



# STEM Careers Project



STEM Careers Project is a joint venture of the Higher Education Commission and Pakistan Atomic Energy Commission, for grooming talented students for careers in Science, Technology; Engineering & Mathematics (STEM).

## Screening TEST: Mathematics NSTC-21, June 29, 2024

Maximum Marks: 100

Maximum Time: 3 hours

**Check List: Before attempting this question paper please make sure that:**

- i) Paper contains 6 pages including this page and no page is torn or missing
- ii) Part I consists of 20 multiple choice questions, Part II contain 50 multiple choice questions and Part III contains descriptive questions
- iii) Answer Sheet for MCQs of Part-I & II, and Answer Booklet for Part III


1. Part I has 5 multiple-choice questions (MCQs) from each of the subjects of Biology, Computer, Chemistry, Mathematics and Physics. There is a choice between Biology or Computer only, rest of the three subjects are compulsory for every candidate. For Biology or Computer one must blacken the corresponding circle in the answer sheet.
2. Part I has 20 MCQs and carries 20 marks. The MCQ portion of the relevant subject of Part II carries 50 Marks. Correct answer carries +1 mark; 1/3 mark will be deducted for each incorrect answer.
3. In Part I and Part II, there are four choices (a, b, c, d) corresponding to each multiple-choice question. Blacken one of these choices, which in your opinion is correct. Rough work may be done in the Answer Booklet for Part III by clearly specifying 'Rough Work'.
4. The descriptive question(s) of Part III should be solved in the Answer Booklet for Part III. This part carries 30 Marks.
5. You are recommended to give frank opinion about the test, including pointing out possible mistakes and legibility problems on the last page of the Answer Booklet. It is meant to motivate you to carefully read the question paper before attempting it. It may be used to discriminate between candidates having similar scores.
6. Recommended time for Part I is about 30 minutes and for Parts II and III is about one hour each. The rest of the time is for carefully reading the paper and commenting on it.
7. No leaf from the question paper or Answer Booklet is to be torn out as all these must be handed over to the examiner, even if no question has been attempted. Anyone found using unfair means would be disqualified.
8. You may use non-programmable calculators.
9. No questions will be entertained and no clarification will be made during the test. In case of doubt, please write down your remarks/comments on the last page of the Answer Booklet.
10. You must attempt all Parts of the paper. To qualify screening test one should pass both Parts I and the portion of Parts II and III that are relevant to the discipline in which you have applied to appear.
11. The term 'estimate' if used in the descriptive portion of Part II means that only an approximate answer is expected from the students. Similarly the term 'sketch' in Part III means drawing a rough graph, which looks like what you might expect from more careful considerations.
12. **Possession of CELL PHONE or any IMAGING DEVICE in the Examination Hall will be treated as an offence under unfair mean rules.**
13. Please put your pen down as soon as you hear the announcement of 'stop writing'.

Students will be short-listed for a one-week Training Camp on the basis of their performance on this Screening Test. Results will be posted on NSTC web page: [www.stem.edu.pk](http://www.stem.edu.pk). Successful candidates will also be informed about their result in about two months after the exam. Please make sure that we have your correct phone/fax number and e-mail address.

Higher Education Commission, H-9 Islamabad  
Phone: +92 51 90402615 Facsimile: +92 51 9257505  
E-mail: [stem@hec.gov.pk](mailto:stem@hec.gov.pk) web site: [www.stem.edu.pk](http://www.stem.edu.pk)

Name: \_\_\_\_\_

Roll No: \_\_\_\_\_

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## PART-I

### [CANDIDATE MUST ATTEMPT THIS PART]

[It contains 20 MCQs, 5 from each biology/computer, chemistry, mathematics and physics,  
for selection to the next phase]

**Choose either Biology or Computer and must blacken the correct option in the answer sheet.**

#### **BIOLOGY**

1. During cellular respiration breakdown of glucose occurs in  
a) Vacuole                      b) Golgi complex                      c) Cytoplasm                      d) Mitochondria
2. The following rays can cause cancer:  
a) X-rays                      b) Gamma rays                      c) Alpha and beta particles                      d) All of these
3. The hypothesis that stands the test of time are called:  
a) Law                      b) Null Hypothesis                      c) Principle                      d) Theories
4. Electric intensity is a ----- quantity.  
a) vector                      b) scalar                      c) basic                      d) none of these
5. One coulomb is equal to the charge of-----electrons.  
a)  $6.25 \times 10^{19}$                       b)  $6.24 \times 10^{18}$                       c)  $6.24 \times 10^{17}$                       d)  $6.25 \times 10^{18}$

**OR**

#### **COMPUTER**

1. Internet uses \_\_\_\_\_ to communicate between devices and networks.  
a) HTTPS                      b) email                      c) internet protocol suite                      d) website
2. Which of the following creates user groups and assigns privileges to them?  
a) Process management                      b) I/O management                      c) File management                      d) Network management
3. In C++, a pointer is  
a) address of a variable                      b) constant value                      c) data type of an address variable                      d) variable for storing address
4. The programming technique where a function calls itself is known as  
a) recursion                      b) encapsulation                      c) inline function                      d) it is a bug
5. Which of the following loop is always executed at least once:  
a) for                      b) do while                      c) while                      d) counter loop

## CHEMISTRY

6. The phenomenon of emission of light in a chemical reaction is known as  
a) Chemiluminescence    b) Photosensitization    c) Luminescence    d) None of these
7. Name the device used to measure the number of nuclear disintegration per minute  
a) Cyclotron    b) Geiger counter    c) Cloud chamber    d) Mass spectrograph
8. Which of the following bonds must be present in alkynes?  
a) Single bond    b) Double bond    c) triple bond    d) Hydrogen bond
9. When a solution contains equal concentration of hydroxyl and hydrogen ions its pH will be around  
a) 0    b) 14    (c) 7    d) 10
10. Which is the most reactive element in the given list?  
a) Fluorine    b) Oxygen    c) Nitrogen    d) Iodine

## MATHEMATICS

11. A quadrilateral with vertices at  $(0, -1), (3, 1), (3, -1), (0, 1)$  is a \_\_\_\_\_.  
a) kite    b) square    c) parallelogram    d) rectangle
12. The center of the circle, \_\_\_\_\_.  
a) is a point on the circle    b) lies outside of the circle    c) lies inside of the circle    d) none of these
13. What is the sum of all the divisors of 600?  
a) 2060    b) 1860    c) 2160    d) 1890
14. What is the sum of the first nine prime numbers?  
a) 100    b) 98    c) 80    d) 77
15. The equations  $2x+7=3$  and  $bx - 10 = -2$  have the same solution. What is the value of b?  
a) -4    b) 6    c) 2    d)  $3/2$

## PHYSICS

16. A ball of mass  $m$  falls from rest onto a floor, from a height  $h$ . It makes elastic collisions with the floor repeatedly. The force exerted by it on the floor, averaged over a long time, is  
a)  $mg$     b)  $2 mg$     c)  $3 mg$     d) proportional to  $m$  and  $h$
17. While passing over an obstacle a light ray slightly bends round the corner. The phenomenon is known as\_\_:  
a) Scattering    b) Polarisation    c) Diffraction    d) Refraction
18. What is the orbital velocity of geo stationary satellite?  
a) 4.15 km/s    b) 2.78 km/s    c) 3.08 km/s    d) 6.66 km/s
19. What is the direction of electric and magnetic fields in an electromagnetic wave?  
a) parallel to each other, b) at  $90^\circ$  to each other, c) at  $45^\circ$  to each other, d) at  $120^\circ$  to each other
20. What is the time period of a seconds pendulum?  
a) 0.5 second    b) 1.0 seconds    c) 1.5 seconds    d) 2.0 seconds

## PART II – MATHEMATICS

21	The points $(1, -1), (4, 2), (10, 8)$ in the plane are				
(a)	Concyclic	(b)	Collinear	(c) Concurrent	(d) None of these.
22	Let the central angle subtended by two points on a circle is $120^\circ$ . Then the inscribed angle subtended by those points is				
(a)	$240^\circ$	(b)	$90^\circ$	(c) $60^\circ$	(d) $180^\circ$
23	How many different tangents can be drawn on a circle?				
(a)	1	(b)	2	(c) 4	(d) Infinite
24	The angle between the tangents at the ends of two perpendicular radii is _____.				
(a)	$0^\circ$	(b)	$45^\circ$	(c) $90^\circ$	(d) $180^\circ$
25	The tangents on the end points of a diameter of a circle are always				
(a)	Collinear	(b)	Concurrent	(c) Parallel	(d) None of these
26	Consider a triangle $ABC$ with $\angle A = 45^\circ$ and $\angle B = 5^\circ$ . What is the type of $\Delta ABC$ ?				
(a)	Right Angle	(b)	Isosceles	(c) Acute	(d) Obtuse
27	All the _____ in a plane are similar				
(a)	Triangles	(b)	Parallelograms	(c) Circles	(d) None of these.
28	If a line intersects two concentric circles with centre $O$ at $A, B, C$ and $D$ , then				
(a)	$AB = CD$	(b)	$AB > CD$	(c) $AB < CD$	(d) None of these
29	If $a$ and $b$ are coprime integers, which of the following must also be coprime?				
(a)	$a^2$ and $b^2$	(b)	$a + 1$ and $b + 1$	(c) $2a$ and $2b$	(d) $a + b$ and $ab$
30	Sum of two different prime numbers is a				
(a)	Prime number	(b)	Composite number	(c) Either Prime or composite	(d) None of these
31	How many distinct prime factors does $2^{16} \times 3^4 \times 5^2$ have?				
(a)	3	(b)	6	(c) 9	(d) 12
32	What is the remainder when $7^{2024}$ is divided by 13?				
(a)	3	(b)	7	(c) 12	(d) 1
33	What is the least number that is exactly divisible by all the numbers from 1 to 10?				
(a)	5040	(b)	2520	(c) 1024	(d) 2048
34	What is the units digit of $2^{2047} \times 3^{11}$ ?				
(a)	1	(b)	7	(c) 6	(d) 9
35	What is the value of $4^{234} \pmod{11}$				
(a)	8	(b)	7	(c) 1	(d) 3
36	If $p$ is a prime number greater than 3, what is the remainder when $p^2$ is divided by 12?				
(a)	1	(b)	5	(c) 7	(d) 9
37	If $n$ is a positive integer such that $n^2$ is divisible by 72, then the smallest $n$ is				
(a)	6	(b)	9	(c) 12	(d) 24
38	From a group 7 men and 6 women, five persons are to be selected to form a committee so that at least 3 men are there in the committee. In how many ways can it be done?				
(a)	756	(b)	564	(c) 735	(d) None of the above
39	The 6 <sup>th</sup> and 17 <sup>th</sup> terms of an A.P. are 19 and 41 respectively. Find the 40 <sup>th</sup> term				
(a)	87	(b)	78	(c) 88	(d) None of the above
40	There are 10 true-false questions in an examination. These questions can be answered in:				
(a)	20 ways	(b)	100 ways	(c) 512 ways	(d) 1024 ways
41	Mayur travels from Mumbai to Jammu in 7 different ways. But he is allowed to return to Mumbai by any way except the one he used earlier. In how many ways can he complete his journey?				
(a)	49	(b)	42	(c) 48	(d) 6

42	What is the Cartesian product of set A and set B, if the set $A = \{1, 2\}$ and set $B = \{a, b\}$ ?						
(a)	$\{(1, a), (1, b), (2, a), (b, b)\}$	(b)	$\{(1, 1), (2, 2), (a, a), (b, b)\}$	(c)	$\{(1, a), (2, a), (1, b), (2, b)\}$	(d)	$\{(1, 1), (a, a), (2, a), (1, b)\}$
43	Let the players who play cricket be 12, the ones who play football 10, those who play only cricket are 6, then the number of players who play only football are _____, assuming there is a total of 16 players.						
(a)	16	(b)	8	(c)	4	(d)	10
44	How many terms are in the expansion of $(2x - \frac{1}{y})^{10}$ ?						
(a)	9	(b)	10	(c)	11	(d)	12
45	The value of $\binom{50}{4} + \sum_{r=1}^6 \binom{56-r}{3}$ is						
(a)	$\binom{55}{4}$	(b)	$\binom{55}{3}$	(c)	$\binom{56}{3}$	(d)	$\binom{56}{4}$
46	There are 27 points in a plane. 5, 10 and 15 points are collinear on distinct lines. By joining these points, how many distinct lines can be formed?						
(a)	194	(b)	170	(c)	435	(d)	None of these
47	10 boys and 10 girls sit alternately in a row and then alternately along a circle. The ratio of number of ways of sitting in a row to the number of ways of sitting along a circle is						
(a)	5	(b)	10	(c)	15	(d)	20
48	If $n(A) = 20$ and $n(B) = 30$ and $n(A \cup B) = 40$ then $n(A \cap B)$ is?						
(a)	20	(b)	30	(c)	40	(d)	10
49	Which of the following function is not a mathematics function?						
(a)	many-to-one	(b)	one-to-many	(c)	one-to-one	(d)	all of the mentioned above
50	A ball is dropped from a height of 49 m. The quadratic equation $d(t) = -t^2 + 49$ provides information about the height of the ball $d$ , after $t$ seconds. In how many seconds, does the ball hit the ground?						
(a)	3	(b)	5	(c)	7	(d)	9
51	Cities A and B are 45 miles apart. Alicia lives in A and Beth lives in B. Alicia bikes towards B at 18 miles per hour. Leaving at the same time, Beth bikes toward A at 12 miles per hour. How many miles from City A will they be when they meet?						
(a)	20	(b)	24	(c)	25	(d)	27
52	The sum of two numbers is $S$ . Suppose 3 is added to each number and then each of the resulting numbers is doubled. What is the sum of the final two numbers?						
(a)	$2S+3$	(b)	$2S+12$	(c)	$2S+6$	(d)	$2S+2$
53	Given that $a, b$ , and $c$ are non-zero real numbers, define $(a,b,c) = a/b + b/c + c/a$ . Find $(2,12,9)$						
(a)	4	(b)	5	(c)	6	(d)	7
54	For how many positive integers $m$ does there exist at least one positive integer $n$ such that $mn < m + n$ ?						
(a)	Infinitely many	(b)	1	(c)	2	(d)	4
55	Cindy was asked by her teacher to subtract 3 from a certain number and then divide the result by 9. Instead, she subtracted 9 and then divided the result by 3, giving an answer of 43. What would her answer have been had she worked the problem correctly?						
(a)	15	(b)	34	(c)	43	(d)	51
56	Compute the sum of all the roots of $(2x+3)(x-4)+(2x+3)(x-6)=0$						
(a)	4	(b)	$7/2$	(c)	0	(d)	6
57	You and five friends need to raise 1500 dollars in donations for a charity, dividing the fundraising equally. How many dollars will each of you need to raise?						
(a)	300	(b)	1500	(c)	9000	(d)	250

58	A company sells peanut butter in cylindrical jars. Marketing research suggests that using wider jars will increase sales. If the diameter of the jars is increased by 25% without altering the volume, by what percent must the height be decreased?						
(a)	26	(b)	16	(c)	36	(d)	46
59	If A and B are matrices of order three then $\text{Det}(AB)$ equals						
(a)	$\text{Det}(A)+\text{Det}(B)$	(b)	$\text{Det}(A)\text{Det}(B)$	(c)	0	(d)	None of these.
60	The LCM of two numbers is 7200, and their HCF is 180. If one number is 360, then the second number is:						
(a)	480	(b)	360	(c)	720	(d)	1440
61	In a group of 8 people, how many ways can you choose a committee of 3 people if two specific individuals refuse to work together?						
(a)	6	(b)	84	(c)	12	(d)	24
62	Determine the sum of the geometric series: $4 + 2 + 1 + 1/2 + \dots$						
(a)	7	(b)	9	(c)	8	(d)	10
63	A recipe calls for a ratio of 2 cups of flour to 1 cup of sugar. If you want to use 4 cups of sugar, how much flour should you use?						
(a)	8 cups	(b)	6 cups	(c)	4 cups	(d)	2 cups
64	If p is inversely proportional to q, and $p=8$ when $q=6$ , what is the value of q when $p=12$ ?						
(a)	6	(b)	5	(c)	2	(d)	4
65	If the sides of two similar triangles are in the ratio 2:3, what is the ratio of their areas?						
(a)	1:1	(b)	1:2	(c)	2:3	(d)	4:9
66	Simplify $\log_3(27) - \log_3(9)$ .						
(a)	1	(b)	2	(c)	3	(d)	4
67	The linear combination of $\text{gcd}(252, 198) = 18$ is?						
(a)	$252 * 4 - 198 * 5$	(b)	$252 * 5 - 198 * 4$	(c)	$252 * 5 - 198 * 2$	(d)	$252 * 4 - 198 * 4$
68	The inverse of 3 modulo 7 is?						
(a)	-1	(b)	-2	(c)	-3	(d)	-4
69	Which of the following is not irrational?						
(a)	$2 + \sqrt{2}$	(b)	$2 - \sqrt{2}$	(c)	$(2 + \sqrt{2})(2 - \sqrt{2})$	(d)	None of the these
70	If LCM of two number is 10 and GCD is 5 then the product of two numbers is?						
(a)	45	(b)	50	(c)	7	(d)	49

### Part III: Mathematics-Descriptive Questions

[30 Marks]

**Question No 1:** Prove that

$$(\sqrt{5} + \sqrt{6} + \sqrt{7})(\sqrt{5} + \sqrt{6} - \sqrt{7})(\sqrt{5} - \sqrt{6} + \sqrt{7})(-\sqrt{5} + \sqrt{6} + \sqrt{7}) = 140.$$

**Question No 2:** Triangle ABC is inscribed in a circle. P, Q and R are any points on arcs AB, BC and AC respectively. Prove that

$$\angle ARC + \angle CQB + \angle BPA = 360^\circ.$$

----End of paper----

Name: \_\_\_\_\_

Roll No: \_\_\_\_\_