1. **(1)** $y = -4 + x$, so

$$\begin{aligned} y' &= 1 \times x^{1-1} \\ &= 1 \end{aligned}$$

(2) $y = 8x^2 + 6 + 7x$, so

$$\begin{aligned} y' &= 2 \times 8x^{2-1} + 1 \times 7x^{1-1} \\ &= 16x + 7 \end{aligned}$$

(3) $y = 4x^2 - \dfrac{5}{x^5}$, so $y = 4x^2 - 5x^{-5}$, so

$$\begin{aligned} y' &= 2 \times 4x^{2-1} - 5 \times \left(-5x^{-5-1}\right) \\ &= 8x + 25x^{-6} \\ &= 8x + \frac{25}{x^6} \end{aligned}$$

(4) $y = -7\sin x - \cos x$, so

$$\begin{aligned} y' &= -7\cos x - 1 \times (-\sin x) \\ &= -7\cos x + \sin x \end{aligned}$$

(5) $y = 6e^x$, so

$$y' = 6e^x$$

(6) $y = 3\sqrt{x} + 3e^x - 8x^7$, so $y = 3x^{\frac{1}{2}} + 3e^x - 8x^7$, so

$$\begin{aligned} y' &= \frac{1}{2} \times 3 \times x^{\frac{1}{2}-1} + 3e^x + 7 \times \left(-8x^{7-1}\right) \\ &= \frac{3}{2}x^{-\frac{1}{2}} + 3e^x - 56x^6 \\ &= \frac{3}{2\sqrt{x}} + 3e^x - 56x^6 \end{aligned}$$

Hence $y' = \dfrac{3}{2\sqrt{x}} + 3e^x - 56x^6$.

(7) Q1 $f'(x) = -3x^2 + 6x + 45$

Q2 $f'(x) = 0$, so from Q1 , $-3x^2 + 6x + 45 = 0$, so we use $a = -3, b = 6, c = 45$ in the quadratic formula. Hence

$$\begin{aligned} x &= \frac{-6 \pm \sqrt{6^2 - 4 \times (-3) \times 45}}{2 \times (-3)} \\ &= \frac{-6 \pm \sqrt{36 - (-540)}}{-6} \\ &= \frac{-6 \pm \sqrt{576}}{-6} \\ &= \frac{-6 + 24}{-6} \quad \text{or} \quad \frac{-6 - 24}{-6} \\ &= \frac{18}{-6} \quad \text{or} \quad \frac{-30}{-6} \\ &= -3 \quad \text{or} \quad 5 \end{aligned}$$

Q3 $f''(x) = -6x + 6$

Q4 $f'(-5) = -3 \times (-5)^2 + 6 \times (-5) + 45 = -60$

2. **(1)** $y = 2$, so

$$y' = 0$$

(2) $y = 6x^2$, so

$$\begin{aligned} y' &= 2 \times 6x^{2-1} \\ &= 12x \end{aligned}$$

(3) $y = -\dfrac{6}{x^3} + 3x^6 - 7x^5$, so $y = -6x^{-3} + 3x^6 - 7x^5$, so

$$\begin{aligned} y' &= -3 \times \left(-6x^{-3-1}\right) + 6 \times 3x^{6-1} + 5 \times \left(-7x^{5-1}\right) \\ &= 18x^{-4} + 18x^5 - 35x^4 \\ &= \frac{18}{x^4} + 18x^5 - 35x^4 \end{aligned}$$

(4) $y = 2\cos x + \sin x$, so

$$\begin{aligned} y' &= 2 \times (-\sin x) + \cos x \\ &= -2\sin x + \cos x \end{aligned}$$

(5) $y = 4\ln x - 5e^x$, so

$$\begin{aligned} y' &= 4 \times \frac{1}{x} - 5e^x \\ &= \frac{4}{x} - 5e^x \end{aligned}$$

(6) $y = \sin x$, so

$$y' = \cos x$$

Hence $y' = \cos x$.

(7) Q1 $f'(x) = -3x^2 + 6x + 45$

Q2 $f'(x) = 0$, so from Q1 , $-3x^2 + 6x + 45 = 0$, so we use $a = -3, b = 6, c = 45$ in the quadratic formula. Hence

$$\begin{aligned} x &= \frac{-6 \pm \sqrt{6^2 - 4 \times (-3) \times 45}}{2 \times (-3)} \\ &= \frac{-6 \pm \sqrt{36 - (-540)}}{-6} \\ &= \frac{-6 \pm \sqrt{576}}{-6} \\ &= \frac{-6 + 24}{-6} \quad or \quad \frac{-6 - 24}{-6} \\ &= \frac{18}{-6} \quad or \quad \frac{-30}{-6} \\ &= -3 \quad or \quad 5 \end{aligned}$$

Q3 $f''(x) = -6x + 6$

Q4 $f'(3) = -3 \times 3^2 + 6 \times 3 + 45 = 36$

3. (**1**) $y = -3x - 7$, so

$$\begin{aligned} y' &= 1 \times \left(-3x^{1-1}\right) \\ &= -3 \end{aligned}$$

(**2**) $y = 6x^2 + 1$, so

$$\begin{aligned} y' &= 2 \times 6x^{2-1} \\ &= 12x \end{aligned}$$

(**3**) $y = \frac{6}{x^4} + 7x^4 - \frac{8}{x^3}$, so $y = 6x^{-4} + 7x^4 - 8x^{-3}$, so

$$\begin{aligned} y' &= -4 \times 6x^{-4-1} + 4 \times 7x^{4-1} - 3 \times \left(-8x^{-3-1}\right) \\ &= -24x^{-5} + 28x^3 + 24x^{-4} \\ &= -\frac{24}{x^5} + 28x^3 + \frac{24}{x^4} \end{aligned}$$

(**4**) $y = -8\cos x$, so

$$\begin{aligned} y' &= -8 \times (-\sin x) \\ &= 8\sin x \end{aligned}$$

(**5**) $y = -\ln x$, so

$$\begin{aligned} y' &= -1 \times \frac{1}{x} \\ &= -\frac{1}{x} \end{aligned}$$

(**6**) $y = 2\cos x$, so

$$\begin{aligned} y' &= 2 \times (-\sin x) \\ &= -2\sin x \end{aligned}$$

Hence $y' = -2\sin x$.

(**7**) Q1 $f'(x) = -3x^2 - 12x$
Q2 $f'(x) = 0$, so from Q1 , $-3x^2 - 12x = 0$, so $-3x\,(x + 4) = 0$, so $x = 0$ or $x = -4$
Q3 $f''(x) = -6x - 12$
Q4 $f'(6) = -3 \times 6^2 - 12 \times 6 = -180$

4. (**1**) $y = -7 + x$, so

$$\begin{aligned} y' &= 1 \times x^{1-1} \\ &= 1 \end{aligned}$$

(**2**) $y = 5x^2 + 5x$, so

$$\begin{aligned} y' &= 2 \times 5x^{2-1} + 1 \times 5x^{1-1} \\ &= 10x + 5 \end{aligned}$$

(3) $y = \frac{4}{x^3} - \frac{1}{x^7}$, so $y = 4x^{-3} - x^{-7}$, so

$$\begin{aligned} y' &= -3 \times 4x^{-3-1} - 7 \times \left(-x^{-7-1}\right) \\ &= -12x^{-4} + 7x^{-8} \\ &= -\frac{12}{x^4} + \frac{7}{x^8} \end{aligned}$$

(4) $y = -2\sin x$, so

$$y' = -2\cos x$$

(5) $y = -6\ln x$, so

$$\begin{aligned} y' &= -6 \times \frac{1}{x} \\ &= -\frac{6}{x} \end{aligned}$$

(6) $y = 3\sqrt{x} + \sin x$, so $y = 3x^{\frac{1}{2}} + \sin x$, so

$$\begin{aligned} y' &= \frac{1}{2} \times 3 \times x^{\frac{1}{2}-1} + \cos x \\ &= \frac{3}{2}x^{-\frac{1}{2}} + \cos x \\ &= \frac{3}{2\sqrt{x}} + \cos x \end{aligned}$$

Hence $y' = \frac{3}{2\sqrt{x}} + \cos x$.

(7) Q1 $f'(x) = 3x^2 + 12x - 15$

Q2 $f'(x) = 0$, so from Q1 , $3x^2 + 12x - 15 = 0$, so we use $a = 3, b = 12, c = -15$ in the quadratic formula. Hence

$$\begin{aligned} x &= \frac{-12 \pm \sqrt{12^2 - 4 \times 3 \times (-15)}}{2 \times 3} \\ &= \frac{-12 \pm \sqrt{144 - (-180)}}{6} \\ &= \frac{-12 \pm \sqrt{324}}{6} \\ &= \frac{-12 + 18}{6} \quad or \quad \frac{-12 - 18}{6} \\ &= \frac{6}{6} \quad or \quad \frac{-30}{6} \\ &= 1 \quad or \quad -5 \end{aligned}$$

Q3 $f''(x) = 6x + 12$

Q4 $f'(4) = 3 \times 4^2 + 12 \times 4 - 15 = 81$

5. **(1)** $y = 5x$, so

$$\begin{aligned} y' &= 1 \times 5x^{1-1} \\ &= 5 \end{aligned}$$

(**2**) $y = 6x^2 + 3x$, so

$$\begin{aligned} y' &= 2 \times 6x^{2-1} + 1 \times 3x^{1-1} \\ &= 12x + 3 \end{aligned}$$

(**3**) $y = 7x^7 - x^5$, so

$$\begin{aligned} y' &= 7 \times 7x^{7-1} + 5 \times \left(-x^{5-1}\right) \\ &= 49x^6 - 5x^4 \end{aligned}$$

(**4**) $y = 7\cos x + 2\sin x$, so

$$\begin{aligned} y' &= 7 \times (-\sin x) + 2\cos x \\ &= -7\sin x + 2\cos x \end{aligned}$$

(**5**) $y = -3\ln x$, so

$$\begin{aligned} y' &= -3 \times \frac{1}{x} \\ &= -\frac{3}{x} \end{aligned}$$

(**6**) $y = \ln x$, so

$$y' = \frac{1}{x}$$

Hence $y' = \frac{1}{x}$.

(**7**) Q1 $f'(x) = -3x^2 + 6x + 9$

Q2 $f'(x) = 0$, so from Q1 , $-3x^2 + 6x + 9 = 0$, so we use $a = -3, b = 6, c = 9$ in the quadratic formula. Hence

$$\begin{aligned} x &= \frac{-6 \pm \sqrt{6^2 - 4 \times (-3) \times 9}}{2 \times (-3)} \\ &= \frac{-6 \pm \sqrt{36 - (-108)}}{-6} \\ &= \frac{-6 \pm \sqrt{144}}{-6} \\ &= \frac{-6 + 12}{-6} \quad or \quad \frac{-6 - 12}{-6} \\ &= \frac{6}{-6} \quad or \quad \frac{-18}{-6} \\ &= -1 \quad or \quad 3 \end{aligned}$$

Q3 $f''(x) = -6x + 6$

Q4 $f'(6) = -3 \times 6^2 + 6 \times 6 + 9 = -63$