Answers:

1. **Formulae:-**

Speed up = Execution time(non pipeline)/Execution Time(pipeline)

Execution Time = CPI * Cycle Time(CPI is cycles per instruction)

Cycle Time = 1/clock rate

Calculation:-

Execution time for non-pipeline=4*1/2.5=1.6ns

Execution time for pipeline = 1 * 1/2 = 0.5ns

Speed up = 1.60/0.5 = 3.2

2.**Solution:**-We have the instruction count: 10^9 instructions. The clock time can be computed quickly from the clock rate to be 0.5×10^{-9} seconds. So we only need to to compute clocks per instruction as an effective value:

Value	Frequency	Product
3	0.5	1.5
4	0.3	1.2
5	0.2	1.0

CPI = 3.7

Then we have,

Execution Time = $1.0*10^9*3.7*0.5*10^{-9}$ = 1.85 sec

3.

Given that 80% of 10^9 instructions require single cycle i.e. no conditional branching & for 20% an extra cycle required.

Time taken by 1 cycle = 10^{-9} sec

Total time=10^{-9}(80/100 * 10^9 + 20/100 *2 *10^9)

= 10^{-9} *10^9(4/5 + 2/5)

=6/5

=1.2 seconds