St John Baptist De La Salle Catholic School, Addis Ababa

Grade 10 Physics Final Examination

Summer

August, 2022

Notes, and use of other aids is **NOT** allowed. Read all directions carefully and **write your answers in the space provided**. To receive full credit, you must show all of your work.

Name:_____ Roll Number:_____ Section:____Time Allowed: **30 minutes**

Useful Constants

- **sin** 60^0 = **cos** $30^0 = \frac{\sqrt{3}}{2}$ **AND sin** 30^0 = **cos** $60^0 = \frac{1}{2}$
- **sin** 37^0 = **cos** $53^0 = 0.6$ **AND sin** 53^0 = **cos** $37^0 = 0.8$
- **sin** 45^0 = **cos** $45^0 = \frac{\sqrt{2}}{2}$ **AND sin** 90^0 = **cos** $0^0 = 1$ **AND sin** 0^0 = **cos** $90^0 = 0$

Multiple Choice Questions

1. In which of the following cases is the object in motion a projectile?
   A. An airplane gliding through air.
   B. A ball kicked into the air. [**Correct Answer**]
   C. A SpaceX rocket ship.
   D. Cruise missiles gliding through the air.

   Why? Remember a projectile has no motive force.

2. What is the velocity of a projectile at the maximum vertical displacement from its initial position?
   A. 0 B. v_x [**Correct Answer**] C. v_y D. Same as the initial velocity
   Why? At the maximum height, the vertical velocity is 0 while we still have the horizontal velocity.

3. For a projectile with a *symmetric* trajectory, what initial throw angle gives us the biggest range?
   A. 15^0 B. 45^0 [**Correct Answer**] C. 37^0 D. 90^0
   Why?

$$R = \frac{V_i^2 \sin 2\theta}{g} \text{ for a symmetric projectile}$$

   Our quantity will be maximum when $\sin 2\theta$ is 1.

$$\sin 2\theta = 1$$

$$2\theta = \arcsin 1$$

$$2\theta = 90^0 \implies \theta = 45^0$$

4. Which of the following is true?
   A. The trajectory of a projectile resembles an elliptical curve.
   B. The vertical motion of a projectile is uniform motion.
   C. The angle made by tangent to the curve of the projectile's trajectory changes instantaneously. [**Correct Answer**]
   D. The horizontal motion of a projectile is uniformly accelerated motion.

   Why?

   - The trajectory of a projectile is a parabolic curve not an elliptical. So, A can't be the answer.
   - The vertical motion of a projectile is uniformly accelerated motion not uniform motion, so B can't be the answer either.
   - The angle actually changes instantaneously along the trajectory since we consider the tangent to the trajectory of the projectile. So, this is the correct answer.
   - The horizontal motion of a projectile motion is uniform motion not uniformly accelerated motion, so D can't be the answer either.

5. If the effects of air resistance were taken into account, which one of the following statements would be correct?
   A. The ball would have travelled a greater horizontal distance before striking the ground.
   B. The ball would have reached a greater maximum height.
   C. The ball's horizontal velocity would have been continually decreasing. [**Correct Answer**]
   D. Nothing would have changed.

Why?
Obviously, we would be expecting quite a few changes. The first is that both the vertical and horizontal velocities will be influenced due to the drag by air which will make them decrease and hence, less range and maximum height. So, the only correct answer here is C.

Problems

6. A softball of mass 1 kg is thrown with an initial velocity of 16 m/s at an angle θ to the horizontal. When the ball reaches its maximum height, its kinetic energy is 32 J.

- What is the value of θ?
  We first need to find the horizontal velocity to find the angle. We can do that by using the general formula of kinetic energy and we replace the velocity in the formula with the horizontal velocity since that is the only velocity we have at the maximum height.

$$KE = \frac{1}{2}mv^2 \implies KE_{max} = \frac{1}{2}mv_x^2$$
$$32J = \frac{1}{2}(1kg)v_x^2$$
$$v_x^2 = 64m^2/s^2$$
$$v_x = 8m/s$$

  Since the horizontal velocity is constant, $v_x = v_{ix}$ Thus, $v_{ix} = 8m/s$, but we know that $v_[ix] = v_i \cos\theta$. Thus, we have:

$$8m/s = 16m/s\cos\theta$$
$$0.5 = \cos\theta$$
$$\theta = \arccos 0.5 = 60^0$$

- What is the maximum height achieved by the ball from its point of release?

$$y = \frac{v_{fy}^2 - v_{iy}^2}{2a_y}$$
$$y_{max} = \frac{-v_{iy}^2}{-g} = \frac{v_i^2\sin^2\theta}{2g}$$
$$y_{max} = \frac{(16m/s \times \sin 60^0)^2}{2(10m/s^2)} = \frac{(16m/s \times \frac{\sqrt{3}}{2})^2}{2(10m/s^2)}$$
$$y_{max} = 9.6m$$

- Calculate the initial vertical velocity of the ball.

$$v_{iy} = v_i \sin 60^0$$
$$v_{iy} = 16m/s \times \frac{\sqrt{3}}{2}$$
$$v_{iy} = 8\sqrt{3}m/s$$

- How long after the ball is thrown will it return to the ground?

$$y = y_i + v_{iy}t + \frac{1}{2}a_y t^2$$
$$0 = 0 + 8\sqrt{3}m/st - 5m/s^2t^2$$
$$0 = t(8\sqrt{3}m/s - 5m/s^2t)$$
$$t = 0 \text{ or } 8\sqrt{3}m/s - 5m/s^2t$$
$$8\sqrt{3}m/s - 5m/s^2t \implies t = \frac{8\sqrt{3}}{5}s$$

- Calculate the horizontal distance that the ball will travel during its flight.

$$x = v_x t$$
$$x = 8m/s \times \frac{8\sqrt{3}}{5}s$$
$$x = \frac{64\sqrt{3}}{5}m$$

Short Answers

7. Consider a projectile launched with initial velocity v at an angle θ to the horizontal. Discuss the difference between the horizontal and vertical components of the projectile's velocity during the flight. Ignore air resistance.

   Look at the posted notes.

8. Discuss what happens to the velocity(*both horizontal and vertical*) of a projectile at maximum height. **Discuss using logic and trigonometry**.

   Look at the posted notes.

9. Derive the equations of trajectory of a projectile and range for a general case(**without assuming symmetry**)

   Look at the posted notes.