

**Question 1:** Evaluate the following limits, if they exist. If a limit does not exist but is  $\infty$  or  $-\infty$ , state which with an explanation of your answer.

(a)[3]  $\lim_{x \rightarrow -3^-} \frac{x + 3}{|x + 3|}$

(b)[4]  $\lim_{x \rightarrow -\infty} \frac{9x^4 + x}{2x^4 + 5x^2 - 1}$

(c)[3]  $\lim_{x \rightarrow \infty} \sqrt{9x^2 - x} - 3x$

## Question 2:

(a)[3] Determine an equation of the tangent line to the curve  $y = \sqrt{x+4} - \cos(x)$  at the point where  $x = 0$ .

(b)[3] After  $t$  seconds a projectile launched from ground level reaches a height of  $s(t) = 20t - gt^2$  metres where  $g$  is a positive constant. At what time  $t$  does the projectile reach its maximum height? (Your answer may contain the constant  $g$ .)

(c)[4] There are two values of  $x$  at which the tangent line to  $y = x^3$  is parallel to the tangent line to  $y = \frac{3}{2}x^2 + 6x + 1$ . Find these two values of  $x$ .

**Question 3:** Determine the derivative of each of the following functions (it is not necessary to simplify final answers):

(a)[3]  $y = \frac{\sqrt{t}}{3 + 2\sqrt{t}}$

(b)[3]  $f(x) = x^7 + \sqrt{7}x - \frac{1}{\pi + 1}$

(c)[4]  $g(x) = \left(x^5 - \frac{x^2}{2}\right) \tan(x)$

**Question 4:** Determine the derivative of each of the following functions (it is not necessary to simplify final answers):

(a)[3]  $f(x) = \left(\frac{3x^2 - 2}{2x + 3}\right)^3$

(b)[3]  $y = \cos\left(\theta + \frac{1}{\theta}\right)$

(c)[4]  $g(x) = x\sqrt{\sec(\pi x)}$

**Question 5:**

(a)[5] Determine an equation of the tangent line to the following curve at the point  $(-1, 2)$ :

$$x^2y^3 - 12 = x^3y^2$$

(b)[5] Are there any values of  $x > 0$  at which  $y = \sin(x - \sin(x))$  has horizontal tangents? If so, find at least one such  $x$ . If not, explain why.