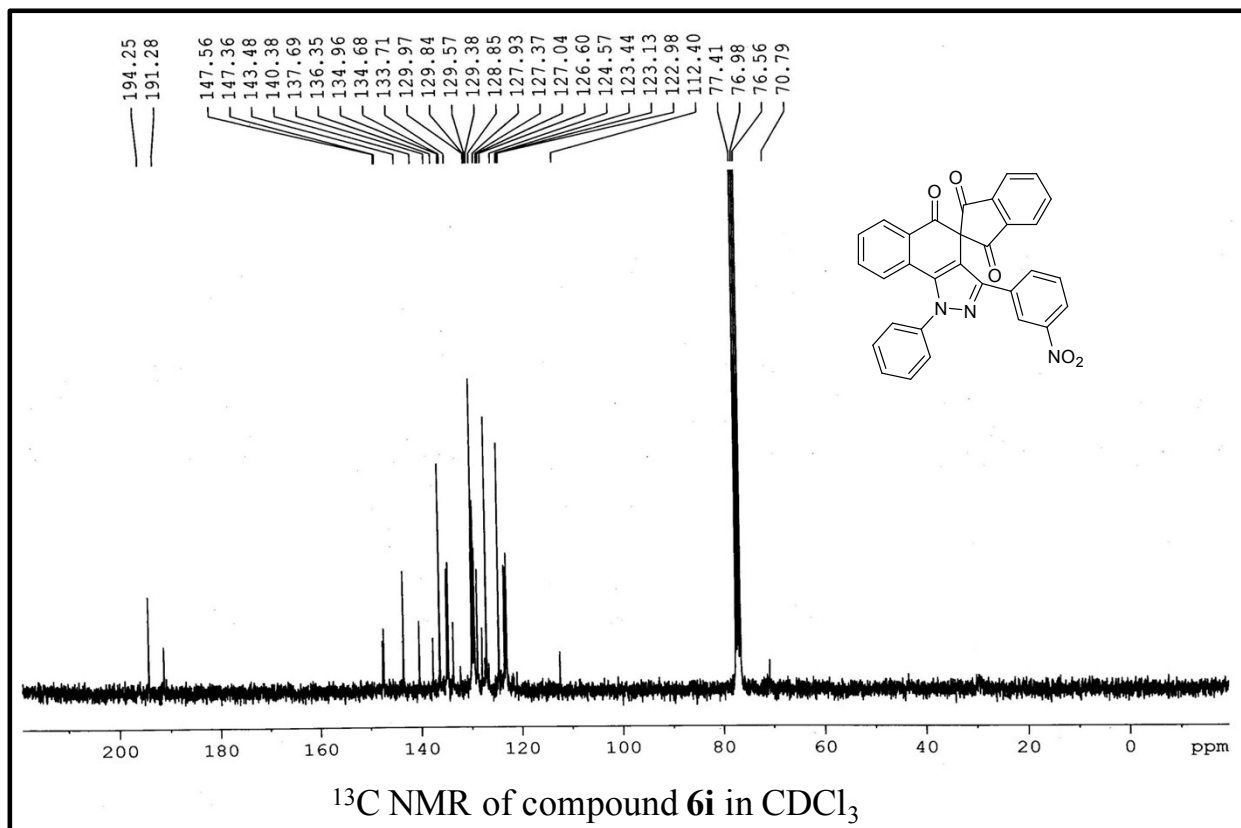
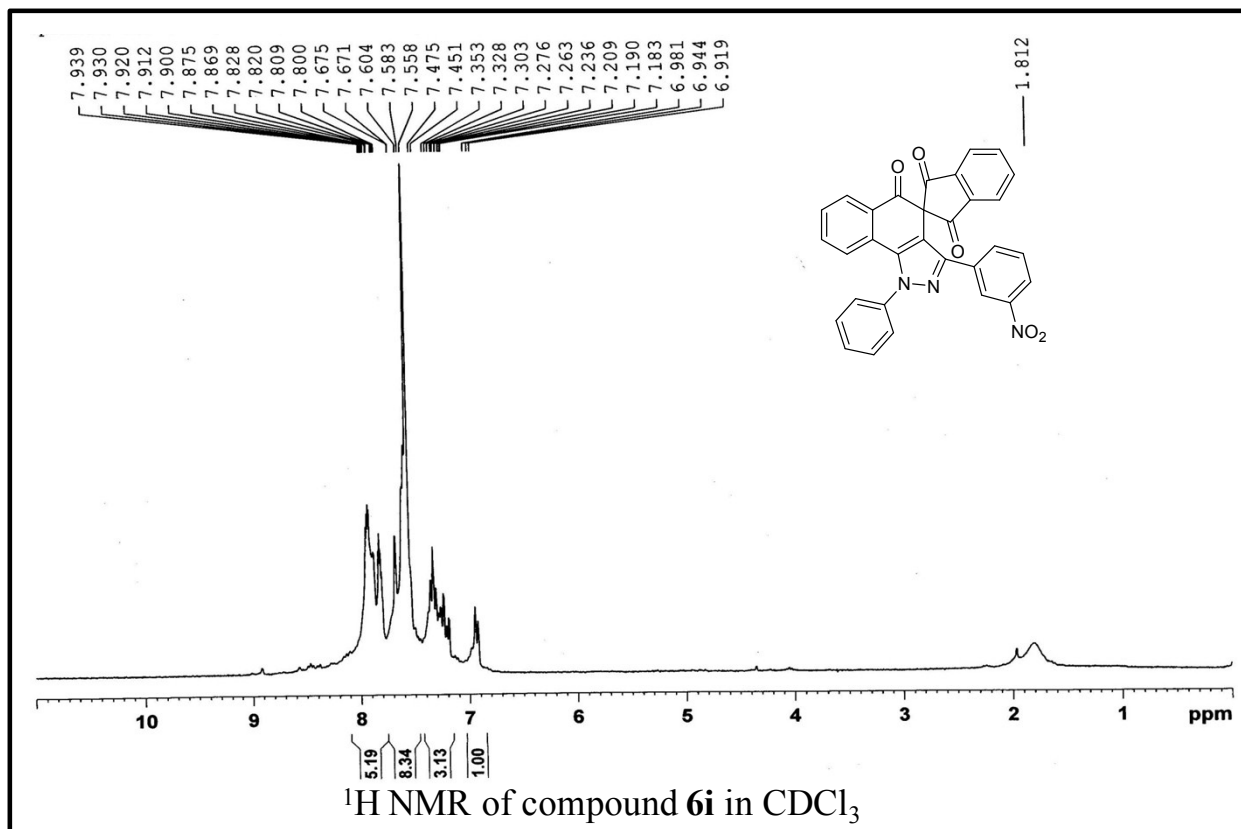


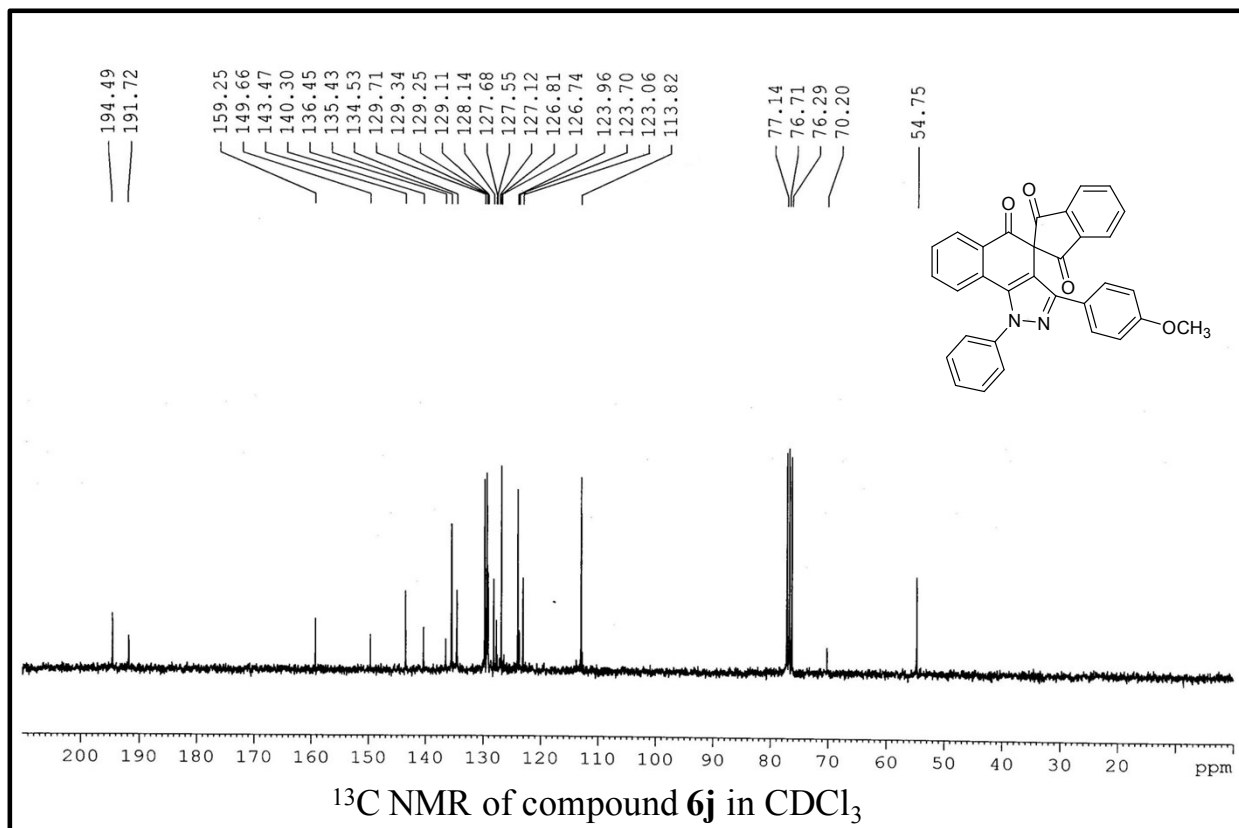
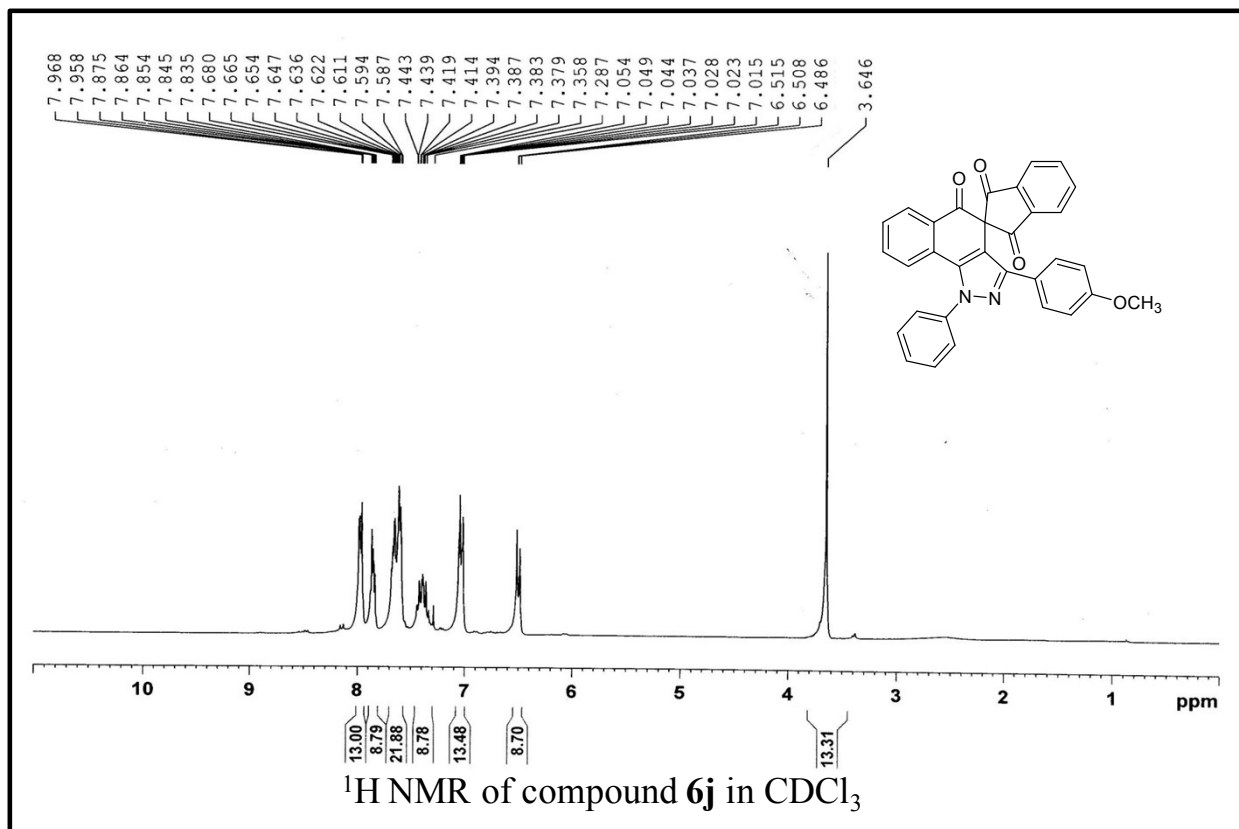


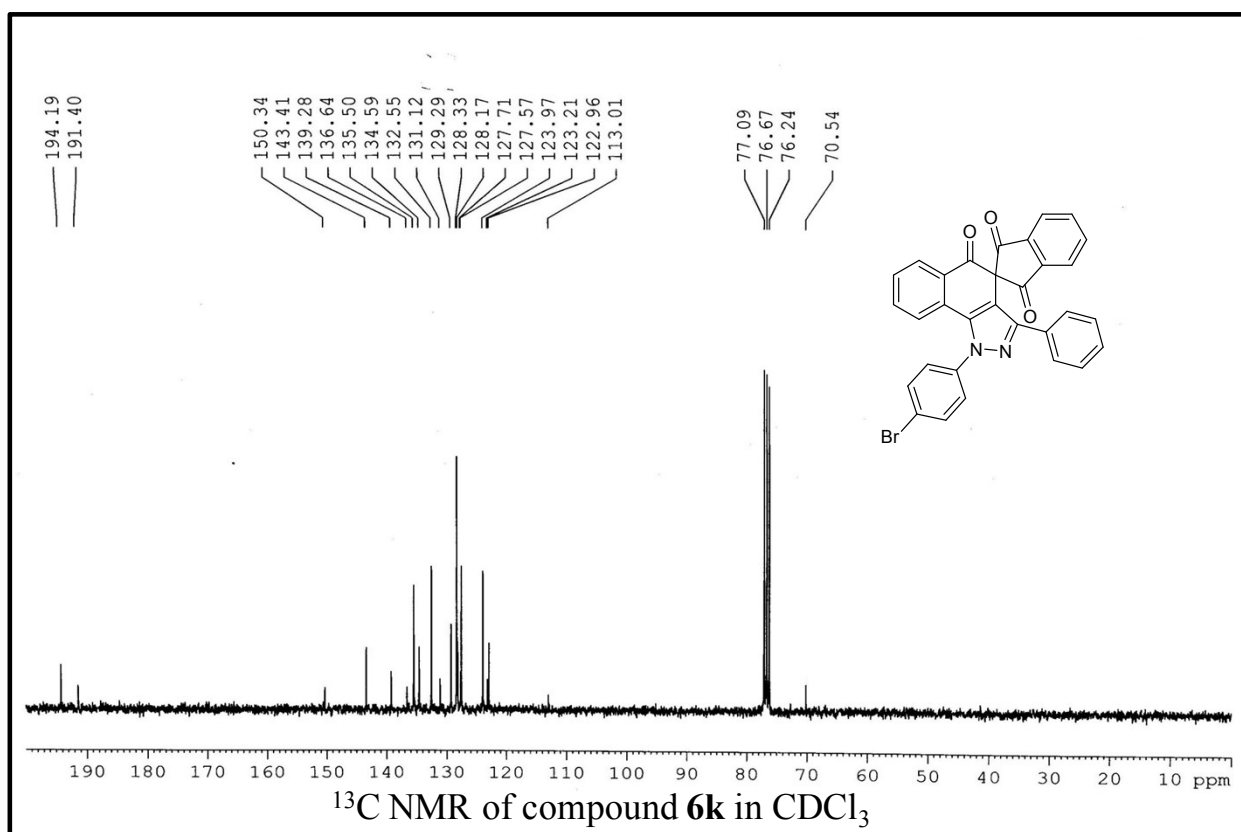
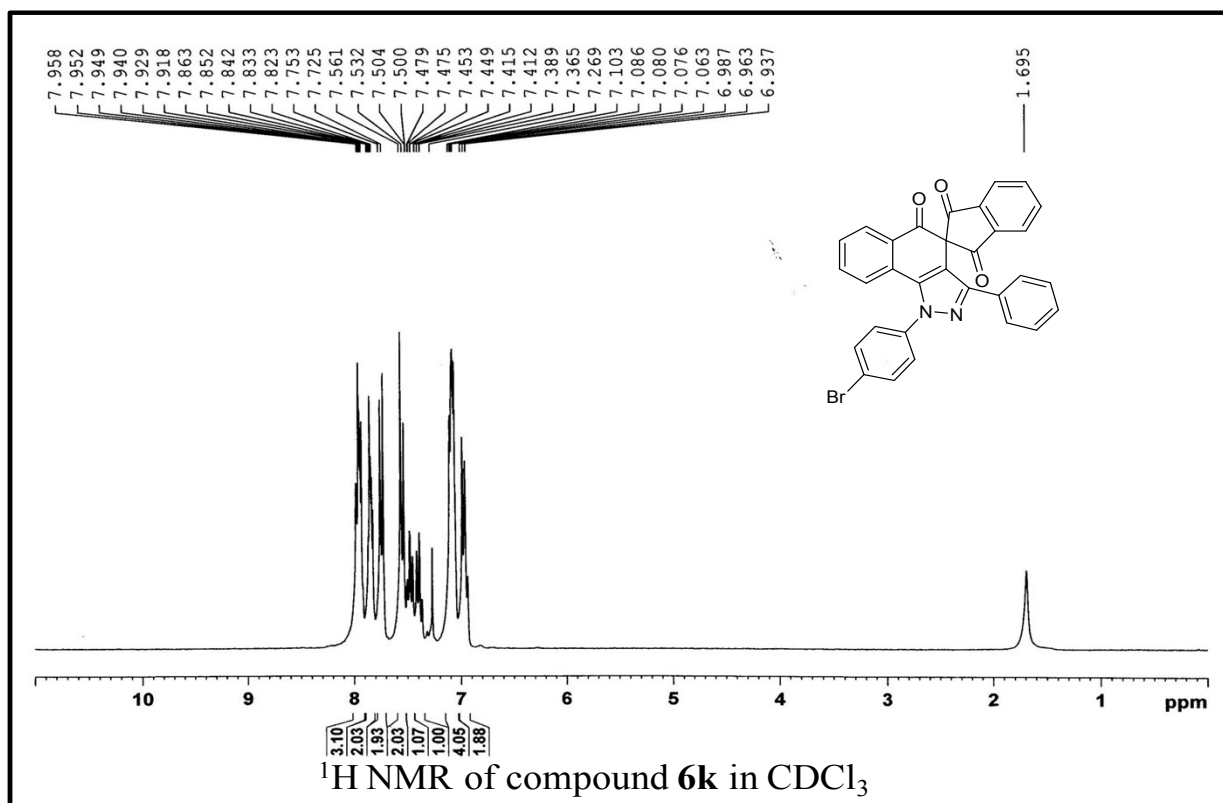


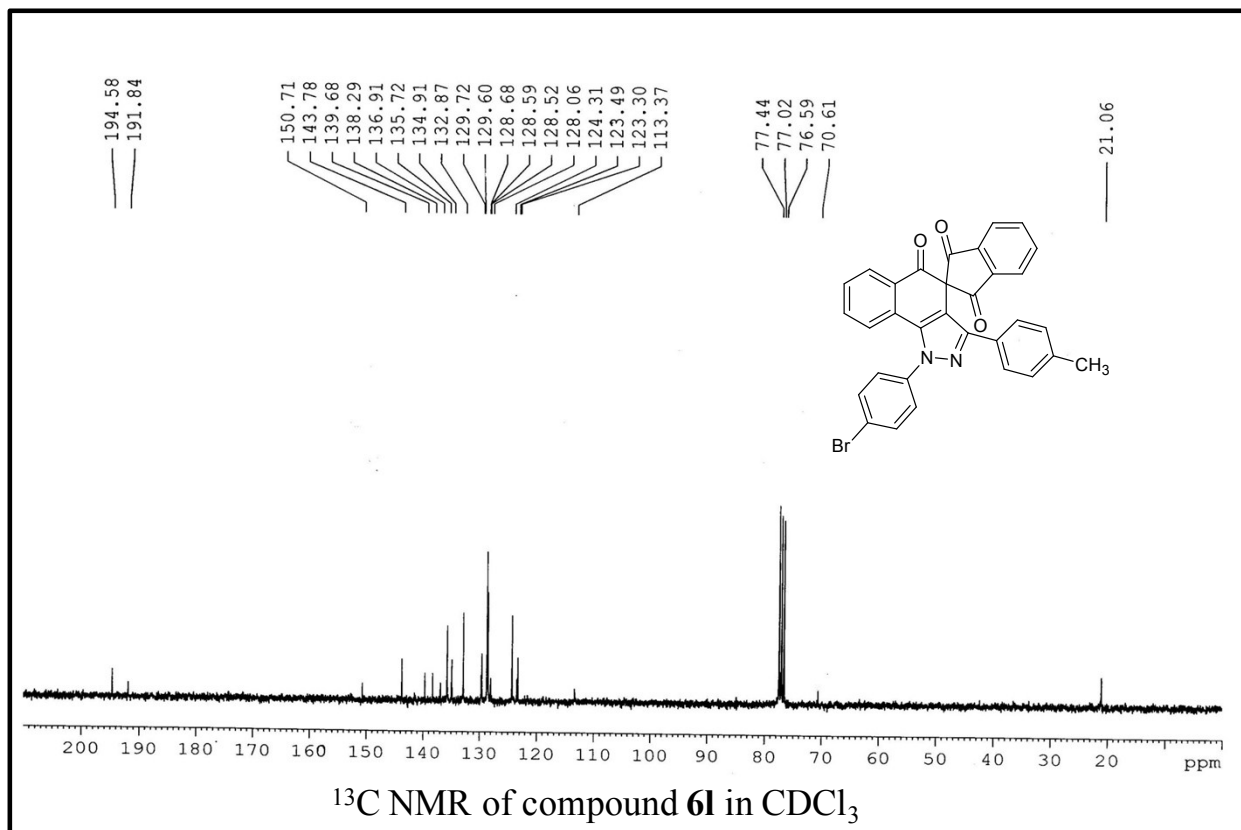
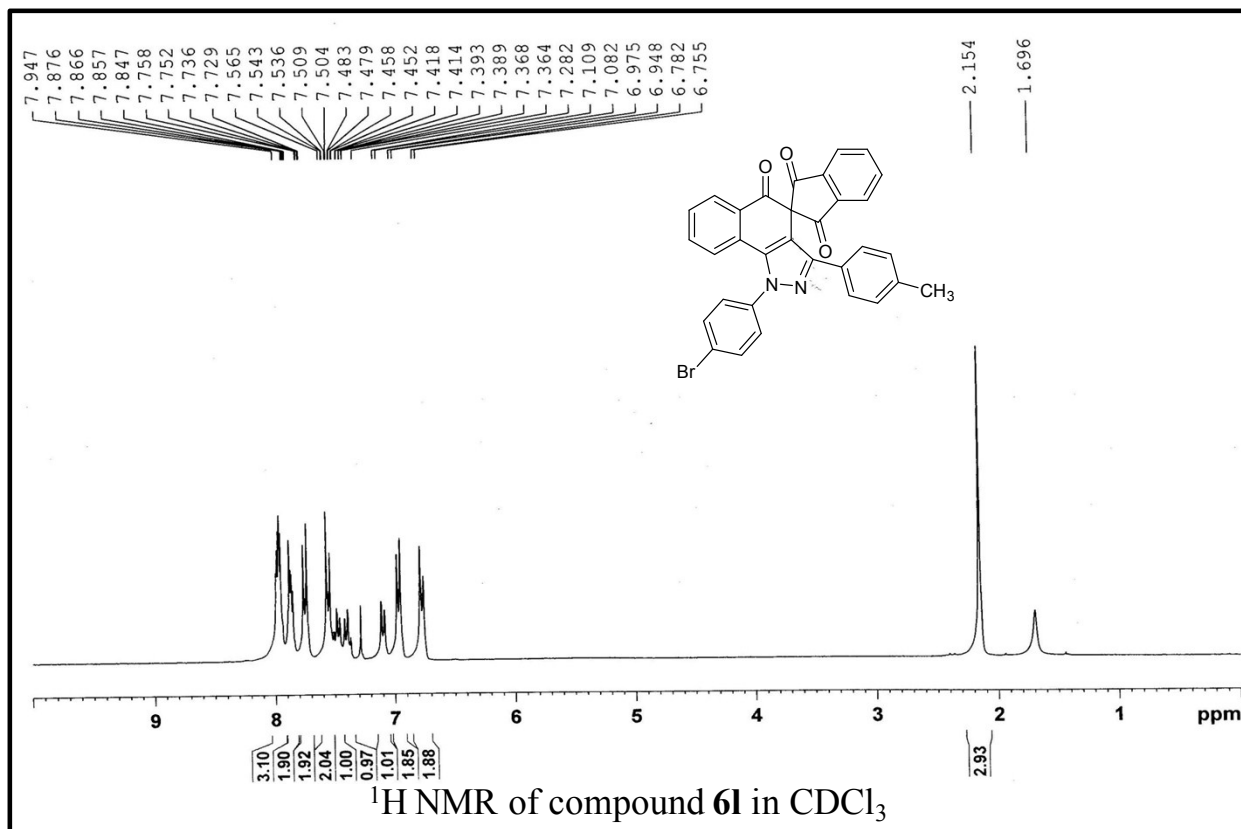


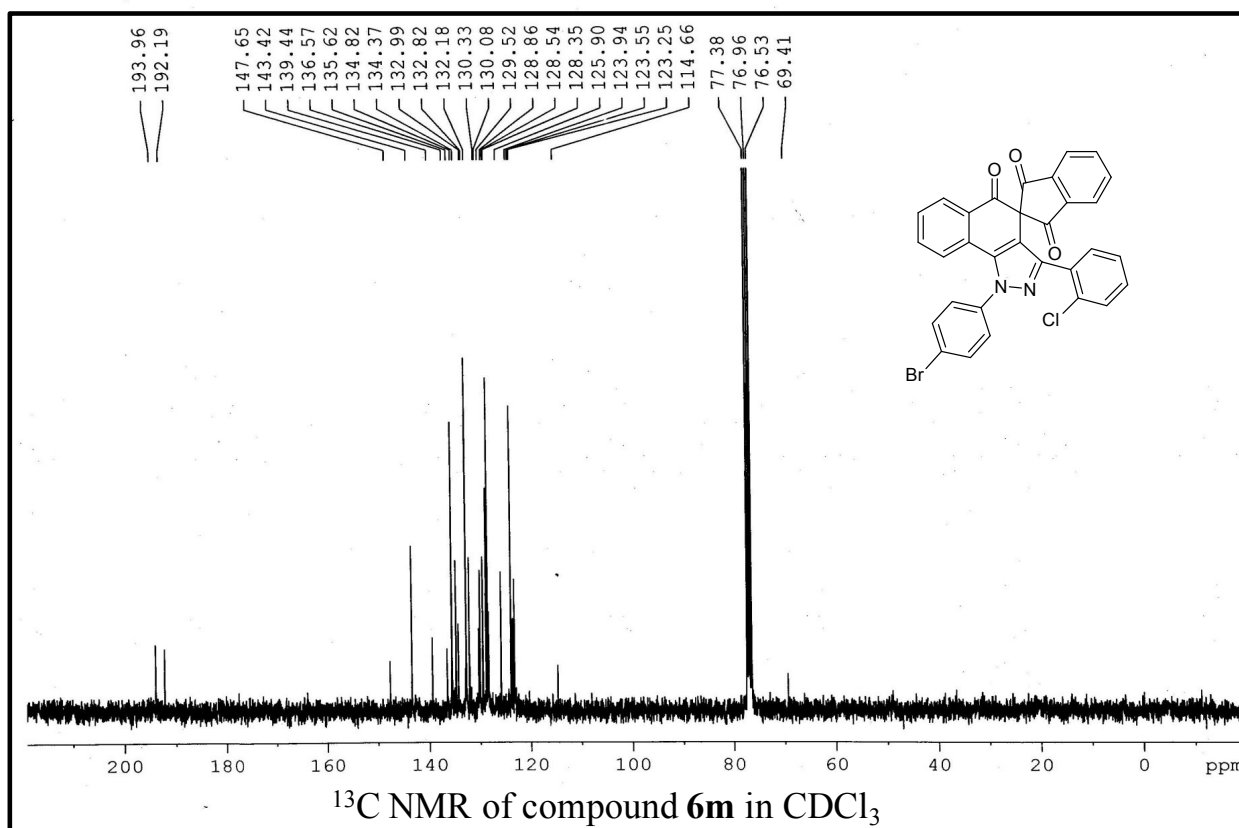
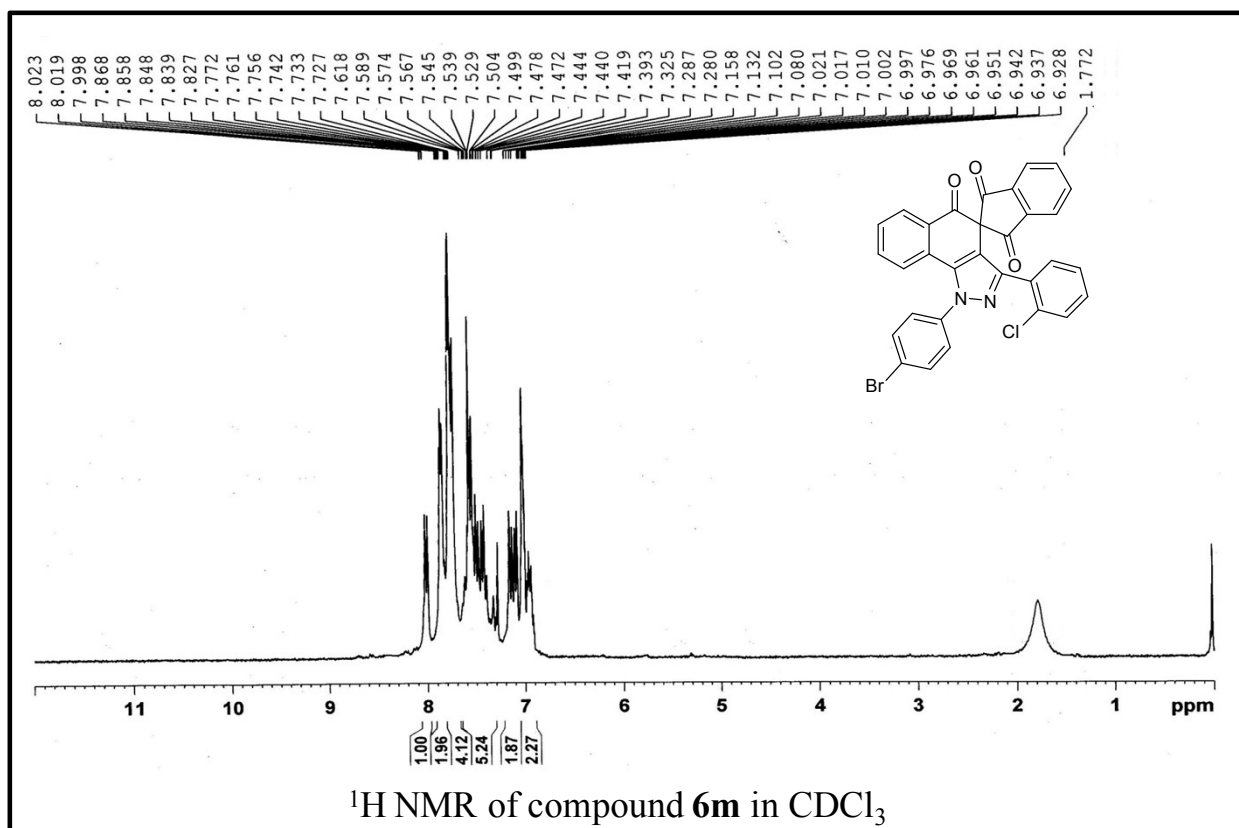


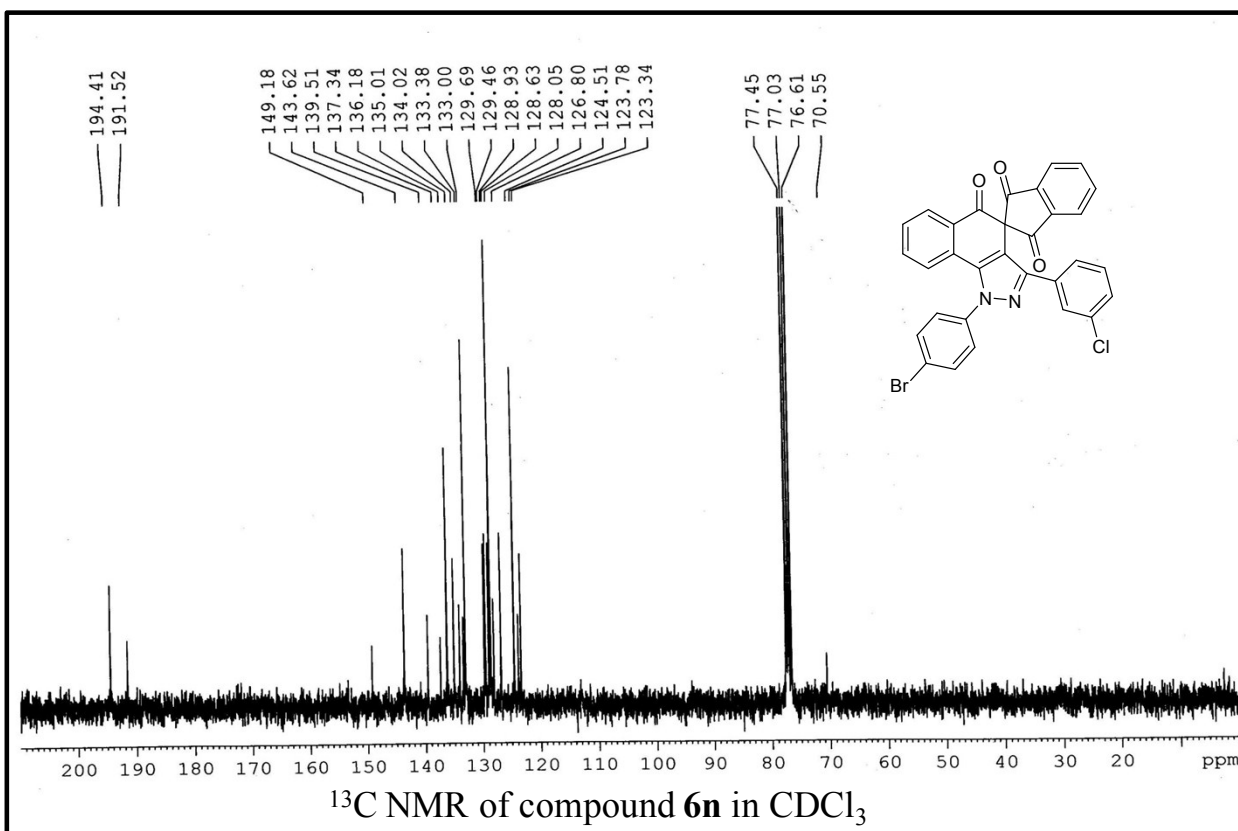
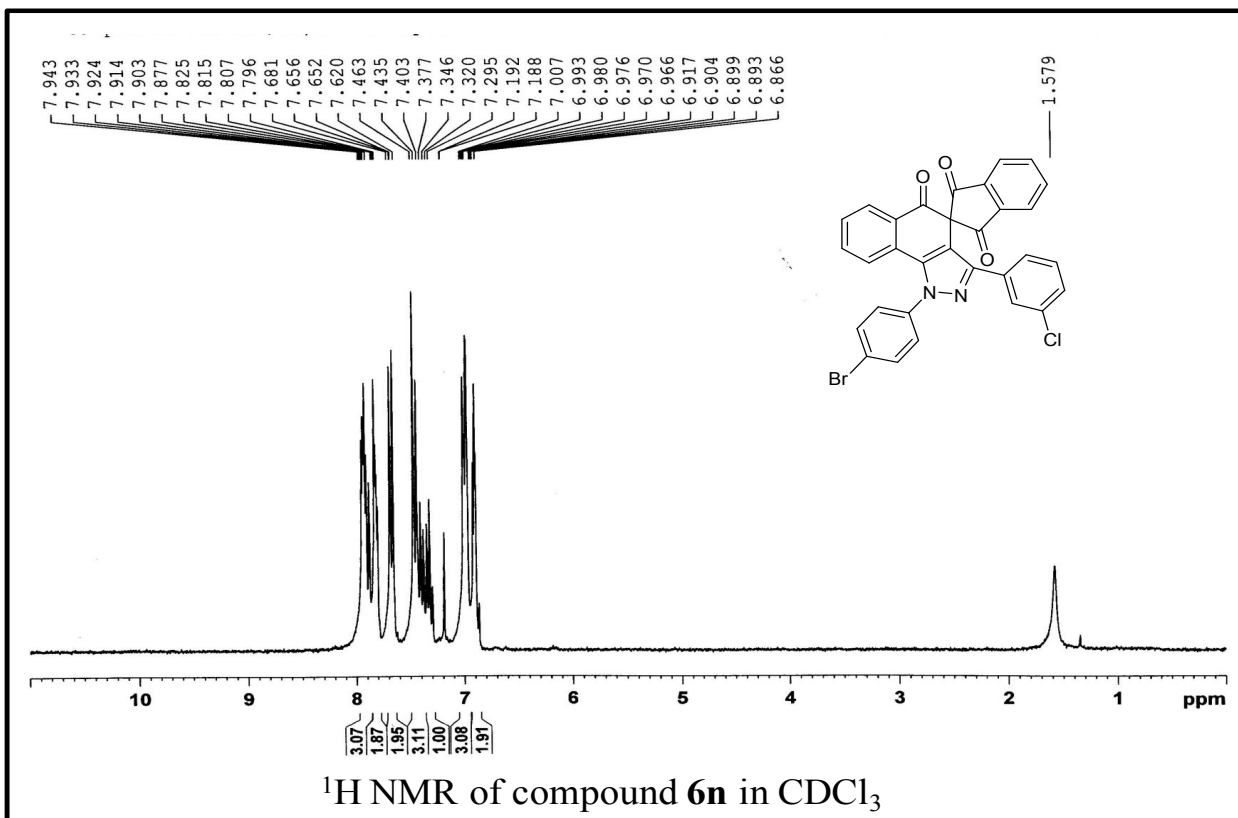


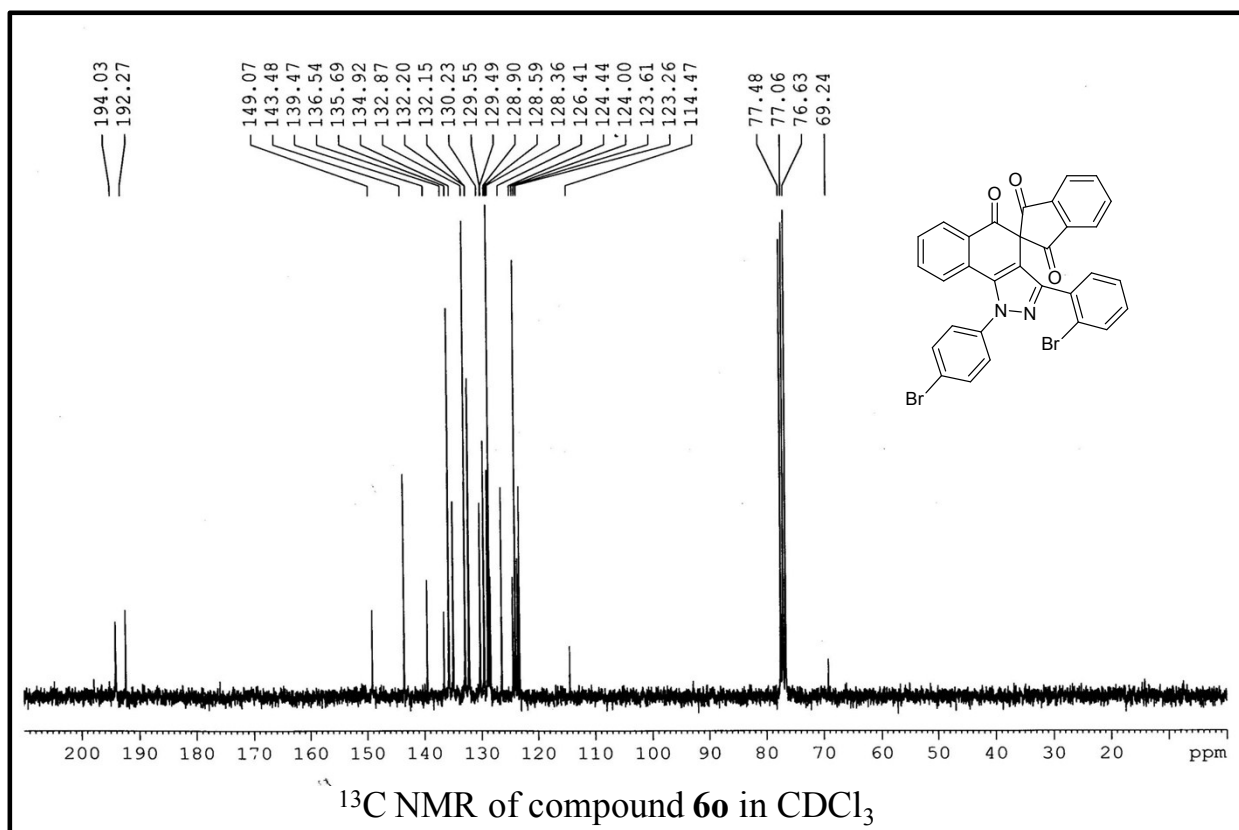
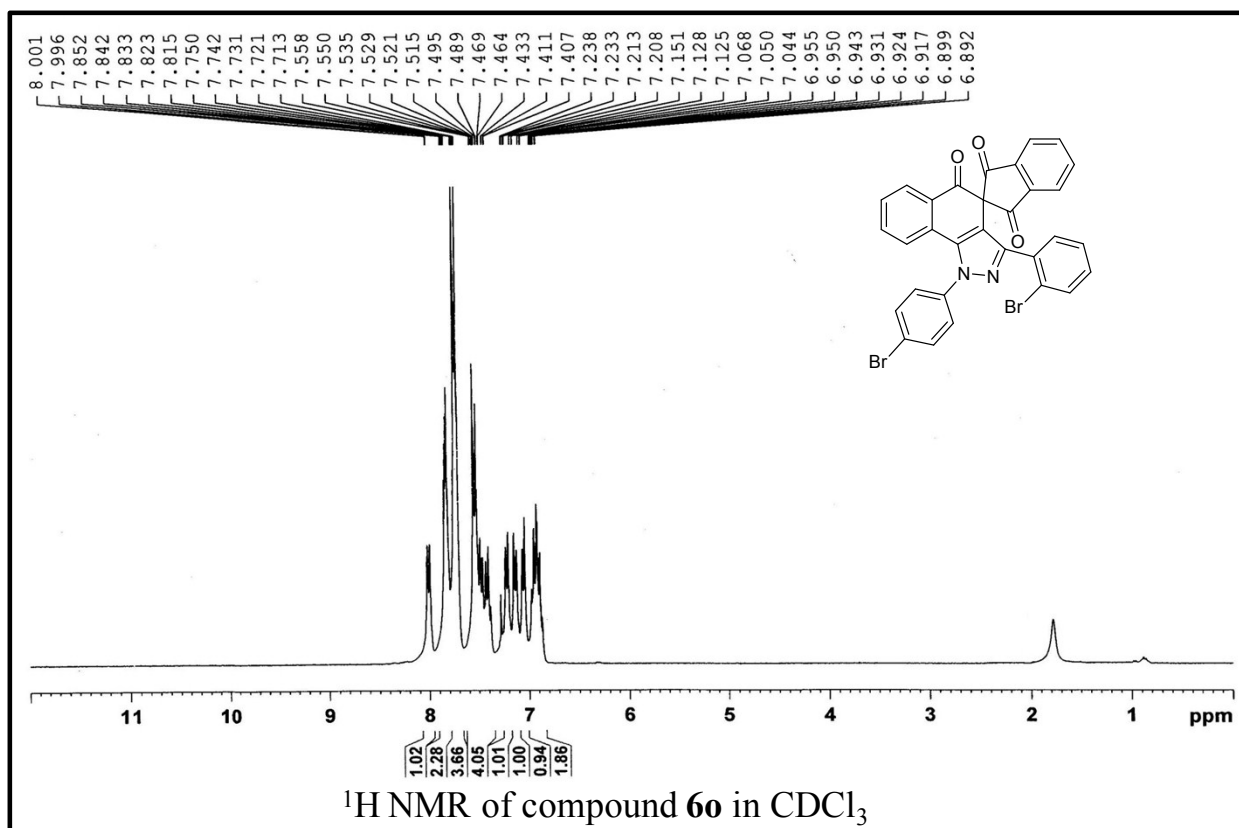


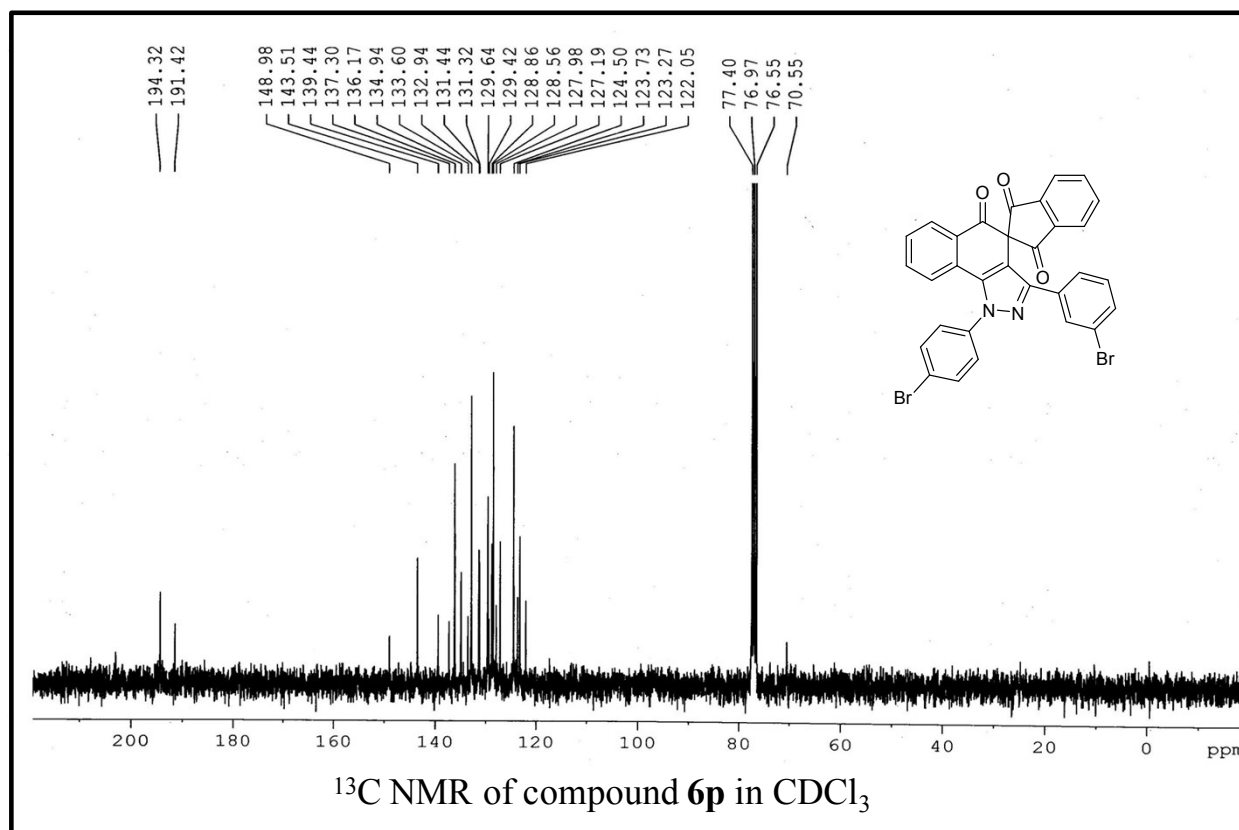
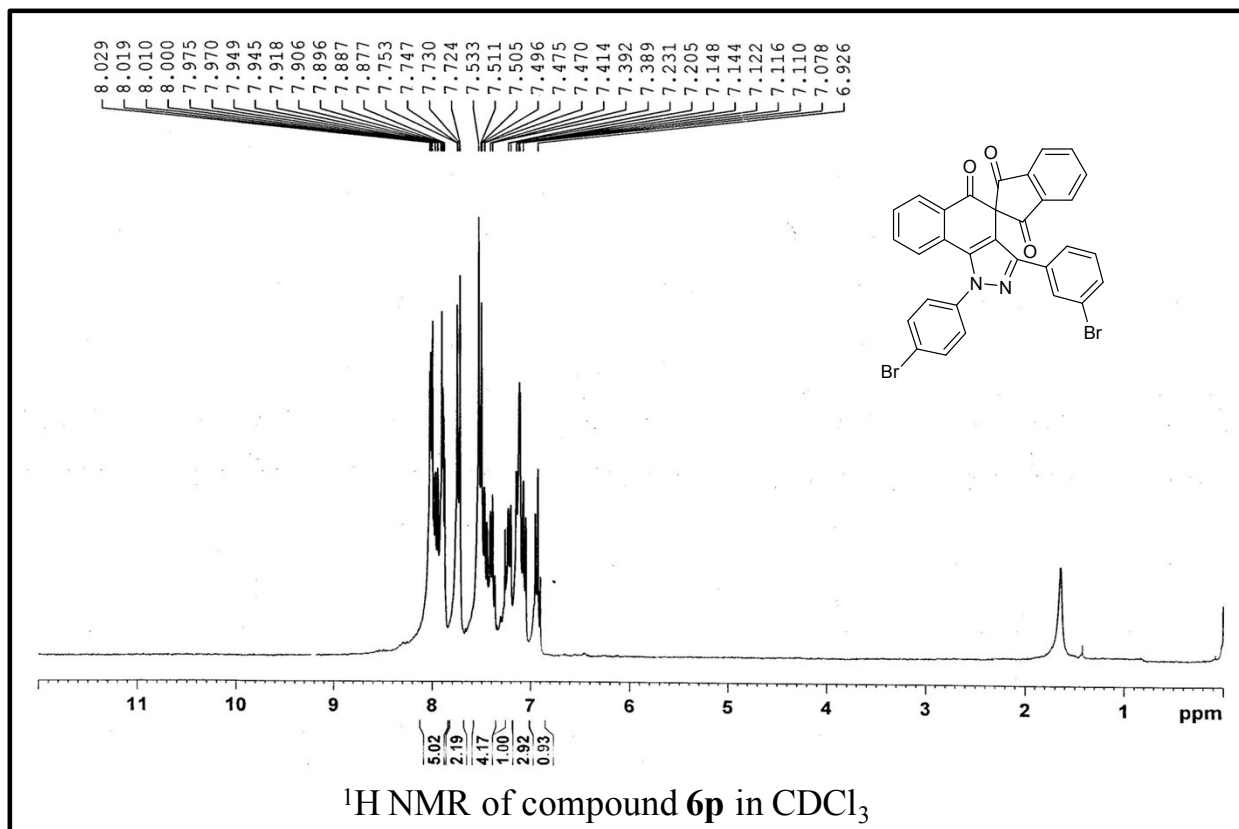


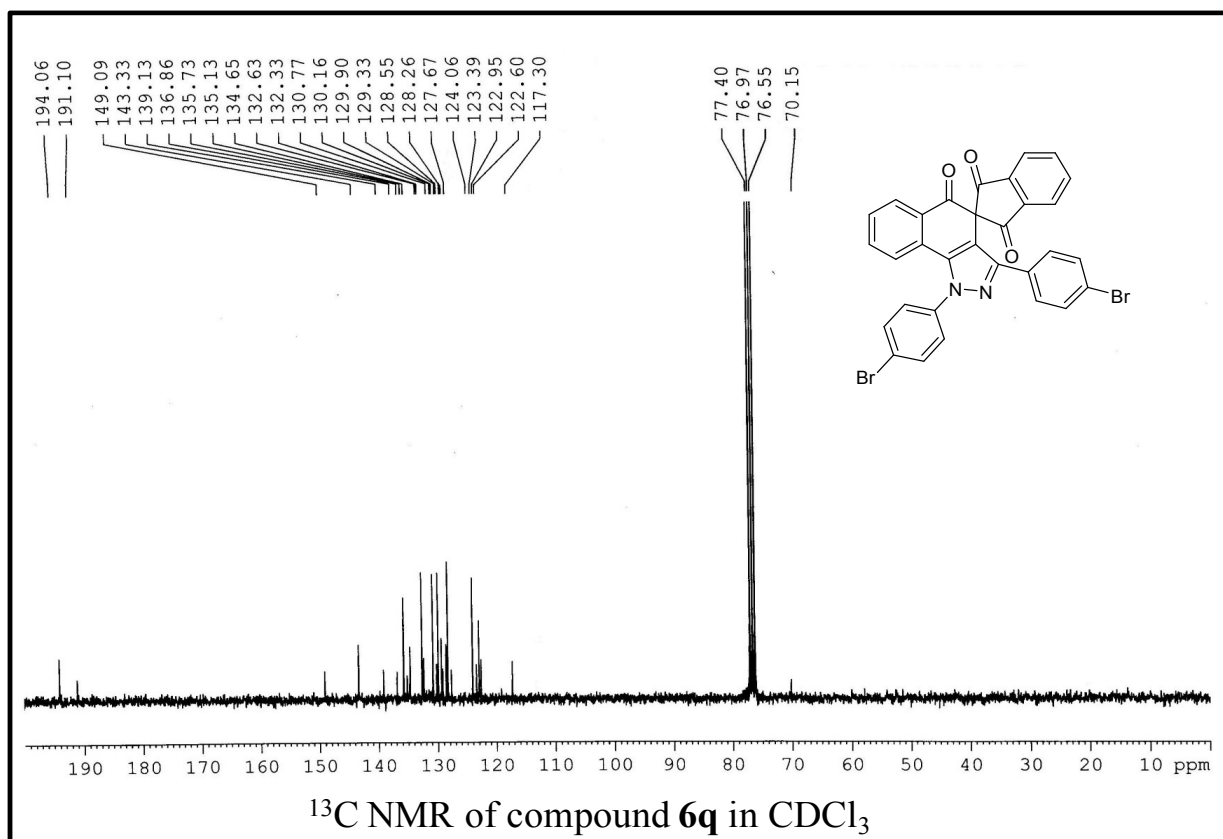
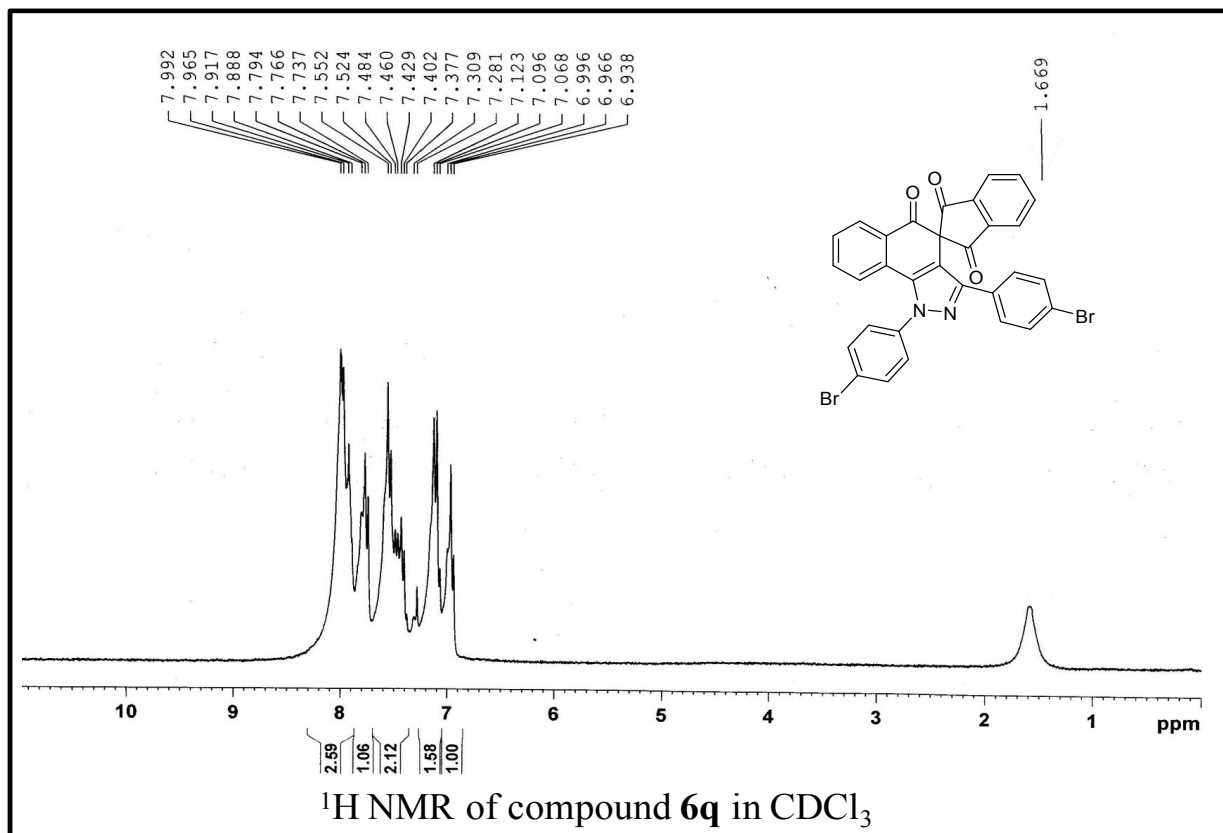


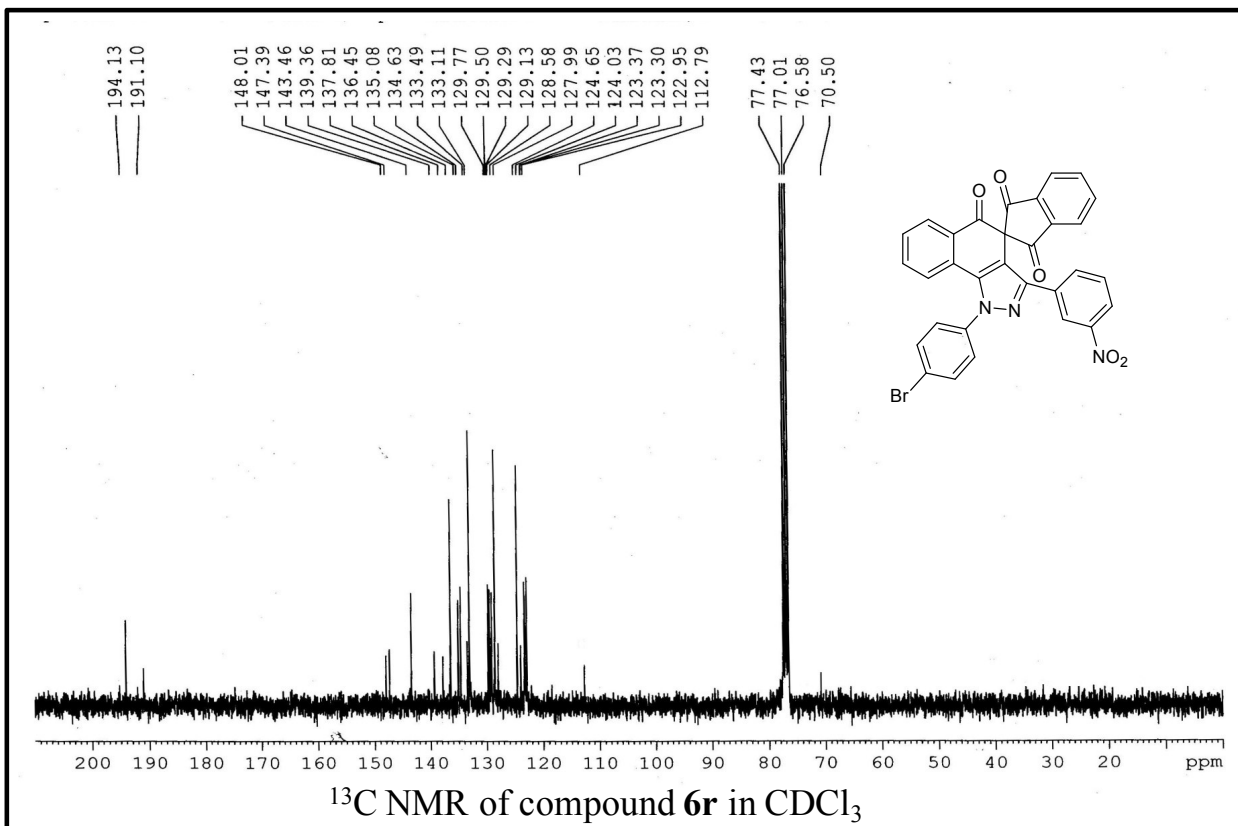
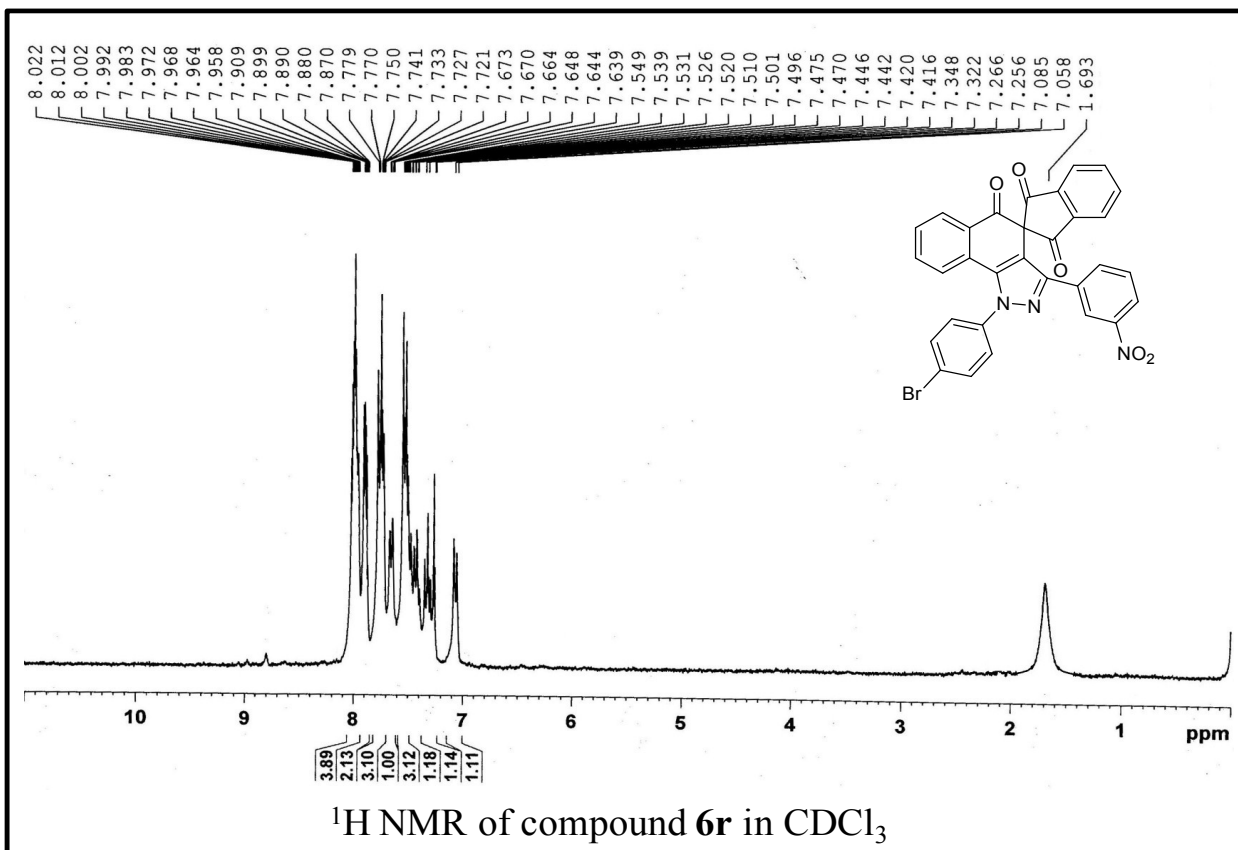


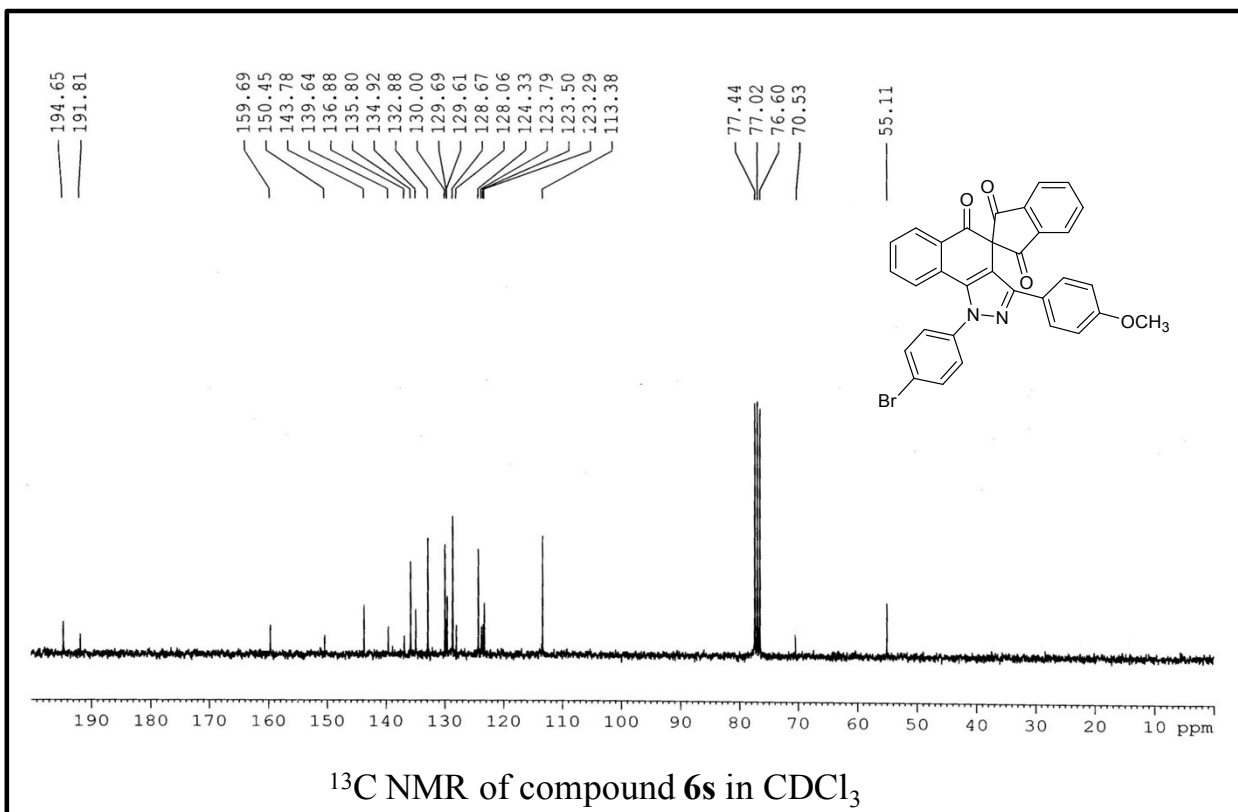
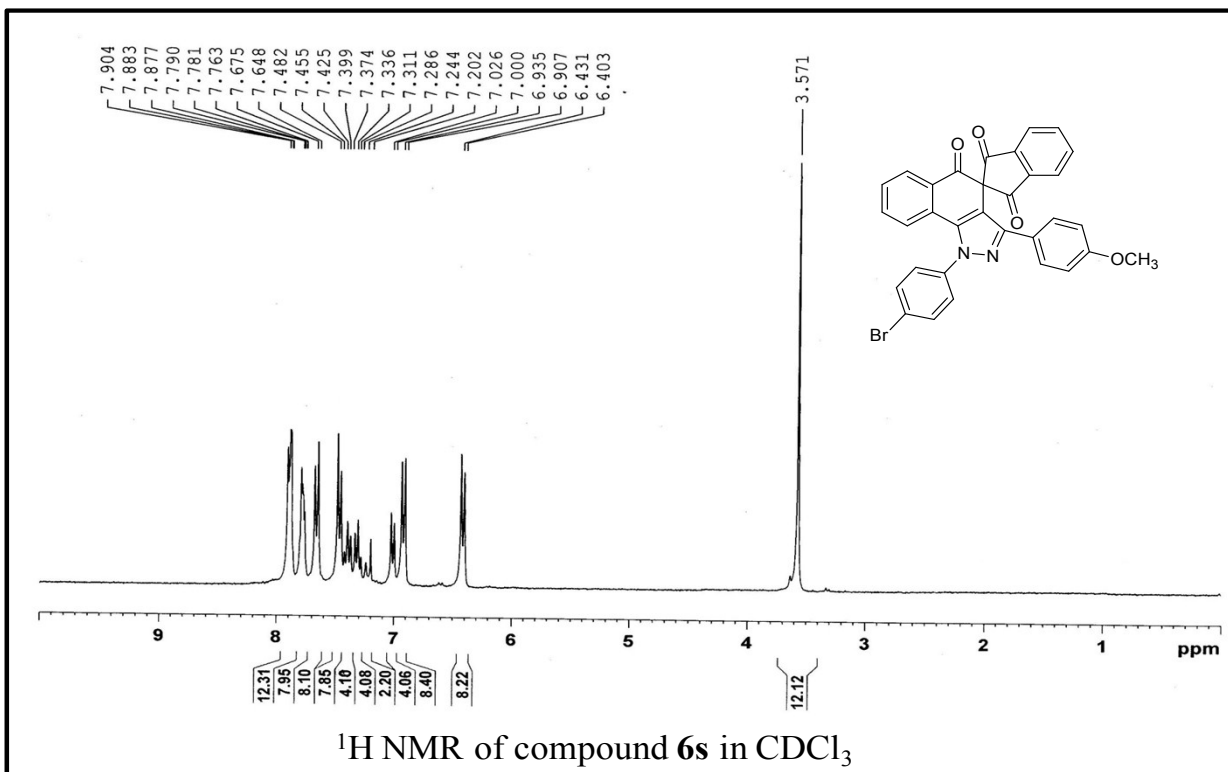


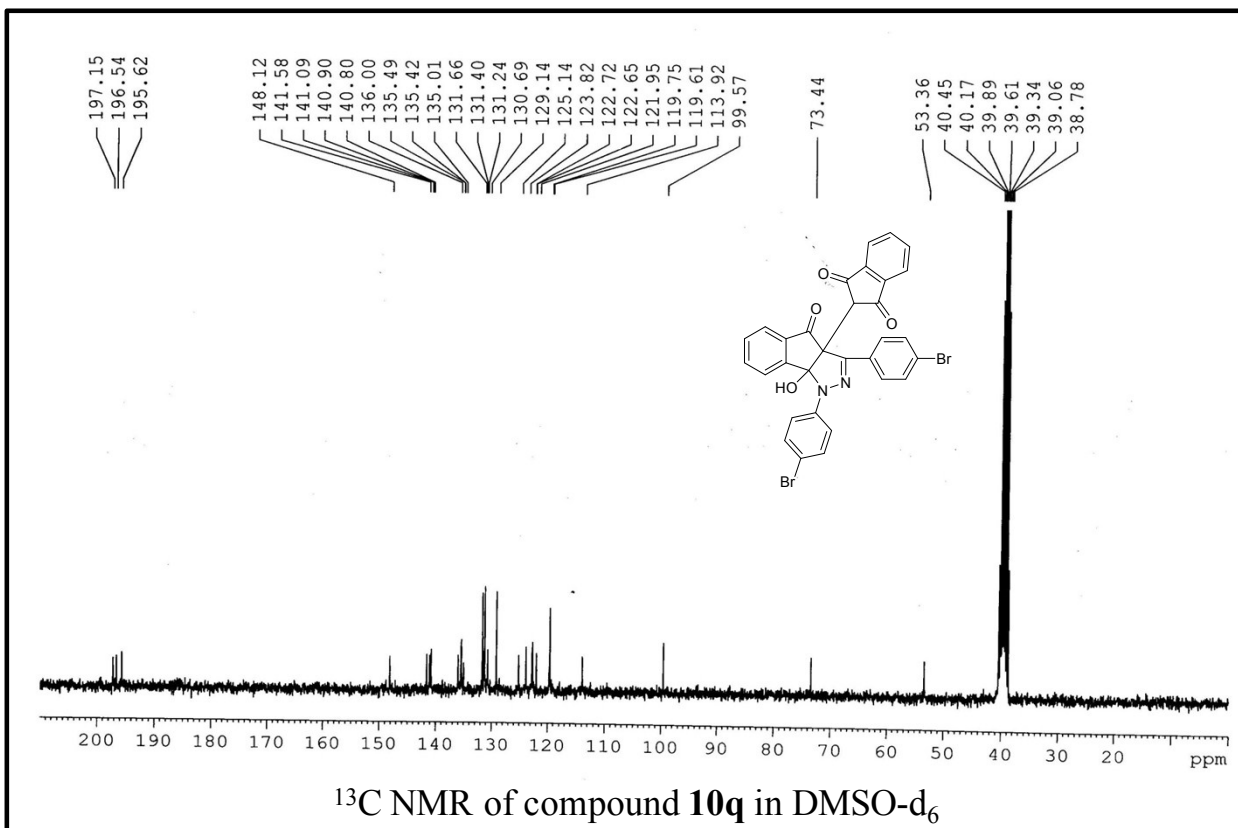
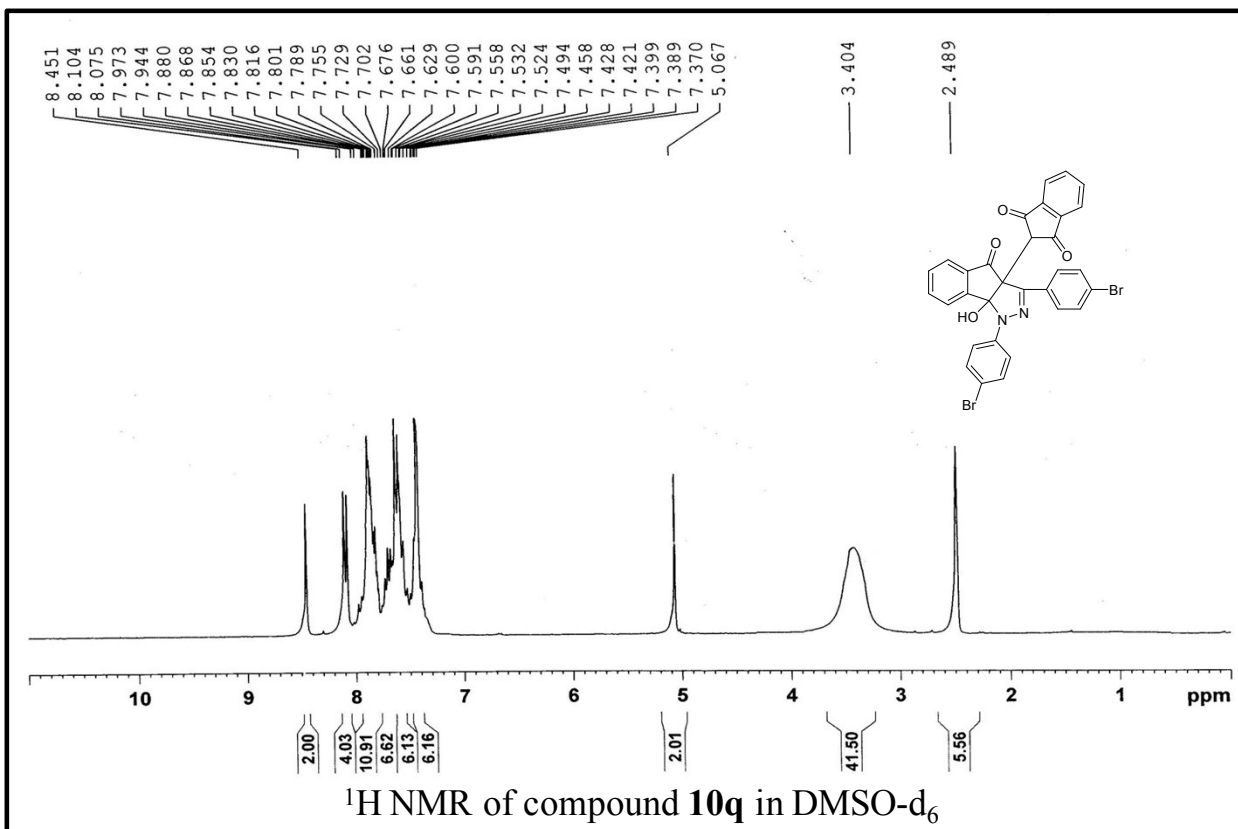












Infrared spectra:

The infrared spectrum of fresh Fe₃O₄@SiO₂-SO₃H magnetic nanoparticles (MNPs) is shown in Fig. **S1(a)**. The Fe–O stretching vibration near 532 cm⁻¹ and O–H deformed vibration near 1622 cm⁻¹ are observed for the magnetic nanocomposites. The appearance of the peaks at 1091 and 1003 cm⁻¹ described to the stretching of the S–O bonds. And peak at about 3195 cm⁻¹ appeared due to the presence of -OH groups. All these observations confirm that the sulfonic groups have functionalized the surface of the MNPs.^{1,2} The infrared spectra of reused catalyst after five runs is shown in Fig. **S1(b)**. It is important to note that all corresponding peaks are intact without any major change which indicates that structure of catalyst doesn't change even after 5 cycles.

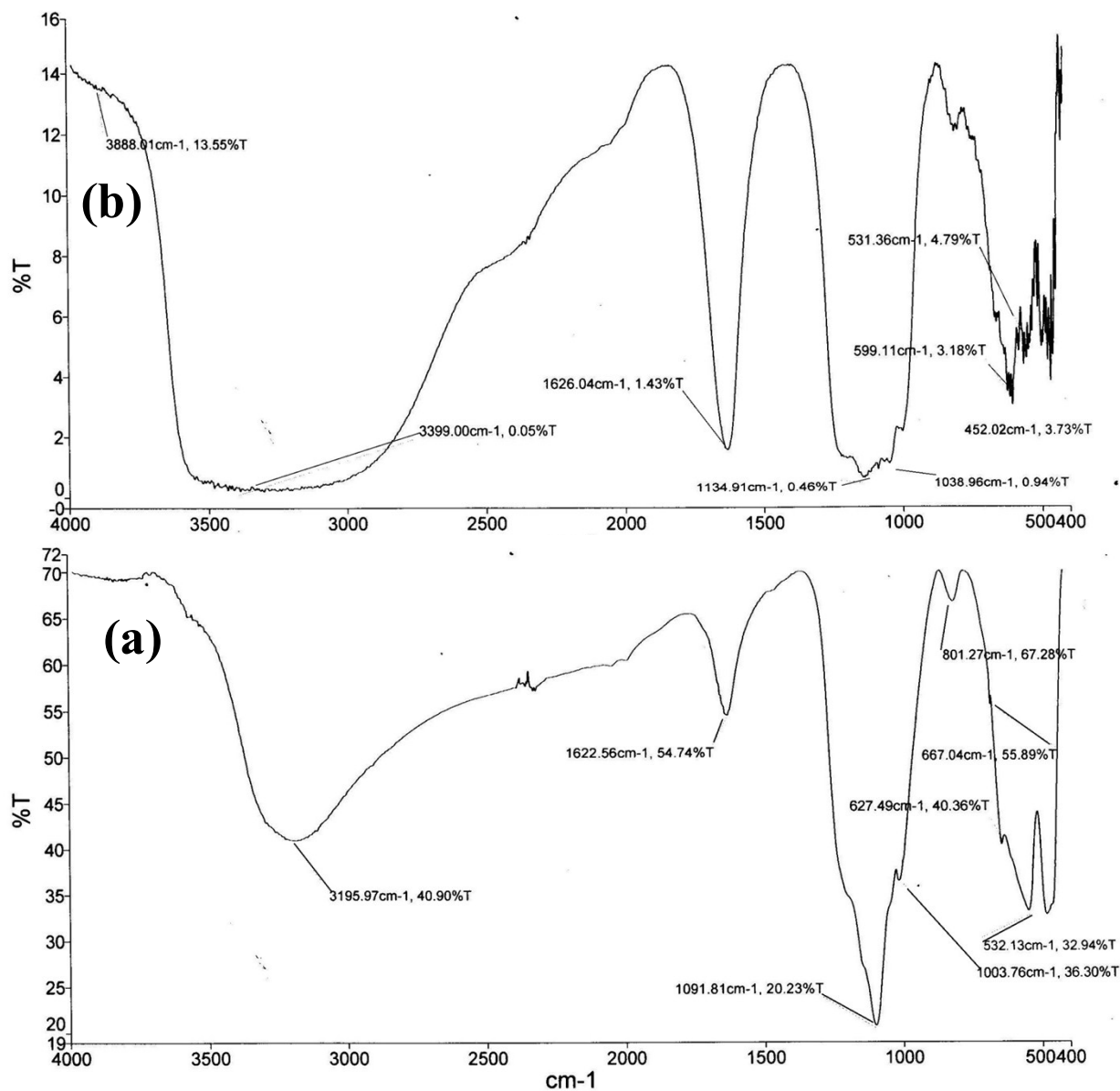


Fig. S1 FT-IR spectra of (a) fresh $\text{Fe}_3\text{O}_4@\text{SiO}_2\text{-SO}_3\text{H}$ MNPs and (b) reused $\text{Fe}_3\text{O}_4@\text{SiO}_2\text{-SO}_3\text{H}$ MNPs after 5 th cycle.

References:

- 1 J. Safari and Z. Zarnegar, *RSC Adv.*, 2015, **5**, 17738.
- 2 N. Koukabi, E. Kolvari, M. A. Zolfigol, A. Khazaei, B. S. Shaghasemi and B. Fasahati, *Adv. Synth. Catal.*, 2012, **354**, 2001.