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Influence of Hybrid Teaching Approach on Attitude and Success Concerning Electrostatics

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ABSTRACT

The study reported in this paper aims to determine the effects of a hybrid approach which is formed by incorporating different teaching methods, namely lecturing, open discussion, problem solving and demonstration, on student success and attitude towards physics. Total number of 80 undergraduate students participated to the research. Half of them are referred as Treatment Group to which the hybrid approach is employed and the rest of the students referred as Control Group to which the traditional teaching method is employed. To evaluate the outcomes of the study, an Electrostatics Test (ET) and an Attitude Scale towards Physics (ASP) are employed. The obtained data processed statistically and it has been clearly shown that a meaningful difference exits between the two groups on success, nevertheless no difference has been detected concerning the attitude.

Keywords: Physics Education; Hybrid Teaching Approach; Teaching Electrostatics; Attitude.

INTRODUCTION

Students consider physics as a difficult subject to learn and understand. Students' understanding of key concepts on electrostatics has been extensively studied, ranging from the simple notions treated in primary school science to the more sophisticated notions addressed in introductory physics courses at university level. The studies at university level determined that students have many misconceptions and learning difficulties on electrostatics topics, for example about electric field and potential (Törnkvist, Pettersson & Tranströmer, 1993; Furio & Guisasola, 1998; Guisasola, Almud´ı & Zubimendi, 2004; Saarelainen, Laaksonen & Hirvonen, 2007), about Gauss's Law (Dunn & Barbanel, 2000; Singh, 2006), about capacitors (Bilal & Erol, 2008).

Nowadays, it is believed that learning process has mainly some cognitive and internalizing dimensions in addition to some environmental factors. Hence, it is very important to decide on what's/when/how to teach? In other words, one has to be very careful on deciding certain methods and has to consider local facilities, specific subject and selected student group. A misjudgment would create a boring and non beneficial classroom atmosphere. The purpose of various teaching methods in science education is to create a society profile that has a creative intelligence and can use all the possible potentials to solve any emerging problems. Different teaching methods would clearly be improving permanent teaching activities as well as their social abilities. It is therefore

crucially important to determine the most suitable teaching model and teaching experience for the properties of the group and subject (Ashcroft & Foreman-Peck, 1994; Capel, Leask & Turner, 2001). Effect of different teaching methods on student success was previously investigated by Bağcı and Şimşek (1999). In their work, individual experiment, puzzle, answer-question, lecturing and discussion sessions were applied different groups and the effects of each methods on success were compared. The research was conducted on randomly selected over all 350 high school students in five classes who were taught by the same teacher. According to the investigation, no meaningful difference had been observed between lecturing and question-answer groups, discussion and question-answer groups, lecturing and discussion groups, and finally puzzle and individual experiment groups. However, individual experiment group was found to be more successful in comparison with puzzling, lecturing, discussion and question-answer groups. Similarly, puzzling group was found to be more successful than lecturing and discussion groups.

A hybrid approach composed of various active learning methods previously applied at Akron University by Ramsier (2001). In his work, considering students' attendance to the classrooms, lecturing and problem solving activities in the classroom were combined with the out-classroom activities such as team projects and homework. At the end of the course, it was found that only 2 students, out of 43, could not complete the course and according to the outcome of the questionnaire, group works and problem solving activities within the classroom were found to be very beneficial. It was especially found that team projects made a great deal of progress on student's interest and curiosity.

Our work, on the other hand, reports the relation between student's success as well as attitude and a specific hybrid approach containing different teaching methods in harmony with the requirements of the students and the subject. Before determining actual teaching methods, a specific attention was paid out on student's requirements and the subject. Following various face to face meetings with the experts of the subject, four individual teaching methods were determined as reported below:

1. Lecturing Method: It is one of the oldest teaching methods in which subjects are thought by a teacher in a logical manner. It is most widely used teaching method of all because of easiness of the application, needed comparatively shorter time and also making certain specific topics easily understandable.
2. Discussion Method: Discussion method is generally employed in order to lead the students to think more, to strengthen their knowledge and to correlate with the previous knowledge. The method is most widely used especially at the stage of internalizing, searching for different solving ways of a problem and finally at the evaluation stage. Some fundamental profits of discussion method are given by Borich (2004) as follows. Discussion method:
    - improves critical thinking capacities of the students,
    - leads students to examine actual solutions,
    - helps to develop suggestions and generalizations,
    - helps to strengthen their abilities of analysis, synthesis and evaluation.
3. Demonstration Method: What is meant by demonstration is to explain and apply a certain technique in front of the students. According to Pippard (1980), the behavior of a system at critical points is valuable and likely to occur on the other side of a transition. These are the ones which are properly introduced with the aid of demonstrations, since these can illustrate dramatically the difficulty of guessing, without help from experiment. This method ought to be used especially to concretize some physics subjects to relate with daily life. It is also frequently used when the laboratory equipment and time are insufficient.

4. Problem Solving Method: This method is important especially to create an effective learning process to increase student's capacity and motivation and also to gain a scientific attitude. Many educational researchers think that problem solving is a very important stage to reach the specific goals (Charles, Lester & O'Daffer, 1994; Masingila & Lester, 1998) have investigated problem solving method and divided into three separate stages: understanding of the problem, solving the problem, replying the question. Proper problem solving activity consists of seven different thinking abilities according to the researchers above (Charles et al., 1994);
    - understanding and formulating the problem,
    - understanding circumstances and variables,
    - finding sufficient data to solve the problem,
    - formulating the sub problems and choosing the proper strategies,
    - applying the problem solving strategies,
    - obtaining the answer, and
    - evaluating the answer.

In order to succeed in physics, it is very important to have a critical thinking ability, to relate any subject with daily life and to be able to solve problems with the scientific methods. Hence, the hybrid approach, employed in this research, consists of discussion section to exchange the ideas and to defense their thoughts, problem solving section in order to understand and solve problems within a group, demonstration section to concretize. A brief scrutiny of the literature indicates that the vast majority of the research is focused on cognitive area of education however affective area such as attitude of the students is left out of the interest. Therefore, the relation between hybrid approach teaching and student attitude towards in general physics, is one of the goals of the present paper and it is believed to be essential. The problem sentence of this specific research can be stated as follows:

- What are the effects of traditional teaching (lecturing) and hybrid teaching approach on the academic success relating electrostatics subjects and attitude towards physics?

METHODOLOGY

a) Design and Subjects

The research, presented here, was carried out on two classes of student teachers studying electrostatics in General Physics II courses (80 students in total) in Education Faculty of Buca, at Dokuz Eylül University, in the spring semester of 2004- 2005 academic year. Electrostatics is one of the important topic of General Physics Courses is taken during the fourth semester for Elementary Mathematics Education Department. It should be pointed out that these students had previously not been taught the topics aforementioned above.

In this research, non-equivalent control group model (Karasar, 2002) is employed. Treatment group comprised of 28 female and 12 male students, the control group, on the other hand, contained 26 female and 14 male students; therefore both groups have 40 students.

b) Data Gathering Tools and Materials

The overall data has been collected by two separate tools. In order to measure the success of the subjects before and after the study, Electrostatics Achievement Test (ET)

developed by the researchers having KR-20 reliability coefficient of 0,74 and containing 30 multiple-choice questions from four different sub topics is used (see appendix). Every correct answer is labeled 3,33 point and, wrong answer is labeled zero point while analyzing data of ET. Therefore Maximum point of ET is 100 and the minimum is zero.

The second data collection tool is an Attitude Scale towards Physics (ASP), originally developed by Akdur (1996) having an alpha reliability coefficient of 0.92 and comprised of 20 items. Half of the items have positive meaning like "I like physics" or "I would like to reserve most of my studying time to physics" and the others have negative meaning like "Without physics studentship would be more enjoyable" or "Physics is the most frightening subject of all". Respondents were instructed to mark their agreement or disagreement with the principal's decision on five point scale: Strongly agree, agree, undecided, disagree or strongly disagree. Rule oriented responses were scored 5-1 from strongly agree to strongly disagree for positive items and 1-5 from strongly agree to strongly disagree for negative items. Maximum point of ASP is 100 and the minimum is 20.

ET and ASP were applied to the control and treatment groups to gather information about the level of success and attitude both before and also after the study.

c) Experimental Process

The experimental part of the entire work for treatment and control group has been carried out in the following sequence:

1. Prior to the study, the students were handed out ET and ASP to conduct pre-measurements.
2. Before teaching planned topics, in order to increase familiarities about how to work within a group and to learn and apply problem solving strategies by means of Problem Solving, students were informed about problem solving by using Problem Solving Worksheet (PSW) and collaborative learning methods and techniques. PSW was developed by the researchers, considering commonly accepted problem solving strategies and containing the following topics: 1. Read the problem and then rewrite it with your own words, 2. Write down the given data 3. Write down the concepts to be found, 4. Try to decide the physics law, principle or theory that you will be using, 5. Illustrate the problem in a picture or in a diagram, 6. Solve the problem and 7. Evaluate the result. Heterogeneous student groups were combined, each having four students. The students were trained the problems belonging to mechanics by means of PSW lasting 4 hour. Consequently, students' ordinary problem solving behaviors were slowly disappeared and more systematic problem solving strategies were partially developed.
3. During the experimental process, every sub topics, Electric Fields, Gaussian Law, Electrical Potential, Capacitors and Dielectrics, was completed in a week. In the first two hours (90 minutes) of every week, the subjects were lectured by the same researcher in both groups. To maintain students' attention, pure lecturing activities were enriched by some question-answer sessions.
4. In the second two hours, a unit worksheet containing three discussion problems relating to the daily events, five problem solving and one problem production activity was handed out in treatment group. In the first fifteen minutes of each unit, three discussion problems were resolved within the groups then all of the students participated to the discussion. Later, every single problem was solved by each group in accordance with the instructions of PSW. Every single group was also supposed to create and solve a genuine problem to test their ability of synthesis stage of Bloom's taxonomy. At the end of the lesson, problem solving worksheets were collected by the researchers and

after the assessment of the worksheets they were delivered back to the students as a feedback activity. In control group, the same questions were solved on board and the same discussion problems were explained to the class by the researcher. On the other hand, about fifteen problems covering all cognitive levels were given to the students as a homework activity.

5. In the thirty minutes of the third two hours of overall weekly six hours, a specially designed demonstration experiment was carried out to increase the understanding level of the students in treatment group. Students try to predict the outcomes of the demonstration experiment before it starts and they joined to the demonstration process in every step by trying to predict what happens when the variables change. Next forty five minutes was used for the individual problem solving activities (homework problems) on the board and in front of the students in both groups. Finally a quiz, lasting about fifteen minutes, was applied to the students to measure the actual specific progress of the students.
6. After all subtopics were completed; ET and ASP were used for collected post data of the process. Overall research completed within the six weeks. The collected data were statistically evaluated and processed by means of mean, standard deviation and t-test statistical techniques.

FINDINGS

In order to check the achievement of students in the treatment and control groups on electrostatics before the research, the arithmetic mean of the pre-scores and standard deviations of the Electrostatics Achievement Test (ET) were calculated and independent samples t-test was used to compare the difference between the averages of the groups is meaningful or not. Results can be seen on the Table 1.

Table 1. *Pre-test Results of Electrostatics Achievement Test*

Group	N	Mean (X)	Standard Deviation (SD)	Degrees of Freedom (df)	t	p
Treatment	40	24,72	10,96	78	1,90	0,229
Control	40	20,40	9,35			

Before the intervention there was no statistically significant difference between both groups (t=1,90; df=78; p>0,05). In order to control the difference in terms of success between treatment (X=65,97; SD=11,38) and control group (X=37,20; SD=15,32) after the study, independent samples t-test was employed and Post-test results of Electrostatics Achievement Test are shown in the Table 2.

Table 2. *Post-test Results of Electrostatics Achievement Test*

Group	N	Mean (X)	Standard Deviation (SD)	Degrees of Freedom (df)	t	p
Treatment	40	65,97	11,38	78	9,53	0,032
Control	40	37,20	15,32			

A statistically significant difference was found between control and treatment group (t=9,53; SD=78; p<0,05) in favor of treatment group.

In order to control the difference attitude towards physics lesson between treatment (X=5807; SD=15,81) and control group (X=55,62; SD=16,09) before the study independent samples t-test was employed, as can be seen in the Table 3.

Table 3. *Pre-test Results of Attitude Scale towards Physics*

Group	N	Mean (X)	Standard Deviation (SD)	Degrees of Freedom (df)	t	p
Treatment	40	58,07	15,81	78	0,60	0,903
Control	40	55,62	16,09			

As shown in Table 3 there was not found a statistically significant difference (t=0,60; df=78; p>0,05) between the groups' attitude towards physics. After the experimental process attitudes towards physics lesson of treatment and control group are slightly dropped. The same technique was used to determine the difference in terms of attitudes between treatment (X=53,20; SD=14,60) and control group (X=49,95; SD=11,86).

Table 4. *Post-test Results of Attitude Scale towards Physics*

Group	N	Mean (X)	Standard Deviation (SD)	Degrees of Freedom (df)	t	p
Treatment	40	53,20	14,60	78	1,09	0,077
Control	40	49,95	11,86			

It gives no significant difference (t=1,09; df=78; p>0,05) between the two groups' attitude towards physics lesson after the study, as can be seen the data in the Table 4.

DISCUSSION

In this study, it was aimed to determine the effects of a hybrid approach which is formed by means of incorporating different teaching methods, namely lecturing, open discussion, demonstration and problem solving on student success on electrostatics and attitude towards physics.

With respect to the data belongs to Electrostatics Achievement pre-test, there is not a meaningful difference between the groups. Throughout the study, both groups' success was increased. According to Electrostatics Achievement post-test results, the instruction structured according to hybrid teaching approach is more successful than traditional instruction. There can be a similar result on Ramsier's work (2001) that uses different teaching methods in his study. Considering the treatment group's students attendance to the discussions on the causes and results of daily events, experiments and also having the chance to see their foreknowledge, misconceptions and changing them by this way, it is an expected situation. We also experienced throughout the application that the discussion part of this approach increased the level of student motivation. During the discussion activities students have specifically learned how to use physics laws in order to achieve for instance a certain specific goal.

In order to help to analyze the situation in a better way, we have continuously monitored the students throughout the entire application period. According to our observations, demonstration of an experiment has made progress to some extent and the concepts of demonstration experiment were immediately used by the students during the in-classroom activities.

In a demonstration experiment both visual communication and also virtual communication is used together (Gürol, 2004). Research on student learning from demonstrations suggests that traditional demonstrations may not effectively help students grasp the underlying scientific concepts or recognize and correct scientific misconceptions they may have (Halloun & Hestenes 1985, Roth, McRobbie, Lucas & Boutonné, 1997; Crouch, Fagen, Callan & Mazur, 2004). We want students to predict the results of the experiment before demonstration and during the experiment they try to find what happens if the variables change. It is known that giving students a couple of minutes to predict the outcome and record their predictions costs very little time and yields better understanding from demonstration (Crouch et al., 2004).

Teaching problem solving strategies to students and solving problems in groups give students to have the chance to see the different ideas about the solution and to learn a good solution way/strategy for a physics problem by this way. Gök and Sılay (2008) found that teaching of problem-solving strategies in cooperative groups was effective on the physics achievement of the students and attitudes. Problem solving activity within the groups created an active classroom atmosphere. We clearly observed the students sharing responsibility and exchanging ideas so creating enjoyable, beneficial and understandable school environments.

However, there has been no meaningful change in terms of the student attitude. We believe that the application time length (period) in this case is insufficient to observe such a meaningful increase or decrease in affective field. Any progress concerning the attitude at any individual research as we all know needs longer periods specifically more than 6 months, therefore we do not primarily propose any significant advance; however, it is important to determine the level of attitude within the treatment and control groups. After the study, attitude of the students in control group dropped to a large extent in comparison with the attitude of the students in treatment group. Therefore instruction in a hybrid teaching approach is more beneficial. Effects of gender and academic area on university students' attitude towards physics was studied by Demirci (2004). In his work, it was found that male students have more positive attitude toward physics than female students and also the result supported that there was a significance difference among the students' academic areas and students' attitude toward physics. It was also noted that generally the department of Physics and Space students' attitude was more positive than others. More negative attitude was found in Biology and Environmental Science and Oceanography students than the other academic departments (Demirci, 2004). In our study, the subjects were from Elementary Mathematics Education Department and they would not use their electrostatics knowledge while they teach mathematics in their future life. This opinion to our view can be affecting the attitude in our study.

CONCLUSIONS and SUGGESTIONS

After the study, it is found a difference between the mean scores of ET of two groups and this difference is statistically meaningful in favor of hybrid teaching approach. Additionally, the activities are used during the hybrid instruction have some advantages in spite of gaining social abilities such as group working, discussion and gaining scientific abilities such as observation, explication. There has been no meaningful change in the students' attitudes towards physics lesson at the end of the study. Attitude can be improved if one increases the period of the application session.

In the first group work experience, researchers can encounter with some adaptation problems among the students based on traditional teaching. In order to achieve, problem solving activities must be practiced in groups before the study. Using time is very important for this approach. If students are familiar to group work and using PSW, there

will be no time limit problems. In the literature, ideal student number in a group is given 3-4 but it is difficult for a new researcher to manage groups in a large classroom. Hence, we suggest working in small groups to reach specific goals.

Inner classroom discussion is ought to be done and controlled on a definite and limited topic. Otherwise, you may miss the specific aim of the instruction. Therefore, the teacher must be careful about limits of the discussion. Both in discussion and class demonstration, it is necessary for the students to check whether their own conversation with others is correct and fruitful or needed to be changed. In demonstration, the students should be asked to predict the result before the experiment and interpret the result after the experiment is completed.

REFERENCES

Akdur, T. E. (1996). *Effect of Collaborative Computer Based Concept Mapping on Students' Physics Achievement, Attitude Toward Physics, Attitude Toward Concept Mapping and Metacognitive Skills at High School Level*. Unpublished Master Thesis, Middle East Technical University, Turkey.

Ashcroft, K. & Foreman-Peck, L. (1994). *Managing Teaching and Learning in Further and Higher Education.* UK: Rutledge.

Bağcı, N., & Şimşek, S. (1999). Fizik Konularının Öğretiminde Farklı Öğretim Metotlarının Öğrenci Başarısına Etkisi, *Gazi Üniversitesi Eğitim Fakültesi Dergisi,* 19(3) 79-88.

Bilal, E. & Erol, M. (2008). Student Understanding of Capacitors in a DC Circuit. *Balkan Physics Letters Special Issue*, 642-647.

Borich, G. D. (2004). *Effective Teaching Methods*. Ohio: Library of Congress Cataloguing in Publication Data.

Capel, S. A., Leask, M. & Turner, T. (2001). *Learning to Teach in the Secondary School.* UK: Rutledge.

Charles. R., Lester, F. & O'Daffer, D. (1994). *How to Evaluate Progress in Problem Solving.* Virginia: The National Council of Teachers of Mathematics.

Crouch, C.H., Fagen, A.P., Callan, J.P. & Mazur, E. (2004). Classroom Demonstrations: Learning Tools or Entertainment? *American Journal of Physics*. 72(6), 835–838.

Demirci, N., (2004). Students' Attitudes Towards Introductory Physics Course. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi.* 26, 33–40.

Dunn, J. W. & Barbanel, J. (2000). One Model for an Integrated Math/Physics Course Focusing on Electricity and Magnetism and Related Calculus Topics. *American. Journal of Physics.* 68, 749–757.

Furio, C. & Guisasola, J. (1998). Difficulties in Learning the Concept of Electric Field. *Science Education.* 82, 511–526.

Gök, T. & Sılay, İ. (2008). Effects of Problem-Solving Strategies Teaching on the Problem-Solving Attitudes of Cooperative Learning Groups in Physics Education. *Journal of Theory and Practice in Education.* 4(2), 253-266.

Guisasola, J., Almud´ı, J.M. & Zubimendi, J. L. (2004). Difficulties in Learning the Introductory Magnetic Field Theory in the First Years of University. *Science Education.* 88, 443–464.

Gürol, M.. (Eds.) (2004). *Öğretimde Planlama, Uygulama ve Değerlendirme*. Elazığ: Üniversite Kitabevi.

Halloun, I.A. & Hestenes, D. (1985). Common Sense Concepts about Motion. *American Journal of Physics*. 53, 1056–1065.

Karasar, N. (2002). *Bilimsel Araştırma Yöntemi.* Ankara: Pegema Yayınevi.

Masingila, J. O. & Lester, F. K. (1998). *Mathematics for Elementary Teachers via Problem Solving.* USA: Prentice Hall.

Pippard, A. D. (1980). Demonstration Experiments in Critical Behaviour and Broken Symmetry. *European Journal of Physics,*1*,* 13-18.

Ramsier, R. D. (2001). A Hybrid Approach to Active Learning. *Physics Education,* 36(2), 124-128.

Roth, W-M., McRobbie, C.J., Lucas, K.B. & Boutonné, S. (1997). Why May Students Fail to Learn From Demonstrations? A social Practice Perspective on Learning in Physics. *Journal of Reseach Science Teaching*. 34, 509–533.

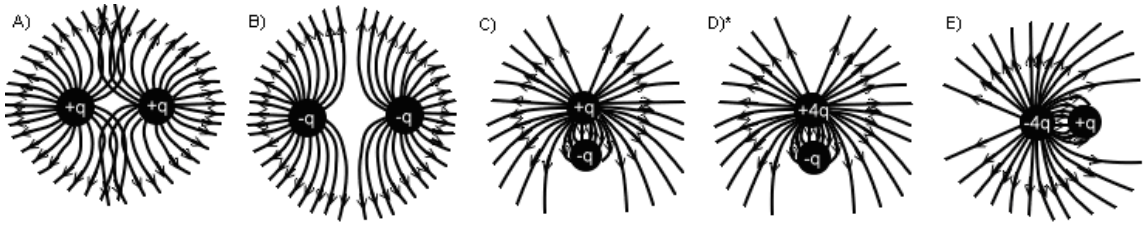
Saarelainen, M., Laaksonen, A. & Hirvonen P.E. (2007). Students' Initial Knowledge of Electric and Magnetic Fields—More Profound Explanations and Reasoning Models for Undesired Conceptions. *European Journal of Physics*. 28, 51–60.

Singh, C. (2006). Student Understanding of Symmetry and Gauss's Law of Electricity. *American Journal of Physics*. 74 (10), 923-936.

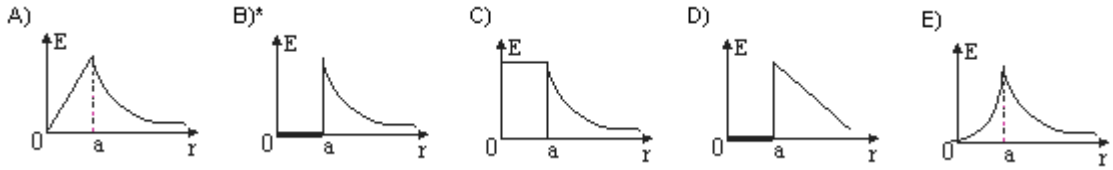
Törnkvist, S., Pettersson, K.-A. & Tranströmer, G. (1993) Confusion by Representation: on Student's Comprehension of the Electric Field Concept. *American. Journal of Physics*. 61**,** 335–338.

APPENDIX. Sample Questions of ET (*correct answer)

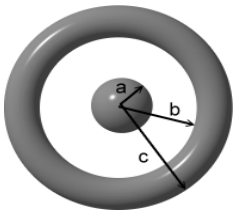
Question 6. Which one of the following correctly represents lines of force surrounding two charged particles?



Question 10. Which of the following shows the variation of the electric field with radial distance for a conducting sphere having a uniform charge and a radius of a?



Question 13. A uniform conducting sphere with a radius of a and a uniform conducting spherical shell having an inner radius of b and an outer radius of c are placed as shown below. Electric field lines between the inner sphere and shell (a<r<b) and outside the shell (r>c) are racially outward. Which of the following concerning the charges of the sphere and shell is correct?



A) Charge of the sphere is +Q, charge of the shell is -2Q.

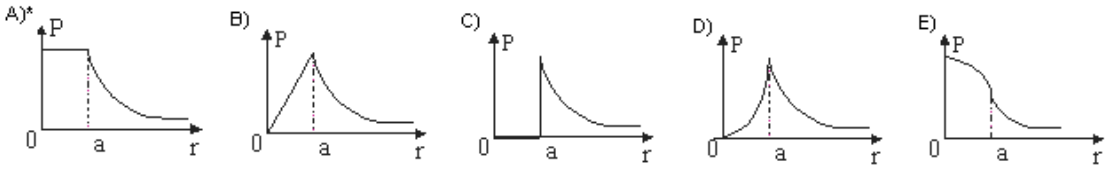
*B) Charge of the sphere is +2Q, charge of the shell is -Q.

C) The sphere is neutral, charge of the shell is -Q.

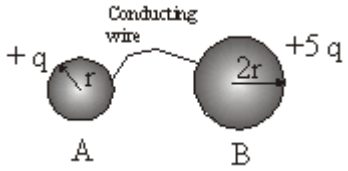
D) The sphere is neutral, charge of the shell is +Q.

E) Charge of the sphere is -Q, shell is neutral.

Question 15. Which of the following shows the variation of the electrical potential with radial distance for a conducting sphere with a radius of a having a uniform charge?



Question 16. Which of the following is definitely true when two uniformly charged conducting spheres one having a radius of r and a charge of +q, the other one having a radius of 2r and having a charge of +5q are connected by means of a conducting wire?



A) The spheres exchange charges until the charge of the spheres is equal.

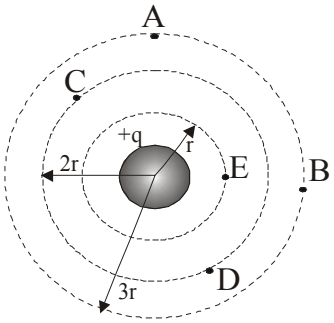
*B) The spheres exchange charges until the potential of the spheres is equal.

C) Charge exchange between the spheres does not occur.

D) At the end of the charge exchange, total amount of the charge of the system is +3q.

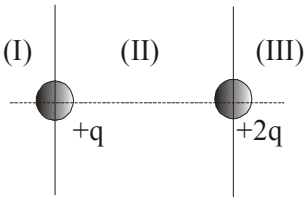
E) At the end of the charge exchange, the charge ratio of the spheres is $(q_A/q_B)=1/4$

Question 17. Equipotential potential surfaces for a uniform field of a particle having a net charge of +q are shown below. Which of the following needs maximum energy when a test charge moves along the paths given below?



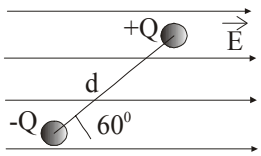
A) From A to B
B) From C to D
*C) From D to E
D) From A to D
E) From B to D

Question 21. Two different charges are placed on a horizontal line as shown below. Where the electrical potential energy of the system is zero?

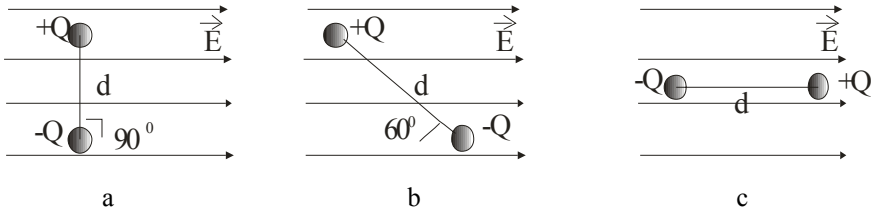


A) Only in part (I)
B) Only in part (II)
C) Only in part (III)
D) Both in parts (I) and (II)
* E) In nowhere

Question 28.



An electrical dipole moment having an angle of 60^0 with the electric field lines is placed as shown on the left. If one rotates electric dipole moment, 30^0 anticlockwise (a), 60^0 anticlockwise (b) and 60^0 clockwise (c) and the works needed to manage the rotations are named as W_1, W_2, W_3 respectively, which of the following is true in terms of the works done?



a b c

A) $W_1 > W_2 > W_3$ B) $W_1 < W_2 < W_3$ C) $W_1 = W_2 > W_3$ D) $W_1 = W_2 > W_3$ *E) $W_2 > W_1 > W_3$