USING IMAGERY IN TEACHING PHYSICS CONCEPTS

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Introduction

With the acceptance of the idea that the physics teacher, or any other teacher for that matter, would have failed in his duties if he had not brought about a transfer of learning, he is more hard pressed than ever to find ways and means of getting his ideas across to his audience. All too often the physics teacher relies on mathematics to support a concept or law to give it a dressing of logical consistency and credibility. As a result, the less mathematically inclined are placed in a position of great disadvantage. This does not mean that we should eschew mathematics entirely in teaching physics. Far from it. What we are trying to say is that the use of mathematics does not always lend itself to fostering thoughts and ideas.

In the absence of concrete support aiding comprehension, the student with a poor sense of imagery would be the hardest hit. The quality of (his) experience (Dewey 1938) in the absence of the real thing would be too shallow to allow construction of images so necessary in the formation of concepts. The resulting failure to internalise what is being taught brings into question the need to assist pupils in their construction of images. How the teacher can assist in enhancing this imagery in his pupils will be illustrated with two examples.

On Heat Capacity

Many teachers are at a loss in explaining the concept of heat capacity. At best it is a rewording or rephrasing of the textbook definition, e.g.

> *The heat capacity of a body is the amount of heat required to raise its temperature by 1°C.*

This approach should suffice if the teacher is handling a set of gifted pupils. For the less mentally endowed, a rephrasing of the original definition does not help. In frustration these students resort to memorizing the definition and regurgitating it during an examination. Their lack of comprehension of the concept is made apparent when asked to give an interpretation of the meaning of the concept in their own words.

In the normal classroom approach, most teachers in their eagerness to get over with the difficulty of explaining this concept merely introduces this equation:

$$C = \frac{Q}{t}$$

where C = Heat capacity

Q = Heat supplied

t = Temperature increase

This will not only obscure the central concept of heat capacity but will also inhibit the less mathematically inclined pupils.

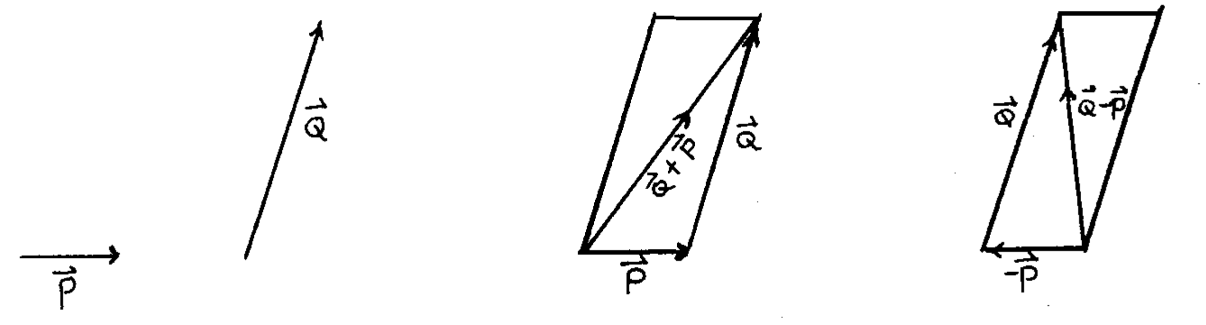
In order that the teacher helps in the construction of an image for the concept of heat capacity, he can illustrate the concept with two identical bowls of rice. If he offers one of them to a young girl, she will be full after finishing it. On the other hand, when he eats the remaining bowl of rice himself, he is still not full. The reason is obvious to all. The teacher has a bigger *appetite for food* than the girl.

Similarly, a large beaker and a small one will have different "appetites for water". Filling the small beaker with a certain quantity of water may cause it to be three-quarters full; the same quantity of water in the large beaker may only fill it a quarter full. These real life experiences should provide sufficient threads to give meaning to heat capacity. When two different objects are heated, they can have different "appetites for heat". The one with a larger appetite for heat, that is the one with a larger heat capacity, will show a smaller rise in temperature than the one with a smaller heat capacity. The amount of heat required to raise different bodies by 1°C can therefore be reasoned to be different.

On Vectors

Teachers of science and mathematics find the concepts of forces and relative velocity unavoidable during their teaching routines as these are fundamental concepts in both science and mathematics syllabuses at secondary school. The generic idea of vectors entrenched in these concepts is the foundation stone for many areas in physics and mathematics, making the mastery of it a desirable prerequisite.

The line of attack that seems to be favoured by most teachers is the use of the left/right or up/down direction to represent mutually perpendicular vectors, with the length of the line being used to represent the magnitude of the vector. Pupils find the use



(a) Two vectors

(b) Addition of two vectors

(c) Subtraction of two vectors

Fig. 1

of this notation devoid of physical meaning when they are first introduced in this way to vectors in their study of forces and relative velocity. The use of mathematics for vector addition and subtraction, and computation of resultants, will only serve to deprive students who are not strong in mathematics the thrill of mastering this important idea.

Short of going to a river bank and observing a low-powered boat being navigated across the river with a fairly strong current downstream, most explanations will degenerate to one involving static sketches on the chalkboard. This approach is not easy to internalise and does not assist pupils in their construction of images. We suggest the following approach.

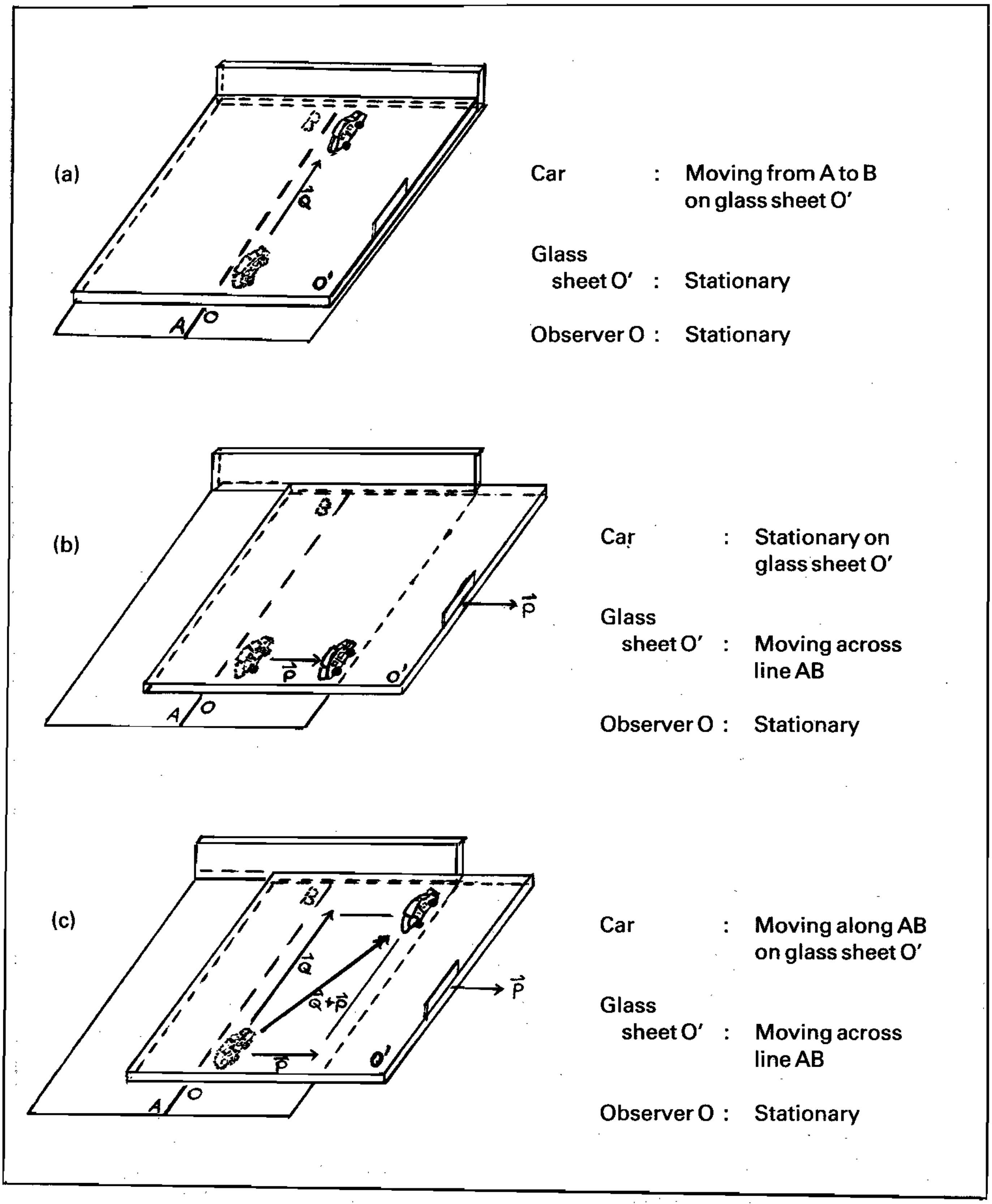
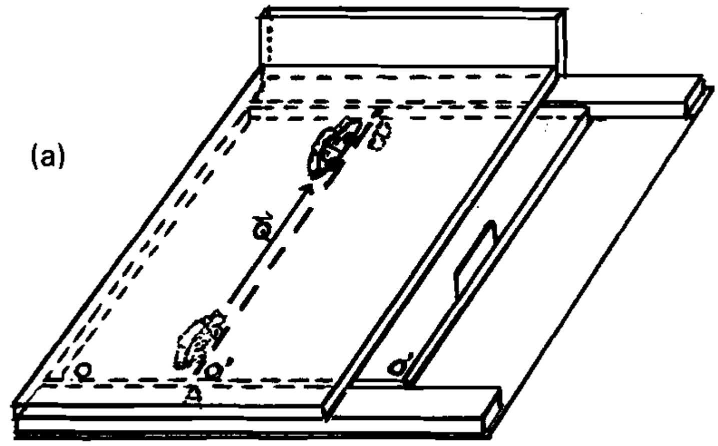

(a)
Car : Moving from A to B on glass sheet O′
Glass sheet O′ : Stationary
Observer O : Stationary
(b)
Car : Stationary on glass sheet O′
Glass sheet O′ : Moving across line AB
Observer O : Stationary
(c)
Car : Moving along AB on glass sheet O′
Glass sheet O′ : Moving across line AB
Observer O : Stationary
B
A
O
O′
$\vec{Q}$
$\vec{P}$
$\vec{Q}+\vec{P}$

Fig. 2

(a)

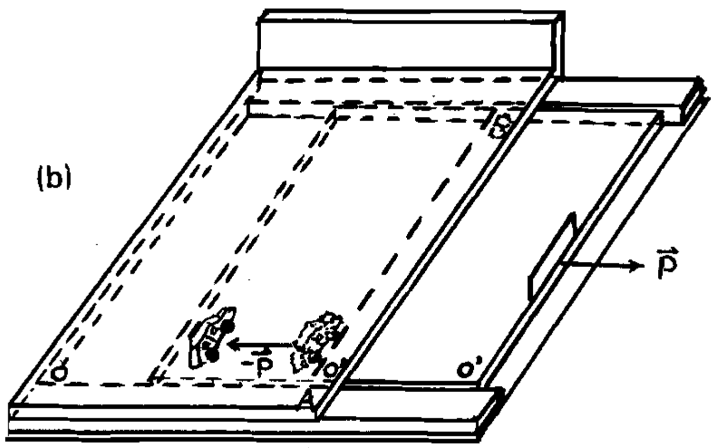


Car : Moving from A to B on glass sheet O

Glass sheet O : Stationary

Observer O' : Stationary

(b)

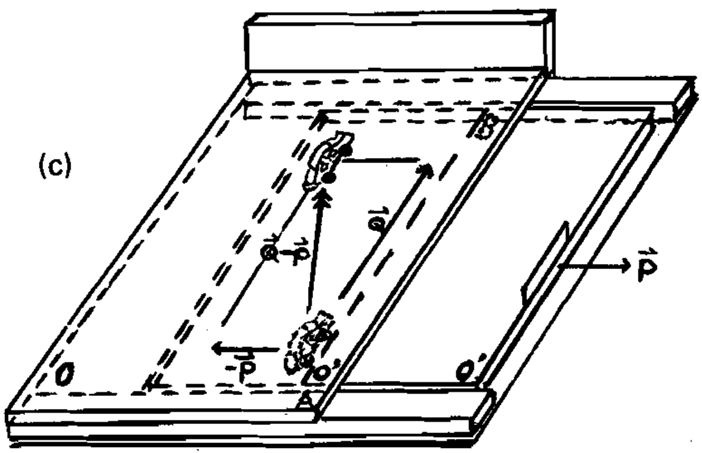


Car : Stationary on glass sheet O

Glass sheet O : Stationary

Observer O' : Moving across line AB

(c)



Car : Moving from A to B on glass sheet O

Glass sheet O : Stationary

Observer O' : Moving across line AB

Fig. 3

Affix a cardboard on the table top. Draw a line AB across the cardboard as in Fig. 2. Place a glass sheet on the cardboard covering the line drawn on the cardboard. Put a spring-loaded car on the glass sheet, and align it with the drawn line. Push the car along the direction indicated by the line, and simultaneously move the glass sheet across the line. The teacher demonstrating this provides the simulation of a river crossing with the observer deemed to be at the river bank, that is, a fixed observer. By proper choice of the angle of tilt of the car from the line AB, it can be shown that the car starting from A can arrive at B despite the water current. These are examples of the addition of two vectors.

The simulation of a bird flying from A to B over the river as seen by an observer floating down the river can be carried out with a slight modification using two pieces of glass (see Fig. 3). Pupils can be alerted to a similar experience when they observe vertically falling raindrops as seeming to be travelling backwards when they are in a moving vehicle. These are examples of the subtraction of two vectors.

The above simulation can also be carried out using overlay transparencies and an overhead projector for large group demonstrations.

Conclusion

These two examples are intended to show how the teacher can help his pupiis understand difficult concepts through appropriate concrete representations or images.

What purpose does it serve when the teacher teaches and his pupils have not learnt? If you do something that has no effect, why do you bother to do it in the first place?

References

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