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: Chemistry
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 9 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.

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ABBREVIATIONS AND SYMBOLS

ampere	A	Faraday constant	F	molal	m
atmosphere	atm	formula molar mass	M	molar	M
atomic mass unit	u	free energy	G	molar mass	M
atomic molar mass	A	frequency	ν	mole	mol
Avogadro constant	N_A	gas constant	R	Planck's constant	h
Celsius temperature	°C	gram	g	pressure	P
centi– prefix	c	heat capacity	C_p	rate constant	k
coulomb	C	hour	h	retention factor	R_f
electromotive force	E	joule	J	second	s
energy of activation	E_a	kelvin	K	temperature, K	T
enthalpy	H	kilo– prefix	k	time	t
entropy	S	liter	L	volt	V
equilibrium constant	K	milli– prefix	m		

CONSTANTS

$R = 8.314\ \text{J·mol}^{-1}\text{·K}^{-1}$

$R = 0.0821\ \text{L·atm·mol}^{-1}\text{·K}^{-1}$

$1\ F = 96{,}500\ \text{C·mol}^{-1}$

$1\ F = 96{,}500\ \text{J·V}^{-1}\text{·mol}^{-1}$

$N_A = 6.022 \times 10^{23}\ \text{mol}^{-1}$

$h = 6.626 \times 10^{-34}\ \text{J·s}$

$c = 2.998 \times 10^{8}\ \text{m·s}^{-1}$

0 °C = 273.15 K

1 atm = 760 mmHg

EQUATIONS

$$E = E^\circ - \frac{RT}{nF}\ln Q \qquad \ln K = \left(\frac{-\Delta H}{R}\right)\left(\frac{1}{T}\right) + \text{constant} \qquad \ln\left(\frac{k_2}{k_1}\right) = \frac{E_a}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

PERIODIC TABLE OF THE ELEMENTS

1 1A												13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
1 **H** 1.008	2 2A																2 **He** 4.003
3 **Li** 6.941	4 **Be** 9.012											5 **B** 10.81	6 **C** 12.01	7 **N** 14.01	8 **O** 16.00	9 **F** 19.00	10 **Ne** 20.18
11 **Na** 22.99	12 **Mg** 24.31	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.97	16 **S** 32.07	17 **Cl** 35.45	18 **Ar** 39.95
19 **K** 39.10	20 **Ca** 40.08	21 **Sc** 44.96	22 **Ti** 47.88	23 **V** 50.94	24 **Cr** 52.00	25 **Mn** 54.94	26 **Fe** 55.85	27 **Co** 58.93	28 **Ni** 58.69	29 **Cu** 63.55	30 **Zn** 65.39	31 **Ga** 69.72	32 **Ge** 72.61	33 **As** 74.92	34 **Se** 78.96	35 **Br** 79.90	36 **Kr** 83.80
37 **Rb** 85.47	38 **Sr** 87.62	39 **Y** 88.91	40 **Zr** 91.22	41 **Nb** 92.91	42 **Mo** 95.94	43 **Tc** (98)	44 **Ru** 101.1	45 **Rh** 102.9	46 **Pd** 106.4	47 **Ag** 107.9	48 **Cd** 112.4	49 **In** 114.8	50 **Sn** 118.7	51 **Sb** 121.8	52 **Te** 127.6	53 **I** 126.9	54 **Xe** 131.3
55 **Cs** 132.9	56 **Ba** 137.3	57 **La** 138.9	72 **Hf** 178.5	73 **Ta** 180.9	74 **W** 183.8	75 **Re** 186.2	76 **Os** 190.2	77 **Ir** 192.2	78 **Pt** 195.1	79 **Au** 197.0	80 **Hg** 200.6	81 **Tl** 204.4	82 **Pb** 207.2	83 **Bi** 209.0	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** (226)	89 **Ac** (227)	104 **Rf** (261)	105 **Db** (262)	106 **Sg** (263)	107 **Bh** (262)	108 **Hs** (265)	109 **Mt** (266)	110 (269)	111 (272)	112 (277)		114 (???)				

58 **Ce** 140.1	59 **Pr** 140.9	60 **Nd** 144.2	61 **Pm** (145)	62 **Sm** 150.4	63 **Eu** 152.0	64 **Gd** 157.3	65 **Tb** 158.9	66 **Dy** 162.5	67 **Ho** 164.9	68 **Er** 167.3	69 **Tm** 168.9	70 **Yb** 173.0	71 **Lu** 175.0
90 **Th** 232.0	91 **Pa** 231.0	92 **U** 238.0	93 **Np** (237)	94 **Pu** (244)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (252)	100 **Fm** (257)	101 **Md** (258)	102 **No** (259)	103 **Lr** (262)

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) 0.2 μm b) 0.2 mm c) 0.2 nm d) 0.2 pm

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

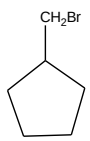
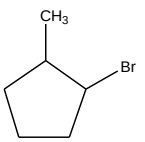
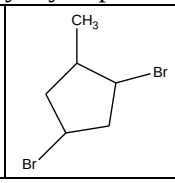
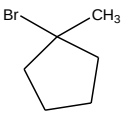
17. A 1,200-kilogram car traveling at 10. m/s hits a tree and is brought to rest in 0.10 second. What is the magnitude of the average force acting on the car to bring it to rest?
   a) 1.2×10^2 N b) 1.2×10^3 N c) 1.2×10^4 N d) 1.2×10^5 N

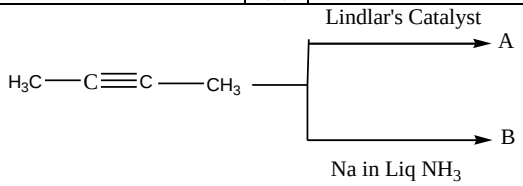
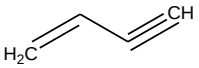
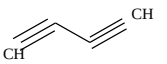
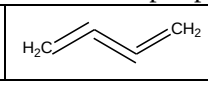
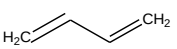
18. When a neutral metal sphere is charged by contact with a positively charged glass rod, the sphere
   a) loses electrons b) loses protons c) gains electrons d) gains protons

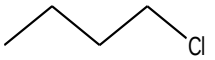
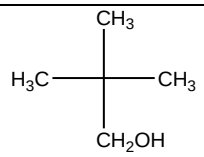
19. An electric iron operating at 120 volts draws 10. Amperes of current. How much heat energy is delivered by the iron in 30 Seconds?
   a) 3.0×10^2 J b) 3.6×10^3 J c) 1.2×10^3 J d) 3.6×10^4 J

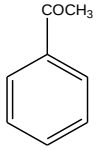
20. A radar gun can determine the speed of a moving automobile by measuring the difference infrequency between emitted and reflected radar waves. This process illustrates
   a) resonance b) diffraction c) the Doppler effect d) refraction

PART II – CHEMISTRY

21	Which of the following isn't a state function						
(a)	Internal energy	(b)	Enthalpy	(c)	Gibbs free energy	(d)	Heat
22	The velocity of the photon						
(a)	Is independent of its wavelength	(b)	Equal to the square of amplitude	(c)	Depends upon its frequency	(d)	Depends upon source
23	Hydrogen effuses four times more rapidly than volume of an unknown gas molar mass of unknown gas should be						
(a)	16 $gmol^{-1}$	(b)	32 $gmol^{-1}$	(c)	48 $gmol^{-1}$	(d)	64 $gmol^{-1}$
24	Which one of the following is a buffer solution						
(a)	Solution of $CuSO_4$	(b)	Blood	(c)	Glue	(d)	Brine
25	Which substance can be used for disinfecting water						
(a)	$KMnO_4$	(b)	Alums	(c)	Ozone	(d)	All
26	How many chiral compounds are possible on monochlorination of 2–methyl butane						
(a)	2	(b)	4	(c)	6	(d)	8
27	The presence of dust particles in air serves						
(a)	As a nucleus to condense water vapour resulting in rain	(b)	To protect the inhabitants of the earth from the effects of ultra violet rays.	(c)	To minimize the inflammatory nature of oxygen	(d)	To maintain the average density of air
28	In the double displacement reaction between aqueous potassium iodide and aqueous lead nitrate, a yellow precipitate of lead iodide is formed. While performing the activity if lead nitrate is not available, which of the following can be used in place of lead nitrate?						
(a)	Lead sulphate	(b)	Lead acetate	(c)	Ammonium nitrate	(d)	Potassium sulphate
29	Formation of alkane by the action of Zn on alkyl halide is called						
(a)	Frankland`s reaction	(b)	Wurtz`s reaction	(c)	Cannizzaro`s reactions	(d)	Kolbe`s reactions
30	$C_{10}H_{22} + 900\ K \rightarrow C_4H_8 + C_6H_{14}$ Name the reaction						
(a)	Elimination	(b)	Addition	(c)	Pyrolysis	(d)	Isomerisation
31	In terms of acidic strength, which one of the following is in the correct increasing order						
(a)	Water < Acetic acid < Hydrochloric acid	(b)	Water < Hydrochloric acid < Acetic acid	(c)	Acetic acid < Water < Hydrochloric acid	(d)	Hydrochloric acid < Water < Acetic acid
32	Which of the following are exothermic processes? (i) Reaction of water with quick lime (ii) Dilution of an acid (iii) Evaporation of water (iv) Sublimation of camphor						
(a)	(i) and (ii)	(b)	(ii) and (iii)	(c)	(i) and (iv)	(d)	(ii) and (iv)
33	How many isotopes have odd atomic number?						
(a)	154	(b)	280	(c)	86	(d)	300
34	The major product formed by monobromination of methyl cyclopentane is						
(a)		(b)		(c)		(d)	
35	The reducing power of a metal depends on various factors. Suggest the factor which makes Li, the strongest reducing agent in aqueous solution						

(a)	Sublimation enthalpy	(b)	Ionisation enthalpy	(c)	Hydration enthalpy	(d)	Electron - gain enthalpy
36	Some of the group - 2 metal halides are covalent and soluble in organic solvents. Among the following metal halides, the one which is soluble in ethanol is						
(a)	$BeCl_2$	(b)	$MgCl_2$	(c)	$CaCl_2$	(d)	$SrCl_2$
37	When 0.5 mole of phosphoric acid is dissolved in aqueous solution how many moles of -ve and +ve ions are collected altogether?						
(a)	0.5	(b)	1	(c)	1.5	(d)	2
38	 In reaction A and B, respectively						
(a)	cis and trans but-2-ene	(b)	trans and cis but-2-ene	(c)	Both cis but-2-ene	(d)	Both trans but-2-ene
39	Dead burnt plaster is						
(a)	$CaSO_4$	(b)	$CaSO_4.H_2O$	(c)	$CaSO_4.1/2H_2O$	(d)	$CaSO_4.H_2O$
40	At 298 K temperature, if partial pressure of all given gases are same, then, which of the following gas possesses least solubility in water?						
(a)	Carbon dioxide	(b)	Formaldehyde	(c)	Methane	(d)	Vinyl chloride
41	Which of the following represents the given mode of hybridization sp^2-sp^2-sp-sp from left to right						
(a)		(b)		(c)		(d)	
42	When an electron is moving with velocity of 2.188×10^6 ms^{-1} in the first orbit of Bohr's model of hydrogen. The de Broglie wavelength of electron is						
(a)	0.33 nm	(b)	0.34 nm	(c)	0.35 nm	(d)	0.36 nm
43	Atomic number of Mn is 25. What is the electronic configuration in the ground state?						
(a)	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^7$	(b)	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 4p^5$	(c)	$1s^2 2s^2 2p^2 3s^2 3p^5 3d^{10}$	(d)	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^5$
44	The balanced chemical equation for the reaction which occurs when Be is added to water is_____?						
(a)	$Be + 2H_2O \rightarrow H_2 + Be(OH)_2$	(b)	$Be + H_2O \rightarrow H_2 + Be(OH)_2$	(c)	$Be + H_2O \rightarrow H_2 + [Be(OH)_4]$	(d)	No reaction
45	A compound (A) on heating gives a colorless gas and a residue that is dissolved in water to obtain (B). Excess of CO_2 is bubbled through aqueous solution of B, (C) is formed, which is recovered in the solid form. Solid (C) on gentle heating gives back (A). The compound is ...						
(a)	$CaCO_3$	(b)	K_2CO_3	(c)	Na_2CO_3	(d)	$CaSO_4.2H_2O$
46	Solubility of CaF_2 is 2.0×10^{-4} gdm^{-3} then K_{sp} of CaF_2 is_____?						
(a)	4.0×10^{-8}	(b)	3.2×10^{-11}	(c)	2.0×10^{-8}	(d)	4.0×10^{-12}
47	Consider the following comparisons of Alkali Metals and Alkaline Earth Metals: 1. While no Alkali Metal is found free in nature, some alkaline earth metals are found free in nature 2. While alkali metals are highly reactive, alkaline earth metals are moderately reactive Which among the above statements is / are correct?						
(a)	Only 1	(b)	Only 2	(c)	Both 1 & 2	(d)	Neither 1 nor 2
48	Which of the following alpha-emitter is commonly used in smoke detectors?						
(a)	Bismuth-209	(b)	Amrecium-231	(c)	Uranium-238	(d)	Protactinium-231
49	Which substance get oxidized in the reaction: $2Al + Cr_2O_3 \rightarrow Al_2O_3 + 2Cr$						
(a)	Al	(b)	Cr_2O_3	(c)	Al_2O_3	(d)	Cr
50	What is the oxidation no. of phosphorus in H_3PO_3, H_3PO_4, H_3PO_2 or phosphorus acid, phosphoric acid, phosphinic acid, respectively?						
(a)	+3, +5, +1	(b)	+3, +5, +2	(c)	+4, +5, +1	(d)	+2, +5, +1

51	$CH \equiv CH + O_3 \xrightarrow[196K]{CH_2Cl_2} X \xrightarrow{Zn/H_2O} Y$ End product Y is?						
(a)	$CH_3CH_2CH_2COOH$	(b)	$CH_3CH_2CH_2CHO$	(c)	$CH_3OCCOCH_3$	(d)	OHCCHO
52	How many of the following metals when heated in an atmosphere of N_2 gas form nitrides? Li, Na, K, Rb, Cs, Mg, Ca, Sr, Ba						
(a)	9	(b)	5	(c)	3	(d)	6
53	If ionic substances completely dissociate, then aqueous solution of which of the following substances having least freezing point?						
(a)	Glucose	(b)	NaCl	(c)	$Al_2(SO_4)_3$	(d)	$CaCl_2$
54	Which type of solution, moist air is						
(a)	Gas	(b)	Liquid	(c)	Solid	(d)	Colloidal
55	Which of the following oxidation no. does not possess by nitrogen in any of its compound?						
(a)	-1/3	(b)	-3	(c)	-4	(d)	+5
56	Which of the following is the component of most of the kidney stones						
(a)	$(COO)_2Ca$	(b)	$(COONa)_2$	(c)	$(COO)_2Ba$	(d)	$(COO)_2Mg$
57	Which substance is a reducing agent in the following reaction? Reaction : $2Al + Cr_2O_3 \rightarrow Al_2O_3 + 2Cr$						
(a)	Al	(b)	Cr_2O_3	(c)	Al_2O_3	(d)	Cr
58	What would be the formality of solution prepared by dissolving 9.48 g of Potash-alum in 5 L water? [M.W of Potash-alum = 948 g/mole]						
(a)	0.04 F	(b)	0.02 F	(c)	0.002 F	(d)	0.004 F
59	Radial nodes present in 3s and 2p-orbitals are respectively						
(a)	0, 2	(b)	2, 0	(c)	2, 1	(d)	1, 2
60	30 g of Mg and 30 g of O_2 are reacted and the residual mixure contains						
(a)	60 g of MgO only	(b)	40 g of MgO and 20 g of O_2	(c)	45 g of MgO and 15 g of O_2	(d)	50 g of MgO and 10 g of O_2
61	For a certain particle, it is found that uncertainty in velocity is reciprocal of uncertainty in position. This implies that						
(a)	Mass of the particle is > unity	(b)	Mass of the particle is unity	(c)	Mass of the particle $\leq h$	(d)	Mass of the particle $\geq h / 4\pi$
62	What would be the concentration in % w/v of aqueous solution in which 80 ml ethanol is dissolved in 4 L solution?						
(a)	4% v/v	(b)	10% v/v	(c)	2% v/v	(d)	8% v/v
63	What will be final weight of 286 g $Na_2CO_3 .10H_2O$ by heating at 373 K						
(a)	206 g	(b)	162 g	(c)	186 g	(d)	124 g
64	Naphthalene is soluble in ether or benzene due to						
(a)	Dipole-dipole attraction	(b)	Similar London forces	(c)	Hydrogen bond	(d)	Ionic attraction
65	Which would undergo S_N^2 reaction slow.						
(a)		(b)		(c)		(d)	a and b
66	For nucleophilic substitution bimolecure S_N^2 reaction give the correct order of reactivity.						
(a)	2° halide < 3° halide < 1° halide	(b)	3° halide < 2° halide < 1° halide	(c)	3° halide < 2° halide > 1° halide	(d)	1° halide <3° halide 2° halide
67	 gives which observation in Lucas test?						
(a)	Reaction not take place	(b)	Give colour layer	(c)	Oilly point on layer	(d)	Milky solution
68	Splitting of spectral lines under the influence of magnetic field is called						
(a)	Stark effect	(b)	Zeeman effect	(c)	Photoelectric effect	(d)	None of these

69	For which compound iodoform test is not possible						
(a)	C_2H_5OH	(b)	CH_3CHO	(c)		(d)	Benzophenone
70	How many enantiomer pairs are obtained by monochlorination of 2, 3-dimethyl butane?						
(a)	two	(b)	three	(c)	four	(d)	one

Part III: Chemistry-Descriptive Questions
[Max points 30: All questions carry equal points]

Question 1. What is the difference between a chemical process and a physical process in chemistry?

Question 2. Explain with the help of examples that a geometrical isomerism is different from conformation.

Question 3. Why propane is stored in household tanks but not natural gas?

Question 4. How will you separate a mixture of *o*-nitrophenol and *p*-nitrophenol?

----End of paper----