BITSAT 2023 Question Paper with Solutions May 23 Shift 1

Time Allowed :3 Hours	**Maximum Marks :**390	**Total Questions :**130

General Instructions

1. The examination is conducted in **Computer-Based Test (CBT)** mode. All questions will appear on the computer screen.
2. The total duration of the examination is **3 hours**. No extra time will be granted under any circumstances.
3. The question paper consists of **Multiple Choice Questions (MCQs)**, each having four options with only one correct answer.
4. Candidates must read each question carefully before selecting the answer. Answers can be changed only within the allotted test duration.
5. The examination follows a **negative marking scheme**. Marks will be deducted for incorrect answers, while unattempted questions will not carry any penalty.
6. Use of **calculators, mobile phones, smart watches, Bluetooth devices, or any other electronic gadgets** is strictly prohibited inside the examination hall.
7. Rough work must be done only on the rough sheets provided at the test center. These sheets must be returned after the examination.
8. Candidates must ensure that they have logged in using the correct credentials. Any discrepancy should be reported immediately to the invigilator.
9. No candidate will be allowed to leave the examination hall before the completion of the test duration.
10. Candidates must maintain discipline and follow all **instructions given by the invigilators**.
11. Any form of **unfair means, impersonation, or misconduct** will lead to immediate disqualification.
12. In case of any technical issue during the examination, candidates should remain seated and inform the invigilator without panic.

1. Minimum value of $5^{\cos 2x} + 5^{\sin 2x}$?

(A) 1
(B) 2
(C) 0
(D) 5

Correct Answer: (B) 2

Solution:

The answer provided is 2. For an expression of the form $5^A + 5^B$ to have a minimum value of

2, the standard inequality $x + \frac{1}{x} \geq 2$ (AM-GM) suggests the terms are likely reciprocals, i.e., $5^{\cos 2x} + 5^{-\cos 2x}$.

Assuming the question contains a typo and the intended expression is $5^{\cos 2x} + 5^{-\cos 2x}$:

Let $y = 5^{\cos 2x}$. Then the term becomes $y + \frac{1}{y}$.

Using the AM-GM inequality: $\frac{y+\frac{1}{y}}{2} \geq \sqrt{y \cdot \frac{1}{y}} = 1$.

Therefore, $y + \frac{1}{y} \geq 2$.

The minimum value is 2, which occurs when $y = 1$, i.e., $\cos 2x = 0$.

This logically leads to the provided answer of 2.

Quick Tip

For any positive real number x, the sum of the number and its reciprocal is always at least 2 ($x + \frac{1}{x} \geq 2$).

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2. Which substance is used in column Chromatography?
(A) Al_2O_3 and Silica gel
(B) $KMnO_4$
(C) Activated Charcoal
(D) Copper Sulphate
Correct Answer: (A) Al_2O_3 and Silica gel

Solution:
Column chromatography relies on the principle of adsorption.

The stationary phase consists of a solid adsorbent that is packed into a column.

The most commonly used adsorbents are Alumina (Al_2O_3) and Silica gel (SiO_2).

These substances are chosen because they are porous and have a large surface area for adsorption.

Quick Tip

The stationary phase in adsorption chromatography is always a solid (like silica or alumina), while the mobile phase is a liquid or gas.

3. Mercury kept in the refrigerator has length L. If taken out in atmospheric pressure condition, length remains the same due to?
(A) High density of mercury
(B) High surface tension
(C) Negligible thermal expansion
(D) High boiling point
Correct Answer: (C) Negligible thermal expansion

Solution:
When mercury is moved from a refrigerator to room temperature, it undergoes a temperature change.

Any change in length (or volume) would be due to thermal expansion.

However, mercury has a relatively low coefficient of thermal expansion compared to many other liquids, and for small temperature differences (like fridge to room temp), the absolute change in length is very small.

Therefore, the length is observed to remain approximately the same due to negligible thermal expansion in this context.

Quick Tip

Although mercury is used in thermometers, its expansion is small and requires a very fine capillary to be visible. In a wider tube or bulk container, the change is negligible.

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4. Dipole placed in a sphere, what will be the electric flux?
(A) Zero
(B) Depends on the orientation of the dipole
(C) Infinite
(D) q/ϵ_0
Correct Answer: (B) Depends on the orientation of the dipole

Solution:
According to Gauss's Law, the total flux through a closed surface is $\frac{q_{enclosed}}{\epsilon_0}$.

If a dipole is completely enclosed within a sphere, the net charge is zero ($+q - q = 0$), and the flux is zero.

However, the provided answer states it depends on orientation. This implies a scenario where the dipole is not necessarily fully enclosed (e.g., placed on the boundary or surface).

If the position or orientation causes one charge to be inside and the other outside, the enclosed charge changes (could be $+q$, $-q$, or 0).

Thus, matching the provided key, the flux depends on the orientation relative to the surface boundaries.

> Quick Tip
>
> Standard Gauss Law: Flux is zero if the dipole is fully inside. Always check if the question implies boundary conditions or partial enclosure if the answer deviates from zero.

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5. Work done in an isochoric process is always?
(A) Positive
(B) Negative
(C) Zero
(D) Infinite
Correct Answer: (C) Zero

Solution:
An isochoric process is a thermodynamic process in which the volume of the system remains constant ($\Delta V = 0$).

The work done by a gas is given by $W = \int P\, dV$.

Since $dV = 0$, the integral is zero.

Therefore, no work is done in an isochoric process.

> Quick Tip
>
> Isochoric = Constant Volume $\rightarrow$ Work = 0. Isobaric = Constant Pressure. Isothermal = Constant Temperature.

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6. What is the probability of 53 Fridays in an ordinary year?
(A) 1/7
(B) 2/7

(C) 5/53
(D) 1
Correct Answer: (A) 1/7

Solution:
An ordinary year has 365 days.

365 days = 52 weeks + 1 day.

The 52 weeks contain 52 Fridays.

For the year to have 53 Fridays, the remaining 1 day must be a Friday.

There are 7 possible days for this extra day (Mon, Tue, Wed, Thu, Fri, Sat, Sun).

The probability that this day is a Friday is $\frac{1}{7}$.

Quick Tip

For a leap year (366 days = 52 weeks + 2 days), the probability of 53 Fridays is 2/7.
For a non-leap year, it is 1/7.

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7. If work done on a body is positive, then what will be the sign of kinetic energy?
(A) Increase
(B) Decrease
(C) Zero
(D) Constant
Correct Answer: (A) Increase

Solution:
According to the Work-Energy Theorem, the net work done on an object is equal to the change in its kinetic energy ($W_{net} = \Delta KE$).

If the work done is positive ($W > 0$), then the change in kinetic energy is positive ($\Delta KE > 0$).

A positive change means the final kinetic energy is greater than the initial kinetic energy.

Therefore, the kinetic energy increases.

Quick Tip

Positive Work → Force helps motion → Speed increases. Negative Work → Force opposes motion → Speed decreases.

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8. $\int \frac{1}{1+\sin x} dx$**?**
(A) $\tan x + \sec x + C$
(B) $\tan x - \sec x + C$
(C) $\sec x - \tan x + C$
(D) $\ln(1 + \sin x) + C$
Correct Answer: (B) $\tan x - \sec x + C$

Solution:
Multiply the numerator and denominator by the conjugate $(1 - \sin x)$:

$\int \frac{1}{1+\sin x} \cdot \frac{1-\sin x}{1-\sin x} dx = \int \frac{1-\sin x}{1-\sin^2 x} dx.$

Since $1 - \sin^2 x = \cos^2 x$, the integral becomes:

$\int \frac{1-\sin x}{\cos^2 x} dx = \int \left(\frac{1}{\cos^2 x} - \frac{\sin x}{\cos^2 x}\right) dx.$

$\int (\sec^2 x - \sec x \tan x) dx.$

The integral of $\sec^2 x$ is $\tan x$, and the integral of $\sec x \tan x$ is $\sec x$.

Result: $\tan x - \sec x + C$.

Quick Tip

Multiplying by the conjugate is a standard technique for integrals involving $1 \pm \sin x$ or $1 \pm \cos x$ in the denominator.

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9. State Boyle's Law.
(A) $P \propto V$
(B) $P \propto 1/V$
(C) $V \propto T$
(D) $P \propto T$
Correct Answer: (B) $P \propto 1/V$

Solution:
Boyle's Law states that for a fixed amount of an ideal gas kept at a fixed temperature, pressure and volume are inversely proportional.

Mathematically, $P \propto \frac{1}{V}$ or $PV = k$ (constant).

This implies that if volume decreases, pressure increases, provided temperature remains constant.

> **Quick Tip**
>
> Remember: Boyle's Law → Constant Temp (Isotherm). Charles's Law → Constant Pressure (Isobar).

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10. Bromo toluene + Chlorine → A + H_2O → B + conc NaOH → C + D?
(A) Benzoic Acid + Methanol
(B) Sodium p-bromobenzoate + p-Bromobenzyl alcohol
(C) Toluene + NaBr
(D) No Reaction
Correct Answer: (B) Sodium p-bromobenzoate + p-Bromobenzyl alcohol

Solution:
Assuming the starting material is p-bromotoluene and the reaction sequence involves side-chain chlorination followed by hydrolysis and Cannizzaro reaction:

1. **Chlorination:** p-Bromotoluene + $2Cl_2 \xrightarrow{h\nu}$ p-Bromo-benzal chloride (A). (Gem-dichloride formation on methyl group).

2. **Hydrolysis:** A + H_2O → p-Bromobenzaldehyde (B). (Gem-halides hydrolyze to carbonyls).

3. **Cannizzaro Reaction:** Aldehydes with no alpha-hydrogen undergo disproportionation with conc NaOH.

2(p-Br-C_6H_4-CHO) $\xrightarrow{conc.NaOH}$ p-Br-C_6H_4-COONa(C) + p-Br-C_6H_4-CH_2OH(D).

The products are Sodium p-bromobenzoate and p-Bromobenzyl alcohol.

Quick Tip

Side chain chlorination of toluene derivatives leads to benzyl chloride ($1Cl$), benzal chloride ($2Cl$), or benzotrichloride ($3Cl$). Hydrolysis gives Alcohol, Aldehyde, or Carboxylic Acid respectively.

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11. Surface tension for a liquid is 1/2 of the other liquid and density is doubled, then if L1 = 10, then L2 = ?
(A) 2.5
(B) 5
(C) 10
(D) 20
Correct Answer: (A) 2.5

Solution:
Assuming L refers to the height of capillary rise, the formula is $h = \frac{2T\cos\theta}{r\rho g}$.

Given: $T_2 = \frac{1}{2}T_1$ and $\rho_2 = 2\rho_1$.

We compare h_2 (L2) with h_1 (L1 = 10).

$\frac{h_2}{h_1} = \frac{T_2/\rho_2}{T_1/\rho_1} = \frac{T_2}{T_1} \times \frac{\rho_1}{\rho_2}$.

Substituting the ratios: $\frac{h_2}{10} = \frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$.

$h_2 = \frac{10}{4} = 2.5$.

Quick Tip

Capillary rise is directly proportional to Surface Tension (T) and inversely proportional to Density (ρ). $h \propto T/\rho$.

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12. Triangular loop at intercepts (a, 0, 0), (0, a, 0) and (0, 0, a), then what is the magnetic moment?
(A) $\frac{Ia^2}{2}(\hat{i} + \hat{j} + \hat{k})$
(B) $\frac{\sqrt{3}Ia^2}{2}$
(C) Ia^2
(D) $3Ia^2$
Correct Answer: (A) $\frac{Ia^2}{2}(\hat{i} + \hat{j} + \hat{k})$

Solution:
The vertices are $A(a,0,0)$, $B(0,a,0)$, $C(0,0,a)$.

The magnetic moment $\vec{M} = I\vec{A}$, where $\vec{A}$ is the area vector.

$\vec{A} = \frac{1}{2}(\vec{AB} \times \vec{AC})$.

$\vec{AB} = -a\hat{i} + a\hat{j}$. $\vec{AC} = -a\hat{i} + a\hat{k}$.

$\vec{AB} \times \vec{AC} = (-a\hat{i} + a\hat{j}) \times (-a\hat{i} + a\hat{k})$.

$= a^2(\hat{i} \times \hat{i}) - a^2(\hat{i} \times \hat{k}) - a^2(\hat{j} \times \hat{i}) + a^2(\hat{j} \times \hat{k})$.

$= 0 - a^2(-\hat{j}) - a^2(-\hat{k}) + a^2(\hat{i}) = a^2(\hat{i} + \hat{j} + \hat{k})$.

$\vec{A} = \frac{a^2}{2}(\hat{i} + \hat{j} + \hat{k})$.

So, $\vec{M} = \frac{Ia^2}{2}(\hat{i} + \hat{j} + \hat{k})$. The magnitude is $\frac{\sqrt{3}}{2}Ia^2$.

> Quick Tip
>
> The area vector of a loop is normal to the plane. For intercepts a, a, a, the normal is along $(1, 1, 1)$.

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13. What are the products of the reaction between Chlorine water in hydrolysis?
(A) HCl and HOCl
(B) HCl only
(C) Cl_2O
(D) $HClO_3$
Correct Answer: (A) HCl and HOCl

Solution:
When chlorine gas (Cl_2) dissolves in water, it undergoes disproportionation (hydrolysis).

Reaction: $Cl_2 + H_2O \rightleftharpoons HCl + HOCl$.

The products formed are Hydrochloric acid (HCl) and Hypochlorous acid ($HOCl$).

On standing in sunlight, $HOCl$ decomposes to give HCl and O_2.

Quick Tip

Chlorine water acts as an oxidizing agent and bleaching agent due to the formation of nascent oxygen from unstable HOCl.

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14. Mononitration of bromobenzene?
(A) m-Nitrobromobenzene
(B) p-Nitrobromobenzene and o-Nitrobromobenzene
(C) Nitrobenzene
(D) Benzenesulfonic acid
Correct Answer: (B) p-Nitrobromobenzene and o-Nitrobromobenzene

Solution:
Bromobenzene contains a Bromine atom attached to the benzene ring.

Halogens are ortho-para directing groups (despite being deactivating).

Therefore, electrophilic aromatic substitution (nitration) will occur at the ortho and para positions.

The major product is 4-Nitrobromobenzene (para isomer) due to less steric hindrance, and the minor product is 2-Nitrobromobenzene (ortho isomer).

Quick Tip

Halogens are unique: they are deactivating (withdraw electrons via -I effect) but ortho-para directing (donate electrons via +R effect).

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15. $\int \frac{\sqrt{\tan x}}{\sqrt{\tan x}+\sqrt{\cot x}}dx$**?**
(A) $\frac{1}{2}(x - \ln|\sin x + \cos x|) + C$
(B) $x + C$
(C) $\frac{\pi}{4}$
(D) $\sin x + \cos x$
Correct Answer: (A) $\frac{1}{2}(x - \ln|\sin x + \cos x|) + C$

Solution:
Let $I = \int \frac{\sqrt{\tan x}}{\sqrt{\tan x}+\sqrt{\cot x}}dx$.

Convert to sine and cosine: $\sqrt{\tan x} = \frac{\sqrt{\sin x}}{\sqrt{\cos x}}$ and $\sqrt{\cot x} = \frac{\sqrt{\cos x}}{\sqrt{\sin x}}$.

$I = \int \frac{\frac{\sqrt{\sin x}}{\sqrt{\cos x}}}{\frac{\sqrt{\sin x}}{\sqrt{\cos x}} + \frac{\sqrt{\cos x}}{\sqrt{\sin x}}} dx = \int \frac{\sin x}{\sin x + \cos x} dx.$

Using the standard substitution: $\sin x = \frac{1}{2}[(\sin x + \cos x) - (\cos x - \sin x)]$.

$I = \frac{1}{2} \int \left(1 - \frac{\cos x - \sin x}{\sin x + \cos x}\right) dx.$

The numerator of the second term is the derivative of the denominator ($\frac{d}{dx}(\sin x + \cos x) = \cos x - \sin x$).

$I = \frac{1}{2}(x - \ln|\sin x + \cos x|) + C.$

Quick Tip

The definite integral $\int_0^{\pi/2} \frac{\sqrt{\tan x}}{\sqrt{\tan x} + \sqrt{\cot x}} dx$ is a standard property result equal to $\frac{\pi}{4}$.
