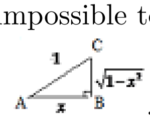
1. **B** $\frac{8^3-2^3}{3}+\frac{8^2-2^2}{2}+(8-2)+\ln(8)-\ln(2)=168+30+6+\ln(4)=204+2\ln(2)$.
2. **B** $(0^2+2)+(1^2+2)+(2^2+2)+(3^2+2)=22$.
3. **A** It's just a quarter-circle; hence, $\frac{1}{4}(2\pi)(4)=2\pi$.
4. **E** $g(x)=\cos(x)-i\sin(x)$; $\displaystyle\int_0^{\pi}\cos(x)-i\sin(x)dx=\sin(\pi)-\sin(0)+i\cos(\pi)-i\cos(0)=-2i$.
5. **C** $u=-x^2; du=-2xdx\to-\frac{1}{2}\displaystyle\int_0^1-2xe^{-x^2}dx=-\frac{1}{2}\left(e^{-1}-e^0\right)=\frac{e-1}{2e}$.
6. **D** First, evaluate $f(x)$ using integration by parts; we see that $\displaystyle\int\sin(\ln(x))dx$
$=x\sin(\ln(x))-\displaystyle\int\cos(\ln(x))dx$. Since this cancels with $g(x)$, we're left with $x\sin(\ln(x))$ from 0 to $e^{\frac{\pi}{2}}$. This is $e^{\frac{\pi}{2}}$; while $\ln(0)$ would cause a problem by itself, $x\sin(\ln(x))$ goes to 0 as x goes to 0.
7. **E** $f'(x)+g'(x)=e^x(\sin(x)+\cos(x))=e^{\frac{\pi}{2}}$.
8. **D** We need $\displaystyle\int_0^k x^3dx=\int_k^4 x^3dx\to k^4/4=64-k^4/4\to k^4=128\to k^2=8\sqrt{2}$.
9. **D** $f(x)<0$ on (-1, 3); hence, $\displaystyle\int_{-5}^{-1}3x^2-6x-9dx-\int_{-1}^{3}3x^2-6x-9dx+\int_{3}^{5}3x^2-6x-9dx=224$.
10. **C** The trick here is not subtracting 16 from both sides. If $f(x)<g(x)$, then $x^4-4x^3+6x^2-4x+1<16$; thus, $(x-1)^4<16$, and $-1<x<3$. The area of the region is thus $\displaystyle\int_{-1}^{3}16-(x-1)^4dx=\frac{256}{5}$.
11. **B** Break $\frac{6}{x^2-9}$into partial fractions to obtain $\frac{1}{x-3}-\frac{1}{x+3}$; integrate to obtain $\ln(x-3)-\ln(x+3)$; plug in the limits to obtain $\ln 7-\ln 3$. 12. **D** $|2|+|-2|=4$.
13. **B** Note that the odd powered terms cancel and so we have $120\displaystyle\int_{-1}^{1}x^4+x^2dx=2(120/5+120/3)=128$. 14. **D** I and IV will always overestimate the integral; II will always underestimate; III is impossible to determine without knowing the actual function.
15. **B** Consider the diagram 

. Note that $\arccos(x)+\arcsin(x)=$ m$\angle$A + m$\angle$C $=\frac{\pi}{2}$, regardless of x; hence $\displaystyle\int_0^{\frac{1}{2}}\frac{\pi}{2}dx=\frac{\pi}{4}$.
16. **A** Once again using a triangle, we see that $\sin(\arccos\frac{x}{2})=\sqrt{1-\frac{x^2}{4}}=\frac{1}{2}\sqrt{4-x^2}$. Using trig substitution to evaluate the integral, we get $\arcsin\frac{x}{2}+\frac{1}{2}\sqrt{1-\frac{x^2}{4}}$; plugging in, we get $\frac{3\sqrt{3}+2\pi}{12}$.
17. **B** $1+\sin(2x)=(\sin^2(x)+\cos^2(x)+2\sin(x)\cos(x))=(\sin(x)+\cos(x))^2$. Letting $u=\sin(x)+\cos(x)$, this is $\displaystyle\int\frac{du}{u^2}=-\frac{1}{u}=-\frac{1}{\cos(x)+\sin(x)}$. Plugging in, we get $2-\sqrt{3}$.
18. **E** Clearly, a and r must be the roots of the polynomial, with $a<r$; this would integrate the entire region on which the polynomial is positive. We find these roots to be $-\frac{5}{2}$ and 6; $[36-6.25]=29$.
19. **E** It can be shown that $f(x)$ is its own inverse; hence, $f(x)-g(x)=0$ and this integral is zero.
20. **C** $\displaystyle\int_{-\ln 2}^{\ln 2}\cosh(x)dx=2\int_0^{\ln 2}\cosh(x)dx=2\sinh(\ln 2)=2-\frac{1}{2}=\frac{3}{2}$.
21. **C** Let k represent the distance traveled since Hurricane Zeta started pushing; then, $f(x)=-x^2+2x+k$. The roots of this parabola are $\frac{-2\pm\sqrt{4+4k}}{-2}=1\pm\sqrt{1+k}$, and the area will be $\displaystyle\int_{1-\sqrt{k+1}}^{1+\sqrt{k+1}}-x^2+2x+kdx$. Note that we can't just differentiate this straight up, since there's a k in the integrand. We split this integral into $\displaystyle\int_{1-\sqrt{k+1}}^{1+\sqrt{k+1}}-x^2+2xdx$ and $\displaystyle\int_{1-\sqrt{k+1}}^{1+\sqrt{k+1}}kdx$. The first can be done by ordinary methods, and for the second we'll integrate, set in terms of k, then differentiate. After doing this (the process is simple enough), we obtain $\frac{dA}{dt}=2\sqrt{k+1}\frac{dk}{dt}$; $\frac{dk}{dt}=2$, so $2(3)(2)=12$.

22. **C** $f'(x) = 2x\sin(\sqrt{x^2}) \to f'(\frac{\pi}{3}) = \frac{2\pi}{3}\frac{\sqrt{3}}{2} = \frac{\pi\sqrt{3}}{3}$

23. **B** $\sqrt{\frac{1-x}{1+x}} = \sqrt{\frac{(1-x)^2}{1-x^2}} = \frac{1-x}{\sqrt{1-x^2}} = \frac{1}{\sqrt{1-x^2}} - \frac{x}{\sqrt{1-x^2}}$; integrating, we get $\arcsin(x) + \sqrt{1-x^2}$; plugging in, this is $\frac{\pi+3\sqrt{3}-6}{6}$.

24. **D** Let $u = \frac{x}{2}$; $dx = 2du$. Rewriting the integrand in terms of u, we get $2u^{2u}(1+\ln(u))$ $= 2u^u(u^u(1+\ln(u))$. Since $u^u(1+\ln(u))$ is the derivative of u^u, when integrating we get $(u^u)^2$; plugging in $u=1$ and $u=2$ (taken from the corresponding x-values), we get 15.

25. **A** $f(x) = x^3 - 6x^2 + 5x + C; f(0) = f(1) = C; f(2) = -6 + C \to 2C = -6 + C \to C = -6$; $f(-2) = -8 - 24 - 10 - 6 = -48$.

26. **B** Let $u = \cos(x) + 1 \to du = -\sin(x)$; this integral becomes $-\displaystyle\int_2^{\frac{3}{2}} \frac{du}{u} = -\ln\frac{3}{4} = \ln\frac{4}{3}$.

27. **A** Just graph the function on the interval.

28. **B** $kN = \frac{dN}{dt} \times t \to \frac{dN}{N} = k\frac{dt}{t} \to \ln(N) = k\ln(t) + C \to N = Ct^k$; plugging in $t=1$ gives $C = 1337$ and plugging in $t=2$ gives $k=2$; hence, when $t=3$, $N = 1337(3^2) = 1337(9) = 12033$.

29. **A** Let $x = \tan(u)$; the integrand becomes $\frac{\ln(\tan(u))}{(\tan^2(u)+1}(\sec^2(u))du = \ln(\tan(u))du$, and the limits become 0 and $\frac{\pi}{2}$. Rewrite this integral as $\displaystyle\int_0^{\frac{\pi}{2}} \ln(\sin(u))du - \int_0^{\frac{\pi}{2}} \ln(\cos(u))du$; let $I_1 = \displaystyle\int_0^{\frac{\pi}{2}} \ln(\sin(u))du$ and let $I_2 = \displaystyle\int_0^{\frac{\pi}{2}} \ln(\cos(u))du$. Leaving I_1 alone, substitute $u = \frac{\pi}{2} - t$ for I_2; we get $\displaystyle\int_{\frac{\pi}{2}}^0 \ln(\cos\left(\frac{\pi}{2} - t\right))(-dt) = -\int_{\frac{\pi}{2}}^0 \ln(\sin(t))dt$. Switching the bounds to get rid of the negative sign, this integral becomes $\displaystyle\int_0^{\frac{\pi}{2}} \ln(\sin(t))dt$; hence, $I_1 = I_2$, and the answer is zero. NOTE: This question should not be changed to E. Both I_1 and I_2, despite being improper integrals, are convergent (to a value of $\frac{-\pi\ln 2}{2}$)

30. **E** Note that the integral is dy, not dx! It's just $-8x$.