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In the Classroom

INFRARED-SPECTROSCOPY CHECKERS

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The classic strategy game of checkers has been modified to help students study the interpretation of infrared spectra.

The exercise gives students practice in functional group recognition, allows them to learn from the mistakes of others, and presents the reading of infrared spectra in a fun and exciting way. The game is easily modified by varying the complexity of "unknowns" or the degree of interpretation expected.

Playing infrared-spectroscopy checkers allows students to help themselves and each other while enjoying their study time in the process.

Introduction

One of the more difficult aspects of the sophomore organic sequence is the determination of structure from spectra. Infrared spectra seem particularly baffling to students because there are many absorptions and some occur in overlapping areas.

Students often think that learning to interpret infrared spectra is difficult, unimportant, and generally boring. Interpretation

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involves a type of reasoning that is somewhat foreign to them. Learning and applying the mental processes usually requires significant time investment that they may regard as tiring. Playing infrared-spectroscopy checkers allows students to help themselves and each other while enjoying their study time in the process.

Checkers is a very old game, thought to date back to ca 6000 B.C., and the rules are well known. It is widely played by people of all ages. (Checkers is known as "draughts" in England.) It is well suited to modification for educational uses because it can be played by study groups as small as two.

An entire class can be divided up into as many groups as are necessary. Students often take the game home to practice. The effectiveness of games in education has been previously documented in the literature [1]. There is ample precedent of application of game strategies to diverse aspects of chemical education [2–4].

This version is played on a 6 × 6 board rather than the standard English 8 × 8 board. This shortens the game time and still allows for some strategies. Those wanting a longer game could play the 8 × 8 standard or even the 10 × 10 sometimes used in Europe.

Rules of Checkers

Those who want a comprehensive set of rules should consult the American Checkers Federation website at http://www.primenet.com/~krow/.

Adaptations for Infrared-Spectroscopy Checkers

There is only one major departure from the rules of conventional checkers. In order to move to a certain square, a player must successfully interpret the spectrum (to the extent required) specified by the number of the square. The most effective way to play the game is to have a third student serve as referee. The student referee determines whether or not the players have adequately deciphered the spectrum. The problem of repeated guessing or passing can be resolved by instituting a "three-strikes-and-your-out" rule. If a player misses moving three times, the game is forfeit. Also, the game can be played against a "nonscience" opponent. In that event, if the chemistry opponent is unable to move, then the nonscience player would have the option of not moving. If the chemistry player is unable to move for three turns, they would lose the game.

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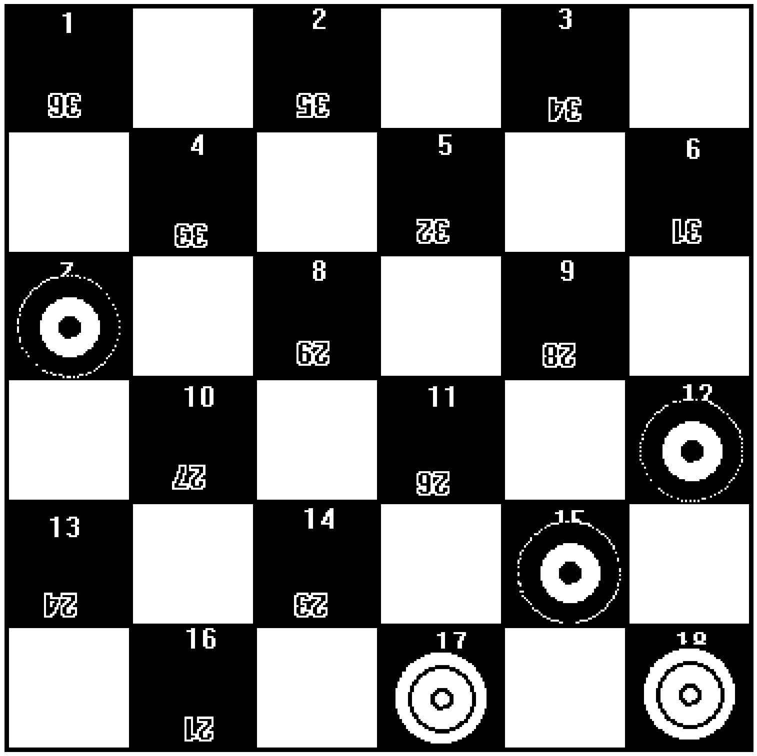

FIGURE 1. THE MODIFIED GAME BOARD FOR INFRARED-SPECTROSCOPY CHECKERS.

Notice that the board has two sets of numbers (oriented in opposite ways, see Figure 1). In effect, each player has a set of numbers which is different from those of the other player. In one version of the game, each player would has to make the required interpretation of the spectrum corresponding to the destination square.

For example, in Figure 1 if the white player must move from square 18 to square 11, they must interpret the corresponding spectrum. (The black player would have to interpret spectrum 26 to move there.)

Spectrum 11 is that of acetone. A student in sophomore organic would be expected to determine that spectrum 11 (Figure 2) is a ketone. If the player fails to make the required identification, the turn is lost.

For the beginning undergraduate, this game is harder than it may first appear. Students should have had instruction in infrared spectroscopy and a quiz on the material before attempting this game. A time limit for moves is helpful for moving the game along. For sophomore organic students, the starting minimum should be at least 3 minutes.

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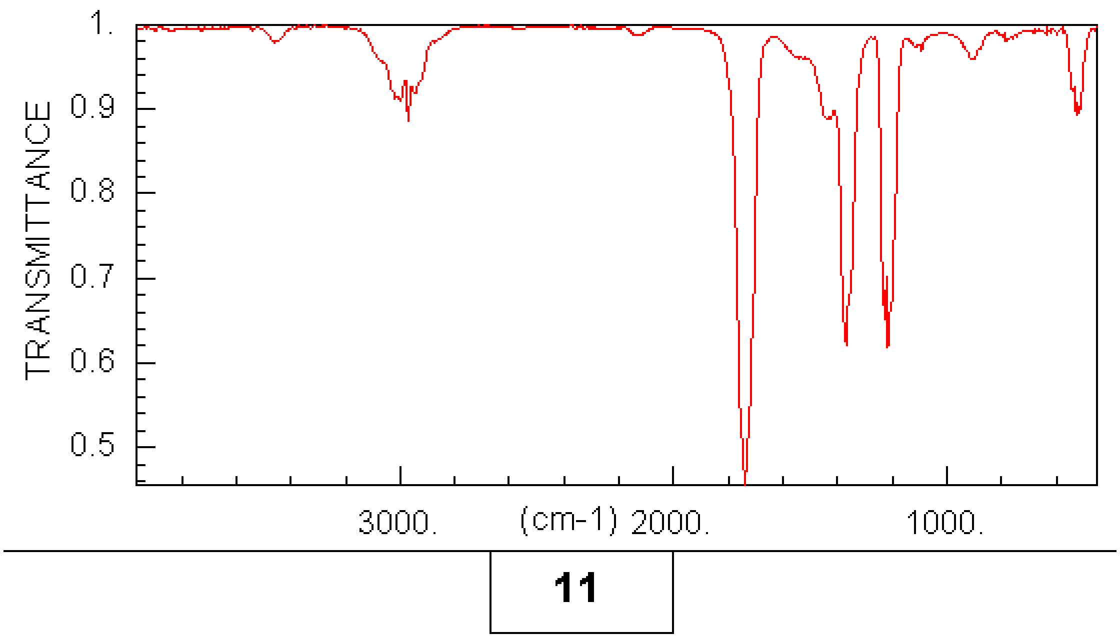

FIGURE 2. THE INFRARED SPECTRUM OF ACETONE.

The game level can be varied by changing the degree of interpretation required. For students in sophomore organic, a first game might require only the correct identification of a single functional group. This can be made more difficult by requiring two functional groups. More advanced students might be challenged to provide a more complete structure determination. The 6 × 6 board and 36 unknown spectra are included in the supplementary material.

Spectra of varying complexity can be used. There is no reason to use the spectra in the order given. Although it is tedious, a standing "unknown board" can be made having 36 slots for random arrangement of the spectra. The spectra included can be cut out and placed in the slots in any order. (The "unknown" images have a numerical tag that can be bent behind the spectrum.) Because a compound name such as carvone may not evoke a clear picture, structural diagrams should be included in any key the students will use.

Infrared spectra and structural diagrams were obtained from the NIST Webbook at http://webbook.nist.gov/chemistry.

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