Q1: Match the following terms with their definitions. [--3-/3 points]

#	Term	Matching Number	Definition
~~1~~	P class	3	the set of decision problems decidable in polylogarithmic time on a parallel computer with a polynomial number of processors.
~~2~~	NP class	6	machines in this category have not found widespread application, but one can view them as generalized pipelines in which each stage performs a relatively complex operation.
~~3~~	NC class	1	all problems that can be solved in polynomial time by deterministic algorithms.
4	SISD class	5	with several processors directed by instructions issued from a central control unit, are sometimes characterized as "array processors".
~~5~~	SIMD class	2	all problems that a nondeterministic algorithm can solve in polynomial time.
~~6~~	MISD class	4	represents ordinary "uniprocessor" machines.

Q2: Answer with True or False. [--4-/4 points]

#	Statement	Answer
1	The growth of microprocessor speed/performance exponentially is known as Moore's law.	True
2	PRAM is a model of global-memory parallel processors Random access machine	True
3	The multiprocessor model PRAM stands for parallel random-access memory.	False
4	The diameter of a *p*-processor linear ring array is *p-1*.	False
5	Building a parallel processor out of a massive number of very simple processors does better on the inherently sequential part of a computation. faster	False
6	Programs running on EREW-PRAM never issue instructions that would simultaneously access the same location	True
7	The LogP model parameters are: Latency, Overhead, Gap, and Processor multiplicity.	True
8	A sequential algorithm for multiplying an $m \times m$ matrix takes $O(m^2)$ m^3 steps to execute.	False

1.25

Q3: A programmer has parallelized 20% of a program. What is the expected speedup on 4 processors? (Show your work) [1.25/2 points]

$f = 20\% = 0.2$ ✗ → $= 8\%$

$P = 4$

using Amdahl's law:

$$\text{speed up} = \frac{1}{f + \frac{(1-f)}{P}}$$

$$= \frac{1}{0.2 + \frac{0.8}{4}} = 2.5$$

0.8 0.2 −1/4 −1/4 −1/4 → = 1.176

Parallel processing rules:

$S(p)$ Speedup $= \frac{T(1)}{T(p)}$

$E(p)$ Efficiency $= \frac{T(1)}{p\,T(p)}$

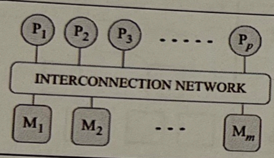
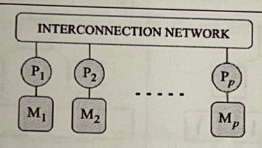
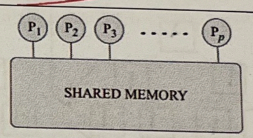
$R(p)$ Redundancy $= \frac{W(p)}{W(1)}$

$U(p)$ Utilization $= \frac{W(p)}{p\,T(p)}$

$Q(p)$ Quality $= \frac{T^3(1)}{p\,T^2(p)\,W(p)}$

Amdahl's law: speedup $= 1/(f + (1-f)/p)$

Q4: Write the correct model's name under each of the following figures, where P is Characterized by p (processors) and M by m (*memory modules*). [3/3 points]

		
Modular memory machine (MMM)	local memory machine (LMM)	Parallel random access machine ~~(PR~~ (PRAM)

Q5: Give the final result of the following problems: [4/4 points]

a) Semigroup of ([64,2,2,2], /) [1/1 point]

[8,8,8,8]

b) Prefix of ([10,2,4,1], -) [1/1 point]

[10,8,4,3]

c) Diminished prefix of ([2,4,6,8], +) [1/1 point]

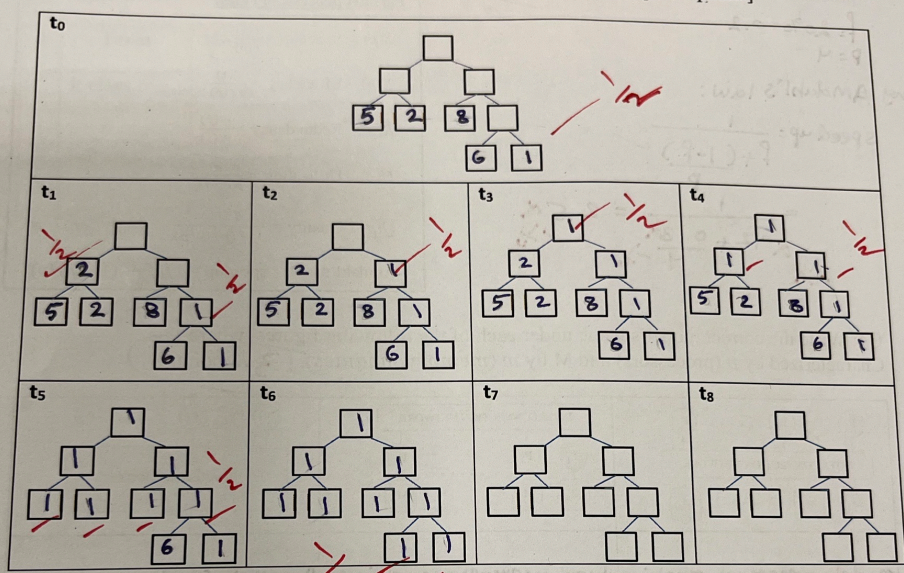
[0,2,6,12]

d) Diminished prefix of ([1,5,7,3], *) [1/1 point]

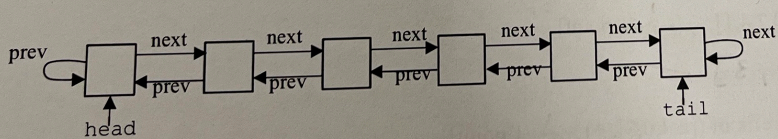
[1,1,5,35]

4

Q6: perform the following semigroup computation ([5, 2, 8, 6, 1], MIN) on a binary tree of 9 processors. Fill in the below graphs, as needed, to show your work. [----/4 points]



Q7: Assume you have a doubly linked list, with two pointers, `head`: points at the head of the list, and `tail`: points at the last item in the list as shown in the following figure. [-----/5 points]



Read the following algorithm then answer question a and b:

5/5
excellent

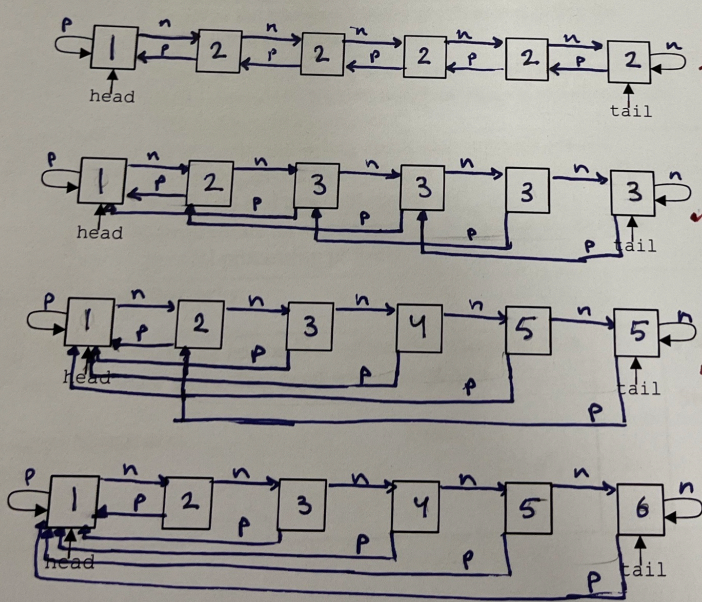
```
Processor j, 0 ≤ j < p, do {initialize the partial ranks}
    if prev[j] = j then
        rank[j] := 1
    else rank[j] := 2
    end if
while rank[prev[tail]] != 1 Processor j, 0 ≤ j < p, do
    rank[j] := rank[j] + rank[prev[j]] - 1
    prev[j] := prev[prev[j]]
end while
```

distance to head

e) What does this algorithm do? [-1-/1 point]
Ranking the linked list in increasing order starting with 1 from head to tail

f) Show the execution of your algorithm on a 6 node doubly linked list, including all the steps of the algorithm. Don't forget to show your work using pointers and ranking values. [-4/4 points]

n : next
P : Prev



½
1½
1½
½