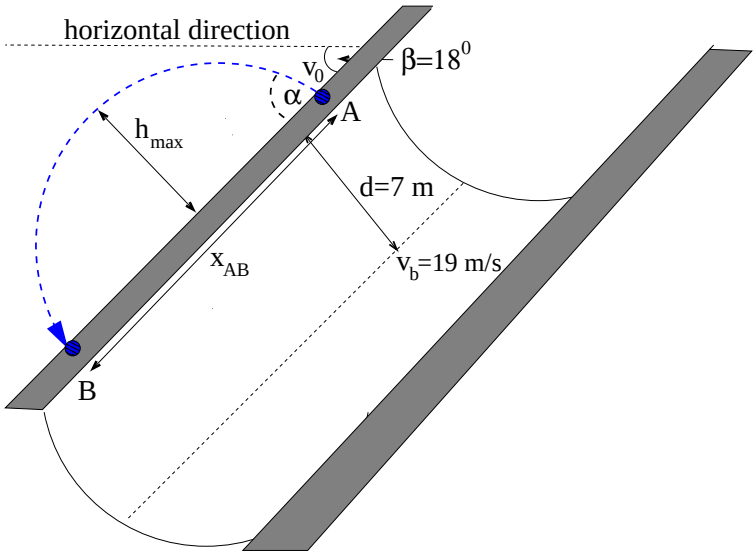
Half-Pipe Physics

Worksheet 17
22 March 2023

The purpose of this worksheet is to practice formatting output data and to practice the use of FUNCTION sub-programs.

The typical speed of a snowboarder at the base of the half-pipe at the PyeongChang 2018 Olympic Winter Games was around $v_\mathrm{b} = 19$ m/s. The height of the half-pipe wall was $d = 7$ m, and the pitch angle was $\beta = 18^0$, as shown in this graphical illustration:



The take-off velocity v_0, maximum height h_max, maximum airborne time t_AB, and maximum distance along the half-pipe x_AB of a snowboarder are given by ($g = 9.81$ m/s^2) the following equations:

$$v_0 = \sqrt{v_\mathrm{b}^2 - 2\,g\,d\,\sin\alpha/\cos\theta}\,, \tag{1}$$

$$h_\mathrm{max} = v_0^2\,\sin^2\alpha/(2\,g)\,, \tag{2}$$

$$t_\mathrm{AB} = (v_0\cos\alpha)\,(\tan\alpha + \tan\beta)/(g/2)\,, \tag{3}$$

$$x_\mathrm{AB} = \frac{v_0^2\,\cos^2\alpha}{(g/2)\,\cos\beta}(\tan\alpha + \tan\beta)\,, \tag{4}$$

where $\alpha \equiv 90^o - \beta - \theta$ and $\theta = 6^o$. To use these values in a Fortran code, they must first be converted from degrees to radians.

Task

Write a structured Fortran program (no preamble is required) which computes v_0, h_max, t_AB, x_AB and writes the results of the quantities to standard output, exactly as shown here:

```
Airborne time: t_AB= 3.27 seconds
Maximum height reached: h_max=  9.99 meter
Distance traveled along half-pipe: x_AB= 21.41 meter
Take-off speed: v_0= 15.32 meter/second
Take-off angle: alpha= 66.00 degrees
```

(turn over)

Program Design

- The program must consist of a main program and one `FUNCTION` sub-program named `x_AB`.
- The purpose of `FUNCTION x_AB` is to compute x_{AB} from Eq. (4) and return its value to the main program.
- The data output is handled in the main program.
- Use the `Fw.d` specifier to format the output data.

Rename your Fortran source code to `LastFirst_WS17.f90` and email this file to `ewhart317@gmail.com`. Put `PHYS 317 WS 17` in the subject line.