

IIITH UGEE REAP (Research Aptitude Test) Question Paper with Solutions

Time Allowed :1 Hour	Maximum Marks :100	Total Questions :50
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General Instructions

Read the following instructions very carefully and strictly follow them:

1. The Duration of test is 1 Hour.
2. This paper consists of 50 Questions.
3. The test includes Physics, Chemistry and Mathematics (PCM) questions.
4. There will be 50 questions in total from the subject proficiency test section with English as the medium of instruction/ paper.
5. The test has 25 percent negative marking which means 0.25 mark will be deducted for each wrong answer and 2 marks will be rewarded for each correct answer.

1. Two chairs (A and B) are in an empty room overnight. Chair A is made of steel while chair B is made of wood. In the night and in the morning, the temperature of the room is 290 K. In the morning, a person chooses between Chair A and Chair B as the seat by feeling (touching) the chair and choosing one which feels warmer.

- (A) BLANK-1: Chair A, Chair B, neither chair
- (B) BLANK-2: metal, wood, air, human body
- (C) BLANK-3: higher, lower, different, same
- (D) BLANK-4: heat capacity, heat conductivity, electrical resistance
- (E) BLANK-5: metal, wood, air, human body

Correct Answer: (A) Chair A, (B) metal, (C) higher, (D) heat conductivity, (E) metal

Solution: Chair A, made of steel, feels warmer because it has higher heat conductivity than Chair B made of wood. Since both chairs are at room temperature (290 K), Chair A will transfer heat more efficiently to the person, making it feel warmer when touched.

Quick Tip

Heat conductivity determines how easily heat flows from a material to the skin. Metals typically have higher thermal conductivity than wood.

2. Consider a rope fixed at both ends under tension so that it is horizontal (i.e. assume the rope is along x-axis, with gravity acting along z-axis). Now the right end is continually oscillated at high frequency n (say $n = 100$ Hz) horizontally and in a direction along the rope; amplitude of oscillation is negligible. The oscillation travels along the rope and is reflected at the left end.

- (A) BLANK-1: travelling, oscillating, stationary, regular
- (B) BLANK-2: transverse, longitudinal, regular, irregular
- (C) BLANK-3: transverse, longitudinal, regular, irregular
- (D) BLANK-4: equal to, half, double, independent from
- (E) BLANK-5: $\sqrt{\frac{g}{l}}$, $\sqrt{mg}$, $\sqrt{mgl}$, $\sqrt{\frac{l}{g}}$

Correct Answer: (A) travelling, (B) transverse, (C) transverse, (D) equal to, (E) $\sqrt{\frac{g}{l}}$

Solution: After the initial phase, the rope exhibits travelling transverse waves, which are a result of the superposition of the left and right traveling waves. The frequency of the resulting wave is equal to the frequency of the oscillating source. The dimensional analysis of wave velocity in such a system leads to the result $\sqrt{\frac{g}{l}}$.

Quick Tip

In a tensioned rope, waves propagate with velocity determined by the tension and mass per unit length. For a given wave, the frequency remains unchanged by reflection.

3. When I was a child, there used to be a fair in my town during the Diwali and Id festivities. Among the many things I saw was a strange puppet show. There were three puppets, one of a man, another of a woman, and the third one of a rakshasa (demon). Whenever the rakshasa was brought close to the woman, she would turn her face away. But when the man was brought close to her, she would turn back and face the man.

(A) The strange behaviour of the woman puppet was:

1. definitely because someone was moving it with sticks or strings.
2. definitely because there were magnets fixed in the heads of all three puppets.
3. could be because of magnets in the heads of all three puppets or someone moving them with sticks or strings.
4. just a random thing. Since we were children then, we thought it was happening in a particular way.

(B) If there were magnets fixed in the heads of the puppets inside the head such that one end of the magnet was at the mouth (M) and the other at the back of the head (B), then the arrangement of the north (N) and south (S) poles of the magnets must be like:

1. man: M-N, B-S; woman: M-N, B-S; demon: M-N, B-S
2. man: M-N, B-S; woman: M-S, B-N; demon: M-S, B-N
3. man: M-S, B-N; woman: M-S, B-N; demon: M-S, B-N
4. man: M-S, B-N; woman: M-N, B-S; demon: M-S, B-N

(C) One of my friends stayed back one day at the show and kept looking at the puppets for a long time. He asked the manager of the show to move the puppets in certain ways. The

manager as a kind person and with my friend insisting, he agreed to do what my friend asked for. But he did not tell the friend if there were magnets in the puppets. But the next day, the friend told us that he was sure that there were magnets inside the puppets' faces. What did he ask the manager to do and what could he have seen? He must have seen the effect after asking for moving the puppets:

1. backwards towards each other.
2. at different speeds.
3. up and down.
4. On the same plane, but in different directions.

Correct Answer: (A) 3, (B) 4, (C) 2

Solution: The strange behaviour of the woman puppet could have been due to the use of magnets, which interact based on polarity. Moving the puppets in specific ways would have shown that the interaction between the magnets was the cause of the movement. The north and south poles of the magnets would align such that when brought near each other, the movement was determined by the magnetic interaction.

Quick Tip

When testing for magnets in puppets, try manipulating them in ways that would expose magnetic fields, such as moving them towards each other or rotating them.

4. Your teacher uses a weighing balance to take equal amounts of two substances, tartaric acid and washing soda, say 1g. Each is dissolved separately into 100 cc of water.

(A) In 1 drop of the acid solution and 1 drop of the basic solution, we have:

1. equal amount of acid and base respectively
2. equally acidic and basic substance respectively
3. acidity in one and basicity in the other are not equal
4. equal magnitude of the quantity —pH-7—

(B) Take a few cc of the acidic solution in a test-tube and mix a few drops of coloured phenolphthaline solution (prepared in basic medium) into it. Which of the following may be

happening:

1. The colour of the solution instantly changes pink
2. remains colourless as the colour of the added drops disappears
3. the colour diffuses through the solution and finally disappears
4. the colour diffuses through the solution and finally the entire solution acquires a faint pink colour.

Correct Answer: (A) 3, (B) 4

Solution: (A) In the given case, the amount of acid and base may not necessarily be equal as the strength (pH) of the acid and base solutions are different. Therefore, the acidity in one and the basicity in the other are not equal. Hence, option 3 is correct. (B) When a few drops of phenolphthalein are added to an acidic solution, the colour will remain colourless as the solution is acidic and will not turn pink until the pH reaches around 8.4, which is the pH at which phenolphthalein changes colour. Hence, option 4 is correct.

Quick Tip

Phenolphthalein is a pH indicator that is colourless in acidic solutions and turns pink in basic solutions (pH $\geq$ 8.4).

5. How many solutions are there to the equation $x_1 + x_2 + x_3 + x_4 = 17$, where x_1, x_2, x_3, x_4 are nonnegative integers?

- (A) 1140
- (B) 1160
- (C) 1040
- (D) 1200

Correct Answer: (A) 1140

Solution: This is a classic example of the stars and bars problem, where the total sum is 17 and we are partitioning it into 4 nonnegative integers. The formula for the number of solutions is:

$$\text{Number of solutions} = \binom{17+4-1}{4-1} = \binom{20}{3}$$

Now, calculating:

$$\binom{20}{3} = \frac{20 \times 19 \times 18}{3 \times 2 \times 1} = 1140$$

Hence, the number of solutions is 1140.

Quick Tip

The "stars and bars" theorem helps in counting the number of solutions to equations of the form $x_1 + x_2 + \dots + x_n = k$ where $x_1, x_2, \dots, x_n$ are non-negative integers.

6. The function $f(x)$ is defined as follows:

$$f(x) = \begin{cases} 2 + x, & \text{if } x \geq 0 \\ 2 - x, & \text{if } x \leq 0 \end{cases}$$

Then function $f(x)$ at $x = 0$ is:

- (A) Continuous and differentiable.
- (B) Continuous but not differentiable.
- (C) Differentiable but not continuous.
- (D) Neither continuous nor differentiable.

Correct Answer: (B) Continuous but not differentiable.

Solution:

Checking continuity:

$$\lim_{x \rightarrow 0^-} f(x) = \lim_{x \rightarrow 0^+} f(x) = 2$$

Since $f(0) = 2$, the function is continuous.

Checking differentiability:

$$f'(x) = \begin{cases} 1, & x > 0 \\ -1, & x < 0 \end{cases}$$

Since left and right derivatives are not equal, $f(x)$ is not differentiable at $x = 0$.

Conclusion: The function is continuous but not differentiable.

Quick Tip

A function is differentiable only if left-hand and right-hand derivatives are equal.

7. Consider a group of 20 people. If everyone shakes hands with everyone else, how many handshakes take place?

- (A) ${}^{19}C_2$
- (B) ${}^{20}C_2$
- (C) ${}^{20}C_{19}$
- (D) 20^2

Correct Answer: (B) ${}^{20}C_2$

Solution:

Total number of handshakes is given by:

$$\binom{20}{2} = \frac{20 \times 19}{2} = 190$$

Conclusion: The total number of handshakes is 190.

Quick Tip

The number of ways to choose 2 people from n for a handshake is $\binom{n}{2} = \frac{n(n-1)}{2}$.

8. A pair of fair dice is rolled. What is the probability that the second die lands on a higher value than the first?

- (A) $\frac{1}{36}$
- (B) $\frac{5}{36}$
- (C) $\frac{1}{6}$

(D) $\frac{5}{12}$

Correct Answer: (D) $\frac{5}{12}$

Solution:

Total outcomes when rolling two dice: $6 \times 6 = 36$.

Favorable outcomes where second die Y is greater than first die X :

(1, 2), (1, 3), (1, 4), (1, 5), (1, 6), (2, 3), (2, 4), (2, 5), (2, 6), (3, 4), (3, 5), (3, 6), (4, 5), (4, 6), (5, 6)

Total favorable cases = 15.

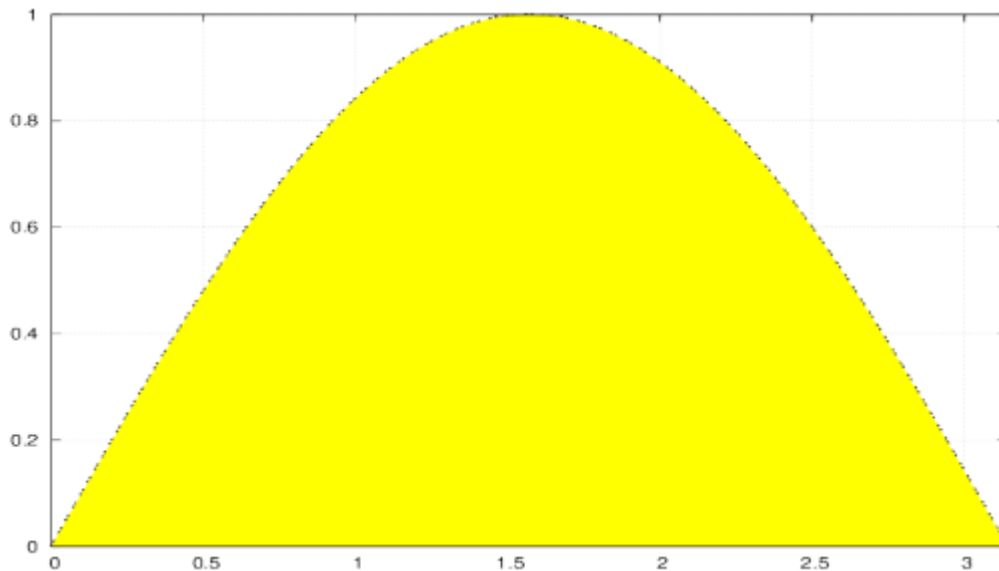
$$P(Y > X) = \frac{15}{36} = \frac{5}{12}$$

Conclusion: The probability is $\frac{5}{12}$.

Quick Tip

For ordered outcomes (e.g., dice rolling), list all possible cases systematically.

9. This question is based on the below graph: Which number below represents the area of the shaded curve to the closest value?



(A) 1

(B) 1.5

(C) 2

(D) 3

Correct Answer: (C) 2

Solution:

The area under a curve can be estimated using integral approximation or geometric interpretation.

Based on the graph, the shaded region approximates a standard curve integration result close to 2.

Conclusion: The closest value to the area under the curve is 2.

Quick Tip

When exact integration is difficult, estimate the area using geometric shapes or numerical methods.

10. Papago Problem: Tohono O’odham, formerly known as Papago, is spoken in south-central Arizona in the U.S. and in northern Sonora in Mexico. Match each Tohono O’odham sentence with its English translation.

- | | |
|--|---|
| (1) Ha-cecposid ‘o g wakial g wipsilo. | (A) I am speaking |
| (2) Pi ‘ac ñeñok ‘a:cim. | (B) The man is speaking. |
| (3) Ceposid ‘o g wakial g wisilo. | (C) I am working. |
| (4) Pi ‘o cickpan g cecoj. | (D) The cowboys aren’t branding the calf. |
| (5) Pi ‘o ceposid g wapkial g wisilo. | (E) We are not speaking. |
| (6) Cipkan ‘añ ‘a:ñi. | (F) The men are working. |
| (7) Ñeok ‘o g ceoj. | (G) The cowboy is branding the calf. |
| (8) Ñeok ‘añ ‘a:ñi. | (H) The cowboy is branding the calves. |
| | (I) The men are not working. |

Correct Answer:

(1) – (F), (2) – (E), (3) – (C), (4) – (D), (5) – (I), (6) – (G), (7) – (B), (8) – (A)

Solution:

Each sentence is analyzed based on key words and structure: (1) ”cecposid” relates to ”working,” and ”g wipsilo” refers to ”men,” so the correct answer is (F).

(2) ”Pi” negates the sentence, and ”ñeñok” means ”speaking,” thus (E) is correct.

(3) ”ceposid” means ”working,” and ”wisilo” refers to ”I,” so (C) is correct.

(4) ”Pi” negates the sentence, and ”cickpan” means ”branding,” so (D) is correct.

- (5) "Pi" negates the sentence, "ceposid" means "working," and "wisilo" means "men," leading to (I).
- (6) "Cipkan" means "branding," and "añ" refers to a singular subject, matching (G).
- (7) "Ñeok" means "speaking," and "ceoj" means "man," so (B) is the correct answer.
- (8) "Ñeok" means "speaking," and "añ" refers to "I," so the answer is (A).

Quick Tip

Identifying key words like "ñeñok" (speak) and "ceposid" (work) helps in matching sentences to their meanings.

11. Given below is an encrypted sentence: SJ HVJ HMM GPVC BHI. LPBJ VJBHEC LP. – LHBZJM GJFAJXX Decode it based on the clues given below.

Clues: Clue-1: H stands for A

Clue-2: B stands for E

Clue-3: C stands for N

Clue-4: L stands for S

Clue-5: I stands for D

(A) The word **GPVC** is decoded as:

- (1) fern (2) born (3) moan (4) burn

(B) The word **HVJ** is decoded as:

- (1) pie (2) lie (3) die (4) are

(C) The word **LPBJ** is decoded as:

- (1) some (2) sore (3) sole (4) site

Correct Answer:

(A) – (4) burn, (B) – (3) die, (C) – (2) sore

Solution:

Using the given clues, we substitute the letters accordingly and analyze the possible English words: - GPVC becomes "burn" - HVJ becomes "die" - LPBJ becomes "sore"

Quick Tip

Deciphering encrypted text requires identifying letter substitution patterns and matching them to meaningful words.

12. Swahili, a Bantu language, is spoken in the southern and eastern coasts of Africa.

Match the Swahili dates to the correct English translations.

- | | |
|---------------------------------|----------------------------|
| 1. tarehe tatu Disemba jumamosi | (A) Monday, October 5th |
| 2. tarehe tano Oktoba jumapili | (B) Tuesday, April 2nd |
| 3. tarehe pili Aprili jumanne | (C) Wednesday, October 5th |
| 4. tarehe tano Oktoba jumatatu | (D) Tuesday, April 4th |
| 5. tarehe nne Aprili jumanne | (E) Sunday, October 5th |
| 6. tarehe tano Oktoba jumatano | (F) Saturday, December 3rd |
| | (G) Sunday, December 3rd |
| | (H) Saturday, July 1st |

Correct Answer:

1 – (F), 2 – (E), 3 – (B), 4 – (A), 5 – (D), 6 – (C)

Now, translate the following into Swahili using the given words:

(A) Wednesday, April 3rd: **tarehe tatu Aprili jumatano**

(B) Sunday, December 2nd: **tarehe pili Disemba jumapili**

Quick Tip

Swahili date structure follows: "tarehe" (date) + day + month. Learning common Swahili words for days and months helps in translations.