1. Answer: D

Solution: Row 4 is a constant multiple of Row 2. Therefore, the determinant is 0.

2. Answer: A

Solution: $|u| = \sqrt{(-48)^2 + (55)^2} = \sqrt{5329} = 73$

3. Answer: E

Solution: The volume of a parallelepiped is the triple product of three of its sides containing the same point. $\overrightarrow{AB} \times \overrightarrow{AC} = \langle -48, 6, 30\rangle \to \langle -48, 6, 30\rangle \cdot \langle 5, -3, 9\rangle = 12$ (the absolute value)

4. Answer: A

Solution: Cofactor = $(-1)^{3+4}\begin{vmatrix} 9 & 2 & 11 \\ 13 & 4 & 9 \\ 5 & 17 & -3 \end{vmatrix} = (-1)(894) = -894$

5. Answer: C

Solution: $\|v\| = \sqrt{(x+1)^2 + x^2 + 2^2} = \sqrt{2x^2 + 2x + 5}$

The derivative of this expression, when set equal to 0 is $\frac{4x+2}{\sqrt{2x^2+2x+5}} = 0$, for which the only solution is $-\frac{1}{2}$. When plugging in number around this value, it is clear that it is a minimum. For example, $x = 0 \to \|v\| = \sqrt{5}, x = -1 \to \|v\| = \sqrt{5}, x = -\frac{1}{2} \to \|v\| = \sqrt{\frac{9}{2}} < \sqrt{5}$

6. Answer: E

Solution: $u \times v = \langle -12, 27, 24 \rangle \to 0 = \langle -12, 27, 24 \rangle \cdot \langle x-7,\ y-10,\ z-2 \rangle$

$$-12x + 84 + 27y - 270 + 24z - 48 = 0 \to -12x + 27y + 24z = 234$$

7. Answer: D

Solution: $AB = \begin{bmatrix} 7*1+-3*3 & 7*4+3*1 \\ 2*1+0*-3 & 2*4+0*1 \end{bmatrix} = \begin{bmatrix} -2 & 31 \\ 2 & 8 \end{bmatrix}$

$(AA)B = \left(\begin{bmatrix} 7 & 3 \\ 2 & 0 \end{bmatrix}\begin{bmatrix} 7 & 3 \\ 2 & 0 \end{bmatrix}\right)\begin{bmatrix} 1 & 4 \\ -3 & 1 \end{bmatrix} = \begin{bmatrix} 55 & 21 \\ 14 & 6 \end{bmatrix}\begin{bmatrix} 1 & 4 \\ -3 & 1 \end{bmatrix} = \begin{bmatrix} -8 & 241 \\ -4 & 62 \end{bmatrix}$

$A(BB) = \begin{bmatrix} 7 & 3 \\ 2 & 0 \end{bmatrix}(\begin{bmatrix} 1 & 4 \\ -3 & 1 \end{bmatrix}\begin{bmatrix} 1 & 4 \\ -3 & 1 \end{bmatrix} = \begin{bmatrix} 7 & 3 \\ 2 & 0 \end{bmatrix}\begin{bmatrix} -11 & 8 \\ -6 & -11 \end{bmatrix} = \begin{bmatrix} -95 & 23 \\ -22 & 16 \end{bmatrix}$

$\begin{bmatrix} -2 & 31 \\ 2 & 8 \end{bmatrix} + \begin{bmatrix} -8 & 241 \\ -4 & 62 \end{bmatrix} + \begin{bmatrix} -95 & 23 \\ -22 & 16 \end{bmatrix} = \begin{bmatrix} -105 & 295 \\ -24 & 86 \end{bmatrix}$

8. Answer: B

Solution: $\cos\theta = \frac{t+2+2(t+1)}{\sqrt{5}*\sqrt{(t+2)^2+(t+1)^2}} = \frac{3t+4}{\sqrt{5}*\sqrt{2t^2+6t+5}} = \frac{2\sqrt{5}}{5}$

9. Answer: A

Solution: $|m| = x^3(x+1)^2 - (x+8x-6)^2(x+1)^2 = (x^3 - x^2 - 8x +$

$6)(x+1)^2 = (x-3)(x^2+2x-2)(x+1)^2$

$$\lim_{x\to 3}\frac{|m|}{x-3} = \lim_{x\to 3}(x^2+2x-2)(x+1)^2 = 208$$

10. Answer: B

Solution: $\begin{bmatrix} x_1 \\ y_1 \end{bmatrix} = \begin{bmatrix} 3 & 2 \\ 2 & 1 \end{bmatrix}\begin{bmatrix} x \\ y \end{bmatrix} \to \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} -1 & 2 \\ 2 & -3 \end{bmatrix}\begin{bmatrix} x_1 \\ y_1 \end{bmatrix}$. Plugging in $x_1 = 3$ yields

$\begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 2y_1 - 2 \\ 6 - 3y_1 \end{bmatrix}$. Since $f(x) = (x+1)^3 - 8,\ 6 - 3y_1 = (2y_1 - 2)^3 - 8$.

Multiplying this out, the only real solution is $y_1 = 2$, so $f^T(3) = 2$.

11. Answer: D

Solution: For the vectors to be orthogonal $t^2 + 2\sqrt{2}t + 2 = 0$. The only solution to this equation is $t = -\sqrt{2}$.

12. Answer: D

Solution. The matrices follow a pattern where the m_{14} entry is always 2 times the number of copies of m. Thus, the answer is $2(23) = 46$.

13. Answer: E

Solution: $\begin{vmatrix} 1-x & -8 \\ -11 & 4-x \end{vmatrix} = 0 \rightarrow x^2 - 5x + 4 - 88 = x^2 - 5x - 84 = (x + 7)(x - 12)$. Thus, the eigenvalues are $x = 12, -7$

14. Answer: C

Solution: Proj $\langle 3, -2, 5\rangle \rightarrow \langle 7, 0, 1\rangle = \frac{21+5}{49+1}\langle 7, 0, 1\rangle = \frac{13}{25}\langle 7, 0, 1\rangle$

Proj $\langle 1, 9, 4\rangle \rightarrow \langle -6, -2, 7\rangle = \frac{4}{89}\langle -6, -2, 7\rangle$

$25A \cdot 89B = 13\langle 7, 0, 1\rangle \cdot 4\langle -6, -2, 7\rangle = -1820$

15. Answer: D

Solution: $|3m| = 3^n|m| = 3^5 * 7 = 1701$

16. Answer: C

Solution: $A^{-1}B = \begin{bmatrix} \frac{1}{2} & \frac{3}{4} & 1 \\ \frac{5}{4} & \frac{3}{2} & \frac{7}{4} \\ 0 & \frac{1}{4} & \frac{5}{2} \end{bmatrix} \begin{bmatrix} -1 & -2 & -3 \\ -4 & -5 & -7 \\ -10 & -6 & -9 \end{bmatrix} = \begin{bmatrix} -\frac{27}{2} & -\frac{43}{4} & -\frac{63}{4} \\ -\frac{99}{4} & -\frac{41}{2} & -30 \\ -26 & -\frac{65}{4} & -\frac{97}{4} \end{bmatrix}$

$A^{-1}B_{23} * A^{-1}B_{31} = -30 * -26 = 780$

17. Answer: B

Solution: Cost of Jimi Hendrix CDs = $\frac{\begin{vmatrix} 17 & 206 \\ 19 & 154 \end{vmatrix}}{\begin{vmatrix} 17 & 23 \\ 19 & 13 \end{vmatrix}} = \frac{-1296}{-216} = 6$

Cost of Harambe dolls = $\frac{\begin{vmatrix} 23 & 206 \\ 13 & 154 \end{vmatrix}}{\begin{vmatrix} 23 & 17 \\ 13 & 19 \end{vmatrix}} = \frac{864}{216} = 4$

$21 * 4 + 43 * 6 = \$342$

18. Answer: B

Solution: $1 \times 2 \rightarrow 1 \times 3 \rightarrow 1 \times 7 \rightarrow 5 \times 7 \rightarrow 5 \times 11. 11^5 = 161051$

19. Answer: A

Solution: $\sqrt{v^4 + v^2 + 4} = 2\sqrt{6} \rightarrow v^4 + v^2 + 4 = 24 \rightarrow v^4 + v^2 - 20 = 0$

$(v^2 + 5)(v^2 - 4) = 0 \rightarrow v = \pm 2 \rightarrow 2 * -2 = -4$

20. Answer: A

Solution: Jerk is the derivative of acceleration with respect to time, meaning it is the third derivative of displacement with respect to time. $s(t) = \langle 5t^4 + 6, 15t^3 - 13t^2, 4t^5 \rangle \rightarrow s'''(t) = \langle 2 * 3 * 4 * 5t, 2 * 3 * 15, 3 * 4 * 5 * 4t^2 \rangle =$

$\langle 120t, 90, 240t^2 \rangle$

$j(2) = \langle 120 * 2, 90, 240 * 2^2 \rangle = \langle 240, 90, 960 \rangle$

21. Answer: B

Solution: $\begin{vmatrix} 1 & 0 & 2 \\ 3 & 0 & -4 \\ -7 & -2 & 9 \end{vmatrix} = 0 - 12 + 0 + 0 - 0 - 8 = -20$

Trace = $1 + 0 + 9 = 10$

$-20 * 10 = -200$

22. Answer: E

Solution: $\begin{vmatrix} 1-\lambda & 0 & 2 \\ 3 & 0-\lambda & -4 \\ -7 & -2 & 9-\lambda \end{vmatrix} = 0 \to (1-\lambda)(0-\lambda)(9-\lambda) - 12 + 14(0-\lambda) - 8(1-\lambda)$. Thus, the leading coefficient is -1, and the constant is -20, so the product of the solutions is -20. All of the roots are real.

23. Answer: A

Solution: $\begin{bmatrix} 1 & 0 & 2 \\ 3 & 0 & -4 \\ -7 & -2 & 9 \end{bmatrix}\begin{bmatrix} 1 & 0 & 2 \\ 3 & 0 & -4 \\ -7 & -2 & 9 \end{bmatrix}\begin{bmatrix} 1 & 0 & 2 \\ 3 & 0 & -4 \\ -7 & -2 & 9 \end{bmatrix} =$

$$\begin{bmatrix} -13 & -4 & 20 \\ 31 & 8 & -30 \\ -76 & -18 & 75 \end{bmatrix}\begin{bmatrix} 1 & 0 & 2 \\ 3 & 0 & -4 \\ -7 & -2 & 9 \end{bmatrix} = \begin{bmatrix} -165 & -40 & 170 \\ 265 & 60 & -240 \\ -655 & -150 & 595 \end{bmatrix}$$

$(m^3)_{33} = 595$

24. Answer: D

Solution: $1 + 2 + 3 - 4 - 7 - 2 + 9 = 2$

25. Answer: E

Solution: $\begin{bmatrix} 1 & 0 & 2 \\ 3 & 0 & -4 \\ -7 & -2 & 9 \end{bmatrix}\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix} \to x + 2z = 0,\ 3x - 4z = 0, -7x - 2y + 9z = 0$. $\langle 0, 0, 0 \rangle$ is the only vector that fits this description.

26. Answer: B

Solution: $1 + 1t = 4 + 3s \to t = 3 + 3s;\ -4 + 0t = -6 - 2s \to s = -1, t = 0$

$4-1(-1)=5+2(0)?\to 5=5$. Since $t=0$, the point of intersection is

$\langle 1,-4,5\rangle$

27. Answer: D

Solution: $(83*57-76*62)^{-(97*29-67*42)}=19^{-(-1)}=19$

28. Answer: A

Solution: $\langle 64\sqrt{6}+64\sqrt{2}, 64\sqrt{6}-64\sqrt{2}\rangle = 256\langle\frac{\sqrt{6}+\sqrt{2}}{4},\frac{\sqrt{6}-\sqrt{2}}{4}\rangle =$

$256\langle\cos\frac{\pi}{12},\sin\frac{\pi}{12}\rangle=\langle 256,\frac{\pi}{12}\rangle$

29. Answer: D

Solution: $(64\sqrt{6}+64\sqrt{2})\left(64\sqrt{6}-64\sqrt{2}\right)=64^2\left(\sqrt{6}+\sqrt{2}\right)\left(\sqrt{6}-\sqrt{2}\right)=$16384

30. Answer: C

Solution: Since 624 a multiple of 24, 625 is one greater than a multiple of 24.

Thus, $\frac{625\pi}{12}$ is coterminal with $\frac{\pi}{12}$, so C is correct.