- The domain of the function

$$\mathbf{r}(t) = \langle t^2, \sqrt{t-1}, \sqrt{5-t} \rangle$$

  (14.1, 1) [1,5]

- $$\lim_{t \to 1} \left(\sqrt{t+3}\mathbf{i} + \frac{t-1}{t^2-1}\mathbf{j} + \frac{\tan t}{t}\mathbf{k} \right)$$

  (14.1, 5) $(2, 1/2, tan 1)$

- A parametric equation for the line segment that joins (0,0,0) to (1,2,3).

  (14.1, 15) $x = t, y = 2t, z = 3t, 0 \leq t \leq 1$

- A Daily Double! Sketch the curve with the equation $\mathbf{r}(t) = \langle t, \cos 2t, \sin 2t \rangle$.

  (14.1, 9) spiral on cylinder in x direction

- The time at which the following two particles collide, if they do indeed collide; for $t \geq 0$, their paths are given by

  $\mathbf{r}_1(t) = \langle t^2, 7t-12, t^2 \rangle \quad \mathbf{r}_2(t) = \langle 4t-3, t^2, 5t-6 \rangle$

  (14.1, 39) $t = 3$

- The derivative of $\mathbf{r}(t) = \langle \cos t, \sin t \rangle$.

  (14.2, 3b) $(-\sin t, \cos t)$

- The derivative of $\mathbf{r}(t) = e^{t^2}\mathbf{i} - \mathbf{j} + \ln(1 + 3t)\mathbf{k}$.

  (14.2, 13) $(2te^{t^2}, 0, 3/(1+3t)$

- The unit tangent vector of the path $\mathbf{r}(t) = \cos t\mathbf{i} + 3t\mathbf{j} + 2\sin 2t\mathbf{k}$ when $t = 0$.

  (14.2, 19) (0, 3/5, 4/5)

- The parametric equations for the tangent line to the curve with the parametric equations

  $$x = e^{-t}\cos t,\ \ y = e^{-t}\sin t,\ \ z = e^{-t}$$

  at the point (1,0,1).

  (14.2, 25) $x = 1 - t, y = t, z = 1 + t$

- $\int(e^t\mathbf{i} + 2t\mathbf{j} + \ln t\mathbf{k})dt$

  (14.2, 37) $(e^t, t^2, t\ln t - t) + \mathbf{C}$

- $f(2, -1, 6)$ where $f(x, y, z) = e^{\sqrt{z-x^2-y^2}}$.

  (15.1, 9a) e

- The approximate value for $f(-3, 3)$ given the contour map for f below:

  (15.1, 31) approx. 56

- (A Daily Double!) Sketch the graph of $f(x, y) = 1 - x^2$.

(15.1, 25) parabolic cylinder

- The contour map of $f(x, y) = x - y^2$ showing the level curves $z = -2, -1, 0, 1, 2$.

  (15.1, 43) parabolas in the positive x direction

- A thin metal plate, located in the *xy*-plane, has temperature $T(x, y)$ at the point (x, y). The level curves of T are called *isothermals* because at all points on an isothermal the temperature is the same. Sketch some isothermals if the temperature function is given by

  $$T(x, y) = 100/(1 + x^2 + 2y^2)$$

  (15.1, 47) concentric ellipsoids (centered at the origin)

- $$\lim_{(x,y)\to(0,0)} \frac{x^2}{x^2 + y^2}$$

  (15.2, 7) DNE

- $$\lim_{(x,y,z)\to(3,0,1)} e^{-xy} \sin(\pi z/2)$$

  (15.2, 17) 1

- The points at which the function $F(x, y) = \sin(xy)/(e^x - y^2)$ is continuous.

  (15.2, 27) $\{(x, y) | y \neq \pm e^{x/2}\}$

- The value of

$$\lim_{(x,y)\to(0,0)} (x^3 + y^3)/(x^2 + y^2)$$

(hint: use polar coordinates).

(15.2, 37) 0

- The value of

$$\lim_{(x,y,z)\to(0,0,0)} \frac{xyz}{x^2 + y^2 + z^2}$$

(hint: use spherical coordinates).

(15.2, 39) 0

- The partial derivatives $f_x(x, y)$ and $f_y(x, y)$ of the function $f(x, y) = xe^{3y}$.

(15.3, 15) $f_x = e^{3y}, f_y = 3xe^{3y}$

- The partial derivative $f_z(x, y, z)$ of the function $f(x, y, z) = xy^2z^3 + 3yz$

(15.3, 25) $f_z = 3xy^2z^2 + 3y$

- The partial derivative $\partial z/\partial x$ of the implicitly defined function $x^2 + y^2 + z^2 = 3xyz$.

(15.3, 41) $(3yz - 2x)/(2z - 3xy)$

- The second partials u_{xx}, u_{yy}, and u_{zz} of the function $u = 1/\sqrt{x^2 + y^2 + z^2}$. (Hint: they satisfy the three-dimensional Laplace equation $u_{xx} + u_{yy} + u_{zz} = 0$.)

(15.3, 69) $u_{xx} = (2x^2 - y^2 - z^2)/(x^2 + y^2 + z^2)^{5/2}$

- (A Daily Double!) The kinetic energy of a body with mass m and velocity v is $K = \frac{1}{2}mv^2$. Show that

$$\frac{\partial K}{\partial m}\frac{\partial^2 K}{\partial v^2} = K$$

  (15.3, 81) $\partial K/\partial m = 1/2V^2, \partial K/\partial V = mV, \partial^2 K/\partial V^2 = m$

- The equation of the tangent plane to the surface $z = 4x^2 - y^2 + 2y$ at the point (-1,2,4).

  (15.4, 1) $z = -8x - 2y$

- The equation of the tangent plane to the surface $z = y\cos(x-y)$ at the point (2,2,2).

  (15.4, 5) $z = y$

- The differential of $u = e^t \sin\theta$.

  (15.4, 25) $du = e^t \sin\theta \; dt + e^t \cos\theta \; d\theta$

- The differential of $w = \ln\sqrt{x^2+y^2+z^2}$.

  (15.4, 27) $dw = (x^2+y^2+z^2)^{-1}(x \; dx + y \; dy + z \; dz)$

- The estimated maximum error in calculating the area of a rectangle of length 30 cm and width 24 cm (with an error at most 0.1 cm in each), using differentials.

  (15.4, 31) 5.4cm^2

- The derivative dz/dt where

  $$z = x^2y + xy^2,\ x = 2 + t^4,\ y = 1 - t^3$$

  (15.5, 1) $4(2xy + y^2)t^3 - 3(x^2 + 2xy)t^2$

- The derivative dw/dt where

  $$w = xe^{y/z},\ x = t^2,\ y = 1 - t,\ z = 1 + 2t$$

  (15.5, 5) $e^{y/z}[2t - (x/z) - (2xy/z^2)]$

- The partial derivative $\partial z/\partial s$ where $z = e^r \cos\theta,\ r = st,\ \theta = \sqrt{s^2 + t^2}$.

  (15.5, 11) $e^r(t\cos\theta - s/(\sqrt{s^2 + t^2})\sin\theta)$

- The partial derivative $\partial u/\partial\theta$, where

  $$u = x^2 + yz,\ x = pr\cos\theta,\ y = pr\sin\theta,\ z = p + r$$

  when $p = 2,\ r = 3,\ \theta = 0$.

  (15.5, 25) 30

- (A Daily Double!) The rate at which the temperature is rising on the bug's path after 3 seconds, where the bug is crawling along the path

  $$x = \sqrt{1+t},\ y = 2 + \frac{1}{3}t$$

  (x and y are measured in cm) starting at $t = 0$ seconds, and the temperature $T(x, y)$ at the point (x, y) satisfies $T_x(2, 3) = 4$ and $T_y(2, 3) = 3$.

  (15.5, 35) 2 degrees per second

- The directional derivative of $f(x, y) = \sqrt{5x - 4y}$ at the point (4,1) in the direction $\theta = -\pi/6$.

(15.6, 5) $5/16\sqrt{3} + 1/4$

- The gradient of $f(x, y, z) = xe^{2yz}$.

  (15.6, 9a) $(e^{2yz}, 2xze^{2yz}, 2xye^{2yz})$

- The directional derivative of the function $f(x, y) = 1 + 2x\sqrt{y}$ at the point (3,4) in the direction of the vector $\langle 4, -3 \rangle$.

  (15.6, 11) 23/10

- The equation of the tangent plane the surface $x^2 + 2y^2 + 3z^2 = 21$ at the point (4,-1,1).

(15.6, 39) $4x - 2y + 3z = 21$

- The points on the hyperboloid $x^2 - y^2 + 2z^2 = 1$ where the normal line is parallel to the line that joins the points (3,-1,0) and (5,3,6).

  (15.6, 53) $(\pm\sqrt{6}/3, \mp 2\sqrt{6}/3, \pm\sqrt{6}/2)$

- A pentagon is formed by placing an isosceles triangle on a rectangle, as shown in the figure. If the pentagon has fixed perimeter P, find the lengths of the sides of the pentagon that maximize the area of the pentagon.

  (Chapter 15 Review, 65) $P(2 - \sqrt{3}), P(3 - \sqrt{3})/6, P(2\sqrt{3} - 3)/3$