Scenario :- Consider a processor with a clock rate of 2 GHz.

A program consisting of 200,000 instructions is executed on this processor in 2 different setups :-

1. Single-Core Setup :- The program takes 0.2 seconds to execute (Execute 1 instruction at a time)
2. Multi-Core Setup :- The program is executed on a 4-core processor in parallel, taking 0.8 seconds to complete. (Multiple instructions are executed simultaneously.)

Q1. Calculate the CPI of the program in the Single Core Setup.

2. Calculate the IPC of the Single-core Setup.

3. Determine the execution time for the program in the Single-core setup using the CPI value.

4. Calculate the Speedup achieved by using the multi-core setup compared to the Single-core setup.

5. Determine the efficiency of the multi-core setup.

Solution :

$$CPI = \frac{\text{total Cycles}}{\text{Total Instruction}}$$

Given data :-

Clock rate = 2 GHz

$= 2 \times 10^9$ Cycle

Clock Cycle per second

Execution Time = 0.2 seconds

Total instruction = 200,000

Total Cycles = Clock Rate x Execution time.

$= 2 \times 10^9 \times 0.2 = 0.4 \times 10^9$

$= 400,000,000$

$$CPI = \frac{400,000,000}{200,000} = 2000$$

↓

an average each execution takes 2000 Cycles to execute.

2. IPC

$$= \frac{2,00,000}{4,00,000,000} = \frac{2}{4000} = \underline{0.0005}$$

↑

Low IPC

Suggests the Processor isn't completing many instructi per Cycle.

3. Execution time (Multi-core)

$$= \frac{2,00,000 \times 2000}{2 \times 10^9} = 0.2 \text{ seconds}$$

4.

$$\text{Speed up} = \frac{\text{Ex. Time (Singh Core)}}{\text{Ex. Time (Multi core)}} = \frac{0.2}{0.08} = \boxed{2.5}$$

5. Speed up = 2.5.

No of Cores = 4.

$$\text{Efficiency} = \frac{\text{Speed up}}{\text{No. of Cores}} = \frac{2.5}{4} = 0.625.$$

or 62.5 %.