Question 9 (12 marks)

a. **i.** $A = 2\left[(9 \times 9) - (3 \times 1) - \int_3^9 \frac{1}{9}x^2 dx\right]$ M1

$= 2\left[81 - 3 - \left[\frac{x^3}{27}\right]_3^9\right]$ M1

$= 2[78 - (27 - 1)]$

$= 2(78 - 26)$

$= 104 \text{ cm}^2$ A1

ii. volume $= 104 \times 18$

$= 1872 \text{ cm}^3$ A1

b. maximum rate when $R'(t) = 0$ M1

$R'(t) = 6t - 4$

$= 0$

$t = \frac{2}{3} \Rightarrow t = 40$ minutes A1

c. $V(t) = \int R(t)dt$ M1

$= \int (3t^2 - 4t + 1)dt$

$= t^3 - 2t^2 + t$ *as V(t) = 0 at t = 0 as no water emptied* M1

$t^3 - 2t^2 + t = 1872$ M1

$(t - 13)(t^2 + 11t + 144) = 0$

$\therefore t = 13$ hours A1

d. At $t = 10$, $V(10) = 10^3 - 2(10)^2 + 10$

$= 810 \text{ cm}^3$ M1

$\therefore$ yes, overflows as only 810 cm^3 removed A1

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