EOCS

Egyptian Olympiad in Computational Science

Qualification Round Exams

2026

Exam Fields

Biology • Chemistry • Physics • Mathematics • CS

Contents

1. Computational Biology

1.1. Easy

1.

In protein synthesis, translocation is initiated with the movement of

(a) tRNA from P-site to the A-site

(b) Dipeptidyl tRNA from A-site to P-site

(c) tRNA from A-site to P-site

(d) tRNA from P-site to E-site

Answer: b

2.

Protein synthesis corresponds to the process of

(a) Duplicating required DNA for synthesis of proteins

(b) Formation of amino acids from mRNA

(c) Formation of mRNA from DNA template

(d) Formation of amino acids from DNA template directly

Answer: b

3.

Which structure is specialized to increase the speed of action potential propagation?

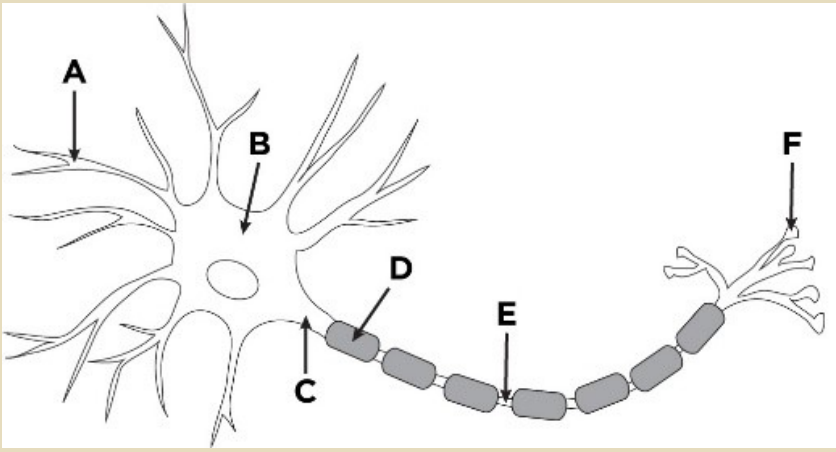

Figure 1: Diagram of a neuron with labeled structures.

(a) Structure A

(b) Structure F

(c) Structure B

(d) Structure D

Answer: d

1.2. Medium

4.

Sickle-cell anaemia allele (HbS) causes severe disease in homozygotes (HbS HbS) but confers malaria resistance in heterozygotes (HbA HbS). This is an example of which type of selection?

(a) Directional selection

(b) Purifying selection

(c) Balancing selection

(d) Disruptive selection

Answer: c

5.

What is occurring in region B in relation to region A?

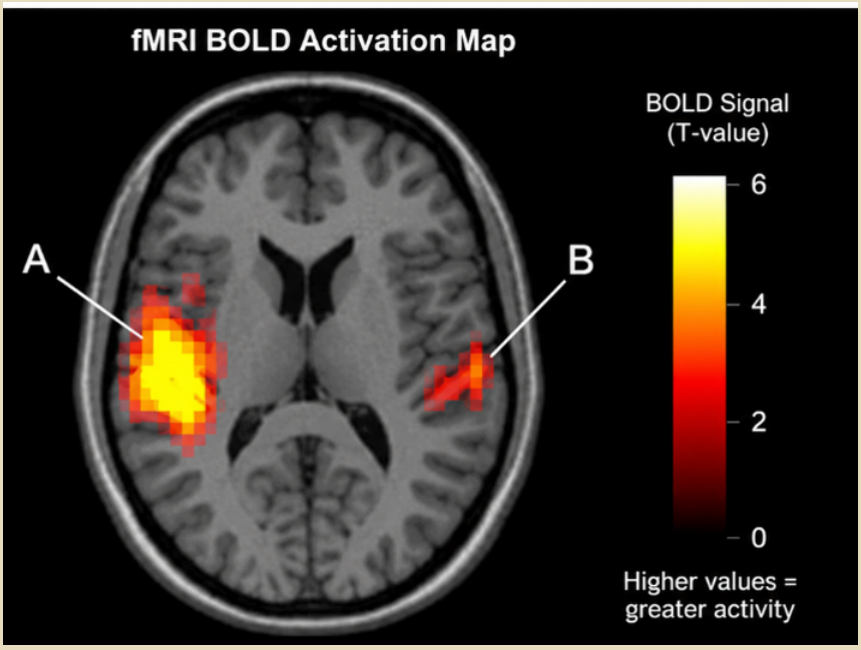

Figure 2: fMRI BOLD activation map showing regions A and B.

A. More neural activity than region A

B. More subjective feeling or awareness than region A

C. Greater accumulation of metabolic waste than region A

D. Lower neural activity than region A

E. Identical neural activity to region A

Answer: d

1.3. Advanced

6.

In the Euler update equation:

$$V(t + \Delta t) = V(t) + \frac{\Delta t}{\tau_m} [-(V(t) - V_{rest}) + R_m I_t]$$

What does I_t represent?

A. Threshold voltage

B. Input current at time t

C. Firing rate

D. Membrane resistance only

Answer: b

2. Computational Chemistry

2.1. Easy

1.

1. A database tracks the Pauling electronegativity scale. As a script checks the elements of Period 3 from left to right (Sodium to Chlorine), the increasing effective nuclear charge pulls the outer electrons closer. What general trend does the script record for the electronegativity values?

(A) They strictly decrease.

(B) They strictly increase.

(C) They remain constant.

(D) They alternate up and down.

Answer: b

2.

2. A stoichiometric algorithm evaluates the complete combustion of methane: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$. A user inputs 16.0 g of CH_4 (Molar mass $\approx$ 16.0 g/mol) into the simulation. Assuming excess oxygen, how many moles of H_2O does the engine predict will be generated?

(A) 1.0 mol

(B) 2.0 mol

(C) 4.0 mol

(D) 16.0 mol

Answer: b

3.

3. A computer program calculates the electrostatic energy between two non-bonded charged particles in a vacuum. The program calculates the energy magnitude based on the product of the charges divided by their separation distance r. If the program cuts the distance r exactly in half but keeps the charges the same, what happens to the amount of energy?

(A) It is halved.

(B) It quadruples.

(C) It doubles.

(D) It remains the same.

Answer: c

2.2. Moderate

4.

4. A program calculates the formal charge (FC) of an atom by establishing the number of its normal valence electrons (V). It then applies a full mathematical penalty for its unshared lone-pair electrons (N) and a half-penalty for its shared bonding electrons (S). Which symbolic expression correctly represents this logic?

(A) $FC = V + N/2 - S$

(B) $FC = V + N/2 + S$

(C) $FC = V - N + S/2$

(D) $FC = V - N - S/2$

Answer: d

5.

5. A virtual lab models a liquid dilution experiment. It obeys the rule stating that the initial moles of the solute equals the final moles of it when diluting a liquid. Using initial solute concentration M_1 in mol/L and initial liquid volume V_1 in L, and a target final liquid volume V_2 in L that will be achieved at the end of the experiment, which algebraic rearrangement can be used to calculate the new concentration M_2 in mol/L at the end of the same experiment?

(A) $M_2 = M_1(V_2/V_1)$

(B) $M_2 = M_1(V_1/V_2)$

(C) $M_2 = (M_1V_2)/V_1$

(D) $M_2 = M_1V_1V_2$

Answer: b

2.3. Advanced

6.

6. A molecular dynamics simulation models van der Waals interactions using a 12-6 Lennard-Jones potential between two molecules. The energy $V(r)$ at distance r includes a repulsive term scaling with r^{-12} and an attractive term scaling with r^{-6}. To locate the energy minimum, the simulation evaluates the spatial derivative dV/dr. Knowing the attractive energy scales proportionally to $-r^{-6}$, how does its derived force component scale in the dV/dr expression?

(A) $+6r^{-7}$

(B) $-6r^{-7}$

(C) $+12r^{-13}$

(D) $-12r^{-13}$

Answer: a

3. Computational Physics

3.1. Easy

1.

For a system of N particles, each particle i has mass m_i and velocity vector $\vec{v}_i$. Which expression defines total kinetic energy?

(a) $KE_{total} = \sum_{i=1}^{N} \frac{1}{2} m_i \vec{v}_i$

(b) $KE_{total} = \frac{1}{2} \left(\sum_{i=1}^{N} m_i \right) \left(\sum_{i=1}^{N} |\vec{v}_i| \right)^2$

(c) $KE_{total} = \frac{1}{2} \sum_{i=1}^{N} m_i |\vec{v}_i|^2$

(d) $KE_{total} = \sum_{i=1}^{N} m_i |\vec{v}_i|^2$

Answer: c

Solution: One particle has $KE_i = \frac{1}{2} m_i |\vec{v}_i|^2$. Summing over all particles gives $KE_{total} = \frac{1}{2} \sum_{i=1}^{N} m_i |\vec{v}_i|^2$.

2.

A body of mass m is raised vertically by height h near Earth's surface. Which expression gives the increase in gravitational potential energy?

(a) mgh

(b) $\frac{mg}{h}$

(c) $\frac{h}{mg}$

(d) $mg + h$

Answer: a

Solution: Near Earth's surface, gravitational potential energy gained is mgh.

3.

If a body of mass m moves with velocity v, which expression defines linear momentum p?

(a) $p = mv^2$

(b) $p = mv$

(c) $p = \dfrac{m}{v}$

(d) $p = \dfrac{v}{m}$

Answer: b

Solution: Linear momentum is the product of mass and velocity: $p = mv$.

3.2. Moderate

4.

A particle moves under gravity in a circular orbit. Which quantity is conserved because the gravitational force is always directed toward the central body?

(a) Kinetic energy

(b) Linear momentum

(c) Angular momentum

(d) Temperature

Answer: c

Solution: A central force exerts zero torque about the center, so angular momentum $\vec{L} = \vec{r} \times m\vec{v}$ is conserved.

5.

A probe escapes a planet of mass M and radius R when its total mechanical energy is zero at infinity. Which expression gives escape velocity v_e?

(a) $v_e = \sqrt{\dfrac{GM}{R}}$

(b) $v_e = \sqrt{\dfrac{2GM}{R}}$

(c) $v_e = \dfrac{GM}{R}$

(d) $v_e = \sqrt{\dfrac{GM}{2R}}$

Answer: b

Solution: Set $\frac{1}{2}mv_e^2 - GMm/R = 0$. Then $v_e^2 = 2GM/R$, so $v_e = \sqrt{2GM/R}$.

3.3. Advanced

6.

Velocity Verlet updates position by $x_{n+1} = x_n + v_n\Delta t + \frac{1}{2}a_n(\Delta t)^2$, then computes a_{n+1}. Which velocity update makes the method second-order accurate?

(a) $v_{n+1} = v_n + a_n\Delta t$

(b) $v_{n+1} = v_n + a_{n+1}\Delta t$

(c) $v_{n+1} = v_n + \dfrac{1}{2}(a_n + a_{n+1})\Delta t$

(d) $v_{n+1} = v_n + \dfrac{1}{2}(a_n - a_{n+1})\Delta t$

Answer: c

Solution: Integrating $dv/dt = a(t)$ by the trapezoidal rule over the timestep gives $v_{n+1} = v_n + \frac{1}{2}(a_n + a_{n+1})\Delta t$, which is second-order accurate.

4. Computational Mathematics

4.1. Easy

1.

Question: A scaling function is defined by $f(x) = 4x - 7$. Evaluate $f(2.5)$.

(a) 3

(b) 5

(c) 2.5

(d) 1

Answer: (a)

2.

Question: Compute the absolute remainder value for the expression: $37 \div 7$

(a) 1

(b) 2

(c) 3

(d) 5

Answer: (b)

3.

Question: Find the slope (m) of a line passing through data coordinates $(2, 5)$ and $(6, 13)$.

(a) 2

(b) 3

(c) 4

(d) 0.5

Answer: (a)

4.2. Medium

4.

Question: Let two processing functions be defined as $f(x) = x^2 - 3$ and $g(x) = 2x + 1$. Compute the composite functional value $f(g(3))$.

(a) 17

(b) 46

(c) 13

(d) 49

Answer: (b)

5.

Question: Find the sum of all integer values of x that satisfy the absolute value boundary constraint: $|3x - 2| \leq 7$.

(a) 2

(b) 3

(c) 5

(d) 0

Answer: (c)

4.3. Hard

6.

Question: A wireless signal transmitter maps out a rectangular coverage area. If the total perimeter boundary constraint is exactly 120 meters, what is the maximum possible area that can be enclosed?

(a) 600 m^2

(b) 800 m^2

(c) 900 m^2

(d) 1200 m^2

Answer: (c)

6. Computer Science

6.1. Easy

1.

A computational science program needs to store a whole-number count of experiment samples, such as 25. Which data type is most appropriate for this value?

(a) Integer

(b) String

(c) Boolean

(d) Character

Answer: a

Solution: A whole-number count is best stored as an integer. Strings store text, booleans store true-or-false values, and characters store single symbols.

2.

A student wants to write the same conditional structure in Python and C++. Which row correctly matches the syntax for an if, else-if, and else chain in both languages?

Row	Python	C++

A	`if x > 0:`
	`elif x == 0:`
	`else:`
		`if (x > 0) {`
		`else if (x == 0) {`
		`else {`

B	`if (x > 0) {`
	`else if (x == 0) {`
	`else {`
		`if x > 0:`
		`elif x == 0:`
		`else:`

C	`if x > 0 then`
	`else if x == 0 then`
	`else then`
		`if x > 0 then`
		`elif (x == 0)`
		`else then`

D	`if x > 0:`
	`else if x == 0:`
	`else:`
		`if x > 0:`
		`elif x == 0:`
		`else:`

(a) Row A

(b) Row B

(c) Row C

(d) Row D

Answer: a

Solution: Python uses `if`, `elif`, and `else` with colons. C++ uses `if (...)`, `else if (...)`, and `else`, usually followed by braces. Therefore, row A correctly matches both languages.

3.

Coding: Average-Balanced Element

A computational science lab records a short sequence of measurement values, such as temperatures or reaction speeds. A middle value is called *average-balanced* if it is exactly the average of the values directly before and after it.

For an index i ($1 < i < N$, using 1-based indexing), this means

$$A[i] = \frac{A[i-1] + A[i+1]}{2}.$$

Check whether the sequence contains at least one average-balanced value.

Input Format

- The first line contains N ($3 \leq N \leq 100$), the number of recorded values.
- The second line contains N integers $A_1, A_2, \ldots, A_N$ ($1 \leq A_i \leq 1000$), the recorded values.

Output Format

Output `YES` if at least one average-balanced value exists; otherwise output `NO`.

Example 1

Input

```
5
10 15 20 12 14
```

Output

```
YES
```

Explanation: At index 2, the value is 15. Its neighbors are 10 and 20, and $\frac{10+20}{2} = 15$.

Example 2

Input

```
4
1 5 2 8
```

Output

```
NO
```

Answer: Programming task

Solution: Scan each middle position from 2 to $N-1$. To avoid fractions, test whether $2A[i] = A[i-1] + A[i+1]$. If any position satisfies this condition, print `YES`; otherwise print `NO`. This runs in $O(N)$ time and uses $O(1)$ extra space.

6.2. Moderate

4.

A computational science program stores experiment IDs in an unsorted list of size N. To check whether one experiment ID is present, the program looks through the list one item at a time. In the worst case, how long can this search take?

(a) $O(1)$

(b) $O(\log N)$

(c) $O(N)$

(d) $O(N \log N)$

Answer: c

Solution: Because the list is unsorted, the program may need to check every experiment ID before finding the target or deciding it is not present. Therefore, the worst-case time complexity is $O(N)$.

5.

A computational science team wants to store N data files from an experiment. File i has size W_i. Each storage bucket can hold total size at most K.

To keep the storage simple, **each bucket may hold at most 2 files**. Every file fits in one bucket by itself. Find the minimum number of buckets needed to store all files.

Input Format

- The first line contains N and K ($1 \le N \le 10^5$, $1 \le K \le 10^9$), the number of files and the maximum bucket capacity.
- The second line contains N integers $W_1, W_2, \ldots, W_N$ ($1 \le W_i \le K$), the file sizes.

Output Format

Output one integer: the minimum number of buckets needed.

Example 1

Input

```
4 5
3 2 1 4
```

Output

```
2
```

Explanation: We can pair the files as $(4, 1)$ and $(3, 2)$. Each pair has total size 5, so 2 buckets are enough.

Example 2

Input

```
3 6
2 3 5
```

Output

```
2
```

Answer: Programming task

Solution: Sort the file sizes. Use two pointers: one at the smallest remaining file and one at the largest remaining file. If they fit together, place them in one

bucket; otherwise place the largest file alone. Each step uses one bucket. This greedy method is optimal and runs in $O(N \log N)$ time.

6.3. Advanced

6.

A computational science program runs N simulation steps in order. Step i takes A_i seconds. A researcher wants to find the longest continuous block of steps that can be reviewed within a time limit of M seconds.

Find the maximum number of neighboring steps whose total time is at most M.

Input Format

- The first line contains N and M ($1 \leq N \leq 2 \cdot 10^5$, $1 \leq M \leq 10^9$), the number of simulation steps and the time limit.
- The second line contains N integers $A_1, A_2, \ldots, A_N$ ($1 \leq A_i \leq 10^6$), the time needed for each step.

Output Format

Output one integer: the maximum length of a continuous block whose total time is at most M. If no single step fits within the time limit, output `0`.

Example 1

Input

```
5 10
2 3 1 5 4
```

Output

```
3
```

Explanation: The longest valid continuous block is $[3, 1, 5]$. Its total time is $9 \leq 10$, and its length is 3.

Example 2

Input

```
3 5
6 7 8
```

Output

```
0
```

Answer: Programming task

Solution: Use a sliding window. Add steps from the right while tracking the total time. If the total becomes greater than M, remove steps from the left until the block is valid again. Track the largest valid block length. Since each step enters and leaves the window at most once, this runs in $O(N)$ time.