1) E ($2-\pi^2/4$)
2) B
3) D
4) D
5) E (does not exist)
6) D
7) B
8) A
9) D
10) B
11) C
12) D
13) B
14) C
15) A
16) D
17) E (1)
18) E ($f'(x)=0$ and concave up)
19) B
20) C
21) B
22) A
23) B
24) E ($\pi/2$)
25) A
26) C
27) B
28) A
29) A
30) D

1) E. $f'(x)=2x\sin x+x^2\cos x\Rightarrow f''(x)=2\sin x+2x\cos x+2x\cos x-x^2\sin x\Rightarrow$
$f''(\frac{\pi}{2})=2-\frac{\pi^2}{4}$.

2) B. Using L'Hopital's rule, the expression becomes $\frac{2x+1}{2x+3}\Rightarrow\frac{3}{5}$.

3) D. The velocity is given by $x'(t)=4t^3-2t\Rightarrow x'(2)=28$, thus it moves to the right at $28\frac{units}{\sec}$.

4) D. Plugging 0 into the expression gives
$f'(x)=2x\sin x+x^2\cos x\Rightarrow f''(x)=2\sin x+2x\cos x+2x\cos x-x^2\sin x$. L'Hoptial's rule is used twice and the expression becomes $\frac{20x^3-2}{-\cos x}\Rightarrow\frac{-2}{-1}=2$.

5) E. Since no limit exists for the function as 1 is approached from the positive side, no limit exists.

6) D. $\frac{dy}{dx}=\frac{dy}{dt}\left(\frac{dt}{dx}\right)=(2t)(t)=2t^2$. $\frac{d^2y}{dx^2}=\frac{d}{dt}\left(\frac{dy}{dx}\right)\left(\frac{dt}{dx}\right)=(4t)(t)=4t^2\Rightarrow 4(2)^2=16$.

7) B. The limit is –1 only when the term in the numerator with the highest exponent is 4. This only occurs when $A=2$ or $A=-2$, thus the sum of all possible values of A is 0.

8) A. $f'(x)=2x\sin(x)\ln(x)+x^2\cos(x)\ln(x)+x^2\sin(x)\ln(x)\Rightarrow f'(\pi)=-\pi^2\ln\pi$

9) D. Between every root of $f(x)$ there is one point where $f'(x)=0$, thus $A=n-1$. Between every root of $f'(x)$, there is one point where $f''(x)=0$, thus $B=n-2$. So $A+B=2n-3$.

10) B. $\frac{dy}{dx}=\frac{-\partial x}{\partial y}=\frac{\cos(x)-y}{x+3y^2}$.

11) C. $f(x)=\log_x 9=\frac{\ln 9}{\ln x}\Rightarrow f'(x)=-\ln 9\left(\frac{1}{x(\ln x)^2}\right)\Rightarrow f'(e)=\frac{-\ln 9}{e}$.

12) D. $g'(x)=\frac{1}{2\sqrt{1+f(x)^2}}\left(2f(x)f'(x)\right)=\frac{f(x)f'(x)}{\sqrt{1+f(x)^2}}$.

13) B. $f(\frac{\sqrt{3}}{2}+0.1)\approx f(\frac{\sqrt{3}}{2})+f'(\frac{\sqrt{3}}{2})(0.1)=\frac{\pi}{3}+2(.1)=\frac{\pi}{3}+0.2$.

14) C. Using substitution, if $u=\frac{1}{3x}$, then the limit becomes $\lim_{u\to\infty}((1+\frac{1}{u})^u)^{\frac{3}{4}}=e^{\frac{3}{4}}\Rightarrow A-B=-1$.

15) A. $f'(x)=3x^2-18x+24\Rightarrow 2(x-4)(x-2)$. Thus the two relative extrema occur at 2 and 4. Since, $f''(x)$ is negative at 2, this is the relative maximum.

16) D. Plugging in h directly gives $\frac{0}{0}$. Using L'Hoptial's rule, the expression becomes $\frac{2f'(x+2h)+2f'(x-2h)}{1}$. When $h=0$ it becomes $4f'(x)$. $f'(x)=2\pi\cos(2\pi x)\Rightarrow 4f'(0)=8\pi$.

17) E. $y=r\sin\theta=\sin^2\theta\Rightarrow\frac{dy}{d\theta}=\sin 2\theta$ $\quad x=r\cos\theta=\sin\theta\cos\theta\Rightarrow\frac{dx}{d\theta}=\cos 2\theta$

$$\frac{dy}{dx}=\frac{dy}{d\theta}\left(\frac{d\theta}{dx}\right)=\tan 2\theta\Rightarrow\tan\left(2\left[\frac{\pi}{8}\right]\right)=1.$$

18) E. Using the product rule of derivatives, it can be seen that $f'(x)=0$, thus NOTA is the correct choice.

19) B. $\frac{dy}{dx}=\frac{y^2}{x^2+1}\Rightarrow\frac{dy}{y^2}=\frac{dx}{x^2+1}$. Integrating both sides gives $\frac{-1}{y}=\arctan(x)+C$. Using the fact that $f(1)=-\frac{4}{\pi}$, $\frac{\pi}{4}=\frac{\pi}{4}+C\Rightarrow C=0$. Therefore $\frac{-1}{y}=\frac{\pi}{3}\Rightarrow y=\frac{-3}{\pi}$.

20) C. If the polynomial is written in the form Ax^3+Bx^2+Cx+D, then $D=2$, $3A+2B+C=13$, $12A+2B=18$, and $6A=6$. So $A=1$, $B=3$, $C=4$, and $D=2$. Thus $f(1)=10$.

21) B. $\frac{d}{dx}[arc\sec(x^2)]=\frac{2x}{x^2\sqrt{x^4-1}}\Rightarrow\frac{2}{x\sqrt{x^4-1}}$.

22) A. If $G'(u)=\sin(\sqrt{u})\Rightarrow\int_x^{x^2}\sin(\sqrt{u})du=G(x^2)-G(x)\Rightarrow$

$f'(x)=2xG'(x^2)-G'(x)=2x\sin x-\sin\sqrt{x}$.

23) B. $f(x)=\frac{3x^3-3x^2-4x-3}{x-2}=3x^2+3x+2+\frac{1}{x-2}$. The third derivative of the first three terms is 0. The third derivative of the last term is the only one that matters. Thus $f'''(x)=\frac{-6}{(x-2)^4}\Rightarrow f'''(3)=\frac{-6}{1}=-6$.

24) E. The expression can rearranged to $\lim_{n\to\infty}\frac{1}{n}\cdot\sum_{i=1}^{n}\frac{1}{\sqrt{1-\left(\frac{i}{n}\right)^2}}=\int_0^1\frac{1}{\sqrt{1-x^2}}=\arcsin(1)-\arcsin(0)=\frac{\pi}{2}$.

25) B. Using substitution, if $h=\frac{1}{u}$, the limit becomes $\lim_{u\to\infty}\ln(\left[1+\frac{1}{u}\right]^u)=\ln e=1$.

26) C. The sum can be rewritten as the integral $\int_0^1\sin(\pi x)dx=\frac{-\cos(\pi)}{\pi}+\frac{\cos(0)}{\pi}=\frac{2}{\pi}$.

27) B. The limit can be rewritten as $\lim_{n\to\infty}e^{\frac{1}{n}\sum_{i=0}^{n}\frac{i}{n}}\Rightarrow e^{\int_0^1 xdx}=e^{\frac{1}{2}}$.

28) A. Using the first theorom of Pappus, the surface area can be found to equal $\pi^2\left(r_0^2-r_i^2\right)$. Thus $\frac{dS}{dt}=\pi^2(2r_0\frac{dr_0}{dt}-2r_i\frac{dr_i}{dt})\Rightarrow\pi^2(2(5)(2)-2(4)(2))=4\pi^2$.

29) A. The water filling the cone forms a cone that has a height twice the length of its radius. Thus $h=2r\Rightarrow V=\frac{\pi h^3}{12}\Rightarrow\frac{dV}{dt}=\frac{\pi h^2}{4}\frac{dh}{dt}\Rightarrow\frac{dh}{dt}=2\bullet\frac{4}{9\pi}=\frac{8}{9\pi}$.

30) D. The limit can be rewritten as $\lim_{n\to\infty}\frac{1}{n}\sum_{i=1}^{n}\sqrt{1-\left(\frac{i}{n}\right)^2}=\int_0^1\sqrt{1-x^2}dx$. This integral is equal to a quarter of the area of a unit circle, thus the answer is $\frac{\pi}{4}$.