## Appendix A: Collaborative Tutorials for Maths 102

The description of Maths 102 from the department's course guide is given below, so readers can judge the nature of the course for which these resources are intended. An excerpt from the study guide is also given to provide additional context. The three resources are:

- Example of a collaborative tutorial problem. An interesting point here is that students have not met the differentiation of trig functions in lectures before they do this problem;
- Example of the marking schedule provided to tutors, to show he emphasis on ideas. All collaborative tutorials have more than 100% possible marks so that completion (i.e. time) is not an essential pre-requisite to gaining full marks;
- The cover-sheet for the tutorials, on which students write their solutions. As shown, half the marks come from the practical component of the tutorial (communication, working together as a group), the other half comes from marking their written solutions.

**MATHS 102: Functioning in Mathematics**

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An introduction to calculus that builds mathematical skills and develops conceptual thinking through active participation in problems that model real life. MATHS 102 makes full use of appropriate technology and prepares students for further study in Mathematics.

**That bonus marks are given**

**Excerpt from Maths 102 Study Guide for Students**

A collaborative assignment task is an activity in which a group of students (usually three) attempt to solve a mathematics problem together. The solution is submitted as a joint effort and all three students will gain the same mark. You do not have to work with the same students every time. The assessment is in two equal parts:

Oral: in which tutors will assess the collaboration of the group members in the problem solving process and the understanding that the whole group has of the problem and its solution.

Written: in which the group's written solution will be handed in and marked in the usual way.

Responses and interactions with these questions for the Five Collaborative tutorials will make up 10% of the total assessment for the course and are completed in the tutorial session, so attendance at the tutorials is essential.

# DEPARTMENT OF MATHEMATICS

## Maths 102 COLLABORATIVE ASSIGNMENT 4

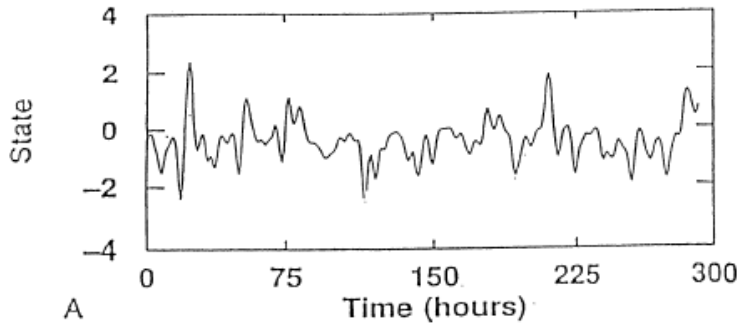
## PARKINSON'S DISEASE

Oliver Sacks, in his book AWAKENINGS deals with people who suffer from Parkinson's Disease and the remarkable effects that administering a certain drug called L-Dopa can have on them. This book has also been made into a film staring Robert de Niro and Robin Williams. The following is adapted from an appendix in the book.

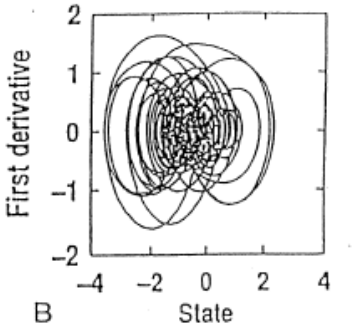
When a patient has Parkinson's Disease, their level of activity can vary from hyperactivity to complete immobility. The following graph, **A,** was obtained from data gathered by a patient who scored himself on a scale of -5 to +5, where 0 represents the normal state. He evaluated himself every 90 minutes for a period of 3 months.

The next graph, **B**, is a representation of "phase-space". You are going to find out what this means.

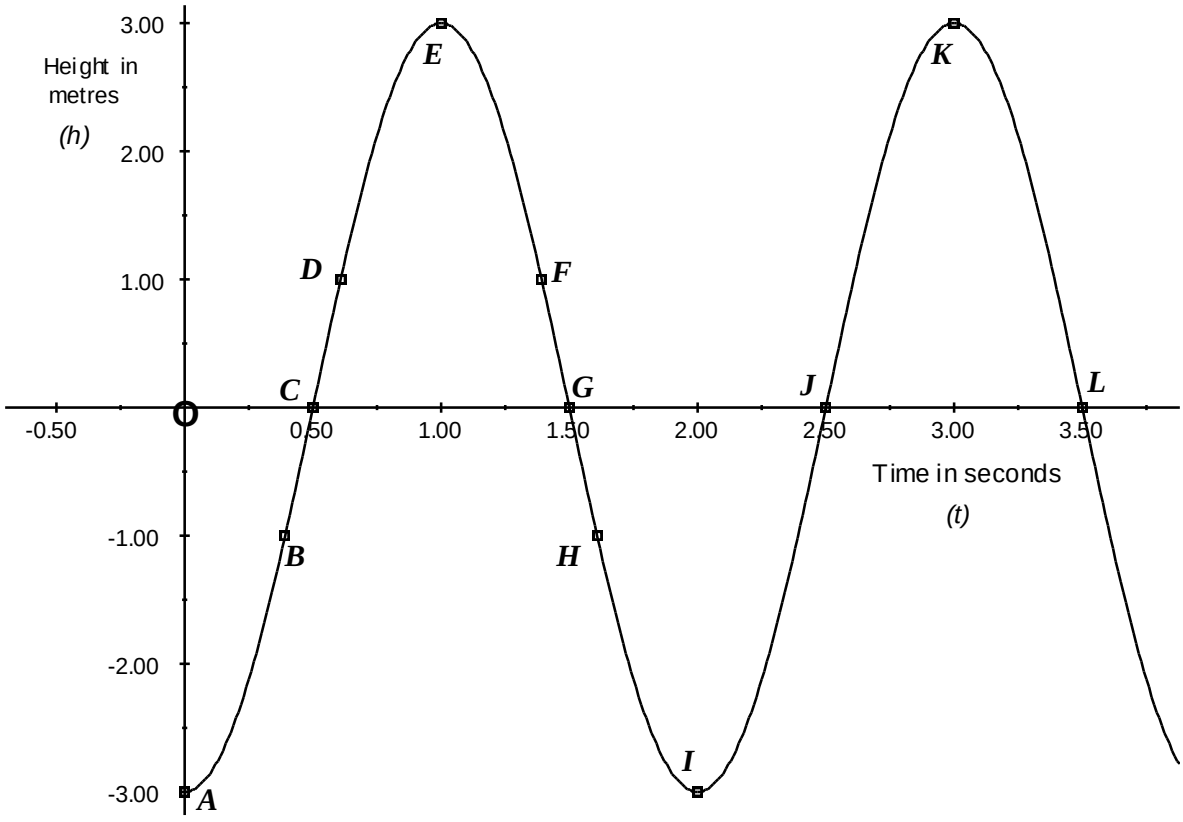
Graph A




Graph B




Here is a graph showing how the height($h$) of a mass bobbing up and down on a piece of elastic varies with time($t$), about the mid-point of the motion(O).



(Questions 1 to 3 refer to the graph about the bobbing mass.)

**Question 1:**

(a) What does the graph tell you about the initial state of the mass and the elastic?

(b) What is the total distance covered by the mass in one cycle?

(c) How many times does the mass bounce 1 full cycle in one hour if it keeps bouncing at the same rate?

(d) What kind of a graph is this? Describe this graph in the form of a function, $h(t) = ?$

**Question 2:** (Refer to the points labelled A, B, C etc.)

(a) At what points is the mass momentarily stationary?

(b) Write down the point(s) where the mass is moving at maximum speed.

(c) Given that B is the point (0.39,-1), and that the gradient at B is 8.9, what would the gradient be at each of the points D, F, and H?

(d) Fill in a table like the one below, for all the letters A to I.

| letter | t-coordinate | h-coordinate | gradient |
|---|---|---|---|
| A | 0 | -3 | 0 |
| B | 0.39 | -1 | 8.9 |
| C | 0.5 | 0 | 9.4 |

(e) Using the table above, or the function $h(t)$ obtained in 1(d), give an appropriate model for the derivative of the function, $h'(t)$.

**Question 3:**

The phase-space graph is obtained by plotting the graph of the gradient, ie. derivative (along the *y*-axis ) against the height (along the x-axis), and drawing it as a smooth curve.

Sketch the phase-space graph, and describe its shape. How does its shape relate to the motion of the mass?

**Question 4:**

In the light of what you have seen in question 3, comment on the graphs of the Parkinsonian Patient given at the start.

# DEPARTMENT OF MATHEMATICS

## Maths 102

### COLLABORATIVE ASSIGNMENT 4

### SOLUTIONS

**Question 1:**

(a) The mass is below the midpoint, with the elastic stretched to its maximum. (reasonable description) (1)

**0.5 mark for 'below'**
**0.5 mark for 'fully stretched'**
**accept reasonable explanation**

(b) (3m +3m)x2=12m (2)

**1 mark for identifying 1 cycle**
**1 mark for 12m, or 0.5 for 6m**

(c) 1 cycle = 2secs $\Rightarrow$ (60/2)x60 =1800 (1)

(d) The graph is of a cosine function: $\Rightarrow$ h(t)=Acos(Bt) (4)

t=0, cos(Bt)=1, $\Rightarrow$ A= -3

t=0.5, h(t)=0 $\Rightarrow$ -3cos(0.5B)=0 $\Rightarrow$ cos(0.5B)=0

$\Rightarrow$ 0.5B = $\pi$/2

$\Rightarrow$ B = $\pi$

h(t)= -3cos($\pi$t)

**1 mark for cos or –cos**
**1 mark for A = –3**
**1 mark for B = $\pi$**
**1 mark for equation**

**Note : Also possible to have a sine graph, using a phase shift : h(t) = 3sin[$\pi$(t – 0.5)]**

**Question 2:**

(a) Stationary when gradient =0 $\Rightarrow$ points A, E, I, K (2)

**1 mark for 1 point**
**1 mark for the rest**

(b) Moving at maximum speed when gradient is greatest:
$\Rightarrow$ C, G, J, L (2)

**1 mark for 1 point**
**1 mark for the rest**

(c) D =8.9
F & H= -8.9 (2)

**Less 0.5 mark per error**

(d)

| letter | t-coordinate | h-coordinate | gradient |
|---|---|---|---|
| D | 0.61 | 1 | 8.9 |
| E | 1.0 | 3.0 | 0 |
| F | 1.39 | 1.00 | -8.9 |
| G | 1.5 | 0 | -9.4 |
| H | 1.61 | -1 | -8.9 |
| I | 2.00 | -3 | 0 |

(4)

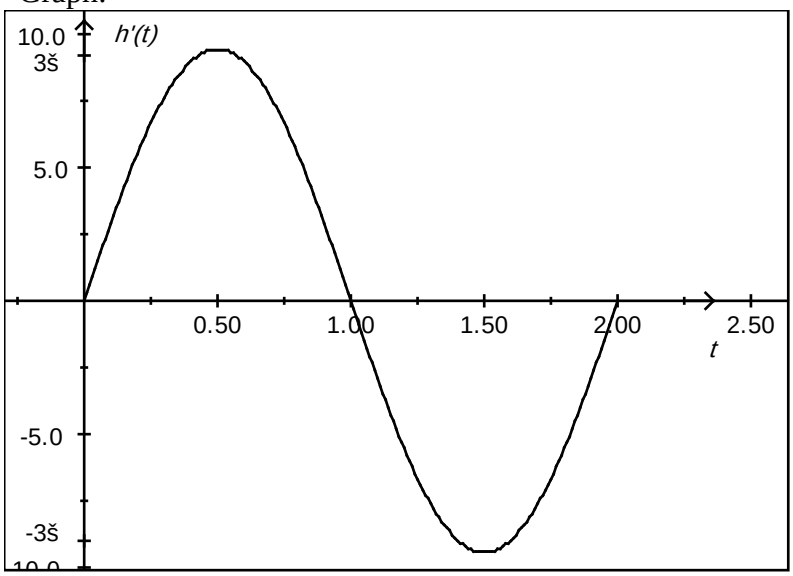
**Less 0.5 mark per error (18 solutions so more than 8 mistakes gets 0 marks.)**

(e) May model using equation or graph:

Equation: From 1(d), $h(t) = -3\cos(\pi t)$

$\Rightarrow h'(t) = 3\pi\sin(\pi t)$

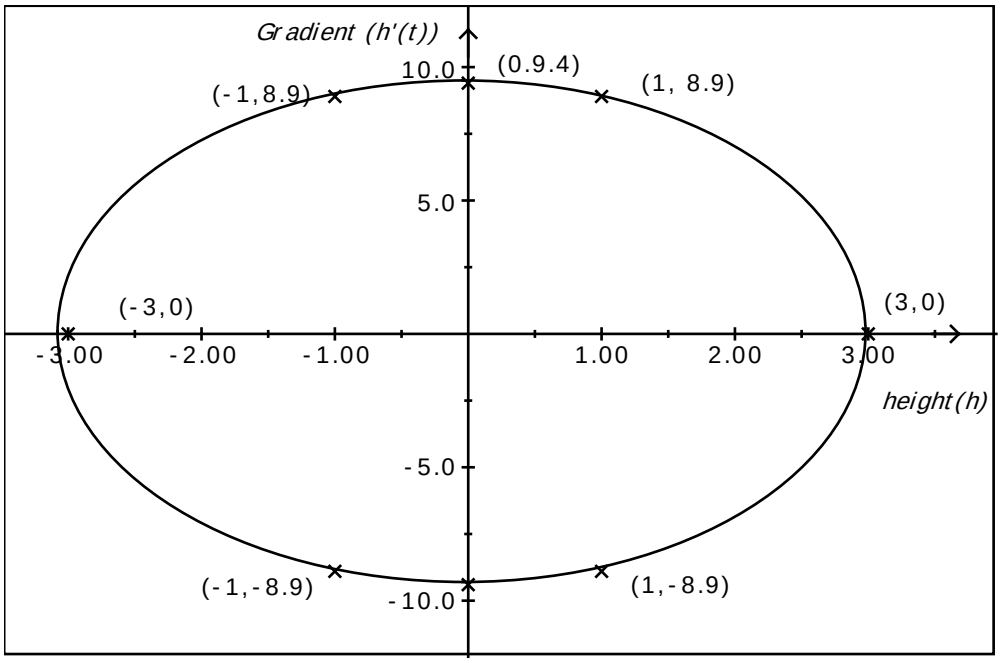
Graph:




(3)

**1 mark for getting <u>type</u> of function,1 mark each for exact values 3π and πt OR if by graph, 1 mark for graph (sine), and 1 mark each for correct value on axes.**

**Question 3:**




The graph is an ellipse, which shows that the motion repeats itself.

(4)

**Note COE from the table in 2(d)**
**1 mark axes correct**
**1 mark smooth shape**
**1 mark goes through points**
**1 mark reas explanation**

**Question 4:**

The loops in the phase graph suggest that the level of activity for sufferers of Parkinson's disease is also cyclical, ie repeats itself in some way..

(1)

**1 mark for reasonable explanation consistent with graph in Qu 3.**

**Total = 26 possible, leave as mark/20**

# MATHS 102 COLLABORATIVE QUESTION

Surname:_____ First Names:_____ Student ID:_____

Surname:_____ First Names:_____ Student ID:_____

Surname:_____ First Names:_____ Student ID:_____

Tutorial Group: ☐

Assignment No: ☐

Marker:.....

Involvement: 1 3 5
Understanding 1 3 5

Oral Mark /10: .....

Written Mark /10: .....

Total: ☐

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