PHYS 2211 Recitation Week 09 Team Members

Hawk vs. Goose

Because of your interest in the environment and your physics experience, you have been asked by the G.P. Burdell Museum of Natural History to assist in the production of an animated film about hawks. In the script, a 1.5 kg hawk hovers motionless with respect to the ground at an elevation of 125 meters, when it sees a goose flying below it, at an elevation of 45 meters. The hawk dives straight down. It is moving at 60 km/hr when it strikes the goose and digs its claws into the goose's body. The 2.5 kg goose was flying north at 30 km/hr just before it was struck by the hawk and killed instantly. The animators want to know the velocity of the hawk and dead goose just after the strike.

Team Score:
(see reverse)

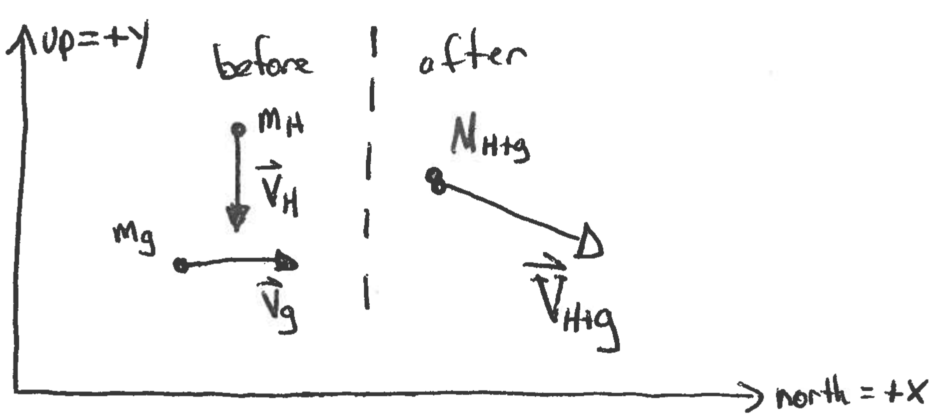
Step One:
Working as a team, formulate a specific physics problem that will answer the question posed. Your formulation should include: a brief written statement of the problem you will solve; a visual representation of the situation that includes all essential physics information; and an explanation of the essential physics approach for solving the problem—i.e. the necessary concepts or principles, any special problem-solving techniques, and/or any key assumptions that must be made in order to set up or solve the problem.

Problem – using knowledge of birds' velocities before collision, find their common velocity after the collision

→ This is a momentum problem: define system = both birds

Then

- gravity and drag are external forces – assume they are negligible in comparison to collision forces (which are large, in comparison)
  → with this assumption, we can apply conservation of momentum to solve problem
- initial positions and motion of birds prior to collision are superfluous information – only velocities immediately before impact matter
- This is a 2D vector problem – use coord system shown in figure



Side view, looking west
(east = out of page = +z)

PHYS 2211 Recitation Week 09 YOUR Name

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Hawk vs. Goose

Your Team Members

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Team Score: (from Step One) ☐ **Individual Score:** (see reverse) ☐

Step Two:
Solve the problem that you formulated in Step One, using the physics approach you have identified. You may work with your team members, but each of you should individually write up your own solution.

① express all velocities in cartesian vector form:

initial $\vec{V}_H = \langle -V_1 \rangle \hat{j}$ where $V_1 = 60$ km/hr

$\vec{V}_g = \langle +V_2 \rangle \hat{i}$ where $V_2 = 30$ km/hr

final $\vec{V}_{H+g}$ = unknown — will have $+\hat{i}$, $-\hat{j}$ components

② Conservation of momentum $\vec{P}_i = \vec{P}_f$

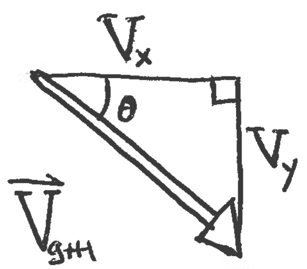
$$\vec{P}_H + \vec{P}_g = \vec{P}_{H+g}$$

$$m_H \langle -V_1 \rangle \hat{j} + m_g \langle +V_2 \rangle \hat{i} = (m_H + m_g)\vec{V}_{H+g}$$

③ Solve for $\vec{V}_{H+g}$ in cartesian form, convert to magnitude + direction:

$$\vec{V}_{H+g} = \left\langle +\frac{m_g}{m_g+m_H} V_2 \right\rangle \hat{i} + \left\langle -\frac{m_H}{m_g+m_H} V_1 \right\rangle \hat{j} = \langle +18.75 \text{ km/hr} \rangle \hat{i} + \langle -22.5 \text{ km/hr} \rangle \hat{j}$$

"V_x" "V_y"



$$|\vec{V}_{g+H}| = \sqrt{V_x^2 + V_y^2} = 29.3 \text{ km/hr} \rightarrow \text{rounds to } \boxed{29 \text{ km/hr}}$$

final speed

$$\tan\theta = \left|\frac{V_y}{V_x}\right| = \frac{22.5 \text{ kph}}{18.75 \text{ kph}} = 1.2$$

$$\theta = \tan^{-1}(1.2) = 50.2^\circ \text{ below horizo}$$

↳ rounds to $\boxed{50^\circ}$

below northward horizontal