Please read all instructions carefully before you attempt the questions.

1. Write your FULL NAME and REFERENCE CODE in block letters on this page and also fill-in all details on the ANSWER SHEET.

2. The Answer Sheet is machine-readable. Please read the instructions on the reverse of the answer sheet before you start filling it up. Only use HB pencils to fill-in the answer sheet.

3. Indicate your ANSWER ON-THE ANSWER SHEET by blackening the appropriate circle for each question. **Do not mark more than one circle for any question**; this will be treated as a wrong answer.

4. This is a multiple choice question paper with one section having a total of 40 questions. Each correct answer will get you 3 marks. Every wrong answer will get you -1 mark. Marks are not awarded or deducted when a question is not attempted. **It is better not to answer a question if you are not sure.**

5. We advise you to first mark the correct answers in the QUESTION SHEET and then to TRANSFER these to the ANSWER SHEET only when you are sure of your choice.

6. Rough work may be done on blank pages of the question paper. If needed, you may ask for extra rough sheets from an Invigilator. Do not scribble or do rough work on the reverse of your hall ticket. If found, the hall ticket will be retained.

7. Use of calculators is permitted. Calculator which plots graphs is NOT allowed.

8. Do NOT ask for clarifications from the invigilators regarding the questions. They have been instructed not to respond to any such inquiries from candidates. In case a correction/clarification is deemed necessary, the invigilator(s) will announce it publicly.

9. This set of question paper must be returned along with your answer sheet and all extra rough sheets used.
SOME USEFUL DATA

Avogadro number = $6.02 \times 10^{23}$ mol$^{-1}$

$RT/F = 0.0257$ V at 25°C

Faraday = 96500 C/eq. wt.

Boltzmann constant $k = 1.38 \times 10^{-23}$ J K$^{-1}$

Mass of an electron = $9.109 \times 10^{-31}$ kg

$e = 1.6 \times 10^{-19}$ C

$h = 6.626 \times 10^{-34}$ J·s

$c = 3 \times 10^8$ ms$^{-1}$

Standard reduction potential of Cu$^{2+} + 2e^- \leftrightarrow$ Cu: +0.34 V at 25°C

Standard reduction potential of Ag$^+$ + e$^- \leftrightarrow$ Ag: +0.80 V at 25°C

$K_b$ for NH$_3$ = $1.8 \times 10^{-5}$

<table>
<thead>
<tr>
<th>Metal</th>
<th>Atomic radius</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>1.31 A</td>
</tr>
<tr>
<td>Mo</td>
<td>1.36 A</td>
</tr>
<tr>
<td>Na</td>
<td>1.86 A</td>
</tr>
</tbody>
</table>

$S = k \ln W$

1. What is [H$^+$] in 1.0 L solution that contains 0.2 M of NH$_4$Cl?
   a) $1.1 \times 10^{-5}$ M
   b) $1.9 \times 10^{-3}$ M
   c) $1.8 \times 10^{-5}$ M
   d) Not solvable with the information given

2. It is not easy to locate H atoms in the structure of proteins obtained by X-ray diffraction due to which of the following reasons:
   a) H atoms are transparent to the X-rays.
   b) H-bonding interaction present in protein structures.
   c) Interaction of H with solvent molecules.
   d) Very low levels of scattering of X-rays by H.

3. Glucose and galactose (found in the human body) are related to each other as:
   a) Enantiomers
   b) Anomers
   c) Epimers
   d) L-sugars
4. Consider the formation of MgO (s). Assume that $\Delta H_r^*$ and $\Delta S_r^*$ are independent of temperature.

$$\text{Mg (s) + } \frac{1}{2} \text{O}_2 (\text{g}) \rightarrow \text{MgO(s)}$$

$$\Delta H_r^* = -602 \text{ kJ/mol}$$
$$\Delta S_r^* = -108 \text{ J/K*mol}$$

Calculate $\Delta G_r^*$ for the formation of MgO (s) at 0 °C and is the reaction spontaneous or non-spontaneous at 0 °C?

a) $-573 \text{ kJ/mol}$, non-spontaneous
b) $-573 \text{ kJ/mol}$, spontaneous
c) $632 \text{ kJ/mol}$, non-spontaneous
d) $-632 \text{ kJ/mol}$, spontaneous

5. Rank the following molecules in order of electrophilicity (from most to least electrophilic):

\[
\begin{array}{cccc}
\text{Me} & \text{NCH}_3 & \text{Me} & \text{O} \\
\text{Me} & \text{O} & \text{O} & \text{O} \\
\text{Cl} & \text{CH}_3 & \text{SCH}_3 & \text{CH}_3 \\
\end{array}
\]

i, ii, iii, iv

a) $\text{i > ii > iv > i}$
b) $\text{i > iv > iii > ii}$
c) $\text{ii > iv > iii > i}$
d) $\text{i > iii > iv > ii}$

6. Which of the following transitions is the highest energy transition in any given organic molecule?

a) n to $\sigma^*$
b) n to $\pi^*$
c) $\sigma$ to $\sigma^*$
d) $\pi$ to $\pi^*$

7. How many absorption lines will the following naturally occurring compound have in its proton- decoupled $^{13}$C NMR spectrum?

\[
\begin{array}{c}
\text{H}_3\text{C} \quad \text{C} \equiv \text{C} \quad \text{CH}_2\text{CH}_3 \\
\text{H}_3\text{C} \quad \text{H} \\
\end{array}
\]

a) 3
b) 4
c) 5
d) 6
8. What would be the final major product of the following chemical reaction if it is carried out twice, once at 5 °C and the second time at 45 °C?

\[
\begin{align*}
\text{H}_3\text{C} & \quad \text{CH} \\
\text{H}_3\text{C} & \quad \text{CH} \\
\text{OH}^{-} & \quad \text{H}_2\text{O} \quad \rightarrow \\
\end{align*}
\]

a) \[
\begin{align*}
\text{H}_2\text{C} & \quad \text{CH} \\
\text{at both the temperatures.}
\end{align*}
\]

b) \[
\begin{align*}
\text{H}_3\text{C} & \quad \text{C} \quad \text{C} \quad \text{OH} \quad \text{O} \\
\text{at 5 °C and} \\
\text{H}_3\text{C} & \quad \text{C} \quad \text{C} \quad \text{CH} \\
\text{at 45 °C.}
\end{align*}
\]

c) \[
\begin{align*}
\text{H}_3\text{C} & \quad \text{C} \quad \text{C} \quad \text{CH} \\
\text{at 5 °C and} \\
\text{H}_3\text{C} & \quad \text{C} \quad \text{C} \quad \text{OH} \quad \text{O} \\
\text{at 45 °C.}
\end{align*}
\]

d) \[
\begin{align*}
\text{H}_3\text{C} & \quad \text{C} \quad \text{C} \quad \text{OH}^{-} \quad \text{O} \\
\text{at 5 °C and} \\
\text{H}_3\text{C} & \quad \text{C} \quad \text{C} \quad \text{CH} \\
\text{at 45 °C.}
\end{align*}
\]
9. 0.1 M solution of a compound transmits 10% of the incident light. Another solution of the same compound transmits 1% of the incident light of the same wavelength in the same container. Calculate concentration of the solution.

a) 0.02 M  
b) 0.20 M  
c) 0.21 M  
d) 0.11 M

10. A polypeptide chain has six -SH groups. Any two SH groups can combine to give a disulphide (-S-S-) bond. If such combinations are allowed to take place randomly, how many different protein structures can be formed?

a) 12  
b) 15  
c) 30  
d) 36

11. Consider the following reaction carried out in presence of catalyst, C:

\[ aA + bB \rightarrow dD + eE \]

The rate law for this reaction is

\[ \text{rate} = k [A]^q[B]^r[C]^s \]

Which of the following statements is false?

a) The exponents q, r and s are often integers.  
b) The overall reaction order is q + r + s.  
c) The exponents q and r are always equal to the coefficients a and b, respectively.  
d) The exponents must be determined experimentally.

12. The crystal lattice structure of sodium, vanadium and molybdenum is BCC (Body centered cubic). Which of the following metallic mixtures are most likely to form a solid solution?

a) V and Mo  
b) V and Na  
c) Mo and Na  
d) Na, V, Mo
13. FBCE is a rectangle. ABCD is a square in it with length of each side being of unit length. If AX has length of \( x \) units then the length of FA is given by

\[
F \quad A \quad x \quad X \quad B
\]

\[
E \quad D \quad 1 \quad C
\]

\begin{align*}
a) & \quad 2(1-x) \\
b) & \quad \frac{x}{1-x} \\
c) & \quad \frac{1}{4x^2} \\
d) & \quad \frac{2x^2}{(1-x)}
\end{align*}

14. At 1000\(^\circ\)K for the following two equilibria, the representative \( K_p \) values are given:

(i) \( \text{CaCO}_3 \leftrightarrow \text{CaO} + \text{CO}_2 \) \hspace{1cm} \( K_p = 4.0 \times 10^{-2} \text{ atm} \)

(ii) \( \text{C} + \text{CO}_2 \leftrightarrow 2 \text{ CO} \) \hspace{1cm} \( K_p = 2.0 \text{ atm} \)

Solid Carbon (C), CaO, CaCO\(_3\) are mixed and allowed to attain equilibrium at 1000 \(^\circ\)K. What is the pressure of CO achieved at equilibrium?

\begin{align*}
a) & \quad 0.56 \text{ atm} \\
b) & \quad 0.08 \text{ atm} \\
c) & \quad 2.8 \text{ atm} \\
d) & \quad 0.28 \text{ atm}
\end{align*}
15. Assume that a Carnot engine is working in reverse in a refrigerator, with perfect thermodynamic efficiency. Calculate the amount of work needed (i) to freeze 100 g of water at 0 °C, the temperature of the surrounding being 25 °C; (ii) to withdraw the same amount of heat from a body at 10^-5 K, the surrounding being at 1 K. \( \Delta H_{\text{melt}} = 6.01 \text{ kJ/mol} \)

a) (i) 601 kJ; (ii) 601 kJ
b) (i) 33.4 kJ; (ii) 33.4 kJ
c) (i) 3.06 kJ; (ii) 33.4 kJ
d) (i) 3.06 kJ; (ii) 33.4 \times 10^5 kJ

16. What is the empirical formula for the following unit cell:

![Unit Cell Diagram]

a) CaTi_{12}O_8
b) CaTiO_12
c) CaTiO_3
d) CaTi_2O_3

17. Which of the parallelograms in the figure below are viable unit cells?

![Parallelograms Diagram]

a) i
b) ii
C) iii
d) all of the above
18. The following reaction is at equilibrium in a cylinder fitted with a movable plunger.

\[ \text{N}_2\text{O}_4(\text{g}) \leftrightarrow 2 \text{NO}_2(\text{g}) \]

If the volume is decreased at constant temperature by moving the plunger, will the **concentration** of \( \text{NO}_2(\text{g}) \) be higher or lower than the original concentration when the equilibrium is re-established?

a) The concentration of \( \text{NO}_2 \) will decrease, as Le Chatelier principle predicts that the equilibrium must shift so as to oppose/minimize/relieve the total pressure.

b) The concentration of \( \text{NO}_2 \) will increase.

c) The concentration of \( \text{NO}_2 \) will decrease. If the volume is decreased, the equilibrium must shift to produce fewer molecules. Thus the equilibrium must shift to the left.

d) The change in the concentration of \( \text{NO}_2 \) is not certain. Le Chatelier principle predicts that the equilibrium must shift to the left to minimize the total pressure. However, the volume has decreased, so the number of \( \text{NO}_2 \) molecules must also decrease, making it difficult to say whether the concentration of \( \text{NO}_2 \) would decrease or increase.

19. To a green solution of \( \text{Ni(H}_2\text{O)}_6^{2+} \), a small quantity of ammonia was added, which turned the solution blue through formation of \( \text{Ni(NH}_3)_6^{2+} \). The value of the equilibrium constant \( K \) for this reaction is \( \sim 10^9 \). To this blue solution, the same number of moles of a chelating ligand ethylenediamine (en) were added, turning the solution violet through formation of \( \text{Ni(en)}_3^{2+} \). The value of \( K \) for this reaction is also \( \sim 10^9 \). Using these same quantities, what would happen if en was added first, then ammonia was added?

a) The violet solution would turn blue.

b) The violet solution would stay violet.

c) There will be an equimolar mixture of \( \text{Ni(NH}_3)_6^{2+} \) and \( \text{Ni(en)}_3^{2+} \), giving the solution a colour which is an intermediate between blue and violet.

d) The question cannot be answered without knowing the concentrations and the volumes of all the reactants.

20. In a mass spectrum of bromine molecule shows three peaks due to the species \( \text{Br}_2^+ \) with the mass numbers 158, 160 and 162. Which isotopes of bromine occur in nature?

a) \( ^{79}\text{Br} \) and \( ^{81}\text{Br} \)

b) \( ^{80}\text{Br} \) and \( ^{81}\text{Br} \)

c) \( ^{79}\text{Br} \) and \( ^{81}\text{Br} \)

d) \( ^{79}\text{Br}, ^{80}\text{Br}, \) and \( ^{81}\text{Br} \)
21. Two 120-cm long test tubes are filled with mercury and then placed in a mercury reservoir in an inverted position, as shown below. The height of the test tubes above the mercury pool is 100 cm. Syringes are used to bring drops of H₂O and ethanol to the top of columns of Hg, as shown below. Drops are added till a small amount of water or alcohol is seen at the top of the Hg column. What will happen to the heights of the Hg columns after the addition? The experiment is done at normal temperature and pressure.

![Diagram](image)

a) Both column heights will be the same.
b) The column below H₂O is shorter.
c) The column below EtOH is shorter.
d) The column that has more number of drops will be shorter.

22. Scanning tunneling microscopy depends upon the flow of electricity (current) between a surface and an atomically-sharp probe tip. Two plots of current vs. tip-to-surface distance are shown below. Which one is correct?

![Diagram](image)

a) A  
b) B  
c) If the tip is more conducting than the surface, then the answer is A. Otherwise, the answer is B.  
d) Insufficient information is given to answer the question.
23. For each set of compounds below, choose the one in which the indicated hydrogen is farthest upfield in a proton NMR spectrum:

A

\[
\begin{align*}
1 & \quad \text{Nitro} \\
2 & \quad \text{O-Methyl} \\
3 & \quad \text{O-Ethyl}
\end{align*}
\]

B

\[
\begin{align*}
1 & \quad \text{CH}_3\text{CH}_3 \\
2 & \quad \text{CH}_3\text{OCH}_2\text{CH}_3 \\
3 & \quad \text{H}_3\text{C} \quad \text{O} \quad \text{C} \\
4 & \quad \text{O} \quad \text{C} \quad \text{CH}_3
\end{align*}
\]

C

\[
\begin{align*}
1 & \quad \text{H}_2\text{C} = \text{CH}_2 \\
2 & \quad \text{H} \quad \text{C} = \text{C} \quad \text{H} \\
3 & \quad \text{O} \quad \text{C} \quad \text{C} \quad \text{H} \quad \text{H}
\end{align*}
\]

a) A3 or A4, B4, C1
b) A1, B2, C3
c) A2, B3, C2
d) A4, B1, C1

24. Consider the following two infinite series:

\[
A = \sum_{n=0}^{\infty} (-1)^n \frac{x^{2n+1}}{(2n+1)!} \quad B = \sum_{n=0}^{\infty} (-1)^n \frac{x^{2n}}{(2n)!}, \text{ where } x \text{ is real}
\]

What is the value of \(A^2 + B^2\) ?

a) 0
b) +\(\infty\)
c) 1
d) Its value cannot be defined, as the series \(A\) and \(B\) are divergent.

25. Four separate solutions are present in separate containers: HCl, NaOH, CH₃COOH, and CH₃COOK. What possible pairs can be used to make a buffer solution?

a) HCl and CH₃COOK
b) NaOH and CH₃COOH
c) CH₃COOH and CH₃COOK
d) All of the above
26. It is well known that the structure of ethylene \((\text{CH}_2=\text{CH}_2)\) is planar. Hence, what would be the structure of allene \((\text{CH}_2=\text{C}=\text{CH}_2)\) and cumulene \((\text{CH}_2=\text{C}=\text{C}=\text{CH}_2)\)?

a) Both will be planar  
b) Both will be staggered  
c) Allene will be planar, and cumulene will be staggered  
d) Allene will be staggered, and cumulene will be planar

27. In the \(T_2\) molecule \(\text{MX}_4\), the \(A_1\) vibrational mode corresponds to all the M-X bonds stretching the same distance simultaneously. With which spectroscopic technique is this vibrational mode observable?

![Diagram of M-X bonds]

a) IR  
b) Raman  
c) Neither  
d) Both

28. An organic molecule \(\text{A}\) on photoexcitation goes to \(^1\text{A}^*\). Its various decay channels are shown below. You measure the concentration of \(^3\text{A}^*\) as a function of time using a fast-response spectrometer, in order to determine the intersystem crossing rate constant \(k_{\text{ISC}}\). Assume that the lifetime of \(^3\text{A}^*\) is very long compared to the other kinetic processes shown there. Which of the following statements would be true for this experiment?

![Diagram of decay channels]

a) The decay of \(^1\text{A}^*\) will be multi-exponential.  
b) The formation of \(^3\text{A}^*\) will be single exponential.  
c) Plotting the concentration of \([^3\text{A}^*]\) as a function of time, and fitting it to a single exponential will not give \(k_{\text{ISC}}\).  
d) Both (B) and (C) above.
29. Consider the four sulphates FeSO$_4$, MnSO$_4$, CoSO$_4$, ZnSO$_4$. Four separate capsules of these materials have been made containing 0.1 mole of the substance and are suspended separately by a thread. Then a strong magnet is brought close to each capsule. Order these sulphates according to the strength of the response that the magnet will produce on these capsules.

a) MnSO$_4$ > FeSO$_4$ > CoSO$_4$ > ZnSO$_4$

b) FeSO$_4$ > MnSO$_4$ > CoSO$_4$ > ZnSO$_4$

c) ZnSO$_4$ > CoSO$_4$ > FeSO$_4$ > MnSO$_4$

d) CoSO$_4$ > FeSO$_4$ > MnSO$_4$ > ZnSO$_4$

30. N$_2$O$_5$ (g) and NO (g) react to form NO$_2$ according to the stoichiometric equation

\[
\text{N}_2\text{O}_5 (g) + \text{NO} (g) \rightarrow 3\text{NO}_2 (g) \quad \text{(R1)}
\]

at a given temperature and pressure. A possible mechanism for this overall reaction is:

\[
\text{N}_2\text{O}_5 \rightarrow^{k_1} \text{NO}_2 + \text{NO}_3 \quad \text{(M1)}
\]

\[
\text{NO}_2 + \text{NO}_3 \rightarrow^{k_2} \text{N}_2\text{O}_5 \quad \text{(M2)}
\]

\[
\text{NO}_3 + \text{NO} \rightarrow^{k_3} 2\text{NO}_2 \quad \text{(M3)}
\]

where NO$_3$ is an unstable intermediate. What would be the rate expression of the disappearance of N$_2$O$_5$ in terms of the concentrations of the stable species and the rate constants given above?

a) The mechanism given above is not correct since the resultant of the reaction M1+M2+M3 is not the original reaction R1.

b) \[
\frac{d}{dt}[\text{N}_2\text{O}_5] = k_1[\text{N}_2\text{O}_5]\left(1 - \frac{k_2[\text{NO}_2]}{k_2[\text{NO}_2] + k_3[\text{NO}]}ight)
\]

c) \[
\frac{d}{dt}[\text{N}_2\text{O}_5] = k_{\text{eff}}[\text{N}_2\text{O}_5][\text{NO}], \text{ where } k_{\text{eff}} \text{ is some function of } k_1, k_2, \text{ and } k_3.
\]

d) \[
\frac{d}{dt}[\text{N}_2\text{O}_5] = k_1[\text{N}_2\text{O}_5]\left(1 + \frac{k_2[\text{NO}_2]}{k_2[\text{NO}_2] + k_3[\text{NO}]}ight)
\]

31. For a cell constructed with a Cu (s) | Cu$^{2+}$ (aq) anode and Ag$^+$ (aq) | Ag (s) cathode at 25.0°C, Calculate the cell potential at 25.0 °C under non-standard conditions: [Cu$^{2+}$] = 0.300 M and [Ag$^+$] = 0.0500 M.

a) 0.44 V

b) 0.41 V

c) 0.40 V

d) 0.34 V
32. Photo-excitation promotes an electron from the HOMO (highest occupied molecular orbital) to the LUMO (lowest unoccupied molecular orbital) of a molecule. Between a molecule in its ground state and its excited state, which would be the stronger oxidant and the stronger reductant?

a) The molecule in its ground state would be a stronger oxidant and also a stronger reductant.

b) The molecule in its excited state would be a stronger oxidant and also a stronger reductant.

c) The molecule in its ground would be a stronger oxidant, and in the excited state, a stronger reductant.

d) The molecule in its ground state would be a stronger reductant, and in the excited state, a stronger oxidant.

33. The stretching frequency of the O–H is about 3600 cm\(^{-1}\). Compared to that, the stretching frequencies of O–D and S–H bonds are very similar and appear at about 2500 cm\(^{-1}\). What can you conclude from these data?

a) The electronic structure of O–D and O–H are same, and that of S–H is different.

b) The force constant of the bonds O–D and O–H is same.

c) S–H is a weaker bond than O–H or O–D bond.

d) All of the above.

34. Read the following two statements carefully:

i) The change in total angular momentum that occurs when a diatomic molecule (i.e. a rigid rotor) changes rotational level from \(J = 2\) to \(J = 3\) is the same as the change in total angular momentum that occurs when an electron on a H atom changes from a \(d\) to an \(f\) orbital, i.e. from \(l = 2\) to \(l = 3\).

ii) The change in energy that occurs when a diatomic molecule (i.e. a rigid rotor) changes rotational level from \(J = 2\) to \(J = 3\) is the same as the change in energy that occurs when an electron on a H atom changes from a \(d\) to an \(f\) orbital, i.e. from \(l = 2\) to \(l = 3\).

Based on the above, which of the following is the correct statement:

a) Both statements i and ii are true.

b) Both statements i and ii are false.

c) Statement i is true, statement ii is false.

d) Statement i is false, and statement ii is true.
35. At room temperature, which of the molecules are expected to give five NMR lines in the proton-decoupled $^{13}$C NMR spectrum?

![Molecules](image)

a) Only i and iii  
b) Only ii and vi  
c) Only iii and vi  
d) All of the above

36. Do you expect that the minimum energy necessary to eject a 3s electron from phosphorus in a photoelectron spectroscopy experiment for the process

$$[\text{Ne}]3s^23p^3 \rightarrow [\text{Ne}] 3s^13p^3 + e^-,$$

be larger than, smaller than, or the same as the 4th ionization energy (IE$_4$) of phosphorus?

a) Smaller  
b) Larger  
c) The same  
d) Cannot be answered from the given information
37. An average human DNA molecule has $5 \times 10^8$ base pairs, with four different kinds of bases. If the DNA sequence was completely random, what would be the residual entropy associated with this typical DNA molecule?

a) $9.57 \times 10^{-15}$ J K$^{-1}$
b) $4.15 \times 10^{-15}$ J K$^{-1}$
c) $6.90 \times 10^{-15}$ J K$^{-1}$
d) $1.38 \times 10^{-14}$ J K$^{-1}$

38. Consider the two diatomic molecules CN and CN$^-$, and the potential energy diagram shown below.

![Potential Energy Diagram]

Which of the following is the correct statement?

a) Bond order of CN is 2.5 and the curve Y corresponds to CN$^-$.
b) Bond order of CN is 3 and the curve X corresponds to CN$^-$. 
c) Bond order of CN$^-$ is 3 and the curve Y corresponds to CN$^-$. 
d) Bond order of CN$^-$ is 2.5 and the curve X corresponds to CN$^-$. 
39. Consider the following two matrices:

\[
A = \begin{pmatrix} 7 & 0 & 0 \\ 0 & 1 & -i \\ 0 & i & -1 \end{pmatrix} \quad \text{and} \quad B = \begin{pmatrix} 1 & 0 & 3 \\ 0 & 2i & 0 \\ i & 0 & -5i \end{pmatrix}
\]

What is the value of \( \text{Tr}(A, B) \), where \( \text{Tr} \) means the trace of a matrix?

a) 0  
b) The trace will be a real number, less than 0  
c) The trace will be a real number, greater than 0  
d) The trace will be a complex number.

40. In valence-bond calculations, contributions of various resonance structures are used to calculate the total energy of a molecule. Given below are four resonance structures of the cyanate ion. Which one contributes least to the total energy?

a) \( \overset{2}{{\text{N}}=\overset{\cdot}{{\text{C}}}=-\overset{\cdot}{\overset{\cdot}{{\text{O}}}}} \)

b) \( \overset{\cdot}{{\text{N}}}=-\overset{2}{{\text{C}}}=-\overset{\cdot}{\overset{\cdot}{{\text{O}}}} \)

c) \( \overset{\cdot}{\overset{\cdot}{{\text{N}}}}=\overset{\cdot}{{\text{C}}}=-\overset{\cdot}{{\text{O}}} \)

d) \( \overset{\cdot}{\overset{\cdot}{{\text{N}}}}=\overset{\cdot}{{\text{C}}}=-\overset{\cdot}{\overset{\cdot}{{\text{O}}}} \)

The following question does NOT carry any marks and is given to collect information only:

41. How much time did you take to complete this chemistry exam?

a) Less than 1 hour.  
b) Between 1 to 2 hours.  
c) Between 2 to 3 hours.  
d) Insufficient time was given.