1. What is the angle between the curves $y = \cos(x-1) - 1$ and $x = e^y$ where they intersect?

A. 0 B. $\frac{\pi}{6}$ C. $\frac{\pi}{4}$ D. $\frac{\pi}{3}$ E. $\frac{\pi}{2}$ F. $\frac{5\pi}{6}$

2. Find the moment of inertia about the z-axis of the portion of the first octant inside the surface $\rho = 2\sin\phi$, if density is given by $\delta(x,y,z) = z$.

A. 0 B. $\frac{\pi}{5}$ C. $\frac{3\pi}{5}$ D. $\frac{6\pi}{5}$ E. $\frac{8\pi}{5}$ F. $\frac{11\pi}{5}$

3. Suppose $\frac{dy}{dt} = k(y+7)$, $y(0) = 0$, and $y(1) = 1$. What is $y(2)$? Here k is a constant.

A. $\frac{15}{7}$ B. $\frac{13}{7}$ C. $\frac{11}{7}$ D. $\frac{9}{7}$ E. 1 F. $\frac{5}{7}$

4. What is the limit

$$\lim_{(x,y)\to(0,0)} \frac{\left(3x^2+y^2\right)\left(1-\cos(x^2+y^2)\right)}{x^6+y^6}$$

A. $\frac{3}{2}$ B. $\frac{5}{2}$ C. $\frac{7}{2}$ D. $\frac{9}{2}$ E. $\frac{11}{2}$ F. limit does not exist

5. The maximal volume of any rectangular prism whose sides a, b, c satisfy $4ab + 9ac + bc \leq 108$ is:

A. 36 B. $\frac{71}{2}$ C. 35 D. 34 E. 33 F. $\frac{65}{2}$

6. Consider a parallelogram $\mathcal{P}$, three of whose vertices are $A = (1,2,1), B = (0,1,1), C = (-1,0,0)$.
   i. Find the area of $\mathcal{P}$.
   ii. $\mathcal{P}$ lies in a plane. Give an equation for that plane.
   iii. If we project $\mathcal{P}$ to the yz plane, we get a parallelogram in the yz plane. What is the area of that parallelogram?

7. Suppose R is the parallelipiped spanned by $\mathbf{u} = \langle a, 0, 0\rangle, \mathbf{v} = \langle b_1, b_2, 0\rangle, \mathbf{w} = \langle c_1, c_2, c_3\rangle$.
   i. Give a formula for the surface area A in terms of $a, b_1, b_2, c_1, c_2, c_3$.
   ii. Give a formula for the volume V in terms of $a, b_1, b_2, c_1, c_2, c_3$.
   iii. If we wanted to find the parallelipiped with maximal volume among all such parallelipipeds with the same surface area A_0, write (but don't solve) the Lagrange multipliers system in the variables $a, b_1, b_2, c_1, c_2, c_3$ that we'd need to solve.
   iv. By examining the equations in the Lagrange multipliers system, show that $\mathbf{u}, \mathbf{v}, \mathbf{w}$ must be mutually orthogonal to maximise volume. (*Hint.* Consider $\frac{\partial}{\partial b_1} V = \lambda \frac{\partial}{\partial b_1} A$.)

8. TRUE or FALSE. For each of the following statements, indicate whether it is true (T) or false (F). Support your answers.
   i. The graph of a solution of the differential equation $\frac{dy}{dt} = \cos y$ is a sinusoidal wave.

   ii. The graph of a solution of the differential equation $\frac{dy}{dt} = \sin t$ is a sinusoidal wave.

   iii. The curve $\mathbf{r}(t) = \langle \frac{1}{4}t^3 - 2, \frac{4}{t} - 3, \cos(t-2)\rangle$ is tangent to the surface $x^3 + y^3 + z^3 - xyz = 0$ at the point $(0,-1,1)$.