AP Quiz: Basic Kinematics

Your name-period here:

For all problems, assume we are on Earth, assume gravity acts in the $-\hat{z}$ direction, and neglect air resistance unless otherwise specified.

1 Launching the ball

(4pt, **All**)You drop a ball onto a surface that causes the ball to bounce back with 75% of the kinetic energy that it started with. If the ball is first dropped from a height of h_1, how long will the ball spend in the air between the first and second bounce?

A. $\sqrt{\frac{3h_1}{2g}}$

B. $\sqrt{\frac{2h_1}{g}}$

C. $2\sqrt{\frac{h_1}{g}}$

D. $\sqrt{\frac{6h_1}{g}}$

E. None of the above

2 Shoot first, ask questions later

1. (4pt) You shoot a projectile horizontally from a height h about the ground with a speed v_0. The projectile hits the ground just as it reaches the target. What is the distance to the target?

   A. $\frac{v^2h}{g^2}$

   B. $\frac{v^2}{gh}$

   C. $v\sqrt{\frac{2h}{g}}$

   D. $h\sqrt{\frac{v}{g}}$

   E. The time when we hit the ground, or the height of the center of the target must be given.

2. (2 pt) In the same scenario as above, if air resistance were present, would the projectile need to be launched at an angle above or below the horizontal in order for it to hit as indicated? Consider only drag forces, not less common effects.

   A. Above. The air resistance would take little momentum from the $\hat{z}$ direction, but much more from $\hat{x}$.

   B. Above. Air resistance would take energy from the bullet, but no momentum, resulting in a lower v

   C. The angle would not change. Air resistance would make the time to fall longer, but also lower v, resulting in no effect.

   D. Lower. The air resistance will make the flight time longer.

   E. Below. Air resistance applies a force upward on the bullet, causing it to hit higher than it would normally.

3 Sometimes you crash and burn

(5 pt)(**All**)Two objects have positions given by $\vec{r}_1 = \left(2\text{m} + 1\frac{\text{m}}{\text{s}}\text{t}\right)\hat{\text{x}} + \left(5\text{m} + 2\frac{\text{m}}{\text{s}}\text{t}\right)\hat{\text{y}}$. The other object has a position given by $\vec{r}_2 = \left(4\text{m} - 2\frac{\text{m}}{\text{s}}\text{t}\right)\hat{\text{x}} + \left(5\text{m} + 1\frac{\text{m}}{\text{s}}\text{t}\right)\hat{\text{y}}$. Will the objects collide, and if so, at what time?

4 A throwback to 7th grade

(5pt, **AP**) Having forgotten the lessons of previous years, you challenge the physics unicorn to a race and wager one million dollars. You move with a velocity given by $\vec{v} = v_s\hat{\mathrm{x}}$. The physics unicorn moves with an acceleration given by $a_u\hat{\mathrm{x}}$. If the physics unicorn finishes in a fraction $f << 1$ of your time, what was the distance from the starting point to the finish?
(5pt, **Honors**) Super-cactus challenges the physics unicorn to a race. Super cactus moves with constant velocity v_c and the physics unicorn moves with constant acceleration a_u. If the race ends with a tie, what was the distance from start to finish?