1. The parametric curve $x = 3\sec t$, $y = 4\tan t$ is represented in rectangular form by the equation

   (a) $\dfrac{x^2}{9} - \dfrac{y^2}{16} = 1$ ________________________________ (correct)

   (b) $\dfrac{x^2}{16} + \dfrac{y^2}{9} = 1$

   (c) $\dfrac{x^2}{16} - \dfrac{y^2}{9} = 1$

   (d) $\dfrac{x}{4} + \dfrac{y}{3} = 1$

   (e) $y = x^2 - 144$

2. If n is the number of intersection points between the two polar curves

$$r = 1 - 2\cos\theta \quad \text{and} \quad r = d \quad \text{where} \quad 0 \le \theta \le 2\pi$$

   Then which one of the following statement is **FALSE ?**

   (a) if $d = 3.5$, then $n = 1$ ________________________________ (correct)

   (b) if $d = 3$, then $n = 1$

   (c) if $d = 2.9$, then $n = 2$

   (d) if $d = 1$, then $n = 3$

   (e) if $d = 0.4$, then $n = 4$

3. Which one of the following points lies on the line that passes through the point $(-4, 5, 2)$ and is perpendicular to the plane given by $-x + 2y + z = 5$?

   (a) $(-3, 3, 1)$ ____ (correct)
   (b) $(-5, 7, 7)$
   (c) $(-3, 3, 3)$
   (d) $(4, 7, 3)$
   (e) $(0, 7, 3)$

4. The **distance** between the two planes

$$\mathcal{P}_1 : 2x + \sqrt{5}y + 4z = \sqrt{5}$$
$$\mathcal{P}_2 : 2x + \sqrt{5}y + 4z = 31\sqrt{5}$$

   is equal to

   (a) $6\sqrt{5}$ ____ (correct)
   (b) 4
   (c) 0
   (d) $\sqrt{5}$
   (e) $\dfrac{2}{\sqrt{5}}$

5. The surface of a mountain is modeled by the equation

$$h(x, y) = 5000 - 0.001x^2 - 0.004y^2.$$

If a mountain climber is at the point (500, 200, 4590), then which of the following vectors points in the direction of **steepest descent** (descend at the greatest rate) ?

(a) $5\,\mathbf{i} + 8\,\mathbf{j}$ ______________________________ (correct)

(b) $5\,\mathbf{i} - 8\,\mathbf{j}$

(c) $-\mathbf{i} + 8\,\mathbf{j}$

(d) $-\,\mathbf{i} - 3\,\mathbf{j}$

(e) $-5\,\mathbf{i} - 3\,\mathbf{j}$

6. $\displaystyle\int_0^{\sqrt{\ln 16}} \int_x^{\sqrt{\ln 16}} \int_1^3 e^{y^2}\, dz\, dy\, dx =$

(a) 15 ______________________________ (correct)

(b) 16

(c) $1 + 4\ln 2$

(d) $\sqrt{\ln 16} + 1$

(e) $\sqrt{\ln 16} - 1$

7. If $w = x\ cos(yz)$, $x = s^2$, $y = t^2$, $z = s - 2t$, then the value of $\dfrac{\partial w}{\partial t}$, when $s = 4$ and $t = 1$, is equal to

(a) $-32\ \sin(2)$ ________________ (correct)

(b) $16\ \sin(1)$

(c) -32

(d) 16

(e) 0

8. Let $f(x, y) = 2x^3 - x^2y + y^2$, $P(-1, 1)$ and $Q(2, -3)$. Then, the **directional derivative** of f at P in the direction of $\overrightarrow{PQ}$ is equal to

(a) 4 ________________ (correct)

(b) 25

(c) 20

(d) 3

(e) -2

9. Let **P** be the **tangent plane** to the surface $x\,y\,z = 10$ at the point $(1, 2, 5)$. Which of the following points is **not** on **P** ?

   (a) $(1, 1, 1)$ ______________________________ (correct)
   (b) $(0, 0, 15)$
   (c) $(3, 0, 0)$
   (d) $(0, 6, 0)$
   (e) $(0, 4, 5)$

10. The graph of the function

$$f(x, y) = \frac{1}{3}x^3 - x^2 + (x-1)y^2$$

   has

   (a) two saddle points, one relative maximum and one relative minimum ___(correct)
   (b) one saddle point, two relative maxima and one relative minimum
   (c) one saddle point, one relative maximum and two relative minima
   (d) two saddle points and two relative maxima
   (e) two relative maxima and two relative minima

11. Let M and m denote, respectively, the **maximum** and **minimum** values of

$$f(x, y) = 2x^2 + 2y^2 - 4x - 4y$$

over the region R. The region R is the triangular region in the xy-plane with vertices (0, 0), (2, 0), and (2, 4), and it includes its boundary. The value of $M + m =$

(a) 12 ____ (correct)

(b) 16

(c) 14

(d) -4

(e) -2

12. The **minimum distance** from the point $(-2, -3, 0)$ to the surface

$$z = \sqrt{3 - 2x - 2y}$$

is equal to

(a) $\sqrt{11}$ ____ (correct)

(b) $\sqrt{13}$

(c) 3

(d) 9

(e) 5

13. The **minimum value** of $f(x, y, z) = xyz + 228$ on the sphere $x^2 + y^2 + z^2 = 27$ is equal to

(a) 201 ____(correct)

(b) 101

(c) 102

(d) 208

(e) 202

14. $\displaystyle\int_1^e \int_0^y \frac{4}{x^2 + y^2}\, dx\, dy =$

(a) π ____(correct)

(b) $\pi \ \ln 4$

(c) $e \ \ln 4$

(d) $e \ \ln \pi$

(e) $e^2 \ \pi$

15. $\displaystyle\int_{-1}^{0}\int_{4x}^{-4x^2} f(x,y)\,dy\,dx =$

(a) $\displaystyle\int_{-4}^{0}\int_{-\sqrt{-y/4}}^{y/4} f(x,y)\,dx\,dy$ ______________________________ (correct)

(b) $\displaystyle\int_{-4}^{0}\int_{\sqrt{-y/4}}^{y/4} f(x,y)\,dx\,dy$

(c) $\displaystyle\int_{-4}^{0}\int_{-\sqrt{y/4}}^{y/4} f(x,y)\,dx\,dy$

(d) $\displaystyle\int_{-4}^{0}\int_{\sqrt{y/4}}^{-y/4} f(x,y)\,dx\,dy$

(e) $\displaystyle\int_{-4}^{0}\int_{-\sqrt{-y/4}}^{-y/4} f(x,y)\,dx\,dy$

16. The **volume** of the solid lying in the **first octant** and bounded by the graphs of $z = 8\,(1 - xy)$, $y = x$, $y = 1$ is equal to

(a) 3 ______________________________ (correct)

(b) 8

(c) $\dfrac{1}{8}$

(d) $\dfrac{1}{3}$

(e) 0

17. Let $f(x,y) = a\,x^2 + a\,y^2$, where $a > 0$ and $R = \{(x,y) : 0 \le x \le a,\ 0 \le y \le a\}$. If the **average value** of f over R is 18, then $a =$

(a) 3 ____(correct)
(b) 2
(c) 6
(d) 9
(e) 18

18. If $R = \{(x,y) : x^2 + y^2 \le 9,\ x \ge 0,\ y \ge 0\}$, then $\displaystyle\iint_R (x+y)\ dA =$

(a) 18 ____(correct)
(b) 54
(c) 9
(d) 15
(e) 27

19. The **volume** of the solid bounded above by $z = 12 - x^2 - y^2$ and below by $z = 2x^2 + 2y^2$ is equal to

(a) 24π ________________ (correct)

(b) 12π

(c) 2π

(d) 36π

(e) 6π

20. If $D = \{(x, y, z) : 0 \leq z \leq \sqrt{9 - x^2 - y^2},\ 0 \leq y \leq \sqrt{9 - x^2},\ 0 \leq x \leq 3\}$, then

$$\iiint_D (x^2 + y^2 + z^2)\, dz\, dy\, dx =$$

(a) $\int_0^{\frac{\pi}{2}} \int_0^{\frac{\pi}{2}} \int_0^3 \rho^4 \sin\phi \ d\rho\, d\phi\, d\theta$ ________________ (correct)

(b) $\int_0^{\frac{\pi}{2}} \int_0^{\frac{\pi}{2}} \int_0^3 \rho^2 \sin\phi \ d\rho\, d\phi\, d\theta$

(c) $\int_0^{\pi} \int_0^{\frac{\pi}{2}} \int_0^3 \rho^4 \sin\phi \ d\rho\, d\phi\, d\theta$

(d) $\int_0^{\frac{\pi}{2}} \int_0^{\pi} \int_0^3 \rho^2 \sin\phi \ d\rho\, d\phi\, d\theta$

(e) $\int_0^{\pi} \int_0^{\pi} \int_0^3 \rho^4 \sin\phi \ d\rho\, d\phi\, d\theta$

21. Let $f(x, y) = y - \sin x$. Which of the following vectors is normal to the **level curve** $f(x, y) = 2$ at the point $(\frac{\pi}{2}, 3)$?

(a) $< 0, 1 >$ ______________________________ (correct)

(b) $< -1, 0 >$

(c) $< \frac{\pi}{2}, 3 >$

(d) $< \frac{\pi}{2}, -3 >$

(e) $< 1, -\frac{\pi}{2} >$

Q	MASTER	1	2	3	4
1	A	E 6	E 1	D 6	C 9
2	A	E 14	E 5	B 12	E 13
3	A	A 2	E 13	D 18	D 16
4	A	B 9	C 21	A 19	E 5
5	A	D 12	E 10	C 5	A 17
6	A	B 5	B 16	B 17	B 19
7	A	E 7	D 19	E 10	B 7
8	A	A 1	D 9	E 8	B 3
9	A	E 20	B 12	A 2	E 1
10	A	B 8	E 3	E 3	D 2
11	A	B 10	B 14	A 21	A 6
12	A	A 18	E 4	A 11	D 18
13	A	B 11	A 2	B 9	A 21
14	A	C 21	B 8	A 13	E 15
15	A	E 17	D 18	A 16	D 12
16	A	C 15	D 6	E 14	C 11
17	A	C 19	B 7	C 20	C 10
18	A	B 13	A 11	B 15	B 4
19	A	D 3	B 17	D 7	A 8
20	A	C 4	B 15	A 1	A 14
21	A	B 16	C 20	C 4	E 20