<table>
<thead>
<tr>
<th>Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1</strong> A</td>
</tr>
</tbody>
</table>
| **2** B | \[
\begin{align*}
2 & \quad 1 & -1 \\
5 & \quad 0 & -3 \\
1 & \quad -2 & 1 \\
\end{align*}
\] \(|-10| = 10 |
| **3** D | There are 12 minutes between the 43 minute mark and the 11 hour mark. This 12/60 of the circle. There is an additional angle caused by the movement of the hour hand. This is 43/60 or the 5 minutes between 12 and 12. So total fraction of the circle moved is the sum of these two fractions. Multiply by \( 2\pi \) to convert to radians. 
\[
\left( \frac{12}{60} + \frac{43}{60} \right) \cdot 2\pi = 1.631882
\]
| **4** B | \( 49 \cdot 4 + 2 = 198 \) |
| **5** B | \[ e^{-d} = \tan\left( \frac{\pi}{4} \right) = \tan\left( \frac{\pi}{8} \right) = \sqrt{2} - 1 \] \(-d = \ln(\sqrt{2} - 1)\) \(d = \ln(\sqrt{2} + 1)\) |
| **6** C | \( 2^{1001} \) |
| **7** E | None are always true |
| **8** C | \( z = re^{i\theta} \quad z = i \) 
\( i = 1 \cdot e^{i\frac{\pi}{2}} \) so 
\( \ln i = \ln\left( e^{i\frac{\pi}{2}} \right) = i \frac{\pi}{2} \) 
\( i' = e^{i\ln i} = e^{i\cdot\left(0, \frac{\pi}{2}\right)} = e^{-\frac{\pi}{2}} = \frac{1}{\sqrt{e^{\pi}}} \) 
\( \frac{\sqrt{e^{\pi}}}{e^{\pi}} \) |
| **9** A | For all values of \( n \), the answer is 0 |
| **10** D | \( p(x)=5 \) is equivalent to \( p(x)-5=0 \). The constant 5 doesn’t change the degree so \( p(x)-5 \) is of the same degree as \( p(x) \) (which is \( \leq 4 \)). If \( p(x) \) is not equal to the constant function \( y=0 \), it can have at most 4 roots, and the problem says that we must be able to find 5 distinct. If the function is the constant function \( y=0 \), then every number is a root, so we can find the five that we need (there are more!). Since \( p(x) \) is \( y=0 \), then the \( p(x)=5 \) is the constant function \( y=5 \), so \( p(5)=5 \) |
| **11** C | Earth rotates \( \frac{2\pi}{24} \) radians/hr 
\( \text{Arclength} = \left( \frac{2\pi}{24} \right) \cdot 4000 \approx 1047 \) mph |
| **12** C | \( C_6 \cdot 6! = 4656960 \) |
| **13** A | \( A=4, B=\frac{2\pi}{3}, C=\frac{16}{3}, D=2, E=6 \) 
\[ \frac{A+B+C+D-E}{E^2} = 0.20632 \approx 0.21 \] |
| **14** E | Volume of tetrahedron 
\[ \text{perimeters} \] 
\[
\begin{align*}
\text{perimeters} & \approx 13 \\
(1,3,-1,1) & = 1 \\
(2,1,-1,1) & = 2 \\
(1,-4,-2,1) & = 2 \\
\end{align*}
\] 
\[
\sqrt{(1-2)^2 + (2-3)^2 + (1+1)^2} = \sqrt{6}
\] 
Similarly the other perimeters are \( 1,3\sqrt{5},3,\sqrt{51},\sqrt{34} \) 
\( AB \approx 13 \) |
| **15** B | Todd: 
\[ Todd = 1000\left(1 + \frac{15}{4}\right)^{40} \approx 4360.38 \] 
\[ Jen = 1000e^{15(10)} \approx 4481.69 \] 
\[ Jen - Todd = 121.31 \] |
16 C  
\[100 = 200e^{30k} \Rightarrow \]  
\[.5 = e^{30k} \Rightarrow k = \frac{\ln .5}{30}\]  
So \(P(75) = 300e^{\frac{\ln .5}{30} \cdot 75} = 35.3553\)

17 D  
1,1,2,3,4,8,13,21,34,55,89, take sum 232

18 C  
\[70^\circ = \frac{70 \cdot \pi}{180} = \theta\]  
\[\theta \cdot \text{radius} = \text{arc length}\]  
\[\Rightarrow \frac{70\pi}{180} \cdot 5 \approx 6.1\]

19 D  
Minor of 2  
\[
\begin{bmatrix}
4 & 7 \\
-4 & 7 \\
2 & 0
\end{bmatrix}
\begin{bmatrix}
4 \\
7
\end{bmatrix} = 28
\]  
(the Cofactor matrix would be the 3x3 matrix made up of the minors times \((-1)^n\)  
\[
\begin{bmatrix}
-21 & 10 & 12 \\
-28 & -21 & 16 \\
45 & 8 & -11
\end{bmatrix}
\]  
note that the sign of 28 has been changed due to its location.  
The adjoint matrix is the TRANSPOSE of this matrix  
\[
\begin{bmatrix}
-21 & -28 & 45 \\
10 & -21 & 8 \\
12 & 16 & -11
\end{bmatrix}
\]  
The product is  
\[
\begin{bmatrix}
19180 & 15960 & -27916 \\
15960 & 41468 & -44912 \\
-27916 & -44912 & 61880
\end{bmatrix}
\]  
answer is -44912

20 B  
If points are on circle they satisfy the circle equation.  
\[(x + 1)^2 + (y - 5)^2 = r^2\]  
\[(x - 7)^2 + (y - 1)^2 = r^2\]  
subracting equation 1 and 2  
\[(x + 1)^2 - (x - 5)^2 = 0\]  
and implies \(x = 2\)  
subracting equation 2 and 3 and subbing \(x = 2\)  
\[9 + (y - 5)^2 - 25 - (y - 1)^2 = 0\]  
which implies \(y = 1\)  
thus equation is  
subbing \(x = 2\) and \(y = 1\) into equation 1, \(3^2 + (-4)^2 = 25\) implies the radius is 5  
equation  
\[(x - 2)^2 + (y - 1) = 25\]

21 B  
\[V = \pi (1.2r)^2 \cdot (9h) = 1.296\pi r^2h\]  
\[\Rightarrow 29.6\% \text{ increase}\]

22 D  
\[\cos a + \cos b = 2\cos\left(\frac{a + b}{2}\right)\cos\left(\frac{a - b}{2}\right)\]  
\[\Rightarrow a + b = 7, \quad a - b = 3\]  
\[\Rightarrow a = 5, b = 2\]

23 D  
\[y - 500 = \frac{1}{4c}(x - 500)^2\]  
(1000,0) is on the parabola so  
\[0 - 500 = \frac{1}{4c}(1000 - 500)^2\]  
so \(4c = -500\)  
\[y - 500 = -\frac{1}{500}(x - 500)^2\]  
\[150 - 500 = -\frac{1}{500}(x - 500)^2\]  
so \(x = 500 \pm 50\sqrt{70}\)  
use the larger to indicate falling
<table>
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<tr>
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<tbody>
<tr>
<td>24</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>( x^2 + 2x - 4y^2 = 3 )</td>
</tr>
<tr>
<td></td>
<td>( \Rightarrow x^2 + 2x + 1 - 4y^2 = 4 )</td>
</tr>
<tr>
<td></td>
<td>( (x + 1)^2 - 4y^2 = 4 )</td>
</tr>
<tr>
<td></td>
<td>( \Rightarrow \frac{(x + 1)^2}{2^2} - \frac{y^2}{1^2} = 1 )</td>
</tr>
<tr>
<td></td>
<td>asymptotes ( y = \pm \frac{1}{2}(x + 1) )</td>
</tr>
<tr>
<td></td>
<td>( \theta = \tan^{-1}\left(\frac{m_1 - m_2}{1 + m_1m_2}\right) )</td>
</tr>
<tr>
<td></td>
<td>( = \tan^{-1}\left(\frac{4}{3}\right) )</td>
</tr>
<tr>
<td></td>
<td>so ( \cos\theta = \frac{3}{5} )</td>
</tr>
<tr>
<td>25</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>P(-x) has 1 sign change → maximum of 1 negative root</td>
</tr>
<tr>
<td>26</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td><img src="image" alt="Diagram" /></td>
</tr>
<tr>
<td></td>
<td>Area of a circle-area of square</td>
</tr>
<tr>
<td></td>
<td>( \pi 2^2 - \left(2\sqrt{2}\right)^2 = 4\pi - 8 )</td>
</tr>
<tr>
<td>27</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>ok no –</td>
</tr>
<tr>
<td></td>
<td>5 0 25</td>
</tr>
<tr>
<td></td>
<td>6 4 20</td>
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<td>7 8 15</td>
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<td></td>
<td>8 12 10</td>
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<tr>
<td></td>
<td>9 16 5</td>
</tr>
<tr>
<td></td>
<td>10 20 0</td>
</tr>
<tr>
<td>28</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>( A = \sqrt{5 + \sqrt{5 + \sqrt{5}...}} = \frac{1 + \sqrt{21}}{2} )</td>
</tr>
<tr>
<td></td>
<td>( B = \sqrt{5 - \sqrt{5 - \sqrt{5}...}} = \frac{-1 + \sqrt{21}}{2} )</td>
</tr>
<tr>
<td></td>
<td>A-B = 1</td>
</tr>
<tr>
<td>29</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>( \frac{20}{45} \binom{6}{2} + \frac{45}{45} \binom{6}{1} + \frac{10}{45} \binom{6}{0} = \frac{43975}{8145060} )</td>
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