1a) Let FNE_e represent the fraction of the reduced execution time for c no enhancement is used.

$$FNE_e = \frac{TNE_e}{T_e}$$

where, $TNE_e \rightarrow$ time during ~~enhanced~~ execution in c no enhancements are in use.

$T_e \rightarrow$ execution time with enhancement

Since the time spent executing code that cannot be enhanced is the same whether enhancement are in use or not and by Amdahl's law: We have

$$\frac{TNE_e}{T_e} = \frac{FNE_{orginal} \times T_{orginal}}{T_{orginal}/\text{Speedup}}$$

$$= \frac{1 - \sum_i FE_i}{1 - \sum_i FE + \sum \frac{FE_i}{SE_i}}$$

Therefore $$FNE_e = \frac{1 - (0.25 + 0.35 + 0.10)}{1 - (0.25 + 0.35 + 0.10) + \left(\frac{0.25}{30} + \frac{0.35}{20} + \frac{0.10}{15}\right)}$$

$$FNE_e = \frac{0.3}{0.3 + 0.0325} = \frac{0.3}{0.3325} = 90\%.$$

$$\text{ii) a) } Speedup_{12} = \left[\frac{1}{1-(0.25+0.35)+\left(\frac{0.25}{30}+\frac{0.35}{20}\right)}\right]$$

$$= 1/0.476 = 2.1$$

$$\text{b) } speedup_{23} = \left[\frac{1}{1-(0.35+0.10)+\left(\frac{0.35}{20}+\frac{0.10}{15}\right)}\right]$$

$$= 1/0.565 = 1.76.$$

$$\text{c) } Speedup_{13} = \left[\frac{1}{1-(0.25+0.10)+\left(\frac{0.25}{30}+\frac{0.10}{15}\right)}\right]$$

$$= \frac{1}{0.665} = 1.503.$$

Thus, if only a pair of enhancements can be implemented, enhancements ~~…~~ offer the greatest speedup.
and selecting the fastest way may not yeild the highest speedup. As Amdahl's law states an enhancement contributes to the speedup only for the fraction of time it is used.

Q1 b) (i) $n = 9$,

Time of vectorised = 25%

Speedup = ?

% of code vectorised.

⇒ If no vector mode was used

Time taken $= 0.75T + 9 \times 0.25T = 3T$.

∴ effective speedup $= \frac{3T}{T} = 3$

Let the fraction of vectorised code be α.

u can use amdhals formula here

∴ $\alpha = \frac{9 \times 0.25T}{3T} = 0.75$.

∴ 75 percent of code has been vectorised.

$$S = \frac{T}{T}$$

$$S = \frac{\cancel{x}}{(1-\alpha)\cancel{x} + \left(\frac{\alpha}{n}\right)\cancel{x}}$$

$$3 = \frac{n}{n - n\alpha + \alpha}$$

$\frac{9}{3} = 9 - 8\alpha$

$\alpha = \frac{6}{8} = \frac{3}{4}$ $\quad 3 = 8\alpha - 6$

(1b)(ii) α – vectorised part, n - processors
rate = x MIPS,
drive eff. mips rate,

→ Suppose the total workload is W million instructions.
Then execution time in seconds.

$$T = \frac{\alpha W}{nx} + \frac{(1-\alpha)W}{x}.$$

∴ effective MIPS rate is

$$\frac{W}{T} = \frac{nx}{\alpha + n(1-\alpha)} = \frac{nx}{n-(n-1)\alpha}.$$

Q1c) Assuming The speed in enhanced mode is n times as fast as that in regular mode.
The harmonic mean execution time T is calculated as,

$$T(\alpha) = \frac{\alpha}{R} + \frac{(1-\alpha)}{nR}$$

where R = execution time in regular mode.

If α varies linearly b/w a & b, the average execution time is

$$T_{avg} = \int_a^b \frac{T(\alpha)\, d\alpha}{b-a}$$

$$= \int_a^b \frac{\frac{\alpha}{R} + \frac{(1-\alpha)}{nR}\, d\alpha}{b-a}$$

$$= \int_a^b \frac{nR\alpha + 1R - R\alpha}{(b-a)(nR)}$$

$$= \int_a^b \frac{((n-1)R\alpha + R1)\, d\alpha}{(b-a)(nR)}$$

$$T_{avg} = \frac{(n-1)(b+a) + 2}{2nR}.$$

$\therefore$ avg execution rate

$$R_{avg} = \frac{1}{T_{avg}} = \frac{2nR}{(n-1)(b+a)+2}$$

avg speed up factor

$$S_{avg} = \frac{R_{avg}}{R} = \frac{2n}{(n-1)(b+a)+2}.$$

if $a \to 0$ & $b \to 1$

$$S_{avg} = \frac{2n}{n+1}$$