MATH 112
Applications to Aerospace

Instructions: Solve each of the following problems and show supporting work neatly. These are open book exercises and graphing calculators may be used. If they are used, explain procedure. The preferred procedure is to open this problem set in Microsoft Word and show your work beneath each problem using MathType to write the mathematical expressions

1. The total solar radiation *H* on a particular surface during an average clear day is given by:

$$H = \frac{5000}{t^2 + 10}$$

   where *t* ($-6 \le t \le 6$) is the number of hours from noon. Note that 6 a.m. is equivalent to *t* = -6. Find the instantaneous rate of change of *H* with respect to *t* at 3 p.m.

2. The altitude *h* (in meters) of a jet as a function of the horizontal distance *x* (in kilometers) it has traveled is given by:

$$h = 0.000104x^4 - 0.0417x^3 + 4.21x^2 - 8.33x$$

   Find the instantaneous rate of change of *h* with respect to *x* for *x* = 120 km.

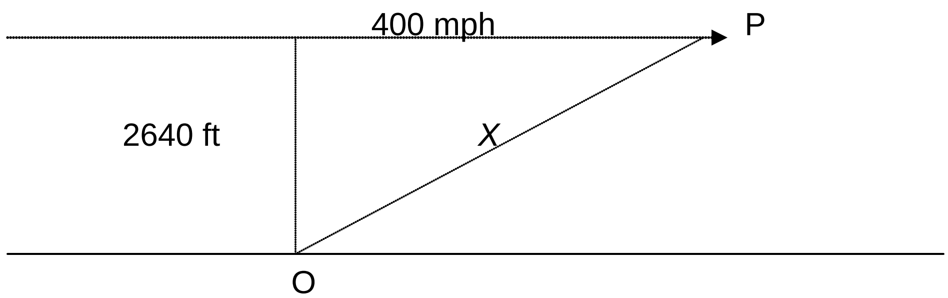
3. The lowest flying speed *v* (in ft/s) at which a certain airplane can fly varies directly as the square root of the wing load *w* (in lb per sq. ft). If *v* = 88 ft/s when *w* = 16 lb /sq ft, find the derivative of *v* with respect to *w*.

4. A bullet is fired vertically upward. Its distance *s* (in ft) above the ground is given by:

$$s = 2250t - 16.1t^2$$ where *t* is the time (in *s*).

   Find the acceleration of the bullet.

5. An airplane flies over an observer with a velocity of 400 mph and at an altitude of 2640 ft. If the plane flies horizontally in a straight line, find the rate at which the distance *x* from the observer to the plane is changing 0.6 min after the plane passes over the observer. RE sketch below.



6. The power supply P (in watts) in a satellite is given by:

$$P = 100e^{-0.005t}$$

where t is measured in days. Find the time rate of change of power after 100 days.

7. A meteorologist sketched the path of the jet stream on a map of the northern U.S. and southern Canada on which all latitudes were parallel and all longitudes were parallel and equally spaced. A computer analysis showed this path to be given by:

$$y = \left(6.0e^{-0.020x}\right)\left(\sin 0.20x\right) \quad \text{where} \quad 0 \le x \le 60$$

The origin is $125.0^\circ W, 45.0^\circ N$ and the point (60,0) is $65.0^\circ W, 45.0^\circ N$.

Find the locations of the maximum and minimum latitudes of the jet stream between $65^\circ W$ and $125^\circ W$ for that day.

8. A missile is launched and travels along a path that can be represented by:

$$y = \sqrt{x}$$

A radar tracking station is located 2 km directly behind the launch pad. Placing the launch pad at the origin and the radar station at (-2, 0), find the largest angle of elevation required of the radar to track the missile.

9. A space vehicle is launched vertically from the ground such that its velocity v (in km/s) is given by:

$$v = \left[\ln^2\left(t^3+1\right)\right]\frac{t^2}{t^3+1}$$

where *t* is the time in seconds. Find the altitude of the vehicle after 10 seconds.

10. The velocity *ds/dt* (in meters/second) of a projectile is given by

$$ds/dt = -9.8t + 16$$

Find the displacement *s* of the object after 4 seconds if the initial displacement is 48 m.