USING DISCUSSION TO IMPROVE STUDENTS' UNDERSTANDING OF ELECTRIC CIRCUITS

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Research consistently shows that many students – even those who are successful problem solvers – do not have an adequate understanding of basis physics concepts. However, there is some evidence that student understanding is helped when students are given opportunities to discuss their ideas about the physics in a situation.

During our session, we demonstrated a teaching procedure called a CUP (Conceptual Understanding Procedure) that is designed to promote student understanding. A CUP involves student discussion about a *qualitative* physics problem set in a real world context. The problem considered during the workshop concerned electric circuits, and was chosen because research that we have been involved in suggests that this is a particularly difficult area for students.

At the start of a CUP, each student is given a copy of the problem to be discussed on an A4 sheet of paper. This problem requires a diagrammatic response. After they have been given time to think about the problem, students then discuss their ideas in groups of three (or four if necessary) and try to reach consensus. Each small group records its response on an A3 sheet of paper, on which the problem is printed. These A3 sheets are then displayed at the front of the room and each small group explains and defends their response, the objective being to achieve a class consensus about the correct scientific answer.

Copies of the A4 and A3 sheet used during this session are provided in APPENDICES A and B respectively. Other CUPs and further details about them are available on our website, the address of which is given below, along with some references.

Finally, teachers sometimes worry that the class will reach a consensus that is 'wrong'. If this happens (and our experience is that this rarely is the case), the exercise is not wasted. Firstly, teachers will be better placed to plan follow-up lessons to help further students' understanding because of the better insights they now have into students' difficulties. Secondly, the students will be ready for further learning because they have invested a lot of time thinking about the issues involved and will be very keen to know the 'correct' answer.

SUMMARY

A CUP involves three stages in which students work

1. Individually

- work alone on questions requiring a diagrammatic answer on an A4 sheet to explore their understanding of a selected concept in a real life situation

2. In triplets

- discuss questions with other members of triplet

- reach a consensus
- commit response to a diagram on a large A3 sheet

3. In whole class group

- look at triplet responses placed on board in front of class
- in an interpretive discussion facilitated by teacher, discuss responses and reach consensus consistent with a correct scientific explanation

FURTHER INFORMATION ON CUPs

1. **Downloadable examples** of CUP exercises and detailed advice for using them are available at:

http://www.education.monash.edu.au/centres/sciencemte/conceptualunderstandingprocedure.html

2. McKittrick, B., Mulhall, P., & Gunstone, R. (1999). Improving understanding in physics: An effective teaching procedure. *Australian Science Teachers' Journal, 45*(3), 27 - 33.

3. There is an article on CUPs on the PEEL CD. Information on PEEL (Project for Enhancement of Effective Learning) and the CD is available at http://peelweb.org/index.html

4. Any queries, comments or suggestions that you may have on CUPs are most welcome. We would be particularly interested to see any examples of CUPs that you might develop. Please send emails to: pam.mulhall@education.monash.edu.au

Ex 10 What is the reading on the voltmeter?

1 The circuit in Fig. 1 is set up like that of an ordinary torch. A voltmeter can be connected between various points in the circuit.

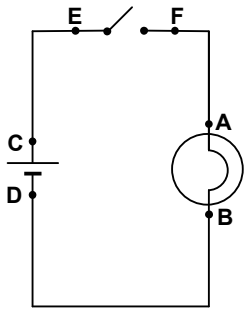
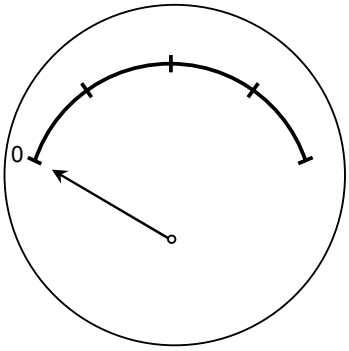


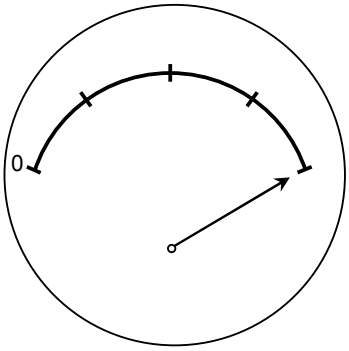
Fig. 1

When the voltmeter is connected between **points A and B** it appears as shown below:

(i) before the switch is closed

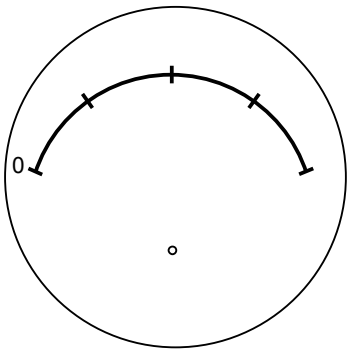


(ii) after the switch is closed

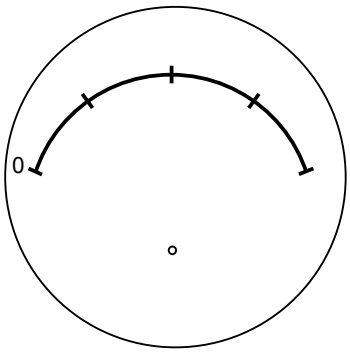


Mark in the approximate position of the **needle** when the voltmeter is connected in the circuit in Fig. 1 between points -

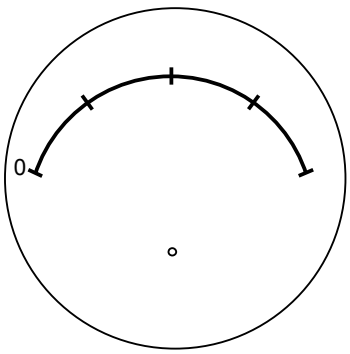
(a) **C and D** before the switch is closed



(b) **E and F** before the switch is closed



(c) **E and F** after the switch is closed



2 The torch circuit of Fig. 1 is modified by adding a second **identical** globe to give the circuits of Figs 2 and 3.

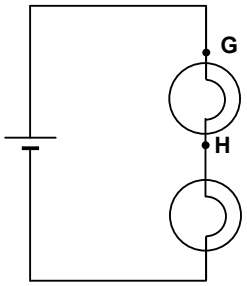


Fig. 2

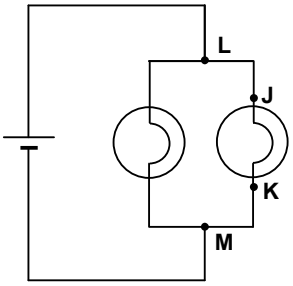
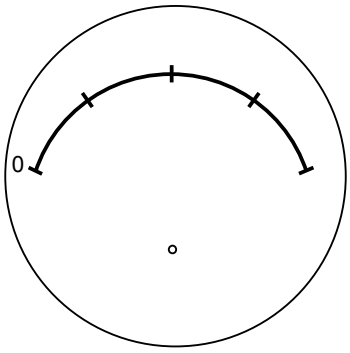
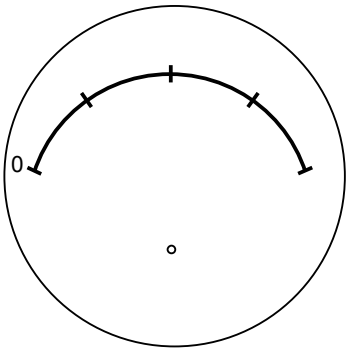
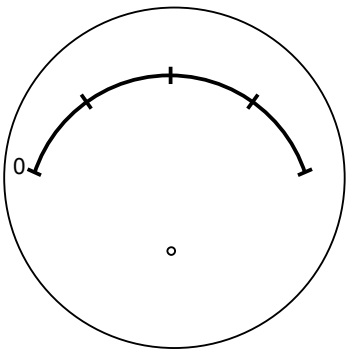


Fig. 3

Mark in the approximate position of the **needle** when the voltmeter is connected in the circuits in Figs 2 and 3 between points -

(a) **G and H**	(b) **J and K**	(c) **L and M**
		

3 The circuit of Figure 3 is modified by adding three more **identical** globes to give the circuit of Figure 4.

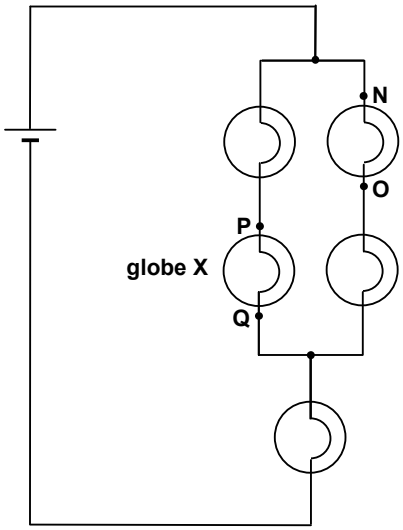
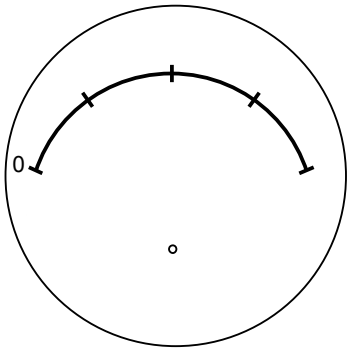
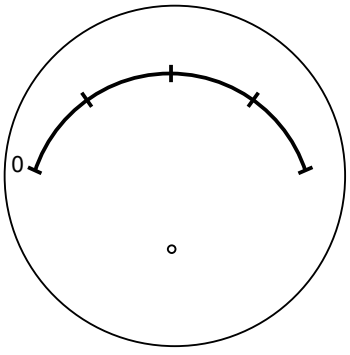
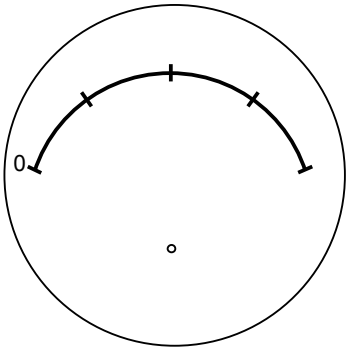


Fig. 4

Mark in the approximate position of the **needle** when the voltmeter is connected between points -

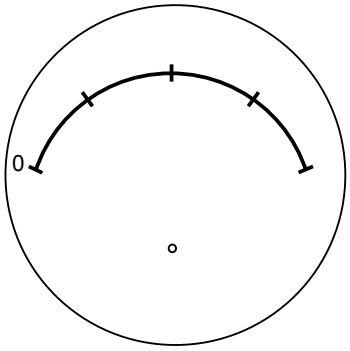
(a) **N and O**	(b) **N and O** after globe X is removed from its socket	(c) **P and Q** with globe X still removed from its socket
		

Ex 10 What is the reading on the voltmeter?

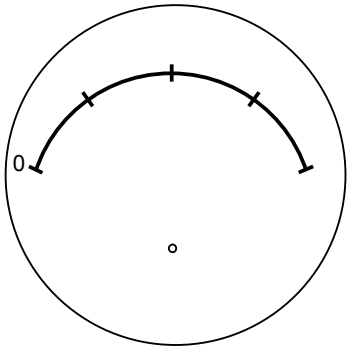
Names

1

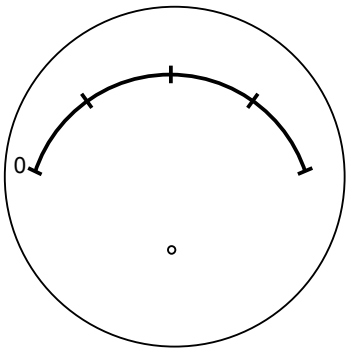
(b) **C and D** before the switch is closed



(b) **E and F** before the switch is closed



(c) **E and F** after the switch is closed



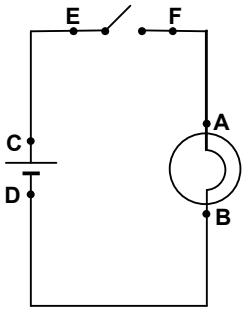


Fig. 1

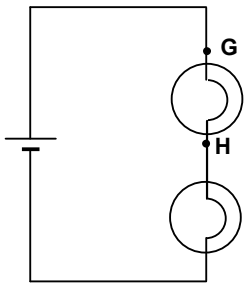


Fig. 2

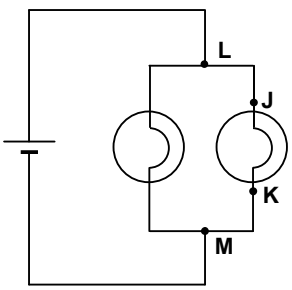
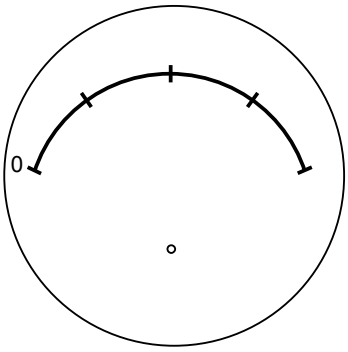


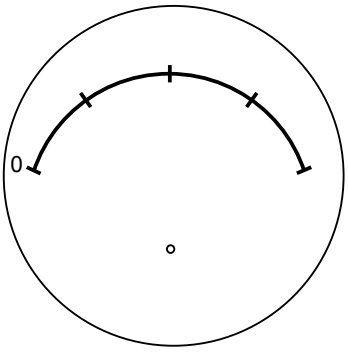
Fig. 3

2

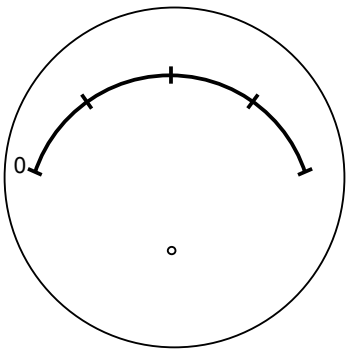
(a) **G and H**



(b) **J and K**



(c) **L and M**



Ex 10 What is the reading on the voltmeter? (cont.)

Names

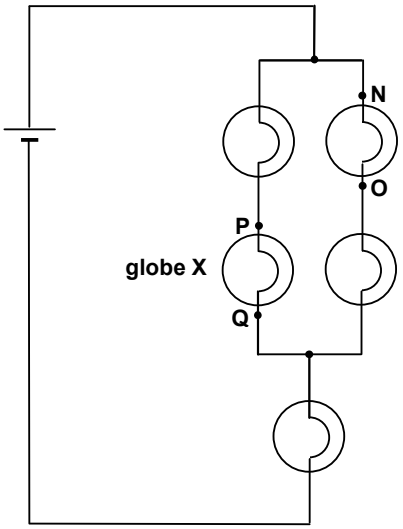


Fig. 4

3	(a) **N and O**	(b) **N and O** after globe X is removed from its socket	(c) **P and Q** with globe X still removed from its socket