The following is a NON-CALCULATOR question. All work must be shown.
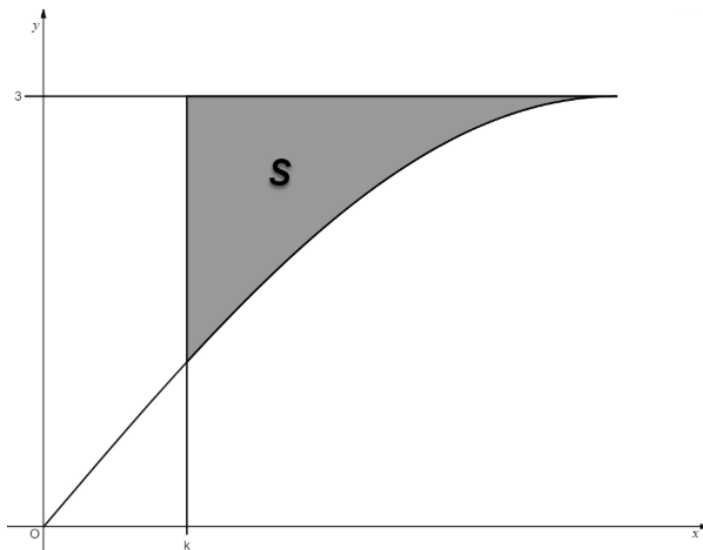
1). Let S be the shaded region in the first quadrant bounded above by the horizontal $y = 3$, below by the graph of $y = 3\sin x$, and on the left by the vertical line $x = k$, when $0 < k < \frac{\pi}{2}$ as shown in the figure below

a). Find the Area of S when $k = \frac{\pi}{3}$

b). The area of S is a function of k. Find the rate of change of the area of S with respect to k when $k = \frac{\pi}{6}$

c). Region S is revolved about the horizontal line $y = 5$ to form a solid. Write, but do not evaluate, an expression involving one or more integrals that gives the volume of the solid when $k = \frac{\pi}{4}$

d). Region S is the base of a solid with cross sections perpendicular to the x - axis that are semicircles. Write, but do not evaluate, an expression involving one or more integrals that gives the volume of the solid when $k = \frac{\pi}{4}$

e). Write, but do not evaluate, an expression involving one or more integrals that gives the perimeter of region S when $k = \frac{\pi}{6}$