Set A

(a) $\alpha = \frac{500 \times 10^6}{2 \times 10^9} = 0.25$

(b) $\lambda = \frac{180}{2} = 90nm$, $f = 10^9 Hz$, $V_{DD} = 0.7V$

$W = 2\lambda = 180nm = 0.18\mu m$

$C = (1.2 \times 0.18 + 0.5 \times 0.18) \times 10^{-15}$

$= 0.306 \times 10^{-15} F$

$P_{sw} = \alpha f C V_{DD}^2$

$= 0.25 \times 10^9 \times (0.306 \times 10^{-15}) \times 0.7^2$

$= 3.75 \times 10^{-8} W$

$= 37.5 nW$

P_{sw} for the chip $= NP_{sw} = 2 \times 10^9 \times 37.5nW = 75W$

(c) $P_{dynamic} = 37.5 + 5 = 42.5nW$

$P_{static} = 1 + 2 + 3 = 6nW$

$P_{total} = 42.5 + 6 = 48.5 nW$

} per transister

(d) Not acceptable, $P_{total} > 45nW$

$P_{total}' = 45nW$

$P_{sw}' = P_{total}' - P_{static} - P_{shortcircuit}$

$= 45 - 6 - 5$

$= 34nW$

$\therefore \alpha' f C V_{DD}^2 = 34nW$

$\frac{P_{sw}'}{P_{sw}} = \frac{\alpha'}{\alpha}$ [f, C, V_{DD} are same]

or, $\frac{34}{37.5} = \frac{\alpha'}{0.25}$

or, $\alpha' = \frac{34}{37.5} \times 0.25$

$= 0.227$

Set B

(a) $\alpha = \frac{500 \times 10^6}{3 \times 10^9} = 0.167$

(b) $\lambda = \frac{270}{2} = 135\,nm$, $f = 1.5 \times 10^9\,Hz$,

$V_{DD} = 0.7V$

$W = 3\lambda = 405\,nm = 0.405\,\mu m$

$C = (12 + 0.5)\,fF/\mu m \times 0.405\,\mu m$

$= 5.06 \times 10^{-15}\,F$

$P_{sw} = \alpha f C V_{DD}^2$

$= 0.167 \times (1.5 \times 10^9) \times (5.06 \times 10^{-15}) \times 0.7^2$

$= 6.21 \times 10^{-7}\,W = 621\,nW$

P_{sw} for the chip = $NP_{sw} = 3 \times 10^9 \times 621\,nW$
$= 1863\,W$

(c) $P_{dynamic} = 621 + 5 = 626\,nW$

$P_{static} = 1 + 2 + 3 = 6\,nW$

$\therefore P_{total} = 626 + 6 = 632\,nW$ } per transister

(d) Not acceptable. $P_{total} > 628\,nW$

$P'_{total} = 628\,nW$

$\therefore P_{sw}' = P_{total}' - P_{short\,circuit} - P_{static}$

$= 628 - 5 - 6 = 617\,nW$

$\therefore \alpha' f C V_{DD}^2 = 617\,nW$

$\frac{P_{sw}'}{P_{sw}} = \frac{\alpha'}{\alpha}$ [f, C, V_{DD} are same]

$\alpha, \alpha' = \frac{P_{sw}'}{P_{sw}} \alpha$

$= \frac{617}{621} \times 0.167$

$= 0.166$