PHYS 161	**QUIZ 4**
March 9, 2009	**10 POINTS**

In a low-level bombing, a bomber releases a bomb at a height of 50 m above the surface of the sea while on a horizontal flight at 300 km/h.

(i) [2] How long does the bomb take to fall to the surface of the sea?

The bomb has no initial vertical velocity and has a distance of 50 m to fall under the influence of Earth's gravity. Thus, our kinematic equation:

$$y(t) = y_i + v_{iy}t + \frac{1}{2}a_y t^2 \tag{1.1}$$

becomes

$$y(t) = y_i + 0 - \frac{1}{2}gt^2 \tag{1.2}$$

If we say that t_{hit} is the time such that $y(t_{hit}) = 0$ then we find

$$t_{hit} = \sqrt{\frac{2y_i}{g}} = \sqrt{\frac{2 \times 50\ m}{9.8\ m/s^2}} \approx \sqrt{10s^2} = \boxed{3.2\ s} \tag{1.3}$$

(ii) [3] How far ahead horizontally of the point of release is the point of impact?

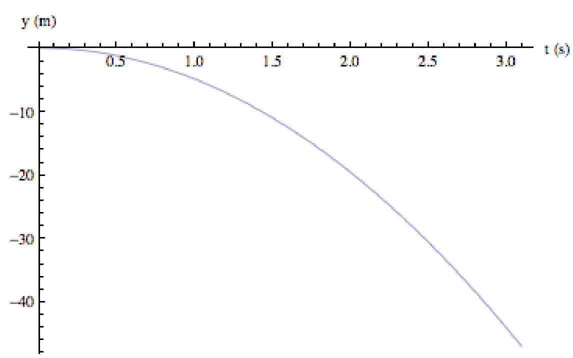
We found that it takes a time t_{hit} to fall to the sea. Because the bomb moves with the plane, we know initial horizontal velocity of the bomb is 300 km/h. There is no horizontal acceleration. Thus, our kinematic equation becomes:

$$x(t) = x_i + v_{ix}t \tag{1.4}$$

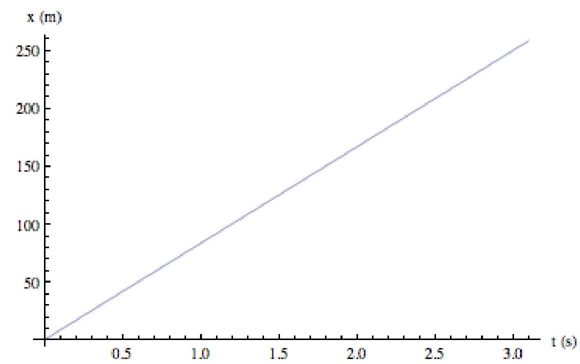
Since we are asked how far ahead from the point of release, we may as well set $x_i = 0$. Thus,

$$x(t_{hit}) = v_{ix}t_{hit} = 300\ km/h\ \times 3.2s \approx \boxed{265\ m} \tag{1.5}$$

(iii) [2] Draw the x-t and y-t graphs of the bomb assuming $t = 0$ as the time of release of the bomb and $x = y = 0$ as the point of release.



(a) y-t graph



(b) x-t graph

(iv) [3] Write down the velocity vector of the bomb as it hits the sea surface taking the vertical direction as the y-axis and horizontal as the x-axis.

The horizontal velocity remains the same at all times. Thus,

$$v_x(t_{hit}) = v_{ix} = 300\ km/h\ = 83.3\ m/s \tag{1.6}$$

THe vertical velocity increases because of gravity. Since gravity is a constant, we know

$$v_y(t) = v_{iy} + at \tag{1.7}$$

We know (because the plane was flying horizontally) that $v_{iy} = 0$. We want to find v_y at t_hit so we find:

$$v_y(t_{hit}) = 0 - gt_{hit} = -9.8\ m/s^2\ \times 3.2s = -31.3\ m/s \tag{1.8}$$

Thus, the velocity vector of the bomb at t_{hit} is

$$\vec{v} = \boxed{300\ km/h\ \hat{\imath} - 31.6\ m/s\ \hat{\jmath}} \quad \text{or} \quad \boxed{83.3\ m/s\ \hat{\imath} - 31.6\ m/s\ \hat{\jmath}} \tag{1.9}$$

Common Errors:

Error (increasing seriousness)	Meaning	Remedy
Omission of units	Carelessness (I hope).	Double check your answers
Mistake in units	Using both meters to kilometers, etc., in one equation.	Write units even in the middle of your work, not just on the answer.
Vector error	Did not consider each component separately.	Make sure you can identify which equations relate vectors and which relate *components*.

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