Question Number	*Answer*
P.	$y = 4x - 2e$
1.	1
2.	$\frac{3(2x^2+7)^5}{20} + C$
3.	400
4.	$\frac{5}{6\pi}$
5.	$4x\cos x - 4x^2 \sin x$
6.	10
7.	$y' = \frac{2x\cos(x^2+y^2) + 1/x}{1/y - 2y\cos(x^2+y^2)}$ or $\frac{y + 2x^2 y\cos(x^2+y^2)}{x - 2xy^2\cos(x^2+y^2)}$ or any other equivalent form
8.	$\frac{\sqrt{3}}{9}$
9	*no solution*
10.	$\frac{5}{2}$
11.	$\frac{\pi^2 - 24}{48}$ or $\frac{\pi^2}{48} - \frac{1}{2}$
12.	~~$90 + \sqrt{2}$~~ THROWN OUT

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: $V = \pi\int_0^h y\,dy = \frac{\pi h^2}{2}$. Hence the height is 6 when the volume is 18π, differentiating and solving gives $dh = \frac{5}{6\pi}$.
5. Following the proof for differentiation of a product:

$$\lim_{h\to 0}\frac{f(x+h)g(x+2h)-f(x)g(x)}{h} = \frac{f(x+h)g(x+2h)-f(x)g(x+2h)+f(x)g(x+2h)-f(x)g(x)}{h}$$

$$= \frac{g(x+2h)\left[f(x+h)-f(x)\right]+f(x)\left[g(x+2h)-g(x)\right]}{h} = \frac{g(x+2h)\left[f(x+h)-f(x)\right]}{h}+2\frac{f(x)\left[g(x+2h)-g(x)\right]}{2h}$$

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 $\ln y - \ln x = \sin\left(x^2+y^2\right)$: $\frac{y'}{y} - \frac{1}{x} = (2x+2yy')\cos\left(x^2+y^2\right)$

Separating variables gives: $y' = \frac{2x\cos(x^2+y^2)+\frac{1}{x}}{\frac{1}{y}-2y\cos(x^2+y^2)}$.

8. Area is equal to: $\frac{1}{2}(\sin x)(\sin x)(\cos x) = \frac{\sin^2 x\cos x}{2} = \frac{\cos x - \cos^3 x}{2}$ 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: $[x\ln x - x]-[-1] = 1 \rightarrow x\ln x - x = 0 \rightarrow x = e$.
10. Series is equal to: $\left(\frac{1}{3}+\frac{1}{9}+\frac{1}{27}+\cdots\right)+\left(\frac{1}{2}+\frac{2}{4}+\frac{3}{8}+\frac{4}{16}+\cdots\right) = \frac{1/3}{1-1/3}+\frac{1/2}{(1-1/2)^2} = \frac{1}{2}+2 = \frac{5}{2}$
11. Differentiating gives: $f'(x) = 3x^2 - 2\sin x\cos x = 3x^2 - \sin(2x)$. So $f'(\frac{\pi}{12}) = \frac{3\pi^2}{144} - \frac{1}{2} = \frac{\pi^2-24}{48}$
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:

$$\left[\sin^2(0)+\sin^2(90)\right]+\left[\sin^2(1)+\sin^2(89)\right]+\cdots\sin^2(45) = 45+\frac{\sqrt{2}}{2}$$

Adding the identical results for sine and cosine gives: $90+\sqrt{2}$