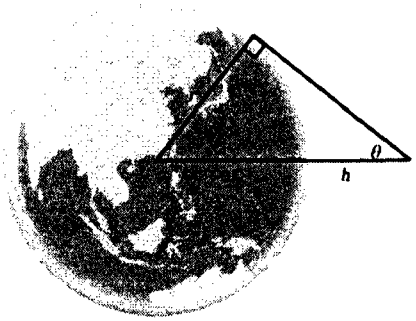
1. Please find the derivative of the following functions.(18%)
   (1) $y = 3\sec^2(\pi x - 1)$ (6%)
   (2) $y = \log_5 \frac{x\sqrt{x-1}}{2}$ (6%)
   (3) $y = \ln(\frac{1+e^x}{1-e^x})$ (6%)

2. When satellites observe Earth, some satellites have sensors that are capable to measure the angle θ as shown in the figure. Let h denote the distance between satellite and Earth's surface and let r represent Earth's radius (r = 6378 km). Please calculate the rate at which h is changing with respect to θ when $\theta = 30°$. (15%)



3. Please answer the following questions. (22%)
   (1) Please find the **extreme** and **reflection points** of $f(x) = x^2e^{-x}$ (6%)
   (2) Please find an equation of **tangent line** to the graph of $y = (\ln x)^{\cos x}$ at $(e, 1)$ (6%)
   (3) Let $0 \le x \le 2$, please evaluate the definite integral for the **surface area** generated by revolving $y = 1 - \frac{x^2}{4}$ about the y-axis. (10%)

4. Please evaluate the integral of the following functions. (25%)
   (1) $\int_1^9 \frac{1}{\sqrt{x}(1+\sqrt{x})^2}dx$ (5%)
   (2) $\int \frac{1}{\sec x \tan x}dx$ (5%)
   (3) $\int \frac{x}{16x^4-1}dx$ (5%)
   (4) $\int_0^1 e^x \sin x dx$ (5%)
   (5) $\int_0^{\pi}\int_0^{\sin x}(1+\cos x)dydx$ (5%)

5. The maximum volume of an ellipsoid. (20%)
   (1) Please calculate the volume of an ellipsoid given by $\frac{x^2}{a^2}+\frac{y^2}{b^2}+\frac{z^2}{c^2}=1$. (10%)
   (2) For a fixed sum $a+b+c=k$, please show that the ellipsoid of maximum volume is a sphere. (10%)