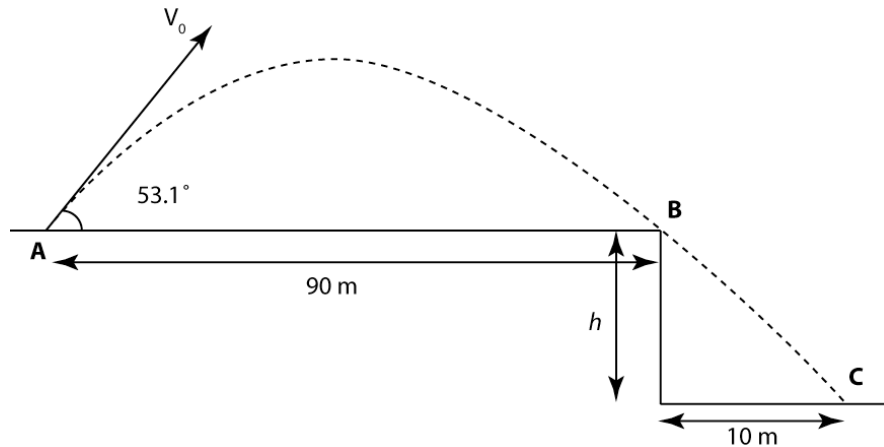


Problem Session

2D Kinematics

1. A projectile is fired from point **A** at an angle of 53.1° with the horizontal, and arrives at point **C** after just missing the corner at point **B**. Find its initial velocity v_0 and the height h .



2. *Fast and Furry-ous*

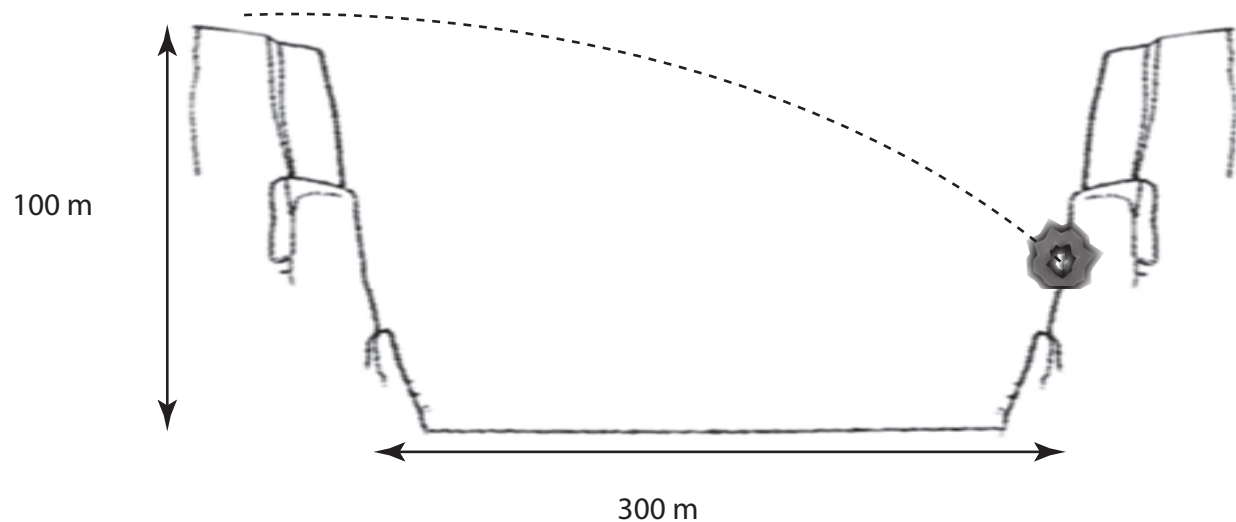
The determined coyote (*Carnivorous Vulgaris*) is out once more in pursuit of the elusive roadrunner (*Accelleratti Incredibus*). The coyote wears a pair of Acme jet-powered roller skates, which provide a constant horizontal acceleration of 15.0 m/s^2 . The coyote starts at rest 70.0 m from the brink of a cliff at the instant the roadrunner zips past him in the direction of the cliff.



- If the roadrunner moves with constant speed, determine the minimum speed he must have in order to reach the cliff before the coyote.
- At the edge of the cliff, the roadrunner escapes by making a sudden turn, while the coyote continues straight ahead. His skates remain horizontal and continue to operate while he is in flight, so that the coyote's acceleration while in the air is $(15\hat{i} - 9.80\hat{j}) \text{ m/s}^2$. If the cliff is 100 m above the floor of the canyon, determine where the coyote lands in the canyon.
- Determine the components of the coyote's impact velocity.

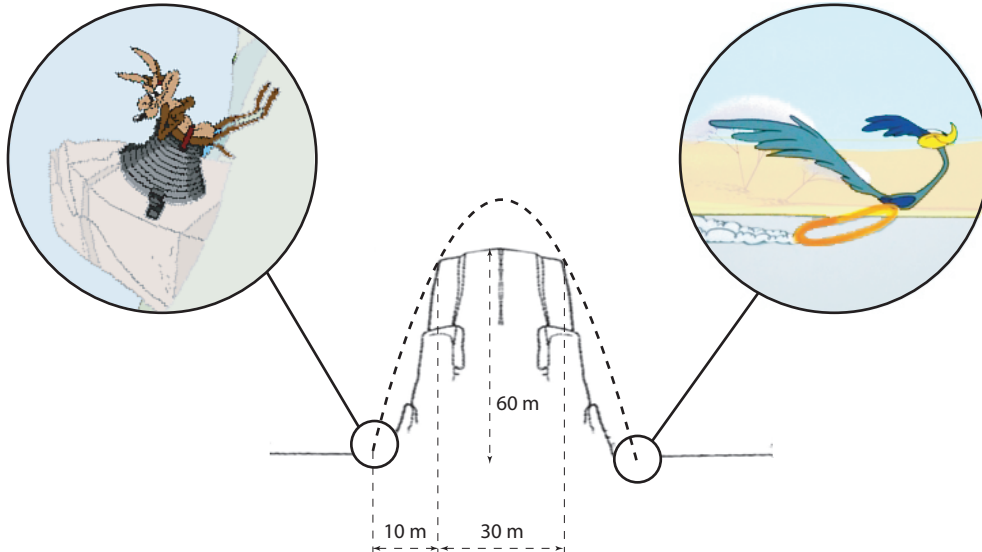
3. *Beep, Beep*

The determined coyote (*Road-Runnerus Digestus*) is out once more in pursuit of the elusive roadrunner (*Velocitus Tremenjus*). This time he acquires an Acme jet motor providing a constant acceleration of 25 m/s^2 . The coyote starts his jet motor 150 m before the edge of a cliff at the instant the roadrunner zips past him. At the edge of the cliff, the roadrunner escapes by making a sudden turn, while the coyote continues straight ahead (*he'll never learn*). His jet motor remains horizontal and continues to operate while he is in flight.



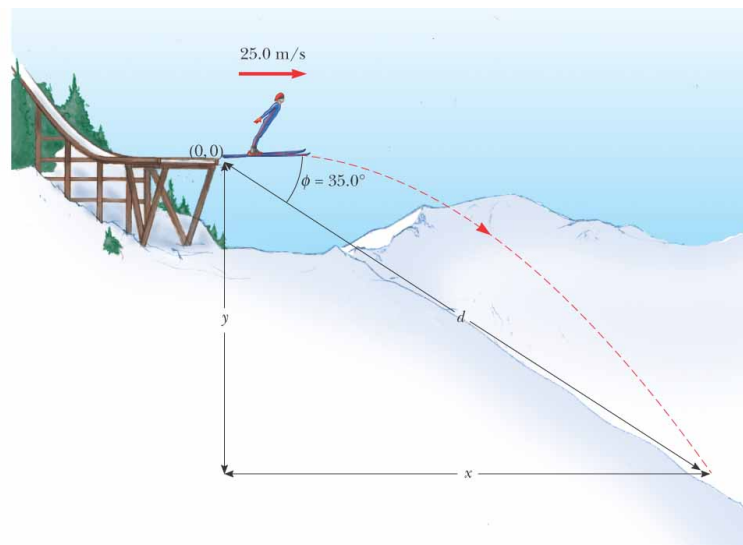
- What is the speed of the coyote when he reaches the edge of the cliff, just before the ground disappears under him?
- If the canyon is 300 m wide, and each side is a 100 m above the canyon floor, at what height does he hit the rockface on the other side of the canyon?
- Determine the components of the coyote's impact velocity.

4. **Zoom at the top!** The determined coyote (*Overconfidentii Vulgaris*) is out once more in pursuit of the elusive roadrunner (*Disappearialis Quickius*). This time he uses an ACME spring-on-a-boulder release system to propel himself up a mountain and catch the roadrunner, by surprise (!), on the other side.



The spring propels the roadrunner with an unknown initial velocity, oriented 82.4° above the horizontal.

- What is the initial speed necessary for the coyote to follow the illustrated trajectory?
 - What maximum height above the top of the mountain will the coyote reach?
 - How much time will the coyote spend in the air before catching the roadrunner?
5. **Ski-Jump** A ski-jumper leaves the ski track moving in the horizontal direction with a speed of 25.0 m/s , as shown in the figure below. The landing incline below him falls off with a slope of 35.0° . **Where does he land on the incline?**

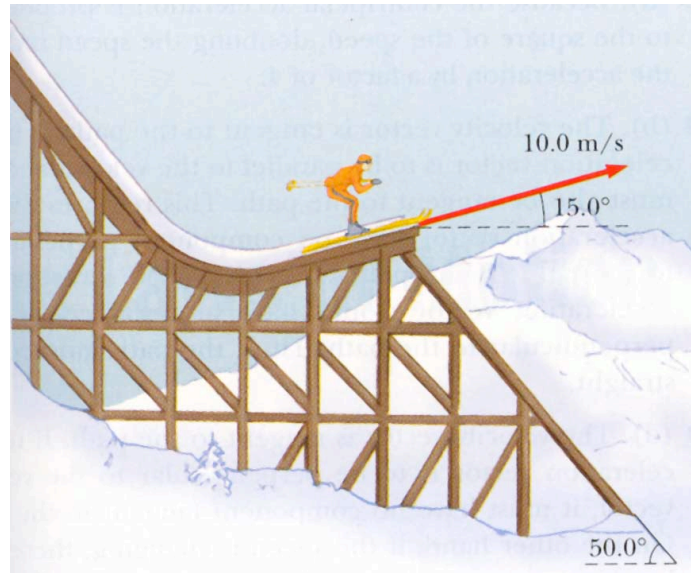


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6. *Another Ski-jump*

A skier leaves the ramp of a ski jump with a velocity of 10.0 m/s, 15.0° above the horizontal, as in the figure below. The slope is inclined at 50.0° , and air resistance is negligible.

- Find the distance from the ramp to where the jumper lands,
- the velocity components just before the landing



Answers

- The initial speed is 30.3 m/s and the height h is 14.8 m.
- The roadrunner must have a speed larger than 22.9 m/s if he wants to reach the edge of the cliff before the coyote. The coyote will land 360 m from the edge of the cliff. His impact velocity is $(114\hat{i} - 44.3\hat{j}) \text{ m/s}$.
- The coyote reaches the cliff with a speed of 86.6 m/s, and he will hit the other side of the canyon 68.5 m above the ground with a velocity of $(150\hat{i} - 24.8\hat{j}) \text{ m/s}$.
- The coyote is propelled with a speed of 43.3 m/s, will reach a maximum height of 34.0 m above the top of the mountain and will (hopefully) catch the roadrunner in 8.76 s.
- $x_f = 89.3 \text{ m}$, $y_f = -62.5 \text{ m}$, considering the initial point to be the origin.
- a) 43.2 m b) $v_x = 9.66 \text{ m/s}$ and $v_y = -25.6 \text{ m/s}$