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-19, March 27, 2022

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. In multicellular organisms, similar cells are organized into groups, called:
   a) Organ b) Organ system c) Tissues d) Individual
2. The process by which one diploid cell divides to generate four haploid daughter cells is called:
   a) Mitosis b) Prophase c) Meiosis d) Anaphase
3. Red blood cells are also called erythrocytes and transport
   a) nerve impulse b) oxygen c) water d) food
4. A series of hypothesis supported by the results of many tests is called
   a) Scientific law b) Theory c) Data d) Deduction
5. Artificial cleaning of blood is known as:
   a)Dialysis b) Diabetes c) Lithotripsy d) Both a & b

OR

COMPUTER

1. All the instructions from the users and various softwares are carried out by the _____.
   a) ALU b) MU c) CPU d) DVD
2. In a multi-button mouse, one button must be designated as the _____ button.
   a) first b) left c) primary d) user
3. Memory that loses its data when power is turned off is considered _____ memory.
   a) static b) volatile c) dynamic d) refreshed
4. The more _____ a processor has, the more powerful it is.
   a) microns b) transistors c) connections d) neurons
5. This _____ cache holds the most recently used data or instructions.
   a) L1 b) L2 c) L3 d) L4

CHEMISTRY

6. Which acid is present in vinegar?
   a) Acetic Acid b) Formic Acid c) Oxalic Acid d) Hydro Chloric Acid

7. Which metal exist in fluid form at standard temperature and pressure conditions?
   a) Mercury b) Bromine c) Sodium d) Calcium

8. Which one is not the contribution of Dalton in Chemistry?
   a) Atomic theory b) Dalton Law c) Law of multiple proportion d) Law of conservation of mass

9 What is the empirical formula of Urea?
   a) CH_4ON_2 b) $C_3H_4NO_3$ (c) CH_3NO_2 d) $C_6H_5NO_2$

10. Which vitamin is known as ascorbic acid?
   a) Vitamin A b) Vitamin B c) Vitamin C d) Vitamin D

MATHEMATICS

11. If $a * b = a-b+ab$, then $2 * 5 + 5 * 2$ is
   a) 14 b) 16 c) 20 d) none of these

12. Which of the fractions below is closest to 1?
   a) 8/7 b) 9/10 c) 10/11 d) 11/10

13. $6^2 + |6| + |-6| - 6^2$ is equal to
   a) -6 b) 0 c) 6 d) 12

14. $\frac{5^5}{5^4}$ is equal to
   a) 1 b) 5 c) 25 d) 125

15. $(a^m)^n =$
   a) $a^m n$ b) a^{m+n} c) a^{mn} d) None of these

PHYSICS

16. Which is a derived unit?
   a) meter b) second c) kilogram d) newton

17. A boy weighing 500 newtons takes 50. Seconds to climb a flight of stairs 18 meters high. His power output vertically is
   a) 9,000 W b) 4,000 W c) 1,400 W d) 180 W

18. Which net charge could be found on an object?
   a) $+3.2\times 10^{-18}$ C b) -1.8×10^{-18} C c) $+2.4\times 10^{-19}$ C d) -0.80×10^{-19} C

19. Compared to insulators, metals are better conductors of electricity because metals contain more free
   a) protons b) electrons c) positive ions d) negative ions

20. Which two quantities are measured in the same units
   a) momentum and work b) energy and power
   c) mechanical energy and heat d) work and power

PART II – CHEMISTRY

21. Which of the following property is **not** the characteristic of dilute HCL?
    (a) It reacts with Zn and gas is evolved.
    (b) If reacts with solid Sodium carbonate to give brisk effervescence.
    (c) It turns blue litmus paper red.
    (d) It turns red litmus paper blue.

22. Which acid is found in bee string?
    (a) Formic Acid (b) Citric Acid (c) Oxalic Acid (d) Tartaric Acid

23. Which process is used to produce baking soda?
    (a) Soda Process (b) Chlor-Alkali process (c) Solvary Process (d) None of these

24. A balances chemical equation always obeys.
    (a) Law of conservation of energy (b) Law of thermal equilibrium
    (c) Law of conservation of mass (d) All these laws

25. Which isotope is used in nuclear reactor to generate electricity?
    (a) C-60 (b) U-235 (c) Na-24 (d) C-13

26. The percentage of Nitrogen in urea is:
    (a) 86 (b) 66 (c) 46 (d) 26

27. How much volume of oxygen at STP in liter is required to completely burn 8g of methane gas?
    (a) 44.8 (b) 22.4 (c) 11.2 (d) 5.6

28. Which element has the same oxidation state in all of its compounds?
    (a) Hydrogen (b) Carbon (c) Oxygen (d) Fluorine

29. The elements of group 16 are also known as:
    (a) Halogens (b) Chalcogens (c) Noble gas (d) ericogens

30. The oxidation reaction is
    (a) Loss of electron (b) Removal of the hydrogen atom
    (c) Addition of an oxygen atom (d) All of the above

31. What is the color of the flame test for sodium?
    (a) Green (b) Yellow (c) Red (d) Violet

32. Acetic acid was added into a solid "S" kept in test tube. A colorless and odorless gas "G" was evolved which turn lime water milky. It was concluded that:
    (a) Solid "S" is sodium acetate and the gas "G" is CO_2
    (b) Solid "S" is sodium bicarbonate and the gas "G" is SO_2
    (c) Solid "S" is sodium hydroxide and the gas "G" is CO_2
    (d) Solid "S" is sodium bicarbonate and the gas "G" is CO_2

33. The numbers of single and double bonds present in benzene are:
    (a) 9 and 6 (b) 9 and 3 (c) 3 and 3 (d) 3 and 9

34. Which of the following is **not** endothermic process?
    (a) Evaporation of water (b) Sublimation of iodine
    (c) Dilution of an acid (d) Melting of ice

35. Which gas is used to fill the plastic bags containing potato chips?
(a) Hydrogen b) Nitrogen (c) Oxygen d) Chlorine

36. Which allotropic form of carbon is a good conductor of heat and electricity?
(a) Graphite (b) Diamond (c) Charcoal (d) None of these

37. Which formula represents bleaching powder?
(a) CaO (b) $CaCl_2$ (c) $Ca(OCl)_2$ (d) $Ca(OH)_2$

38. Fatty acid become rancid due to the process of
(a) Reduction (b) Oxidation (c) Corrosion (d) Decomposition

39. The oxides of metalloids are _____ in nature.
(a) Basic (b) Acidic (c) Neutral (d) Amphoteric

40. Which of the following is **not** a standard condition?
(a) 298K (b) 100 kPa
(c) 100 atm (d) 1 mol dm^{-3} solutions

41. Elements with more than 57 electrons require
(a) f-orbital (b) d-orbital (c) p-orbital (d) s-orbital

42. The decrease in the force of attraction is due to the increase in the
(a) distance only (b) shielding effect only
(c) number of electrons (d) distance and shielding effect

43. The chemical reaction between carbonyl compounds and DNPH is an example of
(a) Condensation reaction (b) Substitution reaction
(c) Addition reaction (d) Elimination reaction

44. In electrolysis of aqueous Copper(II) Sulfate ($CuSO_4$) with Carbon (C) electrode,
(a) oxygen gas is given off at anode (b) Sulfur dioxide is given off at anode
(c) oxygen gas is given off at cathode (d) Sulfur dioxide is given off at cathode

45. The correct order of increasing nucleophilicity is
(a) $Cl^- < Br^- < I^-$ (b) $Br^- < Cl^- < I^-$ (c) $I^- < Br^- < Cl^-$ (d) $I^- < Cl^- < Br^-$

46. The incorrect statement about mineral acid is
(a) They have simpler molecular structure (b) They are more corrosive
(c) They are commonly found in nature (d) They are man made

47. Which among the following reagent can be used to distinguish between $CH_2BrCH=CH_2$ from $CH_3CH=CHBr$?
(a) Br_2/CCl_4 (b) cold $KMnO_4$ (c) $AgNO_3/C_2H_5OH$ (d) $Ag(NH_3)_2OH$

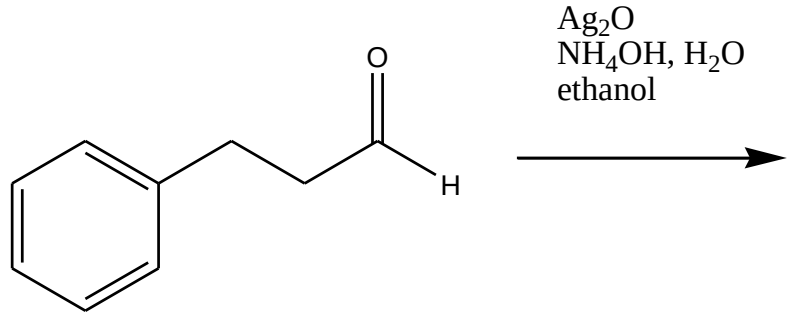
48. Depletion of the ozone layer is caused due to:
(a) Ferrocene (b) Fullerenes (c) Freons (d) Grephene

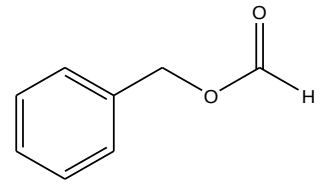
49. Find the volume of O2 required to burn 1 L of propane completely, measured at 0℃ temperature and 1 atm pressure:
(a) 10 L (b) 7 L (c) 6 L (d) 5 L

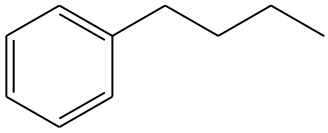
50. Why do we boil the extract with conc. HNO_3 in Lassaigne's test for halogens?
(a) to increase the concentration of NO_3^- ions (b) to increase the solubility product of AgCl
(c) it increases the precipitation of AgCl (d) for the decomposition of Na_2S and NaCN formed

51. The solution which is used to detect the presence of aldehyde or ketone is:
(a) 2,4-dinitrophenylhydrazine (b) benzene solution
(c) Tollen's reagent (d) none of above

52. Which of the following is the major organic product obtained from the following reaction?



(a)


(b)


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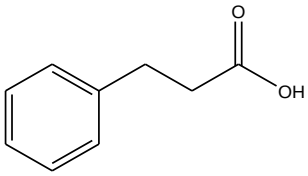
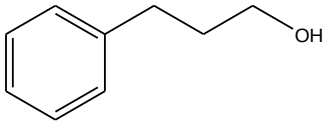


(d)


53. When dichromate (VI) ion becomes reduced to chromium (III) ion, a change of color occurs from
(a) purple to pink (b) purple to colorless
(c) orange to purple (d) orange to green

54. A container has an equal mass of H_2, O_2 and CH_4 at 27℃, the ratio of their volume is

(a) 16:8:1 (b) 8:1:2 (c) 16:1:2 (d) 8:16:1

55. What is the molecular weight of Potash alum?
(a) 458 g/mol (b) 216 g/mol (c) 474 g/mol (d) 356 g/mol

56. When a small number of acids or bases are added to zwitterion ion, it resists a change in:
(a) temperature b) volatility (c) polarity (d) pH

57. A mixture of low boiling hydrocarbons is called
(a) coal (b) petroleum (c) natural gas (d) Liquid Petroleum Gas (LPG)

58. Which of the following is widely used in the oxy-acetylene welding and cutting metals?
(a) ethylene (b) acetylene (c) phenol (d) methanol

59. If graphite (C) is used as an electrode in the presence of concentrated Hydrochloric Acid (HCl), at the anode
(a) chlorine gas is produced (b) oxygen gas is produced
(c) hydrogen gas is produced (d) hydrogen chloride is produced

60. Process in which coal is heated in the absence of air at high temperature and converted into coal gas, coal tar, and coke is called
(a) Destructive distillation (b) Distillation (c) Burning of coal (d) Burning of oxygen

61. To conduct electricity, the ionic metals shall be
(a) Dissolved in water (b) Finely grinded (c) In molten form (d) On ionic lattice

62. What is true about impurities?
(a) They lower the boiling point (b) They lower the freezing point
(c) The lower the melting point (d) They raise the melting point

63. If the nucleon (mass) and proton (atomic) number is 40 and 20 respectively, the element is?
(a) Chlorine (b) Phosphorous (c) Potassium (d) Calcium

64. All of these radicals have a valency of 2, except
(a) SO_4 (b) CO_3 (c) NH_4 (d) $MgCO_3$

65. Valency of plumbum can be
(a) 2 or 4 (b) 4 or 6 (c) 3 or 5 (d) 2 or 3

66. Give that a certain organic compounds absorbs light in the visible region, it CANNOT be true that it
(a) is aromatic (b) is an alkane (c) is colored (d) contains a nitro group

67. Rank the following forces from weakest to strongest between two elementary particles: gravitational / covalent / London dispersion / nuclear
(a) nuclear < London < covalent < gravitational (b) nuclear < covalent < London < gravitational
(c) nuclear < gravitational < covalent < London (d) gravitational < London < covalent < nuclear

68. 0.36 moles of each aluminium and oxygen react with each other to produce aluminium oxide. The amount of product formed is
(a) 0.18 mole (b) 0.27 mole (c) 0.24 mole (d) 0.09 mole

69. Which substance has the highest percentage by mass of Nitrogen?
(a) NH_4NO_3 $M_r=80$ (b) $(NH_4)_2SO_4$ $M_r=132$
(c) $CO(NH_2)_2$ $M_r=60$ (d) $(NH_4)_3PO_4$ $M_r=149$

70. Suppose the entropy of a system increases with increase in some parameter X. What will be the effect on entropy at equilibrium state of the system, when the parameter will be decreased?
(a) the entropy decrease
(b) the entropy increase
(c) the entropy remains constant
(d) Condition is wrong, entropy does not change with any parameter.

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

Question 1. What are the two tests to distinguish between glucose and fructose?

Question 2. How does the half-life period depend on the initial concentration in the case of reactions of the first and nth order?

Question 3. What does acetic acid and sodium acetate form?

Question 4. Why Carboxylic is acidic?

----End of paper----