<table>
<thead>
<tr>
<th>Question Number</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>P.</td>
<td>( y = 4x - 2e )</td>
</tr>
<tr>
<td>1.</td>
<td>1</td>
</tr>
<tr>
<td>2.</td>
<td>( \frac{3(2x^2 + 7)^3}{20} + C )</td>
</tr>
<tr>
<td>3.</td>
<td>400</td>
</tr>
<tr>
<td>4.</td>
<td>( \frac{5}{6\pi} )</td>
</tr>
<tr>
<td>5.</td>
<td>( 4x \cos x - 4x^2 \sin x )</td>
</tr>
<tr>
<td>6.</td>
<td>10</td>
</tr>
<tr>
<td>7.</td>
<td>( y' = \frac{2x \cos(x^2 + y^2) + \frac{1}{x}}{1/y - 2y \cos(x^2 + y^2)} ) or ( \frac{y + 2x^2 y \cos(x^2 + y^2)}{x - 2xy^2 \cos(x^2 + y^2)} ) or any other equivalent form</td>
</tr>
<tr>
<td>8.</td>
<td>( \frac{\sqrt{3}}{9} )</td>
</tr>
<tr>
<td>9.</td>
<td>no solution</td>
</tr>
<tr>
<td>10.</td>
<td>( \frac{5}{2} )</td>
</tr>
<tr>
<td>11.</td>
<td>( \frac{\pi^2 - 24}{48} ) or ( \frac{\pi^2}{48} - \frac{1}{2} )</td>
</tr>
<tr>
<td>12.</td>
<td>( 90 + \sqrt{2} ) THROWN OUT</td>
</tr>
</tbody>
</table>
1. The graph is the unit circle and the point is \(\left(\frac{\sqrt{2}}{2}, \frac{\sqrt{2}}{2}\right)\). The line normal to the graph here is then \(y = x\), which has a slope of 1.

2. Standard integration, no integration by parts.

3. Small numbers with fifteen factors are of the form \(p^2q^4\), \(p\) and \(q\) prime. Enumerating the smallest:
\[
3^2 \cdot 2^4, 2^2 \cdot 3^4, 5^2 \cdot 2^4.
\]
The third smallest is 400.

4. Solving for the volume of the container by solids of revolution:
\[
V = \pi \int_0^k y \, dy = \frac{\pi h^2}{2}.
\]
Hence the height is 6 when the volume is \(18\pi\), differentiating and solving gives \(dh = \frac{5}{6\pi}\).

5. Following the proof for differentiation of a product:
\[
\lim_{h \to 0} \frac{f(x+h)g(x+2h) - f(x)g(x)}{h} = \frac{f(x+h)g(x+2h) - f(x)g(x + 2h) + f(x)g(x + 2h) - f(x)g(x)}{h}
\]
\[
= \frac{g(x+2h)[f(x+h) - f(x)] + f(x)[g(x+2h) - g(x)]}{h} + 2 \frac{f(x)[g(x + 2h) - g(x)]}{2h}
\]
Evaluating the limits gives: \(f''(x)g(x) + 2f(x)g'(x)\), which immediately gives: \(4x \cos x - 4x^2 \sin x\)

6. Solving for surface area in terms of radius gives:
\[
SA = 2r^2\pi + \frac{4000\pi}{r}.
\]
Differentiate and set equal to zero to give \(r = 10\).

7. Implicitly differentiating \(\ln y - \ln x = \sin(x^2 + y^2)\):
\[
\frac{y'}{y} - \frac{1}{x} = (2x + 2yy') \cos(x^2 + y^2)
\]
Separating variables gives:
\[
y' = \frac{2x\cos(x^2 + y^2) + 1}{y - 2y\cos(x^2 + y^2)}.
\]

8. Area is equal to:
\[
\frac{1}{2} \left( \sin x \right) \left( \sin x \right) \left( \cos x \right) = \frac{\sin^2 x \cos x}{2} = \frac{\cos x - \cos^3 x}{2}
\]
Differentiating and setting to zero gives:
\[
\sin x = 3(\sin x)(\cos^2 x) \rightarrow \frac{1}{3} = \cos^2 x.
\]
The maximal area is then \(\frac{1}{3\sqrt{3}}\) or \(\frac{\sqrt{3}}{9}\).

9. Integrating gives:
\[
[\ln x - x] = [-1] = 1 \rightarrow x \ln x - x = 0 \rightarrow x = e.
\]

10. Series is equal to:
\[
\left(\frac{1}{3} + \frac{1}{9} + \frac{1}{27} + \cdots\right) + \left(\frac{1}{2} + \frac{2}{4} + \frac{3}{8} + \frac{4}{16} + \cdots\right) = \frac{1/3}{1-1/3} + \frac{1/2}{1-1/2} = \frac{1/2 + 2}{2} = \frac{5}{2}
\]

11. Differentiating gives: \(f'(x) = 3x^2 - 2\sin x \cos x = 3x^2 - \sin(2x)\). So
\[
\frac{f'(\pi/12)}{12} = \frac{3\pi^2}{144} - \frac{1}{2} = \frac{\pi^2 - 24}{48}
\]

12. \[
\sum_{x=0}^{90} \cos(2x) = \sum_{x=0}^{90} \cos^2(x) - \sin^2(x) = \sum_{x=0}^{90} \cos^2(x) - \sum_{x=0}^{90} \sin^2(x).
\]
Both the sine and cosine series can be summed independently grouping terms as in arithmetic summation:
\[
[\sin^2(0) + \sin^2(90)] + [\sin^2(1) + \sin^2(89)] + \cdots + \sin^2(45) = 45 + \frac{\sqrt{2}}{2}
\]
Adding the identical results for sine and cosine gives: \(90 + \sqrt{2}\)