GATE 2024 Biomedical Engineering (BM) Solutions

General Aptitude (GA) Q.1 – Q.5 Carry ONE mark Each

Ques.1 If '→' denotes increasing order of intensity, then the meaning of the words [simmer → seethe → smolder] is analogous to [break → raze → _____]. Which one of the given options is appropriate to fill the blank?

(A) obfuscate
(B) obliterate
(C) fracture
(D) fissure

Solution. (B) obliterate , To determine which word appropriately fills the blank in the analogy, we need to understand the progression of intensity in both series of words.

- "Simmer," "seethe," and "smolder" all describe states of increasing intensity of heat or anger.
- "Break" and "raze" similarly describe states of increasing intensity of destruction.

Given this pattern, we need a word that represents a higher intensity of destruction than "raze."

Let's evaluate the options:

(A) Obfuscate - This means to confuse or make unclear. It does not fit the context of destruction.

(B) Obliterate - This means to destroy completely, which is a higher intensity of destruction than "raze."

(C) Fracture - This means to break or crack. It is similar in intensity to "break," not higher.

(D) Fissure - This means a narrow opening or crack. It is also not higher in intensity than "raze."

Therefore, the appropriate word to fill the blank is:

(B) obliterate

Ques.4 Which one of the given options is a possible value of x in the following sequence?
$$3, 7, 15, x, 63, 127, 255$$
(A) 35
(B) 40
(C) 45
(D) 31

Solution. To find the value of x in the sequence 3,7,15,x,63,127,255, we should identify the pattern in the sequence.

First, let's observe the given numbers and try to find a pattern.

Notice that each term appears to be one less than a power of 2:

- $3 = 2^2 - 1$
- $7 = 2^3 - 1$
- $15 = 2^4 - 1$
- x
- $63 = 2^6 - 1$
- $127 = 2^7 - 1$
- $255 = 2^8 - 1$

Based on this pattern, x should be $2^5 - 1$:

x=2^5−1=32−1=31

So, the possible value of x in the sequence is 31.

The correct answer is: (D) 31

Ques.5 On a given day, how many times will the second-hand and the minute-hand of a clock cross each other during the clock time 12:05:00 hours to 12:55:00 hours?
(A) 51
(B) 49
(C) 50
(D) 55

Solution. (C) 50 , To determine how many times the second-hand and the minute-hand of a clock will cross each other between 12:05:00 and 12:55:00, we need to understand their relative speeds and crossing pattern.

Calculation Steps:

1. Relative Speed and Crossing Pattern:
   - The second-hand completes one full rotation (360 degrees) every 60 seconds.
   - The minute-hand completes one full rotation (360 degrees) every 60 minutes.
   - The relative speed between the second-hand and the minute-hand is 360÷60=6 degrees per minute.
2. Crossing Points Calculation:
   - From 12:05:00 to 12:55:00, both hands start at 12 and move towards each other.
3. Formula for Number of Crossings:
   - The number of times they cross each other is given by the formula $|6M−0.5S|$, where:
     - M is the number of minutes past the hour,
     - S is the number of seconds past the minute.
4. Specific Analysis for the Time Interval (12:05:00 to 12:55:00):

- For each minute, they cross once because the relative angle covered by the second-hand relative to the minute-hand (6 degrees per minute) ensures one crossing per minute.
5. Total Calculation:
   - From 12:05:00 to 12:55:00, there are 50 minutes (from 5 minutes past 12 to 55 minutes past 12).
   - Therefore, they cross 505050 times during this interval.

Conclusion:

The second-hand and the minute-hand of the clock will cross each other 50\boxed{50}50 times between 12:05:00 and 12:55:00 hours.

Q.6 – Q.10 Carry TWO marks Each

Q.6 In the given text, the blanks are numbered (i)−(iv). Select the best match for all the blanks. From the ancient Athenian arena to the modern Olympic stadiums, athletics (i) the potential for a spectacle. The crowd (ii) with bated breath as the Olympian artist twists his body, stretching the javelin behind him. Twelve strides in, he begins to cross-step. Six cross-steps (iii) in an abrupt stop on his left foot. As his body (iv) like a door turning on a hinge, the javelin is launched skyward at a precise angle.

(A) (i) hold (ii) waits (iii) culminates (iv) pivot

(B) (i) holds (ii) wait (iii) culminates (iv) pivot

(C) (i) hold (ii) wait (iii) culminate (iv) pivots

(D) (i) holds (ii) waits (iii) culminate (iv) pivots

Solution. (D) (i) holds (ii) waits (iii) culminate (iv) pivots , Let's fill in the blanks one by one:

1. From the ancient Athenian arena to the modern Olympic stadiums, athletics ____ the potential for a spectacle.
    ○ The correct form should be singular, so "holds" is appropriate.
2. The crowd ____ with bated breath as the Olympian artist twists his body, stretching the javelin behind him.
    ○ The crowd (singular collective noun) "waits" with bated breath.
3. Twelve strides in, he begins to cross-step. Six cross-steps ____ in an abrupt stop on his left foot.
    ○ "Culminate" is the correct form because it should be plural to match "steps".
4. As his body ____ like a door turning on a hinge, the javelin is launched skyward at a precise angle.
    ○ The subject "body" is singular, so "pivots" is the appropriate form.

Thus, the best match for all the blanks is:

(D) (i) holds (ii) waits (iii) culminate (iv) pivots

Ques.12 To solve the equation $x = 2 \cos x$ using Newton-Raphson's method, which one of the following iterations should be used?

(A) $x_{n+1} = x_n - \dfrac{x_n - 2\cos x_n}{1 + 2\sin x_n}$

(B) $x_{n+1} = x_n + \dfrac{x_n - 2\cos x_n}{1 + 2\sin x_n}$

(C) $x_{n+1} = x_n + \dfrac{1 + 2\sin x_n}{x_n - 2\cos x_n}$

(D) $x_{n+1} = x_n - \dfrac{1 + 2\sin x_n}{x_n - 2\cos x_n}$

Solution.(A) $x_{n+1} = x_n - \dfrac{x_n - 2\cos x_n}{1 + 2\sin x_n}$,

Ques.13 During the repolarization phase of a neuron, the cell is brought back to the resting potential by the action of a Sodium-Potassium pump. Which one of the following statements is

TRUE for the active transport of Na+ and K+ ions through the cell membrane?

(A) For every 3 Na+ transported out of the cell 2 K+ is transported into the cell.

(B) For every 3 Na+ transported into the cell 2 K+ is transported out of the cell.

(C) For every 2 Na+ transported out of the cell 3 K+ is transported into the cell.

(D) The ratio of Na+ and K+ transport is always equal to one.

Solution.(A) For every 3 Na+ transported out of the cell 2 K+ is transported into the cell.

Regarding the active passage of Na+ and K+ ions through the cell membrane during a neuron's repolarization phase, the following is accurate:(A) For every 3 Na+ transported out of the cell 2 K+ is transported into the cell.

Ques.14 The cardiac rhythm in a healthy human heart originates from _____.

(A) Sinu-atrial node (SA)

(B) Atrio-ventricular node (AV)

(C) Aorta

(D) Right atria

Solution.(A) Sinu-atrial node (SA) ,In a healthy human heart, the cardiac beat comes from:(A) Sinu-atrial node (SA)

Ques.16 Which of the following statements is TRUE for a PET imaging system?

(A) Two coincident photons of 511 keV energy are detected 180o apart.

(B) Photons of 51.1 keV energy are detected 360o around the body.

(C) Photons of energy 511 keV are detected 360o around the body.

(D) Coincident photons with 51.1 keV energy are detected 180o apart.

Solution.(A) Two coincident photons of 511 keV energy are detected 180o apart. For an imaging device that uses PET (positron emission tomography), this is accurate. Pairs of gamma rays (511 keV each) indirectly released by a radionuclide that emits positrons are detected by PET. A radionuclide's positron annihilates an electron in the tissue, creating two 511 keV photons that fly 180 degrees apart in opposite directions. Functional imaging in medicine is made possible by the ability to localize the positron emitter within the body by the detection of these coinciding photons.

Ques. 18 Bioglass 45S5 has a composition of _____.

(A) 45 wt% SiO2 and 5:1 molar ratio of Calcium to Phosphorus.

(B) 45 wt% Hydroxyapatite and 5 wt% SiO2.

(C) 45 wt% Hydroxyapatite and 5:1 molar ratio of CaO and Ca3(PO4)2.

(D) 45 wt% SiO2 and 5 wt% Hydroxyapatite

Solution. (A) 45 wt% SiO2 and 5:1 molar ratio of Calcium to Phosphorus. Bioglass 45S5 is composed of the following:(A) 45 weight percent SiO2 and a 5:1 molar ratio of phosphorus to calcium.Thus, (A) is the right response.

Q. 19 Macrophages that are resident in the liver are _____.

(A) Histiocyte cells

(B) Langerhans cells

(C) Kupffer cells

(D) Fibroblast cells

Solution.(C) Kupffer cells , The right response is(C) Kupffer cells, The liver contains specialized macrophages called ketter cells. They are essential for blood filtration and the elimination of infections, debris, and old red blood cells from the liver's bloodstream.

Q.22 The Fourier transform of $e^{-|2t|}$ is _____.

(A) 4 /4 − ω2

(B) 4/ 4 + ω2

(C) 2/ 2 + ω

(D) 2/ 2 − ω

Solution.(B) 4/ 4 + ω2 ,

Ques.28 A group of four people were residing together when a new virus was detected. If the probability of each person being infected is 0.1, then the probability that at least two of them are infected is _____. Give your answer rounded off to 3 decimal places.

Solution. Using the complement rule, we can calculate the likelihood that two or more individuals out of four have the infection (subtracting the likelihood that none or one person has the infection from 1).

Let's indicate:

p: Each person's probability of infection = 0.1 $q = 1 - p$

For every individual, q=1−p = 0.9 is the probability of not being infected.

The probability that at least two out of every four individuals being infected is what we're looking for. This is the likelihood that neither one person nor zero are infected, multiplied by zero.

Determine the likelihood that 0 or 1 individual gets infected first:Chance that precisely 0 persons have the infection

$P(0) = q(4) = (0.9)$

P(0) = q 4 = (0.9) 4

Chance that precisely one individual has the infection

$P(1) = 4 \cdot p \cdot q\, 3 = 4 \cdot 0.1 \cdot (0.9)$

3 P(1) = 4 p · q 3 = 4 0.1 · (0.9) 3

Compute P(at least two infected) P(at least two infected) now:

P (at least two infected) = 1 − [P(0) + P(1)]

P(two or more infected) = 1−[P(0)+P(1)]

Let's calculate this in detail:

Determine P(0).

P(0) = P(0) = (0.9) 4 ≈0.6561 P(0) = (0.9) 4 ≈0.6561

Determine P (1)

P(1): P = 4 · 0.1 · (0.9) 3 ≈0.2916 P(1) = 4 · 0.1 · (0.9) 3 ≈0.2916

Add the values of P(0) and P(1) for K(0) and K(1): K(0) + K(1) ≈ 0.6561 + 0.2916 = 0.9477 P(0) + P(1) ≈ 0.6561 + 0.2916 = 0.9477

Determine P(at least two infected) = P (at least two infected):

P(two or more infected) = 1 - 0.9477 = 0.0523 P(two or more infected) = 1 - 0.9477 = 0.0523

Consequently, the likelihood that two or more of every four individuals are infected is around 0.052 0.052 (rounded to three decimal places).

Ques.47 A mechanical ventilator operating in volume controlled mode is set to deliver 600mL of tidal volume (TV) with a flow rate of 40 L/min. The frequency of breathing is set to 10 breaths per minute. If the flow rate is doubled which one of the following happens?

(A) The inspiratory time will increase.

(B) The expiratory time will increase.

(C) The tidal volume will increase.

(D) The frequency of breathing will decrease.

Solution.(B) The expiratory time will increase, Tidal volume (TV) and breathing frequency are predetermined in a volume-controlled mechanical ventilation mode. The inspiratory time will shorten if the flow rate is increased because the same tidal volume will be delivered more quickly. As a result of the fixed breathing frequency, the expiratory time will rise in order to preserve the predetermined frequency.Consequently, (B)—The expiratory time will increase—is the right response.