1. A Complete the square on the z term to yield 
\((x - 2)^2 + (y + 3)^2 + (z + 4)^2 = 9\). Then the sphere has center \((2, -3, -4)\) and radius 3.

2. B Since \(\cos x = \sum_{n=0}^{\infty} \frac{(-1)^nx^{2n}}{(2n)!}\), the series sums to \(\cos \pi = -1\).

3. C \(\sin^2 n \leq 1\), \(\frac{1+\sin^2 n}{n^2} \leq \frac{2}{n^2}\). Since \(\sum_{n=1}^{\infty} \frac{2}{n^2}\) converges by the P-test, the series converges by the Comparison Test with \(\sum_{n=1}^{\infty} \frac{2}{n^2}\).

4. D \(\overrightarrow{AB} = (2, 0, 1) - (1, 1, -1) = (1, -1, 2)\). Since \(\overrightarrow{AB} \cdot \overrightarrow{d} = 2 - 2 + 0 = 0\), the orthogonal vector is \((2, 2, 0)\).

5. E The Alternating Series Estimation Theorem states that \(|s - s_n| \leq b_{n+1}\) where \(b_n = \frac{1}{n^2}\) in this case. Letting \(n = 7\), we have \(|s - s_7| \leq \frac{1}{8^2} = \frac{1}{64}\).

6. B \(f(x) = \frac{d}{dx} \left(\frac{1}{1-x}\right)\), so \(f(x) = \sum_{n=1}^{\infty} nx^{n-1}\).

7. C In the x-y plane, the equation describes a circle. Therefore, in 3-dimensional space, as \(z\) varies, the equation describes a cylinder.

8. E \(\text{comp}_b \overrightarrow{a} = \frac{\overrightarrow{a} \cdot \overrightarrow{b}}{|\overrightarrow{a}|} = \frac{-2 + 3 + 2}{\sqrt{1 + 2^2 + 2^2}} = \frac{3}{\sqrt{6}}\).

9. D \(\overrightarrow{a} = \overrightarrow{PQ} = (2, -1, 2) - (3, -3, 3) = (-1, 2, -1)\). Therefore, a unit vector in the direction of this vector is \(\overrightarrow{u} = \frac{1}{\sqrt{(-1)^2 + 2^2 + (-1)^2}} \langle -1, 2, -1 \rangle = \left\langle \frac{-1}{\sqrt{6}}, \frac{2}{\sqrt{6}}, \frac{-1}{\sqrt{6}} \right\rangle\), or \(-\frac{1}{\sqrt{6}} \mathbf{i} + \frac{2}{\sqrt{6}} \mathbf{j} - \frac{1}{\sqrt{6}} \mathbf{k}\).

10. D Since the center is 3 and the radius is 1, the series converges at least when \(2 < x < 4\). Testing \(x = 2\) yields \(\sum_{n=0}^{\infty} \frac{(-1)^n(2-3)^n}{4n+1} = \sum_{n=0}^{\infty} \frac{1}{4n+1}\) which diverges by comparison to \(\sum_{n=1}^{\infty} \frac{1}{n}\). Testing \(x = 4\) yields \(\sum_{n=0}^{\infty} \frac{(-1)^n(4-3)^n}{4n+1} = \sum_{n=0}^{\infty} \frac{(-1)^n}{4n+1}\) which converges by the Alternating Series Test. Therefore, the interval of convergence is \((2, 4]\).

11. D The series converges by the Alternating Series Test. To test for absolute convergence, we examine \(\sum_{n=1}^{\infty} \frac{4}{n^2 + 4 + n}\), which diverges by the Limit Comparison Test with \(\sum_{n=1}^{\infty} \frac{1}{n}\).

Therefore, the series is convergent, but not absolutely convergent.

12. C From the Maclaurin Series formula, \(f^{(n)}(0) x^n = \frac{(-1)^n+1}{n!} x^n\). Let \(n = 10\) to yield \(f^{(10)}(0) x^{10} = \frac{(-1)^{10+1}}{10!} x^{10}\). Solving for \(f^{(10)}(0)\) yields \(f^{(10)}(0) = \frac{-1(10!)}{10 \cdot 2^{10}} = \frac{g!}{2^{10}}\).

13. E \(\lim_{n \to \infty} \frac{\frac{a_{n+1}}{a_n}}{\frac{a_n}{a_{n-1}}} = 1\).

\(\lim_{n \to \infty} \frac{4(n+1)^2 + 3(n+1) + 3}{4n^2 + 3n + 3} = \lim_{n \to \infty} \frac{4n^2 + 3n + 3}{4n^2 + 3n + 3} = 1\).

Therefore, the Ratio Test is inconclusive for \(\sum_{n=0}^{\infty} (-1)^n\).

14. A Light \(\sum_{n=0}^{\infty} (-1)^n x^{2n+1}\), so the 3rd degree Taylor Polynomial for \(\sin(2x)\) is \(T_3(x) = 2x - \frac{(2x)^3}{3!} = 2x - \frac{4x^3}{3}\). Therefore, the 3rd degree Taylor Polynomial for \(f(x) = 3x - \frac{4x^3}{3}\).

15. A Applying the Ratio Test, we have \(\lim_{n \to \infty} \frac{a_{n+1}}{a_n} = \lim_{n \to \infty} \frac{(2012)^{n+1} x^{n+1}}{(n+1)!} \cdot \frac{n!}{(2012)^n x^n} = \frac{1}{x}\).
\[
\lim_{n \to \infty} \frac{2012|x|}{n} \to 0 \text{ for all values of } x. \text{ Therefore, the radius of convergence is } \infty.
\]

<table>
<thead>
<tr>
<th>(n)</th>
<th>(f^{(n)}(x))</th>
<th>(f^{(n)}(3))</th>
<th>(\frac{f^{(n)}(3)}{n!} (x - 3)^n)</th>
</tr>
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<tr>
<td>0</td>
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<td>(e^{-3})</td>
<td>(e^{-3} (x - 3)^0)</td>
</tr>
<tr>
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<td>(-e^{-x})</td>
<td>(-e^{-3})</td>
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<tr>
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<td>(e^{-x})</td>
<td>(e^{-3})</td>
<td>(e^{-3} (x - 3)^2)</td>
</tr>
</tbody>
</table>

From the chart above, \(\lim \frac{|(x - 2)^{n+1}}{n!} (x - 3)^n\) = \(\lim \frac{\sqrt{n+2}}{\sqrt{n+3}} |x - 2|\). We want the limit, \(|x - 2| < 1\), which is true when \(-1 < x - 2 < 1\), or \(1 < x < 3\). Therefore, the radius of convergence is 1. The series diverges (limit > 1) when \(|x - 2| > 1\), i.e., \(x > 3\) or \(x < 1\). Since the Ratio Test is inconclusive (limit = 1) at the endpoints, we must test them separately: When \(x = 1\),

\[
\sum_{n=1}^{\infty} (-1)^n(1 - 2)^n = \sum_{n=1}^{\infty} \frac{1}{\sqrt{n+2}} \text{ which is divergent by the Integral Test or by Limit Comparison Test with } \sum_{n=1}^{\infty} \frac{1}{n^{1/3}}. \text{ When } x = 3, \sum_{n=1}^{\infty} (-1)^n(3 - 2)^n = \sum_{n=1}^{\infty} (-1)^n \frac{1}{\sqrt{n+2}}, \text{ which is convergent by the Alternating Series Test. Therefore, the interval of convergence is } (1, 3].
\]

19. (a) From the chart below, \(\cos x \approx T_2(x) = \frac{\sqrt{3}}{2} - \frac{1}{2} (x - \frac{\pi}{6}) - \frac{\sqrt{3}}{4} \left(x - \frac{\pi}{6}\right)^2\)

\[
\sum_{n=1}^{\infty} \frac{\sin n}{6} = \sum_{n=1}^{\infty} \frac{1}{n!}(\frac{\pi}{6})^n f^{(n)}(\frac{\pi}{6})
\]

<table>
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<tr>
<td>0</td>
<td>(\cos x)</td>
<td>(-\frac{\sqrt{3}}{2})</td>
</tr>
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</tr>
<tr>
<td>2</td>
<td>(-\cos x)</td>
<td>(-\frac{\sqrt{3}}{2})</td>
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</tbody>
</table>

(b) \(a = \frac{\pi}{6}, n = 2\). To find \(M\), note that \(|f^{(3)}(x)| = |\sin x| \leq 1\) on the interval \(x \in \left[0, \frac{\pi}{2}\right]\). Therefore, \(M = 1\), and \(|R_2(x)| \leq \frac{1}{3!} \left|x - \frac{\pi}{6}\right|^2\). This error is largest on the interval \(x \in \left[0, \frac{\pi}{2}\right]\) at \(x = \frac{\pi}{2}\), so on the interval, \(|R_2(x)| \leq \frac{1}{3!} \left|\frac{\pi}{3}\right|^2 = \frac{\pi^3}{6 \cdot 27}\).
20.

(a) The series is an Alternating Series. \( |a_n| = ne^{-n^2} \), which is decreasing and approaching 0 
\( \lim_{n \to \infty} \frac{n}{e^{n^2}} = \lim_{n \to \infty} \frac{1}{2ne^{n^2}} = 0 \). Therefore, the series is convergent by the Alternating Series Test.

(b) Since the series is alternating, \( |s - s_3| \leq |a_4| = 4e^{-16} \)

(c) \( \sum_{n=1}^{\infty} |a_n| = \sum_{n=1}^{\infty} ne^{-n^2} \). Let \( f(x) = xe^{-x^2} \). 
\( f \) is positive, continuous, and decreasing \( (f'(x) = (1 - 2x^2)e^{-x^2} < 0) \), so we can apply the Integral Test:
\[
\int_1^{\infty} xe^{-x^2} \, dx = \lim_{t \to \infty} \int_1^{t} xe^{-x^2} \, dx = \lim_{t \to \infty} -\frac{1}{2} e^{-t^2} \bigg|_1^{t} = \frac{1}{2} e^{-1}.
\]
Since the improper integral converges, the series converges by the Integral Test.

(d) Using the error formula for the Integral Test, \( |s - s_3| \leq \int_3^{\infty} xe^{-x^2} \, dx = \lim_{t \to \infty} -\frac{1}{2} e^{-t^2} + \frac{1}{2} e^{-9} = \frac{1}{2} 6^{-9} \).