Answers

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1. At $x = -2$, $m = -2$

At $x = 2$, $m = 2$

2. At $x = -4$, $m = 3$

At $x = -1$, $m = -2$

At $x = 1$, $m = 0$

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3. a) $m = 1$ at (3, 2.5)

b) $m = -2$ at (-3, 5.5)

4. a) $m = 2$ at $x = -3.5$ approx. and $x = 3.5$ approx.

b) $m = 0$ at $x = -2$ and $x = 2$

5. a) Increasing

$x < -4$ or $x > -1$

b) Decreasing

$-4 < x < -1$

6. At $x = -4$, -1 and 4

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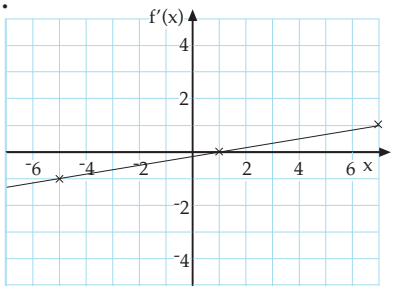
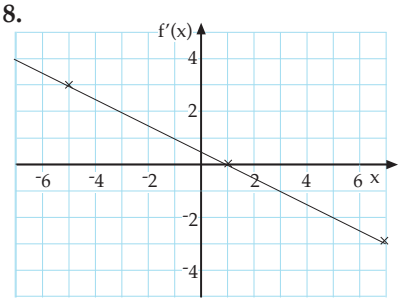
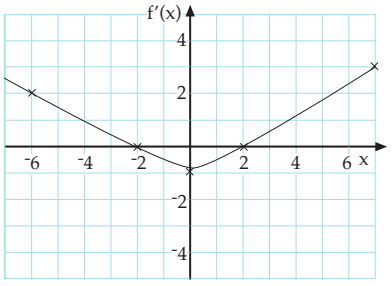
7.



8.

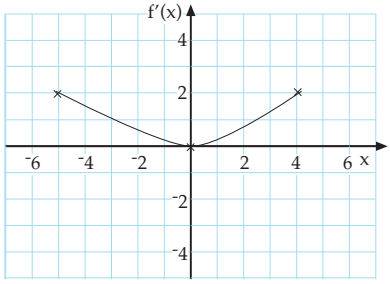


9.



Page 9 cont...

10.



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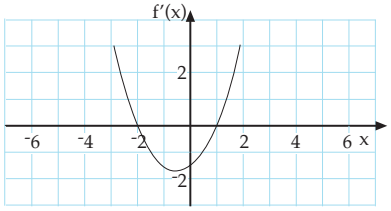
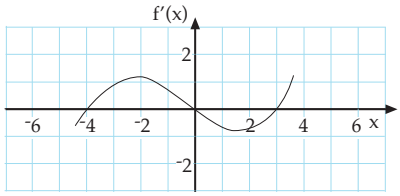
11.



12.



13.

Description	Looks like	Gradient function
Increasing		Always +ve
Decreasing		Always –ve
Maximum		Is zero. Gradient goes from +ve through 0 to –ve
Minimum		Is zero. Gradient goes from –ve through 0 to +ve

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14. Average rate of change = 4

15. Average rate of change = 3

16. Average rate of change = -2

17. Average rate of change = -4

18. Average rate of change = 4

19. Average rate of change = 3

20. Average rate of change = 2.4

21. Average rate of change = 2.01

22. Average rate of change = 2.001

23. Average rate of change = 2.0001

24. Avg. rate of change = 2.000 01

25. Avg. rate of change = 2.000 001

26. Expect the gradient to be 2

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27. $f'(x) = 2x + 2$

28. $f'(x) = 2x - 6$

29. $f'(x) = 5 - 2x$

30. $f'(x) = 2x + 3$

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31. $f'(x) = 3x^2$

32. $f'(x) = -3$

33. $f'(x) = -4x - 1$

34. $f'(x) = 6x^2 - 1$

35. $f'(x) = 20x$

36. $f'(x) = 8x - 5$

37. $f'(x) = 2x + 1$

38. $f'(x) = 2x - 7$

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39. $f'(x) = 15x^2$

40. $f'(x) = 9$

41. $f'(x) = 0$

42. $f'(x) = 2x + 3$

43. $f'(x) = 4x$

44. $f'(x) = 10x - 10x^4$

45. $f'(x) = 15x^2 + 4x$

46. $f'(x) = 10x + 10$

47. $f'(x) = 55x^{10} - 45x^4$

48. $f'(x) = x - 2$

49. $f'(x) = \frac{1}{2}x - \frac{1}{5}$

50. $f'(x) = 2x^2 - \frac{1}{4}$

51. $f'(x) = 2x^3 - 0.75x^2$

52. $f'(x) = 1.2x^5 + 0.9x^2 - 1.5$

53. $f'(x) = 1.5x^2 + 0.6x - 0.8$

54. $f'(x) = 6x^4 + 7x - 1.4$

55. $f'(x) = \frac{3x}{2} - \frac{1}{5} - \frac{x^2}{2}$

56. $f'(x) = \frac{10x^4}{3} - 3x^3 - \frac{6x^2}{5} + 8x - 2$

57. $f(x) = x^2 - 2x - 15$

$f'(x) = 2x - 2$

58. $f(x) = x^3 - 2x^2 + 5x - 10$

$f'(x) = 3x^2 - 4x + 5$

59. $f(x) = 3x^4 + 5x^3$

$f'(x) = 12x^3 + 15x^2$

60. $f(x) = x^4 - 2x^2 - 35$

$f'(x) = 4x^3 - 4x$

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61. $f'(x) = 27x^2 + 2$

62. $f''(x) = 126x^5 - 30x$

63. $\frac{dy}{dx} = 5 - 15x^4$

64. $\frac{dy}{dx} = 2x$

65. $f''(x) = 60x^3$

66. $\frac{d^2y}{dx^2} = 24x - 12$

67. $\frac{dy}{dx} = x - \frac{9}{4}x^2$

68. $\frac{dy}{dx} = -6x^4 + 5x$

69. $f''(x) = \frac{9x}{2} - \frac{4}{3}$

70. $\frac{d^2y}{dx^2} = 192x^2 - 48$

71. $f''(x) = \frac{-48x^2}{5} + \frac{18x}{5} + \frac{8}{3}$

72. $\frac{d^2y}{dx^2} = 3 - \frac{8x}{3}$

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73. $f'(0) = 2$
74. $f'(-2) = -2$
75. $f'(-3) = 7$
76. $f'(-4) = -4.25$
77. $f'(-1) = 2$
78. $f'(4) = 41$
79. $y = x + 1$
80. $y = 2x - 6$
81. $y = -5$
82. $y = -x$
83. $y = -3x - 7$
84. $y = 7x - 4$

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85. Gradient = 8
86. Gradient = -42
87. (-1, 4)
88. (0.5, 1.25)
89. (0, -2), (2, 0)
90. (-3, -1.5), (0, 3)
91. a) $f'(x) = 0.5x - 1.5$
b) $f'(1) = -1$ and Grad. = -1
$f'(5) = 1$ and Grad. = 1
c) $y = 6 - x$ for (1, 5)
$y = x$ for (5, 5)
d) Intersection (3, 3)

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92. $f'(x) = 2x + 8$ min. at (-4, -1)
93. $f'(x) = 2x - 2$ min. at (1, -4)
94. $f'(x) = 2x + 1$ min. at (-0.5, 2.75)
95. $f'(x) = 2x$
minimum at (0, -5)
96. $\frac{dy}{dx} = 6 - 2x$
maximum at (3, 1)
97. $f'(x) = 8x - 12$
minimum at (1.5, 0)
98. $\frac{dy}{dx} = 6x - 8$
minimum at (1.333, 5.667) (4 sf)
99. $f'(x) = -4x - 16$
maximum at (-4, 47)

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100. $\frac{dy}{dx} = x^2 - 4x - 12$
minimum (6, -72)
maximum (-2, 13.33) (4 sf)
101. $f'(x) = 3x^2 - 6x - 9$
minimum (3, -17)
maximum (-1, 15)
102. $\frac{dy}{dx} = -3x^2 + 6x + 9$
minimum (-1, -2)
maximum (3, 30)
103. $f'(x) = 3x^2 - 16x + 5$
minimum (5, -52)
maximum (0.333, -1.185) (4 sf)
104. $\frac{dy}{dx} = 6x^2 + 18x + 12$
minimum (-1, -10)
maximum (-2, -9)
105. $f'(x) = -3x^2 - 2x + 8$
minimum (-2, -12)
maximum (1.333, 6.519)

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106. Turning point (-1, 2)
Increasing $x > -1$
Decreasing $x < -1$
107. Turning point (-3, 13)
Increasing $x < -3$
Decreasing $x > -3$
108. Turning points (-3, -5) and
(-1, $-6\frac{1}{3}$).
Increasing $x < -3$ or $x > -1$
Decreasing $-3 < x < -1$
109. Turning points (-2, $5\frac{1}{3}$) and
(2, $-5\frac{1}{3}$).
Increasing $x < -2$ or $x > 2$
Decreasing $-2 < x < 2$

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110. Turning points (-4, 51.67)
and (5, -69.83)
Increasing $x < -4$ or
Increasing $x > 5$
Decreasing $-4 < x < 5$
111. Turning points (-0.5, 2.8)
and (3, -11.5)
Increasing $x < -0.5$ or $x > 3$
Decreasing $-0.5 < x < 3$
112. Turning point (2, -1)
Increasing $x > 2$
Decreasing $x < 2$
113. Turning point (1, 2)
Increasing $x < 1$
Decreasing $x > 1$
114. Turning points (0, 0)
and ($\frac{1}{2}$, -0.0417)
Increasing $x < 0$ or $x > \frac{1}{2}$
Decreasing $0 < x < \frac{1}{2}$
115. Turning points (-2, -4)
and (0, 0)
Increasing $-2 < x < 0$
Decreasing $x < -2$ or $x > 0$

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116. Prod. = x(31 – x)
x = 15.5
Max prod. = 240.25
117. Area = w(500 – w)
Width = 250 m
Max area = 62 500 metres^2
118. Area = w(1000 – 2w)
Width = 250 m
Height = 500 m
Max area = 125 000 metres^2

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119. Rail: 2x + 2y = 18
Area = $-x^2 + 5x + 54$
x = 2.5 m, y = 6.5 m
Area = 60.25 m^2
120. Area = 0.5 x x y
x + y = 40
Area = $20x - 0.5x^2$
Max Area = 200 cm^2
121. SA $300 = 4x^2 + 6xh$
Vol = $2x^2h$
width (x) = 5 cm
length = 10 cm
height = $6\frac{2}{3}$ cm

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122. Link equation
$3y + 2x = 600$
$x = 300 - 1.5y$
Area $= 2xy$
$= 2y(300 - 1.5y)$
$= 600y - 3y^2$
$(\text{Area})' = 600 - 6y$
$y = 100$ m for max
length $= 100$ m
width (x) $= 150$ m

123. $r^2 + h^2 = 22^2$

$V = \frac{1}{3}\pi r^2 h$

$= \frac{1}{3}\pi(22^2 - h^2)h$

radius = 18.0 cm
height = 12.7 cm

124. Link equation
$y = 9 - x^2$
Area $= 2xy$
$= 2x(9 - x^2)$
$= 18x - 2x^3$
$(\text{Area})' = 18 - 6x^2$
$x = \pm\sqrt{3}$
width (2x) = 3.464 (4 sf)
height (y) = 6
Area = 20.78 units^2

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125. Link equation
$\pi x + 4x + 2y = 5$
$y = 0.5(5 - x(\pi + 4))$
Area $= 2xy$
$= x(5 - x(\pi + 4))$
$= 5x - x^2\pi - 4x^2$
$(\text{Area})' = 5 - 2x\pi - 8x$
$x = 0.35$ m for max
height $= 1.25$ m
width (2x) = 0.70 m

126. $y_2 - y_1 = D$
$D = (x + 2)(6 - x) - ((x - 1)^2 - 9)$
$D = -x^2 + 4x + 12 - x^2 + 2x + 8$
$D = -2x^2 + 6x + 20$
$D' = -4x + 6$
$D' = 0$ for max / min
$x = 1.5$
$D = 24.5$ units

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127. Corner x units long
$V = x(600 - 2x)(400 - 2x)$
$V = 240\,000x - 2000x^2 + 4x^3$
$V' = 240\,000 - 4000x + 12x^2$
$V' = 0$ for max / min
$x = 78.47, 254.85$
Max x = 78.5 mm (3 sf) gives
Vol. = 8 450 000 mm^3 (3 sf)

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128. a) $v(t) = 60 - 10t$ m/s
b) $a(t) = -10$ m/s^2
c) $a(4) = -10$ m/s^2

129. a) $s(0) = 0$ m
$s(6) = -144$ m
$s(12) = 0$ m
b) $v(0) = -48$ m/s
$v(6) = 0$ m/s
$v(12) = 48$ m/s

130. a) $s(0) = 9$ m
b) $s(2) = 1$ m
$s(3) = 0$ m
$s(6) = 9$ m
c) $v(3) = 0$ m/s
$v(6) = 6$ m/s
d) $a(1) = 2$ m/s^2

131. a) $h(t) = 0$
$t = -10$ and 50 seconds
b) $v(5) = 30$ m/s
c) $v(t) = 0$
$t = 20$ seconds
d) $h(20) = 900$ metres

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132. a) $V'(t) = 12 - 1.6t$
$V'(5) = 4$ m^3/h
b) $12 - 1.6t = 6$
$t = 3.75$ hours

133. a) $v(t) = -360 + 12t$
$v(15) = -180$ m/s
$v(30) = 0$ m/s
$v(40) = 120$ m/s
b) min. when $v(t) = 0$ so
$t = 30$ s
$s(30) = 14\,600$ m

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134. a) $s = 4$ m
b) $t = 1$ second (and $t = 4$).
c) 7 m/s
d) Acceleration = 2 m/s^2 for $t = 1$, 2 and 3.
Constant acceleration.

135. a) $s = 30$ m
b) $v = 3$ m/s
c) $a = 0$ m/s^2
d) $t = 1$ second

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136. $V' = 4\pi r^2$ and at $r = 15$ mm
$V' = 2800$ mm^3 per mm increase (2 sf).

137. $H' = 2 - d$ and at $d = 3.5$ m
$H' = -1.5$ m per horizontal m.

138. $V = 6w^3$
$V' = 18w^2$ and at $w = 0.25$ m
$V' = 1.1$ m^3 drop per m decrease (2 sf).

139. $\text{Vol.} = \frac{\pi d^3}{48\,000}$

$V' = \frac{\pi d^2}{16\,000}$ and at $d = 75$ m

$V' = 1.1$ m^3 increase per m travelled (2 sf).

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140. $f(x) = x^3 - 6x^2 + 10x + C$

141. $f(x) = 3x^4 - 2x^3 - 5x + C$

142. $f(x) = 4x^5 - 4x^3 + C$

143. $f(x) = \frac{1}{3}x^3 + \frac{3}{2}x^2 + 2x + C$

144. $f(x) = 3x^3 + 3x^2 + x + C$

145. $f(x) = \frac{1}{6}x^3 - \frac{3}{8}x^2 + 5x + C$

146. $f(x) = \frac{2x^5}{15} + \frac{x^3}{5} - \frac{x^2}{8} + x + C$

147. $f(x) = \frac{x^4}{4} - \frac{5x^3}{3} + \frac{7x^2}{2} - 3x + C$

148. $f(x) = \frac{x^5}{25} - \frac{x^3}{6} - \frac{x^2}{6} - 8x + C$

149. $f(x) = \frac{3x^5}{20} + \frac{5x^3}{9} + \frac{7x^2}{4} - 4x + C$

150. $f(x) = 0.5x^5 - 0.8x^4 + 0.5x^3 - 6x + C$

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151. $f(x) = 0.214x^7 - 1.53x^6 + 3x + C$

152. $f(x) = 2x^7 - x^6 + 9x + C$

153. $f(x) = \frac{-3x^4}{10} - \frac{4x^3}{9} - \frac{2x^2}{5} + C$

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154. $f(x) = 6x^2 - 5x - 3$

155. $f(x) = 4x - 2x^2 + 16$

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156. $y = 3x - \frac{x^2}{2} - 4$

157. $f(x) = x - x^3 - 1$

158. $f(x) = x^3 - x^2 + x + 2$

159. $f(x) = x - \frac{x^3}{3} + \frac{x^2}{2}$

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160. $f(x) = x^3 - \frac{9x^2}{2} - 18x + 20$

161. $y = 2x + 3x^2 - \frac{x^3}{3} + 2\frac{2}{3}$

162. $f(x) = x^4 - 6x^3 + 12x^2 - 10x + 3$

163. $f(x) = x^4 - 5x^3 + 5x^2 + 5x - 6$

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164. $0 = 4 - 2x$ for Max/Min.
Max. at $x = 2$

$f(x) = 4x - x^2 + C$
through (2, 7)

$f(x) = 4x - x^2 + 3$

165. $0 = 4x + 12$ for Max/Min.
Min. at $x = -3$.

$f(x) = 2x^2 + 12x + C$
through $(-3, 0)$

$f(x) = 2x^2 + 12x + 18$

166. $f'(x) = k(x - 1)(x - 3)$

$f'(0) = 3$ gives $k = 1$

$f'(x) = x^2 - 4x + 3$

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

167. $f'(x) = k(x + 2)(x - 3)$

$f'(0) = 12$ gives $k = -2$

$f'(x) = -2(x^2 - x - 6)$

$f'(x) = 12 + 2x - 2x^2$

$f(x) = 12x + x^2 - \frac{2x^3}{3} + C$

through (0, 2)

$f(x) = 12x + x^2 - \frac{2x^3}{3} + 2$

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168. a) $3t^2 - 12 = 0$, $t = 2$ seconds ($t = -2$)

b) $s(t) = t^3 - 12t + 2$

c) $a(t) = 6t$. After 3 seconds
$a(3) = 18\ m/s^2$

169. a) $v(t) = t^2 + t + 6$

b) $s(t) = \frac{1}{3}t^3 + \frac{1}{2}t^2 + 6t + 5$
$s(2) = 21.67$ m (4 sf)

170. a) $a(t) = 140 - 14t$ When $t = 0$, $a = 140\ m/s^2$

b) $s(t) = 70t^2 - \frac{7}{3}t^3 + C$
as $s(t) = 0$ when $t = 0$
$s(t) = 70t^2 - \frac{7}{3}t^3$
$s(1) = 67.67$ m (4 sf)

c) $v(t) = 0$ when $t = 0$ and 20 seconds.
$s(20) = 9333$ m (4 sf)

171. a) When $v = 0$, $t = 3$
$s(t) = 30t - 5t^2 + 2$
$s(3) = 47$ m

b) $s(0) = 2$, $s(2) = 42$
therefore 40 m in the first 2 seconds.

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172. a) 15 cm/s

b) $a(t) = 6t - 18$
$t = 3$ seconds

c) $s(t) = t^3 - 9t^2 + 15t + 150$

d) $3t^2 - 18t + 15 = 0$
$t = 1$ and $t = 5$ seconds

e) $s(5) = 125$ cm

f) $s(1) = 157$ cm

173. a) 34 m/s

b) $a = -6.8\ m/s^2$

c) $v(t) = 0$ at $t = 5$ seconds

d) $h(t) = 34t - 3.4t^2$

e) $s(5) = 85$ m

f) $s(4) = 81.6$ m

g) $s(t) = 0$ so
$t = 10$ seconds

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174. a) $v(t) = 2t^2 - t + 3$

b) $v(3) = 18$ m/s

c) $s(t) = \frac{2}{3}t^3 - \frac{1}{2}t^2 + 3t + 4$

d) $s(6) = 148$ m

e) Dist. $= s(3) - s(2)$
$= 13.17$ m (4 sf)

f) $s(0) = 4$, $s(3) = 26.5$ m
velocity $= 7.5$ m/s

175. a) $a(t) = 2t - 14$
$a(3) = -8$ m/s

b) $s(t) = \frac{1}{3}t^3 - 7t^2 + 40t + 20$

c) $v(t) = 0$ at
$t = 4, 10$
$s(10) = 53.3$ m

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176. a) $a(t) = 0$
$t = 40$ s

b) $v(t) = 8t - 0.1t^2 + 0$ (from plane)
$v(40) = 160$ m/s

c) $s(t) = 4t^2 - 0.0333t^3 + 0$ (from plane)
$s(40) = 4270$ m (3 sf)

177. a) $f'(x) = 2ax + b$ at $x = 2$ $f'(2) = 0$
$0 = 4a + b$
$b = -4a$
$f(x) = ax^2 - 4ax - 3$
$3 = 4a - 8a - 3$
$a = -1.5$ and $b = 6$

b) For the parabola to have a maximum 'a' must be negative.
$3 = 4a - 8a + c$ for $a > 0$
$3 - c > 0$
$c < 3$

178. a) $f'(x) = 6(x - 2)(x - 5)$
At turning points $f'(x) = 0$ giving
$x = 2, 5$

b) $f(x) = 2x^3 - 21x^2 + 60x + C$
through (5, 26)
$26 = 2 \times 125 - 21 \times 25 + 60 \times 5 + C$
$C = 1$
$f(x) = 2x^3 - 21x^2 + 60x + 1$
At $x = 2$
Maximum value (2, 53)

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179. a) $a(t) = -12.5$ m/s^2
$v(t) = -12.5t + C$ and (2, 10)
$10 = -25 + C$
$v(t) = -12.5t + 35$

b) $s(t) = -6.25t^2 + 35t + 0$ as distance from $t = 0$.
$v(t) = 0$ at $t = 2.8$ s
Max. distance therefore 49 m.

180. a) $V = x(200 - 2x)(300 - 2x)$
$V = 4x^3 - 1000x^2 + 60\,000x$

b) $V' = 12x^2 - 2000x + 60\,000$
which is equal to 0 when
$x = 39.2$ and 127.4 mm
Discard 127.4 as it is over half the 200 mm of one side.
$V(\text{max}) = 1\,060\,000$ mm^3 (3 sf)

181. a) $C'(v) = -0.25 + 0.003\,333v$
Set equal to 0 for max / min
$v = 75$ km/h

b) $C(v) = 2.625$ litres/100 km at minimum
Petrol $= 5.17 \times 2.625$
$= 13.57$ litres
Cost $= \$29.58$

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182. a) Diameter = 26, w and h on diagram.

b) $26^2 = w^2 + h^2$
$S = 10wh^2$
$S = 10w(26^2 - w^2)$
$S' = 6760 - 30w^2$
$S' = 0$ for max gives
$w = 15.0$ cm and $h = 21.2$ cm (3 sf)

183. a) Area $= 0.5 \times$ base $\times$ height
$\text{Area} = 0.5xy$
$\text{Area} = 6x + 2x^2 - 0.5x^3$

b) $A' = 6 + 4x - 1.5x^2$
which is equal to 0 when
$x = 3.737$ (ignore negative answer).
Area $= 24.3$ units^2

184. a) $f'(x) = x^3 - 6x^2 + 8x$
$f'(x) = 0$ when
$x = 0, 2$ or 4

b)

x	-1	0	1	2	3	4	5
f'(x)	–ve	0	+ve	0	–ve	0	+ve
grad.	\	min	/	max	\	min	/

Increasing $0 < x < 2$ or $x > 4$.

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Practice External Assessment Task

Question One

a) i) $f'(x) = 3x^2 - 4$
$f'(2) = 8$ **A**

ii) $\frac{dy}{dx} = 3 - 6x - 3x^2$
$m = 6$ **(A)**
$y = 6x + 5$ **M**

b) i) $h'(x) = -x^2 + 3x - 2.$

Turning points $h'(x) = 0$
$x = 1, 2$

Minimum point (1, 1.667)
Maximum point (2, 1.833) **(M)**

Difference = 0.1667 m
= 16.7 cm (3 sf)
which is less than the required 20 cm. **E**

ii) Starts 2.5 m above the ground.
Hollow is across 1 m and up 1.667 m. **(A)**
Lip is across 2 m and up 1.883 m.
End is across 3 m and 1 m above the ground. **M**

c) $f'(x) = 3x^2 - 6x - 6$
$3 = 3x^2 - 6x - 6$
$x = -1, 3$
$(-1, 10)$ and $(3, -10)$ **M**

d) i) $C'(s) = \frac{2s}{3} - 12$
$s = 18$ km/h **A**

ii) $C_{min} = \$117$ per h
$t = \frac{54}{18}$
$= 3$ hours
Cost = \$351 **E**

Question Two

a) $f'(x) = 6x^3 - 3x^2 + x$
$f'(2) = 38$ **A**

b) $f'(x) = 6x^4 - 15x^2 - 7$
$f'(-2) = 29$ **A**

c) $f(x) = 1.5x^4 - 2x^3 - 4x^2 + 5x + C$
$f(x) = 1.5x^4 - 2x^3 - 4x^2 + 5x - 2$ **M**

d) $f'(x) = 4x^3 - 12x^2 - 4x + 12$
$0 = x^3 - 3x^2 - x + 3$
$x = -1, 1, 3$
Min. at $(-1, -7)$ and $(3, -7)$ and max. at (1, 9)
Demonstrate max and min with Calc. **E**

e) i) $w'(t) = 30t^2 - 570t + 2100$
$w'(8) = -540$ kg/day **M**

Question Two cont...

ii) $w'(t) = 30t^2 - 570t + 2100$
$0 = t^2 - 19t + 70$
$t = 5, 14$ days
Min. (14, 1100) **(M)**
Demonstrate this is a minimum. **E**

Question Three

a) i) $f'(x) = 3x^2 + 3x - 6$
$f'(1) = 0$ **(A)**
$x = -2$
$(-2, 12)$ is a max. and $(1, -1.5)$ is a min. **M**

ii) Function is increasing before the min. and after the max. points so $x < -2$ or $x > 1$ **M**

b) i) $f(x) = x^3 - 4.5x^2 - 12x + C$
$f(x) = x^3 - 4.5x^2 - 12x + 2$ **A**

ii) $f'(x) = 3x^2 - 9x - 12$
$0 = x^2 - 3x - 4$
$x = -1, 4$
Min. $(4, -54)$ **M**

c) i) $a(t) = 6t - 24$
$a(2) = -12$ m/s^2 **A**

ii) Flying back towards the radar station when velocity is negative, i.e. $2 < t < 6$ seconds. **E**

iii) $s(t) = t^3 - 12t^2 + 36t + C$
through (5, 10) gives C = 5 m. **(M)**
Furthermost point at t = 2 where s = 37 m **E**

Judgement

The grade in brackets is an alternative if the full grade is not earned. In each question the student needs at least 2 **A** for an **Achievement,** 2 **M** for a **Merit** and 1 **E** plus **1 M** for **Excellence.**

The final grade is found by combining the results of the three questions.

Achievement

Requires two question **Achievements** or better**.**

Merit

Requires two question **Merits** or better.

Excellence

Requires two question **Excellences.**

NZQA External Examination

In the external examinations NZQA uses a different approach to marking based on understanding (u), relational thinking (r) and abstract thinking (t). They then allocate marks to these concepts (maximum of 8 for a question) and add them up to decide upon the overall grade. This approach is not as easy for students to self mark as the NuLake approach, but the results should be broadly similar.