This paper (*Organometallics* **2017**, *ASAP*) examines the synthesis and reactivity of carbene compounds of palladium and platinum. While the paper might seem a bit long, it is generally due to very thorough discussion of spectroscopic and crystallographic results.

1. The bidentate phosphine ligand, compound 1, reacts with [(COD)MCl2] to give either compound 2 (M = Pd) or compound 3 (M = Pt). While these compounds are quite similar, they do exist in different isomeric forms; compound 2 is *trans*- while compound 3 is *cis*-. Account for the differences in geometry.
2. Although compounds 2 and 3 exist as different isomers, they are the same in terms of electron counts. Classify one of these compound, determine the ligand bond number, the valence on the metal and the dn count for the metal.
3. The reactions of compound 2 or 3 with the strong reducing agent KC8 results in the formation of either compound 4 or 6 respectively. Again, compounds 4 and 6 are essentially identical, differing only in the metal atom. Classify one of these compound, determine the ligand bond number, the valence on the metal and the dn count for the metal.
4. Compounds 4 and 6 react with N2C(­*p*-tol)2 to yield compounds 5 and 7 respectively. Compounds 5 and 7 contain a carbene ligand. These ligands can either be thought of as being $\overbar{X}$2 (suggesting one atom, in this case the carbon, is acting as an X type ligand to the metal twice) or LZʹ (the Zʹ indicating that there is a significant Z component to the bonding for this ligand but it is not used in counting) ligands. Describe the bonding interactions for each of these classifications of ligands. Drawing the orbital interactions would likely aid your discussion.
5. Figure 3 shows the carbene region of the 13C{1H} NMR spectrum. Describe how the observed pattern is obtained for compound 5. Your discussion should include a description as to how you would measure the coupling constants. How would the pattern differ for compound 7?
6. Compounds 5 and 7 are similar in terms of electron counting. Classify one of these compounds, determine the electron count, the ligand bond number, the valence on the metal, and the dn count for the metal. Your answer should include specific details as to your classification of the carbene ligand and why you chose that classification.
7. The Pt-C bond length is compound 5 was found to be 1.942 Å which is significantly shorter than has been observed in related compounds with N-heterocyclic carbene (NHC) ligands. Account for the shorter bond length in compound 5.
8. Compound 7 decomposes to give compound 8. Propose a mechanism for this decomposition reaction. Compound 5 does not undergo this decomposition reaction, why? Your answer/discussion for question 1 might help provide some insight into this answer.
9. Compounds 5 and 7 are proposed to react with one equivalent of Ph2SiH2 to yield Ph2HSiC(*p*-tol)2H and either 4 or 6 respectively (scheme 4). What mechanism is proposed for this reaction?
10. Compounds 4 and 6 react with Ph2SiH2 to form compounds 9 and 10 respectively. What sort of reaction is taking place? To aid in answering this question, you should classify either compound 9 or 10, determine the electron count, the ligand bond number, the valence on the metal, and the dn count for the metal. You should then refer to your answer to question 3.
11. In comparing compounds 9 and 10 the authors once again see somewhat different behavior for the palladium and platinum compounds. For compound 9 the authors point out two inequivalent phosphorus environments and two distinct environments for the silane protons (-3.73 and 5.10 ppm). For compound 10 there is a single phosphorus environment and one peak for the silane protons (1.74 ppm). Account for these differences.
12. The reaction of compound 4 with CH3I results in the formation of compound 14 (scheme 5). What sort of reaction is taking place? To aid in answering this question, you should classify compound 14, determine the electron count, the ligand bond number, the valence on the platinum, and the dn count for the platinum. You should then refer to your answer to question 3. Note: a similar reaction does take place with compound 6, but it is not nearly as clean.
13. The reaction of compound 5 with CH3I is also depicted in scheme 5. The authors briefly mention a proposed mechanism in the final sentence before the conclusions. Based on that sentence, propose a mechanism for the formation of compound 11 from compound 5.