1. The set of points equidistant from the points $(2, -1, 1)$ and $(4, 3, -5)$ is a plane. What is the equation of this plane?

(A) $3x + y - 2z = 0$ (B) $2x + 4y - 6z = -6$

(C) $x + 2y - 3z = 11$ (D) $2x + 14y + 10z = 15$

(E) $6x + 2y - 4z = 5$ (F) $x + y + z = 2$

(G) $2x + 2y + 2z = 7$ (H) $x + 7y + 5z = 0$

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2. In Citizens Bank Park, where the Philadelphia Phillies play baseball, the right-field fence is 330 feet from home plate (where the batter stands when he hits), and the fence is about 13 feet high. First-baseman Ryan Howard hits a home run over the right-field fence that starts out 3 feet above home plate with horizontal velocity 66 ft/sec toward the wall and initial upward velocity 84 ft/sec. By how many feet does the ball clear the top of the fence? (Assume the acceleration due to gravity is 32 ft/sec^2 and ignore wind resistance.)

(A) 2 feet (B) 4 feet (C) 6 feet (D) 8 feet

(E) 10 feet (F) 12 feet (G) 14 feet (H) 16 feet

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3. Let P be the plane tangent to the graph of $x^2e^{yz} = 4$ at the point $(2, 0, 3)$. What point on P is closest to the origin?

(A) $(-1, 1, 3)$ (B) $(-1, 1, 0)$ (C) $(2, 0, 3)$ (D) $(\frac{1}{2}, 0, \frac{3}{2})$

(E) $(\frac{1}{5}, 0, \frac{3}{5})$ (F) $(\frac{3}{5}, \frac{1}{5}, 0)$ (G) $(\frac{1}{5}, \frac{3}{5}, 0)$ (H) $(\frac{2}{5}, 0, \frac{3}{5})$

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4. Calculate the arclength of the curve given parametrically by

$$x = 2t^2, \qquad y = \sqrt{3}\,t^4, \qquad z = t^6$$

for $0 \le t \le 2$.

(A) 8 (B) $24\sqrt{3}$ (C) 36 (D) $64\sqrt{3}$

(E) 72 (F) $81\sqrt{3}$ (G) 108 (H) $144\sqrt{3}$

5. The ellipsoid

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{z^2}{c^2} = 1$$

bounds a region of volume $V = \frac{4}{3}\pi abc$. At a moment when $a = 1$, $b = 3$, and $c = 5$, a is changing at a rate of $+2$ and b is changing at a rate of -3, at what rate must c be changing for the volume to remain constant?

(A) -7	(B) -5	(C) -3	(D) -1
(E) 1	(F) 3	(G) 5	(H) 7

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6. The function $f(x, y) = x^3 - 6xy - 3y^2$ has

(A) one local maximum and one saddle point
(B) one local minimum and one saddle point
(C) one local maximum and one local minimum
(D) two local maxima
(E) two local minima
(F) two saddle points
(G) a local maximum and no other critical points
(H) a saddle point and no other critical points

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7. Find the maximum value of the function $f(x, y, z) = xy + yz$ on the surface of the sphere $x^2 + y^2 + z^2 = 4$.

(A) 0	(B) $\frac{1}{\sqrt{2}}$	(C) $\frac{1}{2\sqrt{2}}$	(D) $\frac{1}{2}$
(E) 1	(F) $\sqrt{2}$	(G) 2	(H) $2\sqrt{2}$

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8. Calculate $\iint_T x^2\, dA$ where T is the triangular region with vertices $(0, 0)$, $(1, 0)$ and $(1, 2)$.

(A) 1/3	(B) 1/2	(C) 2/3	(D) 1
(E) 4/3	(F) 3/2	(G) 5/3	(H) 2

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9. Calculate $\displaystyle\int_0^2 \int_{x^2}^4 \frac{e^{\sqrt{y}}}{y}\, dy\, dx$

(A) e^2	(B) $2e^2$	(C) $2e^2 - 1$	(D) $2e^2 - 2$
(E) $e^{\sqrt{2}}$	(F) $2e^{\sqrt{2}}$	(G) $2e^{\sqrt{2}} - 1$	(H) $2e^{\sqrt{2}} - 2$

10. Find the volume of the solid bounded above by the paraboloid $z = 5 - x^2 - y^2$ and below by the paraboloid $z = 4x^2 + 4y^2$.

(A) $\frac{\pi}{4}$ (B) 1 (C) $\frac{\pi}{2}$ (D) π

(E) $\frac{3\pi}{2}$ (F) 2π (G) $\frac{5\pi}{2}$ (H) $\frac{7\pi}{2}$

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11. Use the transformation $u = 3x + y$, $v = x + 2y$ to evaluate

$$\iint_R (3x^2 + 7xy + 2y^2)\, dA$$

where R is the region in the plane bounded by the lines $3x+y = 1$, $3x+y = 2$, $x+2y = 0$ and $x + 2y = 1$.

(A) $\frac{3}{20}$ (B) $\frac{3}{16}$ (C) $\frac{1}{8}$ (D) $\frac{1}{10}$

(E) $\frac{1}{2}$ (F) $\frac{3}{4}$ (G) $\frac{1}{4}$ (H) $\frac{5}{4}$

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12. Compute the volume of the solid bounded by the four surfaces $x+z = -1$, $x+z = 1$, $z = 1 - y^2$, and $z = y^2 - 1$.

(A) $\frac{2}{3}$ (B) $\frac{5}{3}$ (C) $\frac{8}{3}$ (D) $\frac{11}{3}$

(E) 4 (F) $\frac{16}{3}$ (G) $\frac{20}{3}$ (H) $\frac{22}{3}$

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13. Compute the work done by the force field

$$\vec{F} = (6xy - y^3)\,\mathbf{i} + (3y^2 + 3x^2 - 3xy^2)\,\mathbf{j}$$

along the path $\mathbf{c}(t) = (\cos(t)\,,\, \sin(t))$ for $-\frac{\pi}{2} \le t \le \frac{\pi}{2}$.

(A) 0 (B) $\frac{1}{4}$ (C) 1 (D) -1

(E) $-\frac{1}{2}$ (F) $-\frac{1}{4}$ (G) -2 (H) 2

14. Evaluate

$$\int_C xy^3\,dx + 3x^2y^2\,dy$$

where C is the boundary of the region in the first quadrant enclosed by the x-axis, the line $x = 1$ and the curve $y = x^3$, traversed counter-clockwise.

(A) 0 (B) $\frac{1}{2}$ (C) $\frac{1}{3}$ (D) $\frac{1}{4}$

(E) $\frac{1}{6}$ (F) $\frac{1}{11}$ (G) 1 (H) 2

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15. Let $y(t)$ be the solution to the differential equation

$$t\frac{dy}{dt} = t^2 + 2y$$

satisfying $y(1) = 2$. What is $y(2)$?

(A) $2 + 4\ln 2$ (B) $8 + 4\ln 2$ (C) $4 + 2\ln 2$ (D) $8 + 8\ln 2$

(E) $2 + 8\ln 2$ (F) $4 + 4\ln 2$ (G) $2 + 2\ln 2$ (H) $4 + 8\ln 2$