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***INVESTIGATING MISCONCEPTIONS  
IN MECHANICS USING MCQS***

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***SMEC 2014***

## Context and Aim

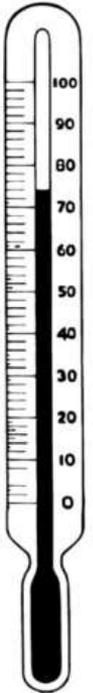
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**Inquiry based learning places a strong emphasis on students questioning what they observe and analysing different possibilities.**

**These skills are at the core of multiple choice questions (MCQs).**

**This research used MCQ-tests to assess student understanding of the topic of Mechanics in Physics for Leaving Certificate.**

**The Aim was to explore whether MCQs could reveal the concepts that caused greatest difficulty for students and to identify the type of misconceptions held by students or “alternative thinking” used by them**



## Style of Research

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### What did I set out to do?

- Designed 6 tests of 10 MCQs each, for one topic
- Invited teachers to use these tests with their students.
- Asked the teachers to photocopy the student work and post it back to me for analysis

### What happened?

- Sixty questions were answered by 100 students in this study.

### When did it happen?

- The study took place in the academic year 2013-14



## Motion 1

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*When a ball is thrown vertically and returns to its starting point, which of the following is true?*

- A Its velocity throughout is constant*
- B Its acceleration was zero at the highest point*
- C The time going up exceeded the time falling down*
- D Its displacement is zero*



*The correct **answer D** was chosen by 52% of students. It is interesting to note however that 44% chose option B.*

## Motion 2

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A car, starting from rest with constant acceleration, travels 64 m in 4 seconds.  
What is the magnitude of the acceleration?

- A 2
- B 4
- C 8
- D 16 .



The correct **answer C** was chosen by 51% of students but 45% chose D. They would appear to have concluded that division of the two given numbers was the best option.

## Motion 3

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A body starts from rest with a uniform acceleration,  $a$ .

The time  $t$  taken for it to undergo a displacement  $s$  is given by

- A.  $t^2 = 2s/a$
- B.  $t^2 = 2a/s$
- C.  $t^2 = a/2s$
- D.  $t^2 = s/2a$

The correct **answer A** was chosen by 47% of students but 37% chose B. Perhaps some of those who chose B were familiar with  $v^2 = u^2 + 2as$  and thought the  $2a/s$  sounded right.

## Momentum 1

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When a cannon ball is fired and the cannon recoils which of the following is true?



- A the cannon's momentum is greater than the cannon ball's momentum
- B the cannon's momentum is equal to the cannon ball's momentum
- C the cannon's momentum is less than the cannon ball's momentum
- D the sum of the two momentum values is zero

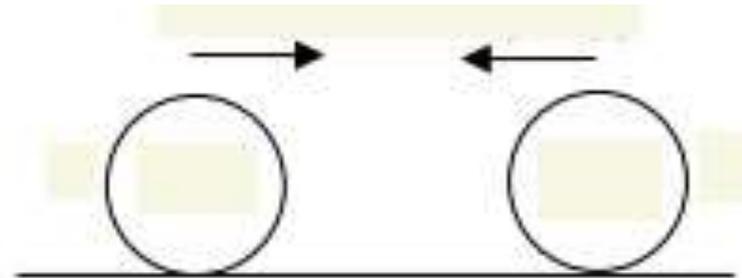
The correct **answer D** was chosen by 34% but 46% chose B. Some of the high number who chose B may have overlooked the vector nature of momentum.

## Momentum 2

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Two bodies, each of mass  $m$ , are travelling in opposite directions with speeds of 4 and 6, respectively, when they collide. After the collision they move together as one body with speed  $v$ . The value of  $v$  in is

- A 10
- B 5
- C 2
- D 1



The correct **answer D** was chosen by 12% of students.

The fact that 50% chose C may indicate difficulties with the use of mathematics in problem solving in Physics

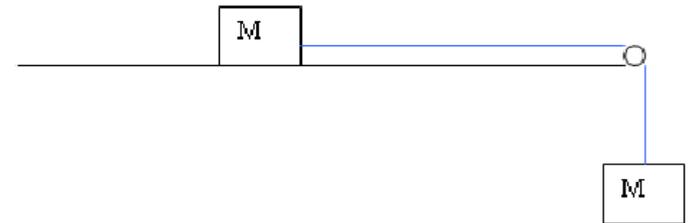
# Force

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If the contact between the table and the box is smooth and if the pulley is smooth, and the inelastic string taut, and the masses equal, the acceleration of the hanging mass will be

- A  $2g$
- B  $g$
- C  $g/2$
- D  $0$

where  $g$  denotes the acceleration due to gravity



The correct **answer C** was chosen by 19% of students but 49% chose B

# Gravity

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The gravitational force between two objects in outer space is 5400 N.  
How large would the force be if the two objects were three times as far apart?

- A 16200 N
- B 1800 N
- C 600 N
- D 200 N



The correct **answer C** was chosen by 28% of students but 59% chose B.

## Work

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When a person holding a box applies a force of 40 N vertically upwards so as to keep the box stationary at a height of 2 m above the ground, the work done by the person is

- A 80 J
- B 40 J
- C 20 J
- D 10 J
- E 0 J



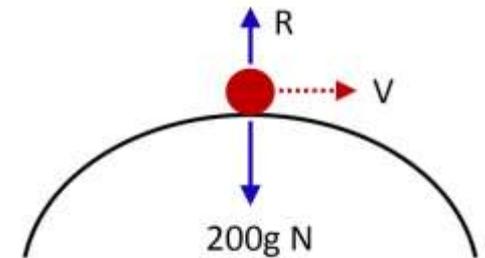
The correct **answer E** was chosen by 26% of students but 35% of students chose A. This might indicate that some students missed the point that while the object is stationary, the displacement is zero and the resultant work is zero.

## Circular Motion

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A bridge is in the shape of an arc of a circle of radius 80 m. The greatest speed that a ball of mass 200 kg can travel over the highest point of the bridge without losing contact with the road is

- A 32
- B 28
- C 24
- D 20
- E 16



The correct **answer B** was chosen by 43% of students but 23% chose C

## Simple Harmonic Motion 1

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A horizontal platform is oscillating in a vertical plane with simple harmonic motion of amplitude 0.05 m.

The greatest number of oscillations per second so that an object at rest on the platform remains in contact with the platform at all times is



- A  $7\pi$       B  $2\pi$       C  $\frac{7}{\pi}$       D  $\frac{\pi}{2}$       E  $\frac{\pi}{7}$

**Answer C**

*only 3% chose C but 24% B 30% D and 22% E*

## Simple Harmonic Motion 2

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It is assumed that the depth of water in a harbour rises and falls with simple harmonic motion. On a certain day the low tide has a depth of 9 m at 1220 and the following high tide had a depth of 13 m at a time of 1820.

Which of the following is true:

- A amplitude is 4 m and period is 12 hours
- B amplitude is 2 m and period is 6 hours
- C amplitude is 4 m and period is 6 hours
- D amplitude is 2 m and period is 12 hours

The correct **answer D** was chosen by 23% of students but 21% opted for A, 18% for B and 19% for C

## Reflections

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- Well designed MCQs are very powerful and efficient for assessment
- MCQs are very revealing of individual's strengths and weaknesses
- MCQs lend themselves to analysis by spreadsheets
- This research was based on a far larger sample size than Classroom research and by involving 9 different teachers in a wide variety of schools, the findings may be considered to reveal student misconceptions generally rather than in a particular set of circumstances.



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Thank you !

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