1. **D** The first three nonzero terms in question are $x - x^3/6 + x^5/120$. Plugging in, we get $\int_0^1 (1 - x^2/6 + x^4/120)dx = 1 - \frac{1}{18} + \frac{1}{600} = \frac{1703}{1800}$.

2. **B** Using the Ratio Test, we get $\lim_{x\to\infty} \frac{(2x+2)!}{(x+1)^{x+1}(x+10!} \times \frac{x!x^x}{(2x)!} = \lim_{x\to\infty} \frac{(2x+2)(2x+1)x^x}{(x+1)^2(x+1)^x}$ $= \lim_{x\to\infty} \frac{2(2x+1)}{x+1} \times \left(\frac{x}{x+1}\right)^x = \lim_{x\to\infty} \frac{4x+2}{x+1}\left(1+\frac{1}{x}\right)^{-x} = \frac{4}{e} > 1$ and so our series diverges.

3. **C** Rewrite this as $r^2 = \frac{25}{4\cos^2(\theta) + 9\sin^2(\theta)} \to 4(r\cos(\theta))^2 + 9(r\sin(\theta))^2 = 25 \to 4x^2 + 9y^2 = 25$.
Write this ellipse in standard form: $\frac{x^2}{\frac{25}{4}} + \frac{y^2}{\frac{25}{9}} = 1$; the area is thus $\pi(\frac{5}{2})(\frac{5}{3}) = \frac{25\pi}{6}$.

4. **B** $A = \pi(a)(7-a)$; the average value is $\frac{\pi}{7}\int_0^7 (7a - a^2)da = \frac{\pi}{7}(\frac{343}{2} - \frac{343}{3}) = \frac{49\pi}{6}$.

5. **E** It says nothing about a *local* minimum. As $t \to -\infty$, so too does this dot product.

6. **C** $x = r\cos(\theta) = 2\cos(\theta) - \sin(2\theta); y = r\sin(\theta) = 2\sin(\theta) - 2\sin^2(\theta)$. Hence $\frac{dx}{d\theta} = -2\sin(\theta) - 2\cos(2\theta)$; $\frac{dy}{d\theta} = 2\cos(\theta) - 2\sin(2\theta)$. Hence $\frac{dy}{dx} = \frac{2\cos(\theta)-2\sin(2\theta)}{-2\sin(\theta)-2\cos(2\theta)}$. Plugging in $\theta = \frac{\pi}{4}$ gives $\sqrt{2} - 1$.

7. **A** $\lim_{t\to\infty} \frac{\ln(e^t+1)}{e^t} = \lim_{t\to\infty} \frac{\frac{e^t}{e^t+1}}{e^t} = \lim_{t\to\infty} \frac{1}{e^t+1} = 0$.

8. **D** For $\ln(x)$, it can be seen that $f^{(n)}(x) = \frac{(-1)^{n+1}(n-1)!}{x^n}$ so $\sum_{n=1}^{\infty} \frac{1}{f^{(n)}(x)} = \sum_{n=1}^{\infty} \frac{(-1)(-x)^n}{(n-1)!} =$ $\sum_{n=0}^{\infty} \frac{(-1)(-x)^{n+1}}{n!} = x\sum_{n=0}^{\infty} \frac{(-x)^n}{n!} = x(e^{-x})$.

9. **E** Use integration by parts to obtain $\int \frac{\ln(x)}{\sqrt{x}}dx = 2\sqrt{x}\ln(x) - \int \frac{2}{\sqrt{x}}dx = 2\sqrt{x}(\ln(x) - 2)$.
Plugging in the limits, we get $4e^2$.

10. **C** If we multiply top and bottom by $\sqrt{1-\sin(x)}$, we can rewrite this integral as $\int_0^{\frac{\pi}{6}} \sqrt{\frac{1-\sin^2(x)}{(1-\sin(x))^2}}dx = \int_0^{\frac{\pi}{6}} \frac{\cos(x)}{1-\sin(x)}dx$. Let $u = 1 - \sin(x)$; then $du = -\cos(x)$ and this evaluates nicely to $-\ln|1-\sin(x)|$. Plugging in the bounds, we get $\ln(2)$.

11. **D** If $f(x)$ is equal to its Maclaurin series, then its Maclaurin series must also be an even function. Hence every odd power must have a zero coefficient. Thus I is true. By symmetry, II is true (one can verify by making the substitution $u = -x$). III is true; while the "counterexample" $f(x) = c$ may come up in disputes, note that the zero function is by definition both odd and even.

12. **C** Since there's 3 petals, the bounds are $0 \le \theta \le \frac{2\pi}{3}$. Hence we get $\int_0^{\frac{2\pi}{3}} \frac{r^2}{2}d\theta = \int_0^{\frac{2\pi}{3}} 2\cos^2(3\theta)d\theta = \int_0^{\frac{2\pi}{3}} (1+\cos(6\theta))d\theta = \theta + \frac{1}{6}\sin(6\theta)$ evaluated at the bounds, giving $\frac{2\pi}{3}$.

13. **B** The area bound by the curve is $\int_0^{\frac{\pi}{3}} ydx$; $y = \sin(t), dx = \sec^2(t)dt$; hence, this is $\int_0^{\frac{\pi}{3}} \frac{\sin(t)}{\cos^2(t)}dt = \sec(\frac{\pi}{3}) - \sec(0) = 1$.

14. **B** The volume bound by the curve will be $\pi\int_0^{\frac{\pi}{3}} y^2dx$; y and dx are as in question 13; hence we get $\pi\int_0^{\frac{\pi}{3}} \frac{\sin^2(t)}{\cos^2(t)}dt = \pi\int_0^{\frac{\pi}{3}} \tan^2(t)dt = \pi\int_0^{\frac{\pi}{3}} \left(\sec^2(t) - 1\right)dt = \tan(t) - t$ evaluated at the limits, which gives $\frac{3\pi\sqrt{3}-\pi^2}{3}$.

15. **A** $\sqrt{1-x^2}\frac{dy}{dx} = y^2 + 1 \Rightarrow \frac{dy}{y^2+1} = \frac{dx}{\sqrt{1-x^2}} \to \arctan(y) = \arcsin(x) + C \to y = \tan(\arcsin(x) + C)$.
Plug in $(0,0)$ to get $C = 0$ then plug in $x = \frac{1}{2}$ to get $\frac{\sqrt{3}}{3}$.

16. **E** There's a vertical asymptote at $x = 1$. Integral diverges.

17. **D** Theorem of Pappus: $V = 2\pi rA$, where A is the area of the triangle in question and r is the distance from the centroid to the origin (since the origin lies on the line that the triangle is being rotated about). Hence, to minimize V, we want to minimize $2\pi\frac{ab}{2}\sqrt{(a/3)^2+(b/3)^2} = \frac{\pi}{3}(\frac{1}{b\sqrt{b}})(b)\sqrt{\frac{1}{b^3}+b^2}$ $= \frac{\pi}{3}\sqrt{\frac{1}{b^4}+b}$. It suffices to minimize what's inside the square root and so $1-\frac{4}{b^5}=0 \to b=\sqrt[5]{4}$.

18. **A** $\frac{dy}{dt}=\frac{1}{t}; \frac{dx}{dt}=2t \to \frac{dy}{dx}=\frac{1}{2t^2}; \dfrac{d(\frac{dy}{dx})}{dt}=\dfrac{-1}{t^3} \to \dfrac{d^2y}{dx^2}=-\dfrac{1}{2t^4}$

19. **B** Making the substitution $u=-x^2$ and integrating, this becomes $2\pi\times -\frac{1}{2}e^{-x^2}$; evaluating at the limits gives $2\pi\times\frac{1}{2}=\pi$.

20. **C** Transforming this sum into an integral gives $\displaystyle\int_0^2 x^4dx = 2^5/5 = 32/5$.

21. **C** Let $u=x^2$. Then our integral becomes $\displaystyle\int_0^{\frac{1}{2}}\frac{2}{1-u^2}du = \int_0^{\frac{1}{2}}\left(\frac{1}{1-u}+\frac{1}{1+u}\right)du = \ln|\tfrac{1+u}{1-u}|$ evaluated at the limits; this is $\ln(3)$.

22. **E** The power series for $\ln(x+1)$ has radius of convergence 1. The series diverges for $x=2$.

23. **B** Use the Ratio Test to determine the radius: $\displaystyle\lim_{k\to\infty}\frac{(k+1)^{k+1}x^{k+1}}{(k+1)!}\times\frac{k!}{x^kk^k} = \lim_{k\to\infty}\frac{x(k+1)^{k+1}}{(k+1)k^k}$ $= \lim_{k\to\infty}\frac{x(k+1)^k}{k^k} = x\displaystyle\lim_{k\to\infty}\left(1+\frac{1}{k}\right)^k = ex$. Since we need $|ex|<1$, $\frac{1}{e}$ is our ROC.

24. **B** This takes integration by parts and a clever u-substitution. We first integrate by parts with $u=\sqrt{x}, dv=e^{-x}dx$ to obtain $-e^{-x}\sqrt{x}+\displaystyle\int_0^\infty\frac{e^{-x}}{2\sqrt{x}}dx$. Note that the first part (that is, $-e^{-x}\sqrt{x}$) goes to zero at both ∞ and 0, and so we're left with $\displaystyle\int_0^\infty\frac{e^{-x}}{2\sqrt{x}}dx$. Now, let $u=\sqrt{x}\Rightarrow du=\frac{1}{2\sqrt{x}}dx$. Then this integral becomes $\displaystyle\int_0^\infty e^{-u^2}du$. Now we use the hint: since e^{-u^2} is an even function,
$\displaystyle\int_0^\infty e^{-u^2}du = \frac{1}{2}\int_{-\infty}^\infty e^{-u^2}du = \frac{1}{2}\sqrt{\pi}$.

25. **A** $\Theta(x)=\frac{1}{1-x} \to \displaystyle\int_0^{\frac{1}{2}}\Theta(x)dx = -\ln(1-\frac{1}{2})+\ln(1)=\ln(2)$.

26. **D** Definition.

27. **A** This is the same thing as saying $\frac{\mu(x-2)(x-1)+\alpha x(x-1)+\theta x(x-2)}{x(x-1)(x-2)} = \frac{1}{x(x-1)(x-2)}$. Plugging in $x=2$, $x=1$, and $x=0$, we can isolate μ,θ, and α respectively to get $\mu=\alpha=\frac{1}{2}$ and $\theta=-1$. Product $-\frac{1}{4}$.

28. **C** $\pi\displaystyle\int_1^\infty\frac{1}{x^{\frac{3}{2}}}dx = \frac{-2\pi}{\sqrt{x}}$; plugging in the bounds gives 2π.

29. **E** Be careful! Note that $y\neq 3x^2$. y is actually a constant 27 for all x. Hence the average value of y over this interval is 27.

30. **C** Substitute $x=2\sin(\theta)$ and evaluate. We wind up with $\arcsin(\frac{x}{2})$, evaluated at 2 and 1, to give $\frac{\pi}{2}-\frac{\pi}{6}=\frac{\pi}{3}$.