

The Effect of Seating Location on students' Performance in Physics: Interactive Use of Computer Presentations

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ABSTRACT

The growing enrolment in schools has resulted in large classrooms with various seating arrangement. In order to observe the effect of seating location on student's performance, the researchers took a sample of 'O' level Physics students. The students were administered a pre-test to form two equivalent groups. The students in one group were randomly assigned the action-zone seats while the other group was seated in the non-action zone seats. The class was taught for four weeks through computer multimedia presentations. A post-test was administered at the end and the students' performance was analyzed on various assessment objectives. Data were analyzed using two-way repeated measure ANOVA. No significant difference was found in the mean score of students' seating in the action zone and the non-action zone. The students differed in their performance on various assessment objectives. There was significant difference in students' performance on recalling component but not in understanding component, or handling information, or problem solving component.

Keywords: Seating Location; Performance; Computer; Assessment Objectives; Physics; ANOVA.

INTRODUCTION

The growing population especially in developing countries has resulted in an increased students' enrolment in educational institutions. As the resources are meager in these countries, the immediate solution is therefore to increase the size of the classrooms. Classrooms are replaced by lecture halls. Students have a variety of options to sit in the class with several rows and columns or they may sit in circular formation, which is not always possible. The students may sit near the instructor; some may choose to sit in the central rows while some may prefer to sit at the back. Does this preference for choosing seat location have any relationship with students' personality? Does seating location affect students' learning



and ultimately their performance? The research literature is scarce in this particular area (Weinstein, 1979; Kalinowski & Taper, 2007).

Koneya (1976) discovered that the highly verbal students in the class expressed their preference for frontal seats. The reason for this preference may be that the focus of teachers' attention is the front and central seats of the classroom, which was termed as the 'action-zone', an area observed with high-verbal interaction as identified by Adam and Biddle, 1970.

Besides, it was found that those students sitting near the instructor are the most interested students, while those sitting near the door or at the back are the ones finding an escape from the studies (Weinstein, 1979; Benedict & Hoag, 2004). Similarly, students choosing front or central seats in the class were found to be more creative, assertive and competitive (Totusek & Staton-Spicer, 1982) and have a high sense of self esteem (Hillmann, Brooks & O'Brien, 1991; Srivastava, Pandey, Srivastava & Srivastava, 1992; Pederson, 1994). Likewise, the students sitting in the front seats were observed to be more focused and engaged than the students sitting in the back rows (Schwebel & Cherlin, 1972; Levine, O'Neal, Garwood & McDonald, 1980; Montello, 1988; Hillmann et al., 1991). It seems as if highly motivated and creative students more frequently occupy the frontal and central seats. If it is so, then there may be a significant difference in the performance of students sitting in the action and the non-action zone.

A few research studies have verified the above assumption and concluded that students sitting near the board usually performed better than those sitting at the back (Adam & Biddle, 1970; Levine et al., 1980; Holliman & Anderson, 1986; Pederson, 1994; Benedict & Hoag, 2004). If seating location is such an important factor in students' performance, can we create a class, which is so interactive that the effect of seating location is eliminated or minimized? Can we take help from the modern technology such as computer multimedia presentations to improve students' performance as a whole? According to Akçay, Durmaz, Tüysüz and Feyzioğlu (2006), the use of computer multimedia applications create interest in students, make them more attentive and improve retention due to increased number of senses. The problem with the researcher was to investigate whether students' seating location affects their performance on different assessment objectives in Physics in two equivalent groups taught with computer presentations.

Wulf (1977) in her research compared the performance of two classes taught by the same teacher. In one class, the students were assigned seats by the teacher, while, in the second class, the students could choose their seats themselves in the classroom. The results revealed that the mean performance of students varied across the rows in the class where the students chose their own seats. The performance of students was higher among the frontal and central seats. However, there was no significant difference in students' performance in the class where the teacher assigned the seats. Majority of the students expressed their preference to sit in the middle-centre and middle-front rows, while no student preferred to sit in the last row. However, it is obvious that some students prefer to sit in the last rows, which was not expressed by the students here.

Marx, Fuhrer and Hartig (2000) conducted a similar research to examine the influence of seating arrangement and location on question asking by students. The sample was 27 German students of grade 4. The researchers used different seating arrangements. One was the traditional row and column arrangement and the second was semi-circle seating arrangement. The researchers also paid due attention to action-zone if it really exists in the classroom. Action zone was considered region comprising frontal and central seats in the class. Each of the seating arrangement was used for two weeks. The teacher randomly assigned the children to seats. The teaching strategies were kept the same for both the seating arrangement. Two observers carefully registered the students' questions and the teachers'

responses. The study continued for eight weeks. Data were analyzed through repeated-measures ANOVA. They found that seating arrangement had a significant relationship with question-asking rate. More questions were asked when the students sat in semi-circle arrangement. The study also identified the presence of action-zones in row-column seating arrangement while no action-zone was traced in semi-circle arrangement. It seems that the semi-circle arrangement of seats was more useful; however, such arrangement is not possible in all classes. The rows and columns arrangement is more often used. The need is to bring improvement in students' performance sitting in rows-columns arrangement.

In another research, Benedict and Hoag (2004) investigated whether there was any association between students' seating preference and their class performance in two economic classes. Different teachers taught the classes. The average number of students in these classes was around 150. The researchers found that the students sitting near the front were likely to get A's while those sitting at the back had higher percentages of getting D's and F's. The students that received C's and B's were evenly distributed around the class. Moreover, when the students were forced to move forward from their preferred seat location, there was a net gain in their performance grades. In case the students chose a back seat, the result was a lower grade performance. However, this is questionable that moving a student from back towards the front would always result in improved performance.

Three years later, Kalinowski and Taper (2007) conducted an experimental research on students enrolled in Introductory Biology at Montana state university. The students were taught in a moderate lecture hall with 11 rows. The students were divided into three groups and were randomly assigned seats in the hall. The study found that there was no effect of seating position on the students' performance. The reasons assigned for such a result were the small size of the lecture room, the low strength of students involved and lastly the students were biology majors and therefore they might have been more motivated in learning biology. Another noteworthy result of the study was that students who chose to sit in the front rows before they were assigned seats scored significantly better than those who chose to sit at the back.

Likewise, Perkins and Weiman (2005) conducted a research in large introductory Physics class at the University of Colorado. The instructor made every possible effort to make the lecture interactive and engaging for students. The seats were randomly assigned. The lecture hall was large with the last row thirteen meters from the demonstration table. Power point presentations were also used on a big screen for good visibility. The seating position of students was changed during the middle of the semester. It was found that the students' grade decreased steadily as the original seat location was further away from the front. Students who performed well in the front seats continued to perform well even when they were moved to the back seat. This result contradicts the findings of Benedict and Hoag (2004).

Tagliacollo, Volpato and Junior (2010) also examined if there existed any association between students' seat location and class performance. Their sample was of two elementary public schools having 194 and 304 students in Brazil. The classrooms had six rows and six columns and the average strength of students was 31.12 ± 3.95 . The seat location of students was recorded and their grades were obtained from the school bimester record. The data obtained were analyzed using three factors ANOVA. The researchers found a significant association between student performance and seating position and between absence and seating position. The students sitting near the board performed significantly better than those sitting at the back. Meanwhile, the percentage of absence from the school was lower for students sitting at the front position than at the back. Besides, it was also found that the reason for choosing the front seat by students was motivation for learning and for the back

seat there was social isolation. The researchers concluded that students' motivation for learning determines their seating position, which then results in better school performance.

Having discussed the review, it was observed that it is difficult to say whether seating position has an effect on the mean performance of students. The reason for this is that some researchers have found a significant difference in the mean performance of students related to seating location, while some have not found the relation. The present researchers undertook the task by identifying the gaps in the previous research studies with a purpose to improve the design. Firstly, the early researchers have randomly assigned seats to the students without ensuring that the students sitting in the action-zone and the non action-zone formed equivalent groups. Thus, a fair comparison could not be made between the groups. In the present study, the researchers ensured that the students sitting in the action and non-action zone belonged to equivalent groups (procedure for group formation is given in methodology section). Secondly, the researchers observed and analyzed the performance of students sitting in the action and non-action zone on various assessment objectives that were not investigated before. The assessment objectives were related to recalling, understanding, and handling information and problem solving. Lastly, the researchers aimed to investigate whether the problem associated with seating location can be minimized through interactive use of computer multimedia presentations. The research study was undertaken in Islamabad, the capital of Pakistan, a country having the sixth largest population in the world with meager resources. The classrooms are over-crowded and the use of computers in teaching is very rare and limited.

METHODOLOGY

a) Research Design

The study was empirical in nature and the researchers used pre-test-post test equivalent group design.

b) Sample

The sample for the research was selected from a private school in Islamabad. The school offered 'O' level syllabi and the classrooms had large strength of students. The size of the classrooms was also large where the researchers could easily experiment with the required seating locations. The total number of Physics students in the final 'O' level class (grade X) for the year 2010 was 42, all of whom were selected and comprised the sample of the study.

c) Formation of Hypotheses

The researchers formed the following hypotheses to observe the effect of seating location on students' performance in various assessment objectives in Physics.

1. H_0 : There is no significant difference in the mean performance of students in the action and non-action zone on the post-test if taught through computer multimedia presentations
2. H_0 : There is no significant difference in the mean performance of students on the assessment objectives if taught through computer multimedia presentations
3. H_0 : There is no significant interaction between seat location and students' performance on assessment objectives if taught through computer multimedia presentations
4. H_0 : There is no significant difference in the mean performance of students in the action and non-action zone on recalling component of the post-test if taught through computer multimedia presentations

5. H_0 : There is no significant difference in the mean performance of students in the action and non-action zone on understanding component of the post-test if taught through computer multimedia presentations
6. H_0 : There is no significant difference in the mean performance of students in the action and non-action zone on handling information and problem solving component of the post-test if taught through computer multimedia presentations

d) Developing of Research Instruments and Data Collection

The data were collected through two Physics tests. The tests were called Physics pre-test and post-test. The purpose of the pre-test was to assist in forming two equivalent groups of students, while, the post-test was used to study the effect of the seating location on students' performance after a duration of four weeks. In order to form the two equivalent groups, the researchers constructed a test containing Physics items. The items were taken from classical mechanics of the Physics syllabus of 'O' level. There were forty multiple-choice items and eight structured questions with various subparts. The structured questions required short answers or mathematical calculations according to the 'O' level pattern. The test was validated by a panel of three subject specialists. These subject specialists had more than ten years experience of teaching the same 'O' level Physics syllabus and were expert in their field. In the light of their expert opinions and suggestions, some of the items were modified in language and improved. The test was administered for pilot testing to twenty Physics students in a nearby school having similar academic facilities and Physics curriculum. The pilot test helped improve the content and wording of some of the items. The result of the pilot test was then used to calculate the reliability of the test. This reliability was found through Pearson correlation formula for which the researchers used SPSS PSAW 18 (Reg.) computer software. The reliability coefficient of the test was 0.78, which was acceptable.

The post-test was also developed through the same process. However, the post-test contained items related to the content that was taught during the four weeks. The post-test was validated by four subject specialists. The test was prepared very carefully so that the correct proportion of assessment objectives could be included. There were 40 multiple-choice questions (MCQs) having 40 marks and short structured questions with 75 marks in accordance with criteria of Cambridge International Examination system. There was no negative marking in the MCQs. The test items contained 30% marks for recalling, 35% marks for knowledge with understanding and 35% marks for assessing handling information and problem solving (based on University of Cambridge weighting of assessment objectives prescribed in 2010 Physics syllabus, 5054). The reliability coefficient of the post-test was 0.83. (A few examples from the post-test are given in Appendix 1)

e) Procedure

The researchers intended to explore whether the seating location of students has any effect on performance of Physics students on various assessment objectives. The seating position was classified into two types: the action zone seats and the non-action zone seats based on Adam and Biddle (1970) classification. Students of grade X ('O' Levels) were chosen for the study. 'O' level is equivalent to grade X standard and is offered by the University of Cambridge, England. Some of the private schools in Pakistan are affiliated with the University of Cambridge and offer 'O' levels curriculum to their students.

Based on the students' performance on pre-test, the researchers formed two equivalent groups through matching students' score. Students in one group were randomly assigned the action-zone seats, while the second group was assigned the non action-zone seats.

In order to understand the action-zone and the non action-zone, the students were seated in six columns and seven rows. The first three rows and the two central seats in the fourth and fifth row formed the 't' shape action zone based on Adam and Biddle (1970) action zone (fig. 1). There were 22 students assigned to action-zone seats while 20 students were assigned the non action- zone seats.

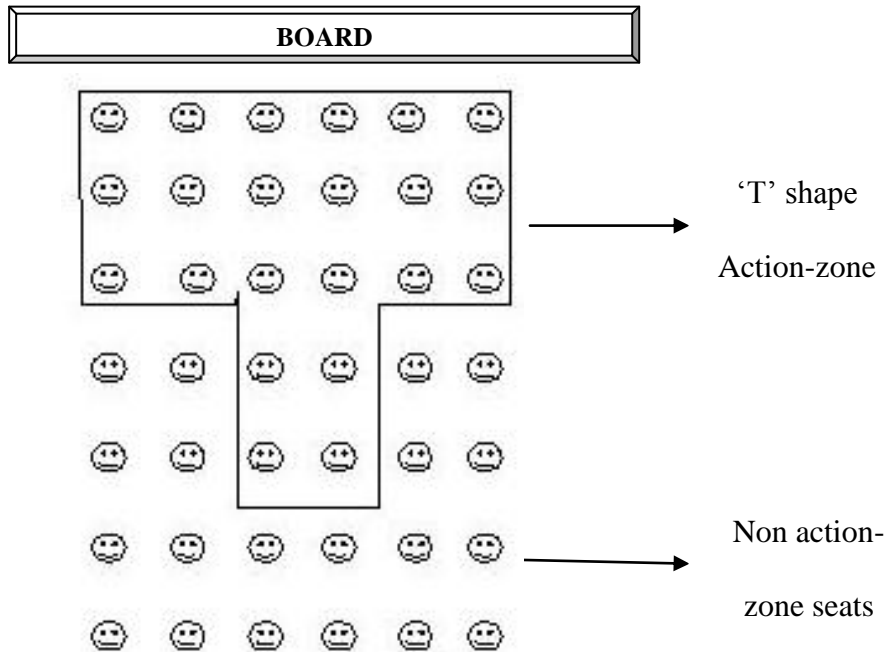


Figure 1. Seating Position of Students in Each Group

The students were taught the units of kinematics, dynamics and deformation ('O' Level syllabus, 2010) through computer power point presentations (collection of animations from Phet, Yanka, virtual physics lab etc, colorful diagrams, short clips, assessment items). The students' experience with multimedia presentation was not common. The science teachers in the school also did not use multimedia presentations for teaching their subject. The most frequently used method in Pakistan is the chalk and talk method (Iqbal, 2004). All the presentations were prepared and presented by the researchers. The students were not involved in making presentations, as it was not the purpose of the study. However, during presentations the teacher would initiate discussion to involve the students and provoke ideas. The teacher would ask questions related to working of any animation, a quiz item, missing values, incomplete diagram, worksheet, etc. that would make the students involve in classroom discussion.

This activity through multimedia continued for 4 weeks. The teacher made every effort to involve the students in the class. Two teacher-assistants also helped the Physics teacher to set up the apparatus in time and search for relevant web resources. At the end of the fourth week, a surprise post-test in the units taught was administered to the class.

f) Data Analysis

One student sitting in the action zone did not take the post-test due to absence. The number of students that appeared in post-test was 21 for the action-zone and 20 in the non action-zone seats. The score of the students on the post-test was found and then tabulated to find the mean differences in the action-zone and the non action-zone for various assessment objectives. The researchers used two-way ANOVA repeated measure design for finding

significant difference in the mean performance of students in the action and non action-zone seats. The data were analyzed using SPSS PSAW statistic 18 (Reg.).

RESULTS

The results of post-test of students in the action zone and the non-action zone on various assessment objectives are presented in Table 1.

Table 1. Mean of students on various assessment objectives seating wise

	Seating Position	Mean	Std. Deviation	N
Recalling component	Action Zone	74.05	15.951	21
	Non-Action Zone	64.65	11.287	20
	Total	69.46	14.504	41
Understanding component	Action Zone	56.95	7.365	21
	Non-Action Zone	54.10	9.867	20
	Total	55.56	8.686	41
Handling information & solving problems	Action Zone	58.10	22.878	21
	Non-Action Zone	59.30	14.553	20
	Total	58.68	19.044	41
Overall Performance	Action Zone	63.032	2.062	21
Overall Performance	Non-Action zone	59.350	2.113	20

Table 1 refers to mean performance of students in the action and the non action-zone on various assessment objectives. The highest mean score of the students was found in the recalling component for both groups. However, the students sitting in the action zone seats performed comparatively better on recalling component than students in the non action-zone. In contrast, the mean performance of students in both the groups was lower on understanding component and handling information and problem solving. The overall mean score of students in the action zone was higher than the students in the non action-zone. An interesting finding here was the comparatively high mean score of students sitting in the non-action zone on handling information and problem solving.

Table 2. Relationship between seating location and overall students' performance

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Seat	138.86	1	138.86	1.56	.22	.04
Error	3482.31	39	89.29			

Table 2 shows the effect of seating location, the between subjects effect on students' performance. The value of F-test, 1.55 was not significant for seating location. Thus, the first null hypothesis could not be rejected and it is concluded that there is no significant main effect of seat location on students' performance if they are taught through computer multimedia presentations: $F(1, 39) = 1.56, p > .05, \eta^2 = .04$

Table 3. Tests of within-subjects effects (Measure: score)

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Assessment	4296.57	1.90	2259.61	11.57	.00	.23
Assessment * Seat	586.33	1.90	308.36	1.58	.21	.04
Error(Assessment)	14489.34	74.16	195.39			

Table 3 shows the F-value for assessment objectives, the within-subject effect. The value of F-test for assessment objectives was significant, so the second null hypothesis is rejected. It can be concluded that there is significant difference in the mean performance of students on different assessment objectives if taught through computer multimedia presentations: $F(1.90, 74.16) = 11.57, p < .05, \eta^2 = .23$

Regarding the interaction of seating location and students' performance on assessment objectives, the F-ratio was not significant. The third null hypothesis cannot be rejected and it is concluded that there is no significant interaction of seat location and students' performance on assessment objectives if taught through computer multimedia presentation. $F(1.90, 74.16) = 1.58, p > .05, \eta^2 = .04$

In order to find which assessment objective has contributed to significance, the researcher analyzed pair-wise comparison of the assessment objectives shown in Table 4.

Table 4. Pair wise comparisons of the various assessment objectives

<u>(I) Assessment</u>	<u>(J) Assessment</u>	<u>Mean Difference (I-J)</u>	<u>Std. Error</u>	<u>Sig.</u>
<u>1</u>	2	13.82*	2.42	.00
	3	10.65*	3.28	.01
<u>2</u>	1	-13.82*	2.42	.00
	3	-3.17	3.26	1.00
<u>3</u>	1	-10.65*	3.28	.01
	2	3.17	3.26	1.00

1=Recalling

2=Understanding

3=Handling information

* = significant

Table 4 shows that all the performances on the assessment objectives were significant except one pair, for which there was no significant difference. This pair was students' performance on understanding component and handling information and problem solving.

Table 5. Univariate ANOVA for recalling component

<u>Source</u>	<u>Sum of Squares</u>	<u>df</u>	<u>Mean Square</u>	<u>F</u>	<u>Sig.</u>
Between Groups	904.69	1	904.69	4.70	.04
Within Groups	7509.50	39	192.55		
Total	8414.20	40			

In order to observe the effect of seating location on each of the assessment objectives separately, the researchers analyzed the data using univariate ANOVA. The performance of students on each assessment objective was analyzed for action-zone and non action-zone. Table 5 refers to the students' performance statistic on recalling component in the action zone and the non action-zone. It can be seen that there existed significant difference in the students' performance on recalling component in the action and non action zone if taught through computer multimedia presentations, $F(1, 39) = 4.70, p < .05, \eta^2 = .11$; thus the fourth null hypothesis can be rejected.

Table 6. Univariate ANOVA for understanding component

<u>Source</u>	<u>Sum of Squares</u>	<u>df</u>	<u>Mean Square</u>	<u>F</u>	<u>Sig.</u>
Between Groups	83.35	1	83.35	1.11	.30
Within Groups	2934.75	39	75.25		
Total	3018.10	40			

Table 6 indicates the students' performance data on understanding component. The value of F-test was not significant as alpha level was greater than .05. Thus, the researchers failed to reject the fifth null hypothesis and it is concluded that there is no significant difference in the mean performance of students in the action and the non action-zone on understanding component, $F(1, 39) = 1.11, p > .05, \eta^2 = .028$

Table 7. *Univariate ANOVA for handling information and problem solving*

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	14.87	1	14.87	.04	.84
Within Groups	14492.01	39	371.59		
Total	14506.88	40			

Similarly, the data in Table 7 shows that the F-test value was very small and not significant for handling information and problem solving component. The seating location has no significant effect on students' performance in handling information and problem solving component. The last null hypothesis failed to be rejected, $F(1, 39) = .040, p > .05, \eta^2 = .001$.

DISCUSSION and CONCLUSION

The research revealed some useful as well as interesting data related to the effect of seating location on students' performance on various assessment objectives. The early researchers found a significant relationship between seating location and students' performance. The present research did not verify this result: there was no significant main effect of seating location on students' performance in 'O' level physics students. The reason for this result might be the formation of two equivalent groups and teaching through computer multimedia presentations. However, the researchers found significant difference in both the groups when analyzed separately for each assessment objective. It was found that the mean performance of students was better on recalling components as compared to understanding, and handling information and solving problems. The reason for this high mean on recalling might be that students retained recalling information well through computer presentation. Comparing the mean performance of students in the action-zone and the non action-zone on recalling component, it was observed that there was significant difference in the score. The students in the action-zone performed significantly better than the non action-zone. As discussed by previous researchers, students sitting near the board were more attentive and focused as expected.

The overall mean score of students in both the groups was lower on understanding component. The students sitting in the action and the non action-zone seats being equivalent scored comparatively same. However, the students in the action zone scored slightly higher than the non action-zone, while this difference was not significant according to ANOVA. The use of computer in the classroom teaching was equally helpful to students in the action zone and the non-action zone.

Regarding the mean performance of students on handling information and solving problems, the results were very interesting. The students in the non action-zone had a higher mean score than the action-zone. However, this difference was not significant and occurred by chance. It seems as if seating location has no significant effect on students' performance on understanding component and handling information and solving problems if two conditions are met. The students in the two zones should belong to equivalent groups and secondly they should be taught through computer multimedia presentations.

Keeping these points in mind, the present research recommends the regular use of computer in teaching, which helps eliminate the impact of seat location in large classrooms. The science teachers need to pay due consideration to action and non action zone seats in the class ensuring that weak and good students are distributed equally in the two zones. In order to improve students' score on understanding component, the science teachers should also carry hands on experiments along with computer use. This is required because Laboratory activities help enhance conceptual understanding (Mbajorgu & Reid, 2006) and develop the ability to interpret and report scientific investigations (Hodson, 1998). The science teachers should put more emphasis on improving students' performance on understanding, and handling information and solving problems; as the pair-wise comparison of these two components resulted in significant difference in the students' performance. A further research in making the science students involve in preparing multimedia presentations and delivering it with reference to seating location may form an interesting study for other researchers.

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APPENDIX 1

Recalling Items

1. Which quantity can be obtained using the equation below?

$$\frac{\text{change in velocity}}{\text{time taken}}$$

A speed B average velocity C distance travelled D acceleration

2. Which one is a statement of Newton's third law of motion?

- A Every force causes a reaction.
- B If there is no resultant force on a body then there is no acceleration.
- C The forces on a body are always equal and opposite.
- D To every action there is an equal but opposite reaction.

3. Which force keeps an electron to move in its orbit around the nucleus of an atom?

- A a gravitational force of attraction from the nucleus
- B a gravitational force of repulsion from the nucleus
- C an electrostatic force away from the nucleus
- D an electrostatic force towards the nucleus

Understanding Items

1. What can not be the resultant of a 5N and 7N force?

- A. 2N B. 5N C. 10N D. Neither of them

2. A body is moving in a circle at a constant speed. Which of the following statements about the body is true?

- A There is no acceleration.
- B There is a force acting at a tangent to the circle.
- C There is a force acting away from the centre of the circle.
- D There is a force acting towards the centre of the circle.

3. If a spring extends permanently due to application of force then

- A. the spring is within the elastic limit
- B. the limit of proportionality is not crossed
- C. the elastic limit is crossed
- D. the elastic limit is not reached but the spring is very flexible

Handling Information and Solving Problems

1. A car speeds up from rest to a speed of 10 m / s in 5 s. What is the average acceleration of the car?

- A 0.5 m / s² B 2 m / s² C 15 m / s² D 50 m / s²

2. A car is travelling at constant speed along a road and drives over a large patch of oil. The driver applies the brakes to stop the car. Compared to braking on a dry road, what may happen?

A The car slows down more quickly because of the greater friction between the tyres and the road.

B The car speeds up at first because of the reduced friction between the tyres and the road.

C The car takes longer to slow down because of the reduced friction between the tyres and the road.

D The car takes longer to slow down because the thinking distance of the driver is greater.

3. A single spring extends by 5mm when a 10 N load is attached to its one end. What will be the extension if two such springs are attached from end to end with the same load?

A. 2.5 mm

B. 5mm

C. 7.5 mm

D. 10 mm

(The researchers have taken some items from University of Cambridge Local Examination Syndicate (UCLES) past papers)