Creativity and Motivation in Physics Education

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To extend the range of experiments with centre of gravity we could use two different versions of the Figure 2. First simple version consists of making a paper model of a butterfly from paper. Then using paper clips as weights on its wings, we can stabilize butterfly to stay on our finger or on a straw.

For the second version we would need a cardboard, two straws (for its antennae), two little balls, elastic band and adhesive tape. Using tape we will fix straws onto the butterfly in the position of its antennae. Then we thread the elastic band through the straws to fix the balls on the top of straws by making knots. By moving straws we will set up the stable position for the butterfly to “sit on” the top of the finger Figure 3.
A mosquito has decided to stop feeding on human blood and serve science instead. He wants to find out the speed of the water pushed through the syringe. For this purpose he has recycled a plastic bottle and modified it into a pendulum [1].

This unconventional pendulum hit by the water started to oscillate with the time period of 1 second. What is the speed of the sprayed water from the syringe? (1 segment in the Figure 4 is equivalent to 2 cm).
1.3 Weighing Figure 5

Thumbelina wants to find out her weight. Her father, a keen physicist, constructed an unconventional scale for this purpose. The Figure 5 shows the scenario where the chessboard with pawns and Thumbelina is balanced. Find out her weight.

1.4 Flick in the Service of Science Figure 6

Old gardener is thinking about his future harvest of cherries. He has prepared a game for his grandchildren — flick-shooting into the watering can with cherries’ stones. What must be the speed of a cherry stone to hit the neck of the watering can exactly? What is the force we have to use to get the cherry stone moving with desired speed? Let’s assume that the weight of a cherry stone is 0.3 g and “the hitting time” is 0.05 s. 1 segment in Figure 5 corresponds to the length of 10 cm.

1.5 “Rescue Mission” Figure 7

Tiny figures are trying to save the mug from falling down. As per situation shown in Figure 7 can you say if they are going to succeed?
2. Motivational Problems

One of motivation “tools” in physics are experiments and unbelievable situations. To demonstrate this we would like introduce some of our experiments with instructions from various parts of physics (Baník I., Baník R., Chovancová M. & Lukovičová J., 2008; Onderová E., Kireš M., Ješková Z., 2006).

2.1 The Resonance Figure 8

One of my sporting tools can be used to demonstrate the resonance. It is a boxing tool connected to the mat on the floor. In addition we need an elastic band and a round box. The boxing tool will serve for our experiment as a pendulum. We will need the rounded box to act as a harmonic forcing function. When the forcing frequency is close to the natural frequency of the pendulum the system will exhibit resonance.
2.2 Balloon — Detective Story with “A Model”

Balloons — that’s ideal entertainment for naughty kids with pins! But did you know that in some places even a pin is powerless? The balloon has one special place on its surface where it is “invulnerable”? How does a pin actually cause a balloon to burst? When we pierce an unblown balloon nothing happens. There will only be a small pinhole (Onderová L., 2007).

For simplicity we can imagine the surface of unblown balloon as small balls connected with elastic bands. In our model the piercing of unblown balloon corresponds to a cut of one of the elastic bands. It means that the mutual bonds are disrupted without any other consequences. In this scenario two neighbouring balls are not connected but it doesn’t influence the rest of bonds among other balls.

The swelling of the balloon and stretching of rubber material represents stretching of elastic bands between balls — the surface of the balloon is expanded. Forces act on each of the balls from the elastic bands surrounding them but they cancel each other out. The resultant force on each of the balls is zero. That’s why each ball is idle. What will happen if we interrupt one of the elastic bands? The equilibrium of the system is violated. The affected ball starts moving in the direction of the resultant force. If you look at the Figure 9 you can see that this situation impacts all other balls as well. Some of the elastic bands start stretching too much and they are raptured. It is a snowball effect and more elastic bands are parted. The grid is torn. The balloon burst.

Even when the balloon is fully blown up there is one particular place on its surface where the rubber material is not fully stretched. It is the place where the rubber material is much darker. If we penetrate balloon in this particular place it doesn’t burst. This situation corresponds to the first scenario. We can see a pinhole but the balloon stays whole.

The reason for a balloon to have this spot is the way of its production. When we look at the unblown balloon we can find the spot with a cruder layer of rubber material. We have to take into account one another factor — the shape of the unblown balloon is not a circle but an oblong one. The pressure of the compressed air in the balloon causes the stretching of the rubber material of its surface but not evenly. “The cruder spot” resists more and that’s why it stretches less than other parts of the surface.

In our model this could be represented by the cruder elastic bands in this place. There is a lesson learned for our little mischiefs. Using a pin to blow out balloon has its well-known effect. But definitely more impressive surprise for the spectators would be to have a fully blown balloon pierced with a pin and stay whole.
2.3 Principles of Conservation, Hand made Experiment Figure 10

We are going to introduce our own simple execution of well-known experiment on Principles of Conservation using needless household things! We are using a cover from an old computer as a holder. We need at least 3 old tennis balls. Then we need thread and clothes pegs. See the execution of the experiment in Figure 10. We need to divert one of the balls and then watch the consequences. Then we will repeat the process with two balls, three balls, etc.

Instead of tennis balls we can use marbles from old computer mice. Alternatively we can have a modified box as a stand. Instead of clothes pegs we can use office clips. Further options of carrying out this experiment are in the hands of students and their imagination.

Figure 10  Experiments with Balls and Marbles

3. Conclusion

Pictorial tasks and experiments could serve for reaching physics lessons and evoke student’s deeper interest in physics.

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References


