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-20, March 19, 2023

Maximum Marks: 100 Maximum Time: 3 hours

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

i) Paper contains 7 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. Write your name on the space provided in the Answer Sheet for Part I and Part II. There are four choices (a, b, c, d) corresponding to each multiple-choice question. Blacken one of these choices as shown in the example, 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. 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 **web site**: www.stem.edu.pk

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) Mitochondria d) Cytoplasm

2. The hypothesis that stands the test of time are called:
a) Law b) Null hypothesis c) Principle d) Theories

3. Cancer is disease of:
a) Simple cell division b) Uncontrolled cell division c) Controlled cell division d) Accelerated cell division

4. A conjugate acid is a specie formed by accepting a
a) Electron pair b) Neutron c) Proton d) Electron

5. In which phase of Meiosis the homologous chromosomes separated from each other
a) prophase 1 b) telophase 1 c) anaphase 1 d) metaphase 1

OR

COMPUTER

1. Internet uses _____ to communicate between devices and networks.
a) HTTPS b) email c) website d) internet protocol suite

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) variable for storing address c) data type of an address variable d) constant value

4. The programming technique where a function calls itself is known as
a) inline function b) encapsulation c) recursion d) it is a bug

5. Which of the following loop is always executed at least once:
a) for b) while c) do while d) counter loop

CHEMISTRY

6. All of the following substance are crystalline except:
a) Ice b) Diamond c) Sucrose d) Plastic

7. Diameter of an atom in the order of
a) 0.2μm b) 0.2mm c) 0.2nm d) 0.2pm

8. Which of the following is not a macromolecule
a) Sand b) Hemoglobin c) Diamond d) Maltose

9 About how many elements in the Periodic Table are Metals
a)60% b) 65% (c) 70% d) 75%

10. Plasma is used in
a) Florescent bulb b) Neon signs c) Laser d) All of these

MATHEMATICS

11. The distance between the points (-2, 2) and (1, 6) is
a) 25 units b) 5 units c) 7 units d) none of these

12. Angles that sum up to 90 ° are known as
a) complementary angles b) vertical angles c) reflective angles d) supplementary angles

13. Total number of lines passing through the point (0,0) are
a) 0 b) 1 c) 2 d) ∞

14. The coordinates of the midpoint of points in plane with coordinates $(-2,8)$ and $(8,-2)$ is
a) (0,0) b) (3,3) c) (2,2) d) (8,8)

15. If $x+\frac{1}{x}=2$, then the value of $x^2+\frac{1}{x^2}$ is:
a) $1/4$ b) 1 c) 3 d) 2

PHYSICS

16. A net force of 10. Newtons accelerates an object at 5.0 m/s^2. What net force would be required to accelerate the same object at 1.0 m/s^2?
a) 1.0 N b) 2.0 N c) 5 N d) 10 N

17. A 1,200-kilogram car traveling at 10. m/s hits a tree and is brought to rest in 0.10 second. What is the magnitude of the average force acting on the car to bring it to rest?
a) 1.2×10^2 N b) 1.2×10^3 N c) 1.2×10^4 N d) 1.2×10^5 N

18. When a neutral metal sphere is charged by contact with a positively charged glass rod, the sphere
a) loses electrons b) loses protons c) gains electrons d) gains protons

19. An electric iron operating at 120 volts draws 10. Amperes of current. How much heat energy is delivered by the iron in 30 Seconds?
a) 3.0×10^2 J b) 3.6×10^3 J c) 1.2×10^3 J d) 3.6×10^4 J

20. A radar gun can determine the speed of a moving automobile by measuring the difference infrequency between emitted and reflected radar waves. This process illustrates
a) resonance b) diffraction c) the Doppler effect d) refraction

PART II – MATHEMATICS

21)	A chord of length 24cm is at a distance of 5cm from the center of a circle. The radius of the circle is						
(a)	$13\ cm$	(b)	$19\ cm$	(c)	$12\ cm$	(d)	$5\ cm$
22)	Find the slope of the line with equation $3x+2y=10$						
(a)	10	(b)	$-3/2$	(c)	$3/2$	(d)	None of these
23)	Consider a triangle ABC with $\angle B = 30°$ and $\angle C = 60°$. What is the type of ΔABC?						
(a)	Right Angle	(b)	Isosceles	(c)	Acute	(d)	Obtuse
24)	Total number of circles that can pass through 2 pair of points in a plane are						
(a)	0	(b)	1	(c)	2	(d)	∞
25)	Length of a diagonal of a rectangle with length $4\ cm$ and width 3 cm is						
(a)	$\sqrt{7}\ cm$	(b)	$5\ cm$	(c)	$4\ cm$	(d)	$3\ cm$
26)	Surface Area of a sphere with radius $3cm$ is						
(a)	$36\pi\ cm^3$	(b)	$36\pi\ cm^2$	(c)	$9\pi\ cm^2$	(d)	$18\pi\ cm^2$
27)	In a right angle triangle length of the hypotenuse is 5cm and length of one side is 4cm. What is the perimeter of the triangle?						
(a)	$6\ cm$	(b)	$8\ cm$	(c)	$12cm$	(d)	None of these
28)	How many minimum points are required to draw a unique line in a plane						
(a)	1 point	(b)	2 points	(c)	3 points	(d)	None of these
29)	If the supplement of an angle is 3 times of its compliment, find the angle.						
(a)	90°	(b)	60°	(c)	45°	(d)	30°
30)	Maximum number of intersection points of 5 non parallel distinct lines in a plane are						
(a)	5	(b)	10	(c)	15	(d)	20
31)	The distance between two parallel tangents of a circle of radius 6 cm is						
(a)	3 cm	(b)	6 cm	(c)	12 cm	(d)	15 cm
32)	The ratio of heights of a cone and a hemisphere with equal bases and equal volumes is						
(a)	$1:1$	(b)	$1:2$	(c)	$2:1$	(d)	None of these.
33)	If $x^2+y^2+z^2=125$ and $xy+yz+za=250$, then $x+y+z$ is:						
(a)	25	(b)	35	(c)	45	(d)	55
34)	The quadratic equation corresponding to the roots $2+\sqrt{5}$ and $2-\sqrt{5}$ is:						
(a)	$x^2-4x-1=0$	(b)	$x^2+4x+1=0$	(c)	$x^2-4x+1=0$	(d)	$x^2+4x+1=0$
35)	The function $f: R \to R$ defined by $f(x)=2x^2+x-1$ is						
(a)	only onto	(b)	only one-one	(c)	both one-one and onto	(d)	neither one-one nor onto

36)	The number of real solutions of the equation $x^4 - 1 = 0$ are						
(a)	0	(b)	1	(c)	2	(d)	4
37)	If $x^2 - 4x + 4 = 0$, then the value of x^2 is						
(a)	0	(b)	2	(c)	4	(d)	16
38)	Which of the following is not irrational?						
(a)	$2(2 - 3\sqrt{3})$	(b)	$2(\sqrt{2} + \sqrt{3})$	(c)	$(\sqrt{2} - \sqrt{3})(\sqrt{2} + \sqrt{3})$	(d)	$2\sqrt{7}/7$
39)	If $d\|a$ and $d\|b$, then						
(a)	$d\|a^b$	(b)	$d\|b^a$	(c)	$d\|(a - b)$	(d)	None
40)	Positive divisor of both a and $a + 1$ is						
(a)	a	(b)	$a - 1$	(c)	1	(d)	All
41)	$-123 \equiv a(\text{mod } 10)$						
(a)	3	(b)	1	(c)	5	(d)	7
42)	$\gcd(2a + 1, 9a + 4) =$						
(a)	a	(b)	$2a$	(c)	$a + 1$	(d)	1
43)	If p is prime and $p\|a^n$, then						
(a)	$p\|a^n$-1	(b)	$p^n\|a^n$	(c)	$a\|p$	(d)	all
44)	The remainders when 2^{50} is divided by 7.						
(a)	4	(b)	6	(c)	2	(d)	1
45)	A girl wrote all the numbers from 100 to 200. Then she started counting the number of one's that has been used while writing all these numbers. What is the number that she got?						
(a)	111	(b)	119	(c)	120	(d)	121
46)	If each of the three nonzero numbers a, b and c is divisible by 3, then abc must be divisible by which one of the following the numbers?						
(a)	8	(b)	27	(c)	81	(d)	121
47)	If n is a positive integer, which one of the following numbers must have a remainder of 3 when divided by any of the numbers 4, 5 and 6?						
(a)	12n+3	(b)	24n+3	(c)	90n+2	(d)	120n+3
48)	When a particular positive number is divided by 5, the remainder is 2. If the same number is divided by 6, the remainder is 1. If the difference between the quotients of division is 3, then find the number.						
(a)	37	(b)	97	(c)	67	(d)	87
49)	A certain number when divided by 222 leaves a remainder 35, another number when divided by 407 leaves a remainder 47. What is the remainder when the sum of these two numbers is divided by 37?						
(a)	8	(b)	9	(c)	12	(d)	17
50)	The number obtained by interchanging the two digits of a two digit number is less than the original number by 27. If the difference between the two digits of the number is 3, what is the original number?						
(a)	74	(b)	63	(c)	85	(d)	Cannot be determined

51)	A six-person committee composed of Alice, Ben, Connie, Dolph, Egbert, and Francisco is to select a chairperson, secretary, and treasurer. In how many ways can this be done if either Alice or Ben must be chairperson?						
(a)	20	(b)	120	(c)	60	(d)	40
52)	A boy lives at X and wants to go to School at Z. From his home X he has to first reach Y and then Y to Z. He may go X to Y by either 3 bus routes or 2 train routes. From there, he can either choose 4 bus routes or 5 train routes to reach Z. How many ways are there to go from X to Z?						
(a)	5	(b)	9	(c)	45	(d)	14
53)	In a group of 50 students 24 like cold drinks and 36 like hot drinks and each student likes at least one of the two drinks. How many like both coffee and tea?						
(a)	10	(b)	20	(c)	30	(d)	40
54)	In an arithmetic progression the m times of m^{th} term is equal to n times the n^{th} term, its $(m+n)^{th}$ term will be						
(a)	0	(b)	mn	(c)	$\frac{m+n}{mn}$	(d)	$1+m+n$
55)	In the expansion of $(2a-3b)^6$, determine the coefficient of the term containing a^4b^2.						
(a)	-4320	(b)	864	(c)	2160	(d)	2880
56)	In a colony, there are 55 members. Every member posts a greeting card to all the members. How many greeting cards were posted by them?						
(a)	990	(b)	890	(c)	2970	(d)	1980
57)	There are 20 points in a plane, how many triangles can be formed by these points if 5 are collinear?						
(a)	1130	(b)	550	(c)	1129	(d)	1140
58)	How many odd 3-digit whole numbers are there? For example, 203 is acceptable but 023 is not.						
(a)	360	(b)	450	(c)	500	(d)	900
59)	Consider the recurrence relation $a_n = a_{n-1} + n$ with initial condition $a_1 = 1$. The value of a_{13} is _____						
(a)	91	(b)	101	(c)	85	(d)	113
60)	How many numbers must be selected from the set $\{1,2,3,4,5,6\}$ to guarantee that at least one pair of these numbers add up to 7?						
(a)	1	(b)	4	(c)	3	(d)	2
61)	If arithmetic mean of $6, 7, 9, x$ is 10, then value of x is						
(a)	20	(b)	22	(c)	18	(d)	24
62)	Find the number of ways of arranging the letters of the words DANGER, so that no vowel occupies odd place.						
(a)	36	(b)	48	(c)	144	(d)	96
63)	If ${}^nP_r = 3024$ and ${}^nC_r = 126$ then find n and r.						
(a)	9, 4	(b)	10, 3	(c)	12, 4	(d)	11, 4
64)	There are 6 equally spaced points A, B, C, D, E and F marked on a circle with radius R. How many convex heptagons of distinctly different areas can be drawn using these points as vertices?						
(a)	7!*6	(b)	$7C_5$	(c)	7!	(d)	Same area

65)	17 students are present in a class. In how many ways, can they be made to stand in 2 circles of 8 and 9 students?						
(a)	$^{17}C_9$ x 9! X 8!	(b)	$^{17}C_9$ x 8! X 7!	(c)	8! X 7!	(d)	$^{17}C_8$ x 8! X 9!
66)	Amir is a window cleaner. He uses the following formula to calculate the amount to charge his customers: Charge = Rs 20+4n, where n is the number of windows a house has. If a house has 7 windows, how much would Amir charge?						
(a)	48	(b)	28	(c)	68	(d)	20
67)	The inverse of the function f(x)=2x-3 is						
(a)	(x+3)/2	(b)	(x-3)/2	(c)	(x+2)/3	(d)	(x-2)/3
68)	Which of these lines is parallel to the line 2y = x+7						
(a)	$y = 2x - 9$	(b)	$y = 2x + 3$	(c)	$y = 0$	(d)	$y = x/2 - 9$
69)	Find x if $Log_x(9/25) = 2$						
(a)	5/3	(b)	5/6	(c)	3/5	(d)	6/5
70)	The period of $y = 2Sin(x - \pi/3) \quad is$						
(a)	2π	(b)	$\pi/3$	(c)	π	(d)	$-\pi$

Part III: Mathematics-Descriptive Questions

[30 Marks]

Question No 1:

Let a, b and c be distinct nonzero real numbers such that

$$a+\frac{1}{b}=b+\frac{1}{c}=c+\frac{1}{a}$$

Prove that $|abc| = 1$.

Question No 2:

In ΔABC, $AB = AC$ and D, E, F are on AB, BC, CA, such that $DE = EF = FD$. Prove that

$$\angle DEB = \frac{1}{2}(\angle ADF + \angle CFE).$$

----End of paper----