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14th International Mathematics and Science Olympiad (IMSO)
Experiment Test

Singapore
22 November 2017

Instructions:

1. Do not turn over this page until you are told to do so.
2. Write your index number in the box at the top right hand corner on every page.
3. Follow all the instructions carefully.
4. Complete **Section 1, 2 and 3** in English. The marks awarded for each section or question is shown in brackets, [].
5. There are 8 printed pages in this booklet, excluding the cover page.
6. You have 90 minutes to complete this test.

INDEX NUMBER

EXPERIMENT Frog muscle twitch

INTRODUCTION

During the 1780s, biologist Luigi Galvani observed an interesting phenomenon while he was conducting experiments involving frogs¹. While cutting a frog's leg, his steel scalpel touched a brass hook holding the leg in place. The leg of the dead frog twitched!

Galvani performed more experiments and was convinced that a life force within the muscles of the frog was the source of "animal electricity". His colleague, Alessandro Volta could replicate Galvani's experiment but was sceptical of his hypothesis.

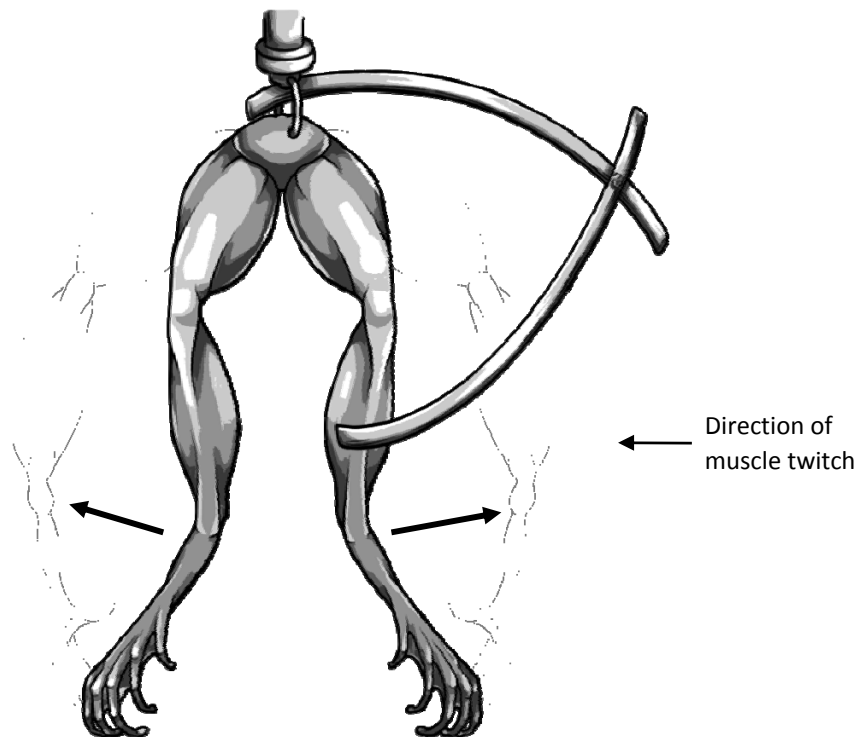


Figure 1: A possible set up for investigating "animal electricity"

What conditions present in the dead frog's muscle during Galvani's accidental discovery were responsible for his observations? Could it be the presence of two different metals? Or substances present in the muscle? Or substances found only in animals?

You will be conducting a simplified version of Galvani's experiment with instrument G instead of frog muscle.

¹ Luigi Galvani and the Twitching Frog's Leg <http://www.batteryfacts.co.uk/BatteryHistory/Galvani.html>

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AIM OF EXPERIMENT

The aim of this experiment is to investigate the conditions that are necessary for the dead frog's muscle to twitch. You will use instrument G instead of frog legs.

WHAT YOU WILL NEED

- A. Circuit consisting of a 9V battery, two copper rods E1 and E2, a switch and instrument G. The parts of the circuit are drawn and labelled in **Figure 2** below:

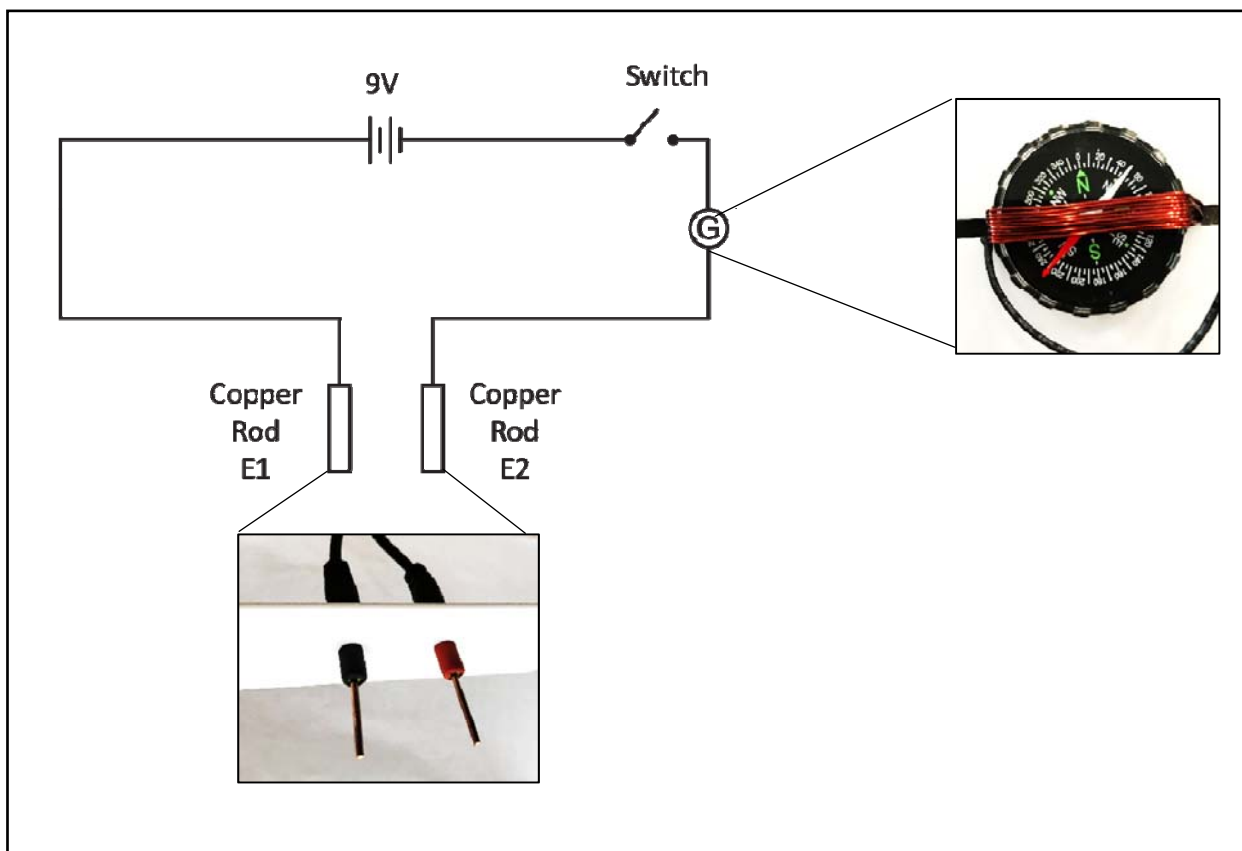


Figure 2

- B. Three liquids (**S1**, **S2**, and **S3**) in separate containers
C. Lemon wedge in container labelled, **S4**
D. Paper towel

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WHAT YOU WILL DO

1. Set up the circuit as shown in **Figure 3** and ensure the switch on the battery holder is set to “OFF” position.

NOTE: Open the lid of container with liquid **S1** carefully to avoid spilling the liquid.

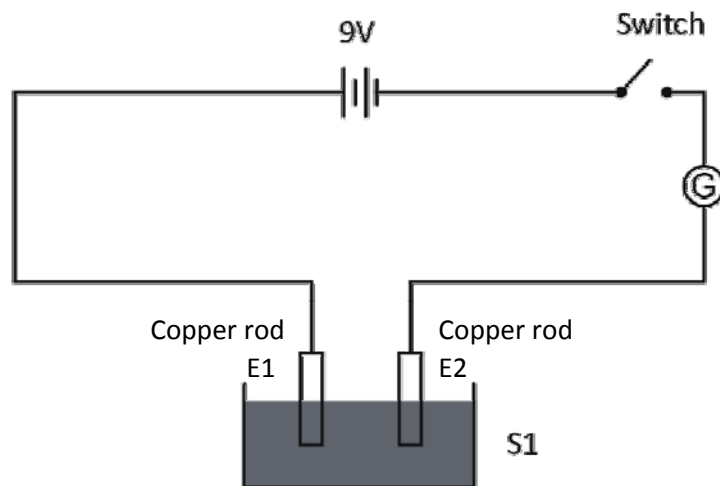


Figure 3

2. Orientate instrument G such that the white compass needle points to “50” as shown in **Figure 4**.



Figure 4

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3. Flip the switch on the battery holder to “ON” position.
4. Observe and record in **Table 1**, the reading on instrument G when the needle stops moving.
5. Observe and record in **Table 2**, what happened in the container and to the copper rods.
6. Wipe the copper rods dry with the paper towel provided.
7. Repeat steps 1 to 4 with **S2** and wipe the copper rods dry.
8. Repeat steps 1 to 4 with **S3** and wipe the copper rods dry.
9. Set up the circuit with the wedge of lemon as shown in **Figure 5** and ensure the switch on the battery holder is set to “OFF” position.

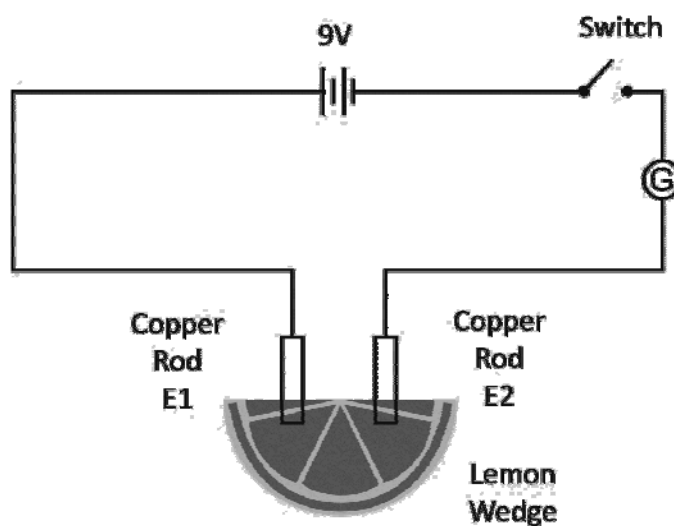


Figure 5

10. Repeat steps 2 to 4 with the wedge of lemon.

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SECTION 1: RESULTS

Based on your observations, record the required readings on instrument G in Table 1.

Table 1

Material	S1 Salt solution	S2 Sugar solution	S3 Lemon juice	S4 Lemon wedge
Reading on instrument G with switch in "ON" position / unit				

[4 marks]

Table 2

Observations of solution S1	Observations of copper rods

[2 marks]

SECTION 2: CONCLUSION

The aim of the experiment is to investigate the conditions that are necessary for the dead frog's muscle to twitch. You used instrument G instead of frog legs.

Based on your observations, what conditions were necessary for the dead frog's muscle to twitch? [2 marks]

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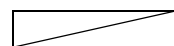
SECTION 3: QUESTIONS

1. Student A replaced solution **S1** in **Figure 3** with a paper clip. He noticed that the white needle deflected by a greater degree as compared to solution **S1**. Based on this observation, comment on the property of the paper clip.
[1 mark]

2. Why is it necessary to wipe the copper rod dry in step 5? [1 mark]

3. **S3** is extracted from the same lemon that the wedge is cut from. Suggest a reason for the difference in your observation with the lemon juice and lemon wedge. [1 mark]

4. If you are given distilled water and a fully saturated salt solution (containing 360 g of salt per litre of water), and materials provided in the above experiment, how would you determine the amount of salt in solution **S1**? List all the steps you will carry out in the space below. [4 marks]



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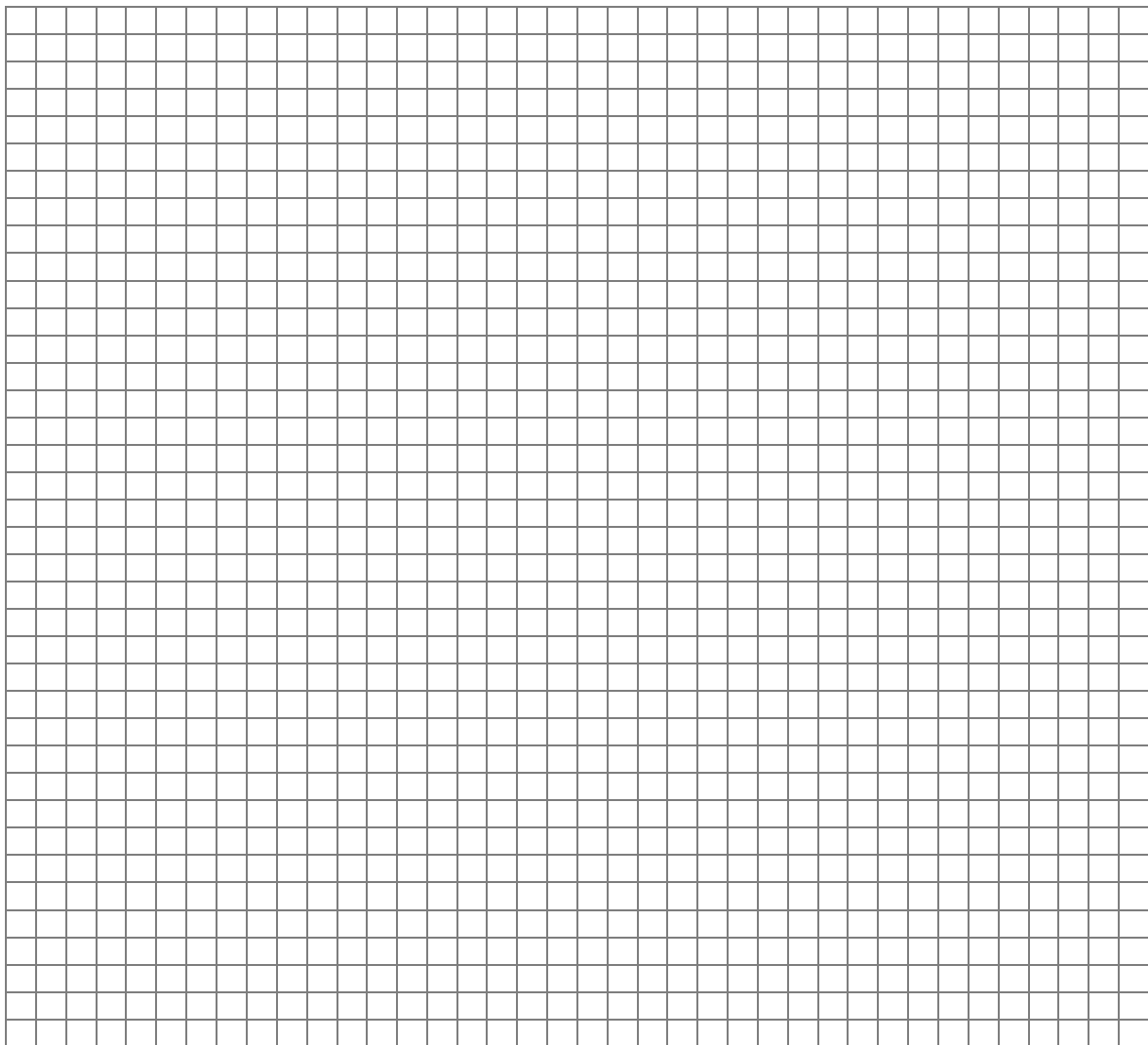
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5. Student B used the same steps in the experiment and obtained readings for three salt solutions. They are tabulated below:

Concentration of salt solution (g/l)	Reading on instrument G (units)		
	1st	2nd	3rd
40	16	18	16
180	79	82	80
250	111	112	113

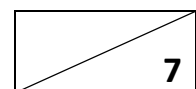
In the grid on the next page, plot a graph to show how the reading on instrument G changes with the concentration of the salt solution. Show on the graph, how you would estimate the concentration of salt solution, **S1**.
[6 marks]

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Estimated concentration of S1: _____ g/l

6. Would you use the same graph to estimate the concentration of salt in **S3**?
Why? [1 mark]



End of Paper