There are three forces acting on a golf ball in flight:

1) lift, because of its shape
2) drag, due to air resistance, and
3) gravity.

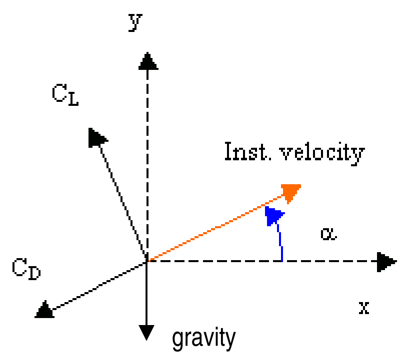


figure from
http://simscience.org/fluid/red/golf_exp.html

As shown in the figure, lift (C_L) is perpendicular to the motion of the ball and drag (C_D) is directly opposite the motion of the ball. Gravity (g) always acts downward.

These forces act to modify the acceleration of the golf ball, as defined by the following equations:

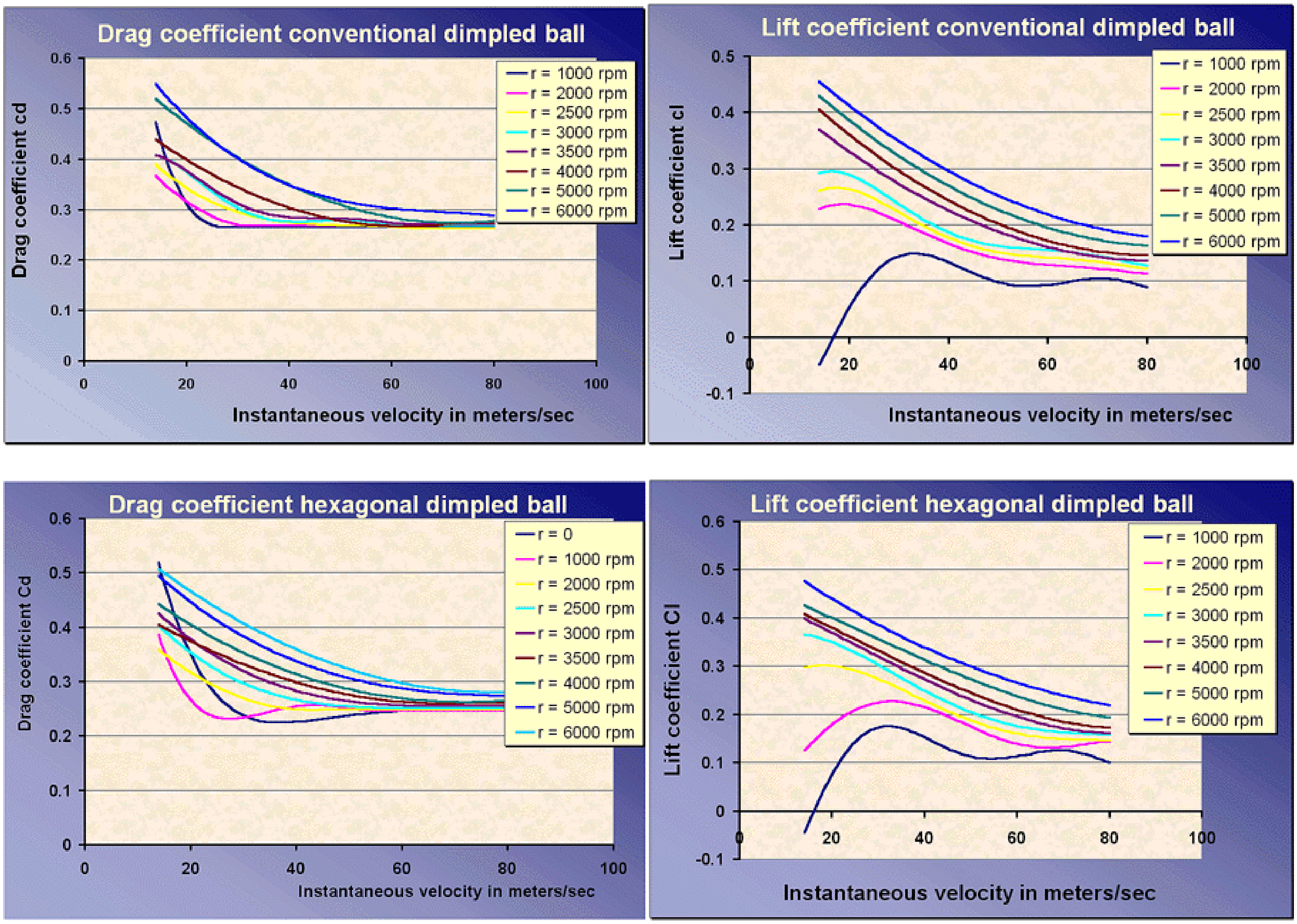
$$x'' = -K * v^2 * (C_D*\cos(\alpha) + C_L*\sin(\alpha))$$
$$y'' = K * v^2 * (C_L*\cos(\alpha) - C_D*\sin(\alpha)) - g$$

where:

K is a constant relating ball shape, ball mass and air density
C_D is the drag coefficient (a function of v and r)
C_L is the lift coefficient (a function of v and r)
g is gravity (9.8 m/s^2)
v is the instantaneous velocity of the ball (m/s)
α is the instantaneous angle of flight (radians above horizontal)
r is rotational velocity (rotations/minute)

Values for K, C_D and C_L can be found at http://simscience.org/fluid/red/golf_exp.html.

Golf Ball Coefficents (source: http://simscience.org/fluid/red/golf_exp.html)



Assignment:

Using the programming or simulation environment of your choice, simulate a golf ball to determine:
(a) optimal launch angle for a launch velocity of 60 m/s and a rotational velocity of 3000 rpm.
(b) optimal launch velocity for a launch angle of 20 degrees and a rotational velocity of 3000 rpm.
In both cases, “optimal” means the longest horizontal flight (range) on a level surface.

Run all simulations using Euler integration and Runge-Kutta 4 integration and compare the results.

Submission:

Submit your code/model, and a report describing your experiments and conclusions.
Experiments can be summarized in a plot of angle vs. range or velocity vs. range.

You may work in pairs on this assignment.