PART B

5. Determine the value of $\frac{dy}{dx}$ for the given value of x.
   a. $y = (2 + 7x)(x - 3), x = 2$
   b. $y = (1 - 2x)(1 + 2x), x = \frac{1}{2}$
   c. $y = (3 - 2x - x^2)(x^2 + x - 2), x = -2$
   d. $y = x^3(3x + 7)^2, x = -2$
   e. $y = (2x + 1)^5(3x + 2)^4, x = -1$
   f. $y = x(5x - 2)(5x + 2), x = 3$
6. Determine the equation of the tangent to the curve $y = (x^3 - 5x + 2)(3x^2 - 2x)$ at the point $(1, -2)$.
7. Determine the point(s) where the tangent to the curve is horizontal.
   a. $y = 2(x - 29)(x + 1)$
   b. $y = (x^2 + 2x + 1)(x^2 + 2x + 1)$

Page 91

8. Use the extended product rule to differentiate the following functions. Do not simplify.
   a. $y = (x + 1)^3(x + 4)(x - 3)^2$
   b. $y = x^2(3x^2 + 4)^2(3 - x^3)^4$

#9

A 9. A 75 L gas tank has a leak. After t hours, the remaining volume, V, in litres is $V(t) = 75\left(1 - \frac{t}{24}\right)^2$, $0 \le t \le 24$. Use the product rule to determine how quickly the gas is leaking from the tank when the tank is 60% full of gas.

C 10. Determine the slope of the tangent to $h(x) = 2x(x + 1)^3(x^2 + 2x + 1)^2$ at $x = -2$. Explain how to find the equation of the normal at $x = -2$.

PART C

T 11. a. Determine an expression for $f'(x)$ if $f(x) = g_1(x)g_2(x)g_3(x) \dots g_{n-1}(x)g_n(x)$.
   b. If $f(x) = (1 + x)(1 + 2x)(1 + 3x) \dots (1 + nx)$, find $f'(0)$.
12. Determine a quadratic function $f(x) = ax^2 + bx + c$ if its graph passes through the point $(2, 19)$ and it has a horizontal tangent at $(-1, -8)$.
13. Sketch the graph of $f(x) = |x^2 - 1|$.
   a. For what values of x is f not differentiable?
   b. Find a formula for f', and sketch the graph of f'.
   c. Find $f'(x)$ at $x = -2$, 0, and 3.

#14

14. Show that the line $4x - y + 11 = 0$ is tangent to the curve $y = \frac{16}{x^2} - 1$.

Page 98 #10

9. Find the point(s) at which the tangent to the curve is horizontal.

a. $y = \frac{2x^2}{x - 4}$

b. $y = \frac{x^2 - 1}{x^2 + x - 2}$

A 10. An initial population, p, of 1000 bacteria grows in number according to the equation $p(t) = 1000\left(1 + \frac{4t}{t^2 + 50}\right)$, where t is in hours. Find the rate at which the population is growing after 1 h and after 2 h.

11. Determine the equation of the tangent to the curve $y = \frac{x^2 - 1}{3x}$ at $x = 2$.

12. A motorboat coasts toward a dock with its engine off. Its distance s, in metres, from the dock t seconds after the engine is turned off is $s(t) = \frac{10(6 - t)}{t + 3}$ for $0 \leq t \leq 6$.

a. How far is the boat from the dock initially?

b. Find the velocity of the boat when it bumps into the dock.

13. a. The radius of a circular juice blot on a piece of paper towel t seconds after it was first seen is modelled by $r(t) = \frac{1 + 2t}{1 + t}$, where r is measured in centimetres. Calculate

i. the radius of the blot when it was first observed

ii. the time at which the radius of the blot was 1.5 cm

iii. the rate of increase of the radius of the blot when the radius was 1.5 cm

b. According to this model, will the radius of the blot ever reach 2 cm? Explain your answer.

14. The graph of $f(x) = \frac{ax + b}{(x - 1)(x - 4)}$ has a horizontal tangent line at $(2, -1)$. Find a and b. Check using a graphing calculator.

15. The concentration, c, of a drug in the blood t hours after the drug is taken orally is given by $c(t) = \frac{5t}{2t^2 + 7}$. When does the concentration reach its maximum value?

16. The position from its starting point, s, of an object that moves in a straight line at time t seconds is given by $s(t) = \frac{t}{t^2 + 8}$. Determine when the object changes direction.

PART C

17. Consider the function $f(x) = \frac{ax + b}{cx + d}$, $x \neq -\frac{d}{c}$, where a, b, c, and d are nonzero constants. What condition on a, b, c, and d ensures that each tangent to the graph of f has a positive slope?

9. Find the point(s) at which the tangent to the curve is horizontal.

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11. Determine the equation of the tangent to the curve $y = \frac{x^2 - 1}{3x}$ at $x = 2$.

Page 98 #12

12. A motorboat coasts toward a dock with its engine off. Its distance s, in metres, from the dock t seconds after the engine is turned off is $s(t) = \frac{10(6 - t)}{t + 3}$ for $0 \leq t \leq 6$.

a. How far is the boat from the dock initially?

b. Find the velocity of the boat when it bumps into the dock.

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ii. the time at which the radius of the blot was 1.5 cm

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b. According to this model, will the radius of the blot ever reach 2 cm? Explain your answer.

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PART C

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   a. How far is the boat from the dock initially?
   b. Find the velocity of the boat when it bumps into the dock.

P. 98
#13

13. a. The radius of a circular juice blot on a piece of paper towel t seconds afte was first seen is modelled by $r(t) = \dfrac{1 + 2t}{1 + t}$, where r is measured in centimetres. Calculate
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   ii. the time at which the radius of the blot was 1.5 cm
   iii. the rate of increase of the radius of the blot when the radius was 1.5 cn
   b. According to this model, will the radius of the blot ever reach 2 cm? Explain your answer.

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PART C

17. Consider the function $f(x) = \dfrac{ax + b}{cx + d}$, $x \neq -\dfrac{d}{c}$, where a, b, c, and d are nonzero constants. What condition on a, b, c, and d ensures that each tangent to the graph of f has a positive slope?

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b. According to this model, will the radius of the blot ever reach 2 cm? Explain your answer.

14. The graph of $f(x) = \frac{ax+b}{(x-1)(x-4)}$ has a horizontal tangent line at $(2, -1)$. Find a and b. Check using a graphing calculator.

Page 98 #15

15. The concentration, c, of a drug in the blood t hours after the drug is taken orally is given by $c(t) = \frac{5t}{2t^2+7}$. When does the concentration reach its maximum value?

16. The position from its starting point, s, of an object that moves in a straight line at time t seconds is given by $s(t) = \frac{t}{t^2+8}$. Determine when the object changes direction.

PART C

17. Consider the function $f(x) = \frac{ax+b}{cx+d}$, $x \neq -\frac{d}{c}$, where a, b, c, and d are nonzero constants. What condition on a, b, c, and d ensures that each tangent to the graph of f has a positive slope?

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P. 98
#16

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PART C

17. Consider the function $f(x) = \dfrac{ax + b}{cx + d}$, $x \neq -\dfrac{d}{c}$, where a, b, c, and d are nonzero constants. What condition on a, b, c, and d ensures that each tangent to the graph of f has a positive slope?

P.106
#9

8. Differentiate each function. Express your answer in a simplified factored form.
   a. $f(x) = (x + 4)^3(x - 3)^6$
   b. $y = (x^2 + 3)^3(x^3 + 3)^2$
   c. $y = \dfrac{3x^2 + 2x}{x^2 + 1}$
   d. $h(x) = x^3(3x - 5)^2$
   e. $y = x^4(1 - 4x^2)^3$
   f. $y = \left(\dfrac{x^2 - 3}{x^2 + 3}\right)^4$
9. Find the rate of change of each function at the given value of t. Leave your answers as rational numbers, or in terms of roots and the number π.
   a. $s(t) = t^{\frac{1}{3}}(4t - 5)^{\frac{2}{3}}, t = 8$
   b. $s(t) = \left(\dfrac{t - \pi}{t - 6\pi}\right)^{\frac{1}{5}}, t = 2\pi$
10. For what values of x do the curves $y = (1 + x^3)^2$ and $y = 2x^6$ have the same slope?
11. Find the slope of the tangent to the curve $y = (3x - x^2)^{-2}$ at $\left(2, \frac{1}{4}\right)$.
12. Find the equation of the tangent to the curve $y = (x^3 - 7)^5$ at $x = 2$.
13. Use the chain rule, in Leibniz notation, to find $\frac{dy}{dx}$ at the given value of x.
    a. $y = 3u^2 - 5u + 2, u = x^2 - 1, x = 2$
    b. $y = 2u^3 + 3u^2, u = x + x^{\frac{1}{2}}, x = 1$
    c. $y = u(u^2 + 3)^3, u = (x + 3)^2, x = -2$
    d. $y = u^3 - 5(u^3 - 7u)^2, u = \sqrt{x}, x = 4$
14. Find $h'(2)$, given $h(x) = f(g(x)), f(u) = u^2 - 1, g(2) = 3$, and $g'(2) = -1$.

A 15. A 50 000 L tank can be drained in 30 min. The volume of water remaining in the tank after t minutes is $V(t) = 50\,000\left(1 - \frac{t}{30}\right)^2, 0 \leq t \leq 30$. At what rate, to the nearest whole number, is the water flowing out of the tank when $t = 10$?

16. The function $s(t) = (t^3 + t^2)^{\frac{1}{2}}, t \geq 0$, represents the displacement s, in metres, of a particle moving along a straight line after t seconds. Determine the velocity when $t = 3$.

PART C

17. a. Write an expression for $h'(x)$ if $h(x) = p(x)q(x)r(x)$.
    b. If $h(x) = x(2x + 7)^4(x - 1)^2$, find $h'(-3)$.

T 18. Show that the tangent to the curve $y = (x^2 + x - 2)^3 + 3$ at the point $(1, 3)$ is also the tangent to the curve at another point.

19. Differentiate $y = \dfrac{x^2(1 - x^3)}{(1 + x)^3}$.

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a. $y = 3u^2 - 5u + 2, u = x^2 - 1, x = 2$

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c. $y = u(u^2 + 3)^3, u = (x + 3)^2, x = -2$

d. $y = u^3 - 5(u^3 - 7u)^2, u = \sqrt{x}, x = 4$

p. 106 #15 New

14. Find $h'(2)$, given $h(x) = f(g(x)), f(u) = u^2 - 1, g(2) = 3$, and $g'(2) = -1$.

A 15. A 50 000 L tank can be drained in 30 min. The volume of water remaining in the tank after t minutes is $V(t) = 50\,000\left(1 - \frac{t}{30}\right)^2, 0 \le t \le 30$. At what rate, to the nearest whole number, is the water flowing out of the tank when $t = 10$?

16. The function $s(t) = (t^3 + t^2)^{\frac{1}{2}}, t \ge 0$, represents the displacement s, in metres, of a particle moving along a straight line after t seconds. Determine the velocity when $t = 3$.

PART C

17. a. Write an expression for $h'(x)$ if $h(x) = p(x)q(x)r(x)$.

b. If $h(x) = x(2x + 7)^4(x - 1)^2$, find $h'(-3)$.

T 18. Show that the tangent to the curve $y = (x^2 + x - 2)^3 + 3$ at the point $(1, 3)$ is also the tangent to the curve at another point.

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c. $y = u(u^2 + 3)^3, u = (x + 3)^2, x = -2$

d. $y = u^3 - 5(u^3 - 7u)^2, u = \sqrt{x}, x = 4$

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16. The function $s(t) = (t^3 + t^2)^{\frac{1}{2}}, t \ge 0$, represents the displacement s, in metres, of a particle moving along a straight line after t seconds. Determine the velocity when $t = 3$.

P.106
#16
New

PART C

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b. If $h(x) = x(2x + 7)^4(x - 1)^2$, find $h'(-3)$.

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