Innovative Methods of Teaching Physics through Simple Computer Programming

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Abstract- *In general, it is thought that programming is very difficult and cannot be used in teaching Physics. However, it is extremely simple and can be used to draw graphics and make the students understand the concepts of a topic visually. In this paper, we have shown the animation of three programs namely Projectile motion, SHM and simple pendulum.*

- ***Projectile Motion****: While teaching projectile motion, we derive the formula of the path of the projectile and tell the students that the path of the projectile is a parabola. We also prove theoretically that the horizontal range is maximum for angle of projection 45 degrees and that horizontal range is same for angles of projection* θ *and* $90 - \theta$*. Students will enjoy the topic if we can show them all the concepts graphical.*
- ***SHM****: The basic understanding of SHM as motion of projection of uniformly rotating particle on diameter of the reference circle is visualized very easily by students.*
- ***Simple Pendulum:*** *The vibrations of the simple pendulum with different length and amplitude have been shown graphically for better understanding.*

We have used PC-Basic (an open Source Software) as simplest programming language to show how various results of different phenomenon can be shown graphically to the students.

Keywords: PC Basic, Projectile, SHM, Pendulum

Introduction

PC Basic is an open source programming language software and is very powerful in not only doing the complex calculations but also making animation programs using the equations derived in Physics for various phenomenon such as showing Projectile motion, SHM, Simple Pendulum motion , beats phenomenon, Lissajous figures etc. However, we have restricted our self to only three animation programs.

Methodology

Programs have been created using PC Basic software for Projectile motion (Annexure-1), Simple Harmonic motion (Annexure-2), Simple Pendulum (Annexure-3)

1. For Projectile Motion: -

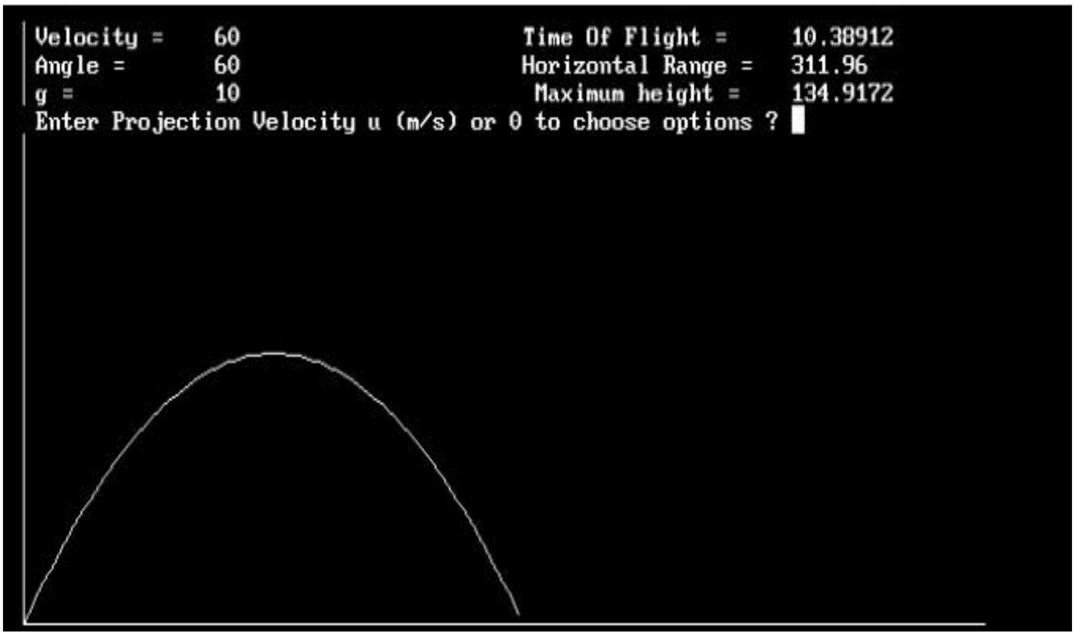


Figure-1

For All cases

u = initial velocity of projection

u_x = component of u in Horizontal direction at point of projection= u cos Θ
u_y = component of u in Vertical direction at point of projection = u sin Θ
Θ = Angle of projection with horizontal at point of projection
g = acceleration due to gravity

Case – I

(Oblique Projection from Ground)

Path of Projectile is Parabolic **:** $y = x \tan \Theta - \frac{1}{2} g x^2/u^2 \cos^2\Theta$

Time of Flight

⇨ $T = (2 u \sin \Theta)/g$

Horizontal Range (HR):

$HR = u_x * T = u \cos \Theta * (2 u \sin \Theta)/ g = (u^2 \sin 2 \Theta)/g$

Maximum height (hm)= $u^2 \sin^2\Theta / 2g$

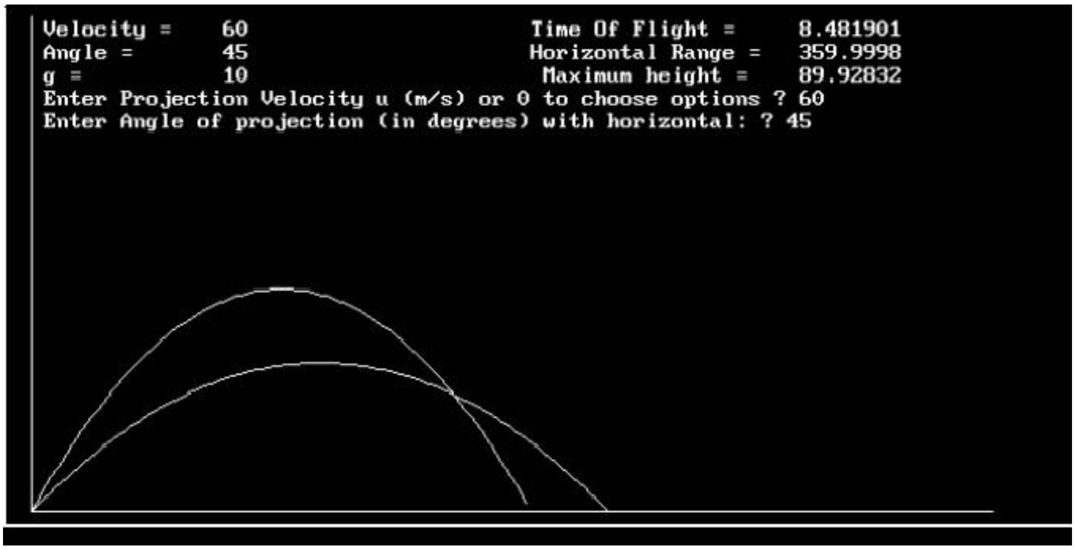


Figure-2

Figure-2 shows 2 curves for u = 60, ϴ = 60, g = 10 and for u = 60, ϴ =45 and g = 10.
Curves clearly show that HR is more for ϴ = 45 but hm is more for ϴ = 60
Try for ϴ = 30, ϴ = 43, ϴ = 47, You will see that HR is Maximum for ϴ = 45

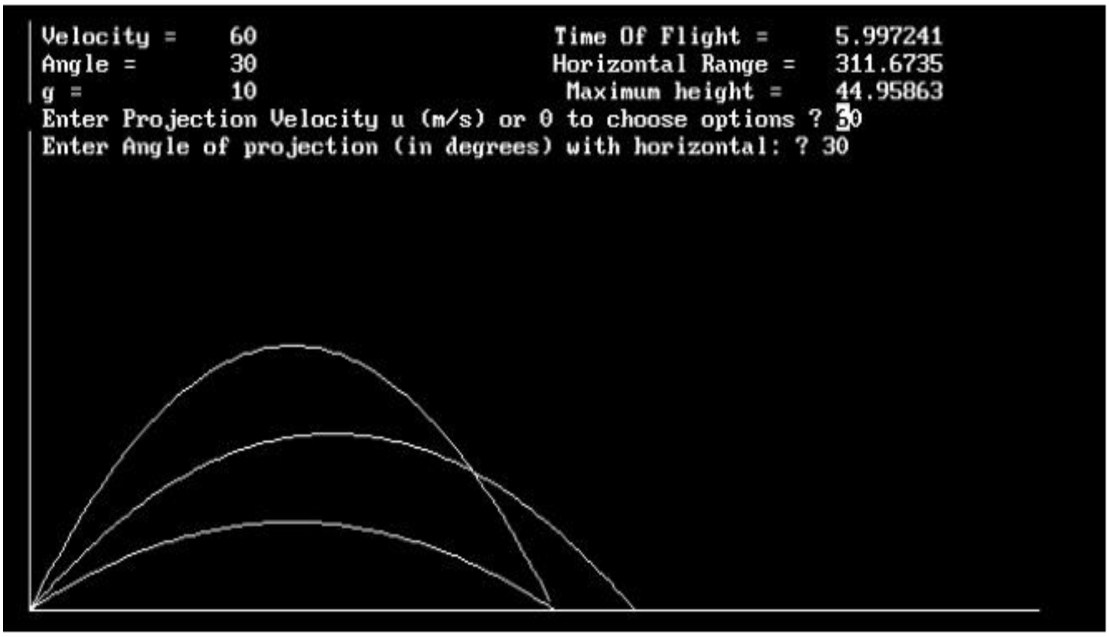


Figure-3

Figure shows that for ϴ=60 and ϴ=30 the HR are same.

Try for any pair of angles whose sum is 90 and you will find that HR is same for both angles, showing the HR is same for angles ϴ and 90 – ϴ. 90 – ϴ with horizontal is equivalent to ϴ with vertical. Therefore, HR is same for equal angles with Horizontal and Vertical.

Case – II

(Oblique Projection from height h)

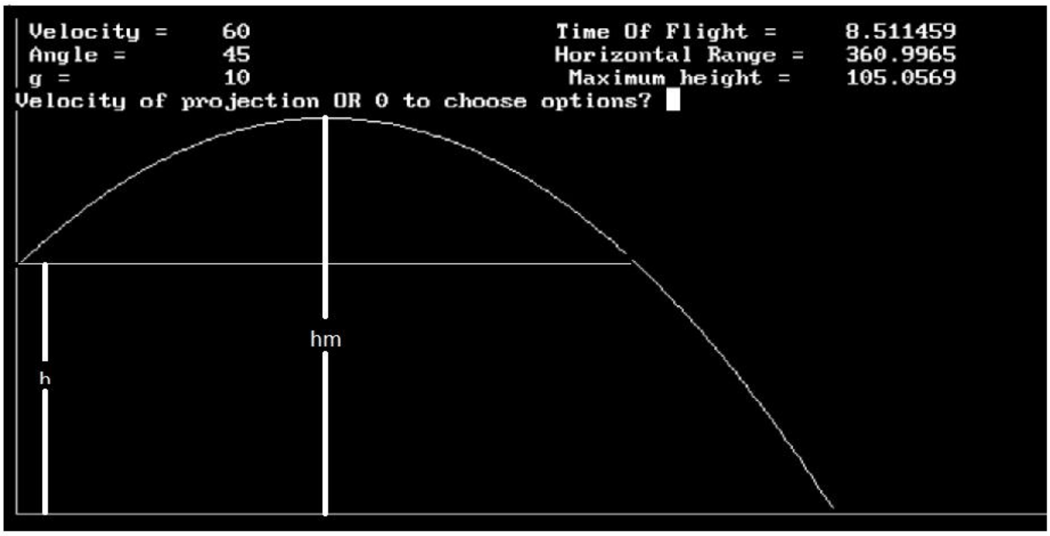


Figure-4

Time of Flight

During flight, the projectile first moves up and then moves down to hit the ground. Taking point of projection as origin (0, 0), the effective vertical distance travelled by the projectile is –h, whose time period is given as.

$$\boldsymbol{T} = \frac{\mathbf{uy} + \sqrt{(\boldsymbol{uy})^2 + 2\boldsymbol{gh}}}{\boldsymbol{g}}$$

Case – III

(Horizonta Projection from height h)

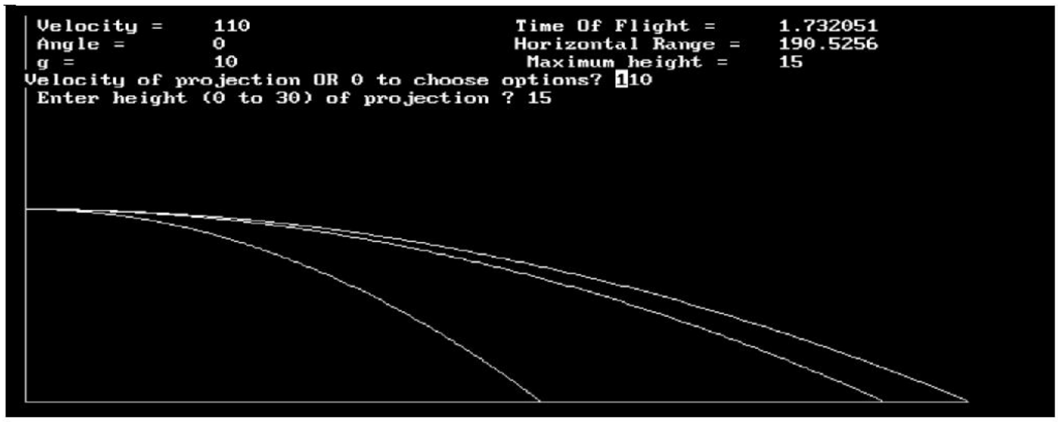


Figure-5

Time of Flight:

T = $(2\ h/g)^{½}$

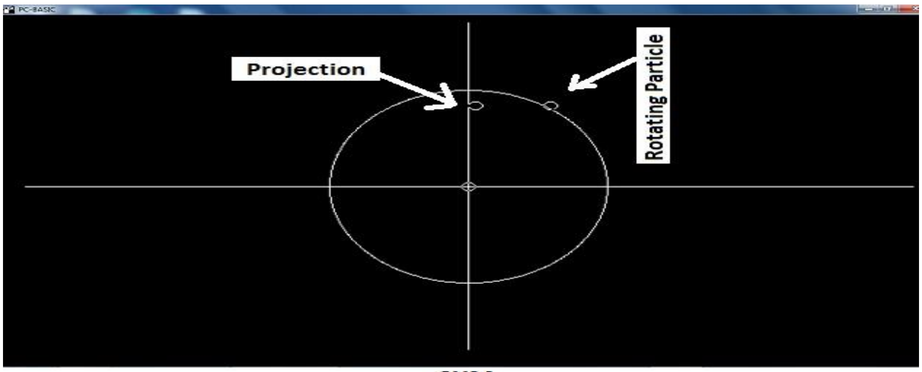
Horizontal Range (HR):

HR = ux * T

Also, $\mathbf{h_m = h}$

1. **For Simple Harmonic Motion**

Here, we see that as the reference particle rotates, its projection on vertical diameter(Y-axis) shows to and fro motion. Hence, we define SHM as the projection of uniformly rotating particle on diameter of the reference circle.

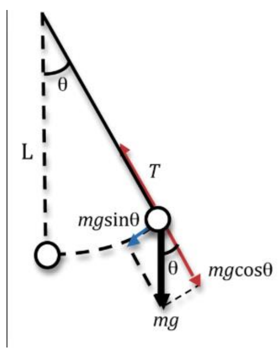


SHM

2. **Simple Pendulum**

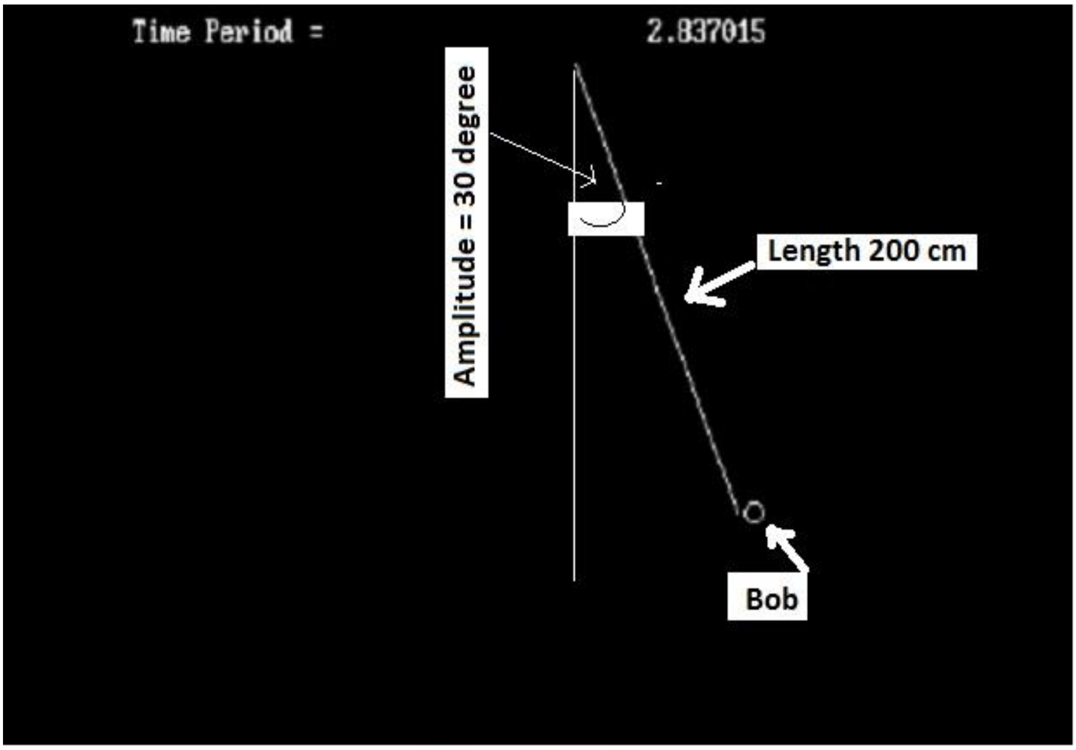
An ideal simple pendulum consists of a point-mass suspended by a flexible, inelastic and weightless string from a rigid support of infinite mass. In practice, we can neither have a point mass nor a weightless string.

In practice, a simple pendulum is obtained by suspended a small metal bob by a long and fine cotton thread from a rigid support.



This gives = $2\pi\sqrt{\frac{l}{g}}$. Damping effect has not been taken in the program.

The angle is not taken to be small (necessary condition for SHM) during demo.



Simple Pendulum

Results

1. In Projectile motion, we have been able to show graphically that
   a. It is enough to deal with only one case of oblique projection from some height.
   b. Horizontal range is maximum for projection angle 45^0.
   c. Horizontal range is same for any two angles whose sum is 90^0.
2. In SHM, we clearly see the rotating particle and its projection on any diameter with to and fro motion of the projection.
3. In Simple Pendulum, we are able to show the vibration of pendulum with different lengths and amplitudes.

Conclusion

It is very easy and interesting to teach Physics by creating animation programs using open source basic programming Softwares which of course through ICT and hence it makes the teaching learning process more effective in attaining LO’s.

References

Nico Rutten, Wouter R Van Joolingen, Jan T van der Veen. The learning effects of computer simulations in science education. Journal of Computer and Education, Elsevier, Volume 58, Issue 1, January 2012,136-153.

Ersin Bozkurt, Aslan llik. The effect of computer simulations over students' beliefs on physics and physics success. Journal of social and behavioral sciences, Elsevier, Volume 2, Issue-2, 2010,4587-4591.

Kuo-En Chang, yu-Lung Chen, He-Yan Lin, Yao-Ting Sung. Effects of learning support in simulation-based physics learning. Journal of Computer and Education, Elsevier, Volume 51, Issue 4, December 2008,1486-1498.

Zacharias Zacharia et al. The effects of an interactive computer based simulation prior to performing a laboratory inquiry-based experiment on students' conceptual understanding of Physics. American Journal of Physics, Volume 71, Issue 6, 2003.

Woodward,J., Carnine,D., and Gersten,R.(1988). Teaching Problem Solving Through Computer Simulations. American Educational Research Journal,25(1), 72-86.