Increasing Active Student Participation in the Classroom Through the Use of "Flash Cards"

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Large lecture classes make it difficult to maintain high levels of student-faculty interaction; in these classes, students traditionally play a relatively passive role. We have been making use of techniques for increasing active student participation in the lecture classroom, and for raising the level of interaction between students and instructors. A central element in these methods is the use of "flash cards" which allow students to instantaneously indicate to the instructor their responses to multiple-choice questions. Students use 8.5 x 11 inch flash cards, labeled "A," "B," "C," "D," "E," and "F" to signal their responses to the instructor. Flash-card questions emphasize qualitative and proportional reasoning, solution strategies for problems, order of magnitude estimates, etc. Responses provide feedback to the instructor on student misconceptions, and pace of student understanding. Here we show an example of how we break down a conventional problem into conceptual elements—a so-called "problem dissection"—which can then be formed into flash-card questions. [Meltzer, D.E. and K. Manivannan, *Phys. Teach.* **34**, 72-76, 1996.]

PROBLEM DISSECTION TECHNIQUE

It is possible to take a fairly complicated problem, involving several different concepts, and break it down into conceptual elements. We work through the problem piece by piece, with constant interaction and feedback from the students through the use of flash cards. In the sample problem presented here, the essential steps leading to the solution are dealt with in questions 1 through 15. (It is important to note that each successive question is presented only after the preceding one has been answered and discussed.) After completing these, the students will proceed to the quantitative phase in the remaining questions.

SAMPLE PROBLEM

Four charges are arranged on a rectangle as shown in Figure 1. ($q_1 = q_3 = +10.0\ \mu C$ and $q_2 = q_4 = -15.0\ \mu C$; a= 10.0 cm and b = 15.0 cm.) Find the magnitude and direction of the resultant electrostatic force on q_1.

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Figure 1. Diagram used for problem dissection

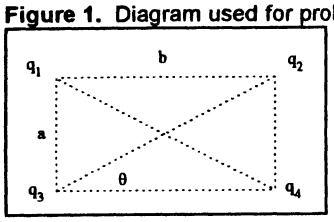
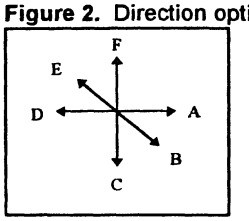


Figure 2. Direction options



1. How many forces (due to electrical interactions) are acting on charge q_1? **(A)** 0 **(B)** 1 **(C)** 2 **(D)** 3 **(E)** 4 **(F)** Not sure / Don't know. For questions **2,3** and **4**, refer to Figure 2 and pick a direction from the choices **A, B, C, D, E, F**. **2.** Direction of force on q_1 due to q_2. **3.** Direction of force on q_1 due to q_3. **4.** Direction of force on q_1 due to q_4. Let F_2, F_3 and F_4 be the *magnitudes* of the force on q_1 due to q_2, due to q_3 and due to q_4 respectively. **5.** F_2 is given by **(A)** kq_1q_2/a^2 **(B)** kq_1q_2/b^2 **(C)** $kq_1q_2/(a^2+b^2)$ **(D)** $kq_1q_2/\_(a^2+b^2)$ **(E)** None of the above **(F)** Not sure/Don't know. Questions **6** & **7** are similar to question **5** with the subscript 2 changed to 3 and 4 respectively. At this point (after discussing questions **1** through **7**), the instructor draws the correct vector diagram showing all the forces acting on charge q_1 and asks the following questions: [For questions **8** through **13**, pick the answer from the list of six choices given below.] **(A)** F_2 **(B)** $-F_3\cos\theta$ **(C)** $F_3\sin\theta$ **(D)** $-F_4$ **(E)** 0 **(F)** None of the above. **8.** X-component of force on q_1 due to q_2; **9.** Y-component of force on q_1 due to q_2; **10.** X-component of force on q_1 due to q_3; **11.** Y- component of force on q_1 due to q_3; **12.** X-component of force on q_1 due to q_4; **13.** Y-component of force on q_1 due to q_4; **14.** *Write down* the X-component of the *net* force on q_1; **15.** *Write down* the Y-component of the *net* force on q_1; **16.** What is the value of angle θ? **(A)** 29° **(B)** 34° **(C)** 40° **(D)** 48° **(E)** 57° **(F)** Not sure/Don't know; **17.** Calculate the magnitude of the resultant force on q_1; **18.** Calculate the direction of the resultant force on q_1.

STUDENTS' ATTITUDES TOWARDS FLASH CARDS

These methods were employed in an algebra-based general physics course at the University of Virginia at Charlottesville. A questionnaire entitled "Flash Cards Student Survey" was distributed to all of the students enrolled in this course (N=41). The response of the students was very positive. On a 1-5 rating scale, students gave a mean response of 4.1 to the statements "gained better understanding," "paid more attention," and "instructor was more aware of problems." [4 = "Agree"; 5 = "Agree Strongly."] Mean response was 2.2 [2 = "Disagree," 3 = "Neutral"] to the statements "waste of time," "disliked holding up cards," and "disliked working in groups."