VMC Vidyamandir Classes SINCE 1986
IIT JEE | MEDICAL | FOUNDATION

CODE A

JEE Advanced-1 | Paper–1 | JEE 2024

Maximum Marks: 180

Timing: 10:00 AM to 1:00 PM **Duration : 3.0 Hours**

General Instructions

1. The question paper consists of 3 Subject (Subject I: **Physics**, Subject II: **Chemistry**, Subject III: **Mathematics**). Each Part has **three** sections (Section 1, Section 2 & Section 3).

2. **Section 1** contains **6 Multiple Correct Answers Type Questions**. Each question has 4 choices (A), (B), (C) and (D), out of which **ONE OR MORE THAN ONE CHOICE** is correct.

Section 2 contains **FOUR (04)** Matching List sets. Each set has **TWO** lists: **List I** and **List II**.
Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.

Section 3 contains **8 Numerical Value Type Questions**. For each question, enter the correct numerical value of the answer using the mouse and the onscreen virtual numeric keypad in the place designated to enter the answer. If the numerical value has more than two decimal places, **truncate/roundoff** the value to **TWO** decimal places.

3. For answering a question, an ANSWER SHEET (OMR SHEET) is provided separately. Please fill your **Test Code, Roll No.** and **Group** properly in the space given in the ANSWER SHEET.

Name of the Candidate (In CAPITALS) : _____

Roll Number : _____

OMR Bar Code Number : _____

Candidate's Signature : _____ **Invigilator's Signature** _____

Syllabus

Physics : Kinematics of a Particle, Relative Velocity, Motion in 2 Dimensions, Dynamics of a particle, Energy and Momentum

Chemistry : Stoichiometry I & II, Atomic Structure, Periodic Properties, Chemical Bonding, States of Matter, Thermochemistry, Thermodynamics, Chemical Equilibrium.

Mathematics : Quadratic Equations, Trigonometry, Sequence and Series, Function, Inverse Trigonometry Function, DC – 1

MARKING SCHEME

SECTION – 1 | (Maximum Marks: 24)

- This section consists of **Six (06)** Questions. Each question has **FOUR** options. **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks:	+4 If only (all) the correct option(s) is(are) chosen
Partial Marks:	+3 If all the four options are correct but ONLY three options are chosen
Partial Marks:	+2 If three or more options are correct but ONLY two options are chosen and both of which are correct
Partial Marks:	+1 If two or more options are correct but ONLY one option is chosen, and it is a correct option
Zero Mark:	0 if none of the options is chosen (i.e. the question is unanswered)
Negative Marks:	–2 In all other cases.

SECTION – 2 | (Maximum Marks: 12)

- This section contains **Four (04**) Matching List sets. Each set has **TWO** lists: **List I** and **List II**.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated according to the following marking scheme.

Full Marks	: +3 If ONLY the correct option is chosen.
Zero Marks	: 0 If none of the options is chosen (i.e. the question is unanswered).
Negative Marks	: −1 In all other cases.

SECTION – 3 | (Maximum Marks: 24)

- This section contains **Eight (08) Numerical Value Type Questions**. For each question, enter the correct numerical value of the answer using the mouse and the onscreen virtual numeric keypad in the place designated to enter the answer. If the numerical value has more than two decimal places, **truncate/roundoff** the value to **TWO** decimal places.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks:	+3 **ONLY** if the correct numerical value is entered.
Zero Mark:	0 In all other cases.

SUBJECT I : PHYSICS 60 MARKS

SECTION 1
MULTIPLE CORRECT ANSWERS TYPE

This Section contains **6 Multiple Correct Answers Type Questions**. Each question has 4 choices (A), (B), (C) and (D), out of which **ONE OR MORE THAN ONE CHOICE** is correct.

1. A train appears to move with a velocity of $12\sqrt{2}$ m/s towards North-West to a cyclist moving at a velocity 4 m/s towards North. Assuming that the speed of the cyclist and the actual velocity of the train (both magnitude and direction) remain unchanged throughout, which of these options is/are correct?

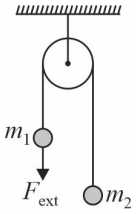
(A) The train's actual velocity is 20 m/s in a direction $\tan^{-1}\left(\frac{3}{4}\right)$ West of North

(B) If the cyclist moves towards East, the train still appears to move towards North-West to him

(C) If the cyclist moves towards East, the train appears to move with a velocity of $16\sqrt{2}$ m/s to him

(D) The velocity of the train as seen by the cyclist is maximum if he moves opposite to the direction of the train's actual velocity

2. Two bodies of masses m_1 and $m_2 (m_2 > m_1)$ are connected by a light inextensible string which passes through a smooth fixed pulley as shown. Then choose the correct option(s).



(A) The instantaneous power delivered by an external agent to pull m_1 with constant velocity v is $(m_2 - m_1)gv$

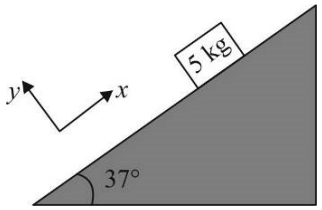
(B) The instantaneous power delivered by an external agent to pull m_1 with constant velocity v is $(m_2 + m_1)gv$

(C) The instantaneous power delivered by an external agent to pull m_1 with constant acceleration a at any instant t, starting from rest, is $[m_2(g+a) - m_1(g-a)]at$

(D) The instantaneous power delivered by an external agent to pull m_1 with constant acceleration a at any instant t, starting from rest, is $[m_2(g+a) + m_1(g-a)]at$

SPACE FOR ROUGH WORK

3. A block of mass 5 kg is kept on a fixed incline. The coefficient of friction between the block and incline is 0.5. x and y axis as shown are parallel to the incline and perpendicular to the incline respectively. Choose the correct options. (Take $g = 10\ \text{m/s}^2$, $\tan 37° = 0.75$)



(A) If the block is released, it slides down the incline with an acceleration of $6\ \text{m/s}^2$

(B) If the block is released, it slides down the incline with an acceleration of $2\ \text{m/s}^2$

(C) The minimum magnitude of force that needs to be applied on the block along $+x$ direction to keep the block at rest is $10N$

(D) The minimum magnitude of force that needs to be applied on the block along $-y$ direction to keep the block at rest is $20N$

4. A particle moving in a straight line has acceleration given by $a = -k\sqrt{v}$ where k is a positive constant and v is instantaneous velocity. Let v_0 be the initial velocity, t be the total time of motion and v_a be the average velocity in time t. Let s be the total distance travelled. Choose the correct options.

(A) $t = \dfrac{2\sqrt{v_0}}{k}$ **(B)** $v_a = \dfrac{v_0}{3}$ **(C)** $s = \dfrac{2}{3}\dfrac{\sqrt{v_0}}{k}$ **(D)** $\dfrac{v_a}{v_0} = \dfrac{1}{2}$

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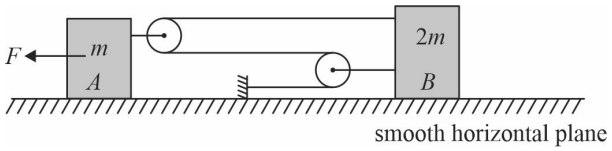
5. An external horizontal force 'F' is applied to a system of two blocks placed on a smooth surface as shown.



(A) Acceleration of block A is $\frac{9F}{17m}$

(B) Acceleration of block A is $\frac{9F}{20m}$

(C) Acceleration of block B is $\frac{6F}{17m}$

(D) Relative acceleration of block A with respect to B is $\frac{15F}{17m}$

6. A heavy particle is tied to the end A of a string of length 1.6 m. Its other end O is fixed. It revolves as a conical pendulum with the string making 60° with the vertical. Then $(g = 10\ \text{m/s}^2)$

(A) Its period of revolution is $\frac{2\sqrt{2}\pi}{5}\text{sec}$

(B) The tension in the string is double the weight of the particle

(C) The velocity of the particle $= \sqrt{24}\ \text{m/s}$

(D) The centripetal acceleration of the particle is $10\sqrt{3}\ \text{m/s}^2$

SPACE FOR ROUGH WORK

SECTION - 2
MATCHING LIST TYPE

This section contains **4** Matching List sets. Each set has **TWO** lists: **List I** and **List II**. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.

7. A particle is moving in a circular path of radius r. Match the entries in Column I with all possible entries in Column II (All quantities have their usual meaning):

Column I		Column II	
(1)	If the particle is moving with constant speed	**(p)**	$\vec{v}.\vec{r}=0$
(2)	If the particle is moving with increasing speed	**(q)**	$\vec{v}.\vec{a}=0$
(3)	If the particle is moving with decreasing speed	**(r)**	$\vec{v}.\vec{a}>0$
(4)	If speed of the particle is given by $v=5-2t$ then at any instant t	**(s)**	$\vec{r}.\vec{a}<0$
		(t)	$\vec{v}.\vec{a}<0$

(A) (1-p,q), (2-p,r,t), (3-p,r,s), (4-p,s) **(B)** (1-p,q), (2-p,r), (3-p,s,t), (4-p,s)

(C) (1-p,q), (2-p,r), (3-p,s), (4-p,s,t) **(D)** (1-p,q), (2-p,r,s), (3-p,s,t), (4-p,s,t)

8. A body is projected from ground from origin with x-axis along horizontal and y-axis along vertical. The path of projectile is given by $y=\sqrt{3}x-\frac{5}{4}x^2$.

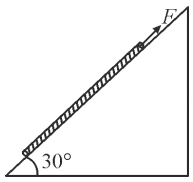
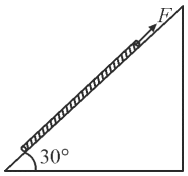
Column I		Column II	
(1)	Range	**(p)**	$\frac{4\sqrt{3}}{5}$ units
(2)	Maximum Height	**(q)**	2 units
(3)	Time of flight	**(r)**	$\frac{3}{5}$ units
(4)	Average velocity for complete journey	**(s)**	$\frac{2}{5}\sqrt{3}$ units

(A) (1-p), (2-s), (3-r), (4-q) **(B)** (1-p), (2-r), (3-s), (4-q)

(C) (1-r), (2-p), (3-s), (4-q) **(D)** (1-q), (2-r), (3-s), (4-p)

SPACE FOR ROUGH WORK

9. Column I contains some questions and Column II contains some answers. Match the correct answer of each question.

Column I		Column II	
(1)	A rope of mass 2 kg on a rough horizontal surface is pulled by a horizontal force of 20N, $\mu_{SL} = 0.5$ 	**(p)**	Tension at the midpoint of rope is 10N
(2)	A rope of mass 2 kg is pulled with a constant speed up an incline of inclination 30° and coefficient of friction $\frac{1}{\sqrt{3}}$ 	**(q)**	Acceleration of rope is $5\,m/s^2$
(3)	A rope of mass 1.0 kg pulled by a constant force of 10N upon incline of inclination 30° and coefficient of friction $\frac{1}{\sqrt{3}}$ 	**(r)**	Force of friction acting is 5N
(4)	A rope of mass 2 kg pulled vertically by a force 20N 	**(s)**	Resultant force on the rope is zero
		(t)	Force of friction acting is 10N

(A) (1-p, q, t), (2-s, t), (3-r, s), (4-p, s) **(B)** (1-p, q), (2-s, t), (3-r, s, t), (4-p, s)

(C) (1-p, q, t), (2-s), (3-r, s), (4-p, s, t) **(D)** (1-p, t), (2-s, t), (3-r, s), (4-p, q, s)

SPACE FOR ROUGH WORK

10. Consider a system of particles. If U, K and p denote the total potential energy, kinetic energy and linear momentum of the system, then match the Column appropriately (i and f stand for initial and final respectively):

Column I		Column II	
(1)	$U_f - U_i$	**(p)**	Is zero when no forces are acting
(2)	$K_f - K_i$	**(q)**	Is zero when no force is doing work
(3)	$(U_f + K_f) - (U_i + K_i)$	**(r)**	Is zero when only conservation forces are doing work
(4)	$p_f - p_i$	**(s)**	Is zero when work done by conservative forces is zero
		(t)	Is zero when there are no external forces and no non-conservative forces

(A) (1-p, q, s), (2-p), (3-p, q), (4-p, t) **(B)** (1-p, q), (2-p, q), (3-p, q, t), (4-p, t)

(C) (1-p, q, s), (2-p, q), (3-p, q, r, t), (4-p, t) **(D)** (1-q, s), (2-p, q), (3-p, q, r, t), (4-p)

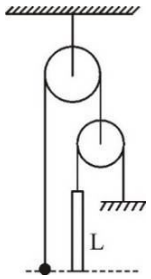
SPACE FOR ROUGH WORK

SECTION 3
NUMERICAL VALUE TYPE

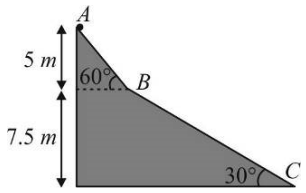
This section contains **8 Numerical Value Type Questions**. For each question, enter the correct numerical value of the answer. If the numerical value has more than two decimal places, **truncate/roundoff** the value to **TWO** decimal places.

1. When two forces of magnitudes F_1 and F_2 act on a body with an angle $\theta_1 = 60°$ between them, the magnitude of their resultant is R_1. If the angle between the forces is changed to $\theta_2 = 120°$ without changing their magnitudes, the magnitude of their resultant becomes R_2. If the ratio $\frac{R_1}{R_2}$ is equal to $\sqrt{\frac{19}{7}}$, the ratio $\frac{F_1}{F_2}$ is equal to _____. (Given $F_1 > F_2$)

2. In the arrangement shown, the mass of the ball is $\frac{3}{2}$ times the mass of the rod. The length of the rod is *L*. The masses of the pulleys and threads are negligible. The ball is set on the same horizontal level as the lower end of the rod and then the system is released from rest. The time after which the ball is on the same horizontal level as the upper end of the rod is $\left(X\left(\frac{L}{g}\right)\right)^{1/2}$. The value of *X* is _____.

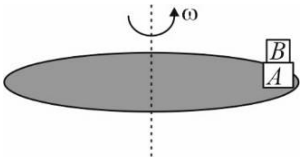


3. A small particle is released from the top of a smooth inclined plane *ABC*. The angle of the incline suddenly changes from 60° to 30° at point *B*. Assume that collision between the particle and the incline is totally inelastic. The speed is (in m/s) of the particle, when it reaches the bottom *C* of the incline is _____. (Take $g = 10\ \text{m/s}^2$)



SPACE FOR ROUGH WORK

4. A circular turntable of radius 1m is rotating about its axis with angular velocity ω. Block A of mass 1 kg is placed at the edge of the table and another block B of mass 0.5 kg is placed over A. Coefficient of friction between A and B is 0.2 while that between A and table is 0.45. What can be the maximum value of ω (in rad/s) so that there is no slipping anywhere. Assume that the size of the blocks is very small as complared to the radius of the turntable. (Take $g = 9.8\ \text{m/s}^2$)



5. Starting from rest, a particle moves a distance x in a straight line with constant acceleration a. Then, the particle moves a further distance x along the same line at constant velocity. Finally, the particle, moving along the same line, decelerates uniformly at rate $\frac{a}{2}$ until it comes to rest. Let the maximum velocity of the particle during its motion be v_{MAX} and let its average velocity over the entire journey be v_{AVG}. The ratio $\frac{v_{MAX}}{v_{AVG}}$ is equal to _____.

6. A thin hollow spherical shell of radius R is cut symmetrically and its lower half is removed to get a hemispherical shell. Now the open base is covered with a circular plate of radius R made of same material and having the same thickness as the shell. The centre of mass of this covered hemisphere lies at a distance of nR from the centre of base, where n is _____ .

7. From a point on the ground at a distance of $3m$ from the foot of a vertical wall, a ball is thrown at an angle of 60°. The ball just clears the top of the wall and afterwards strikes the ground at a distance of 6 m from the foot of the wall on the other side. The height of the wall is _____ (in m). (Take $\sqrt{3} = 1.73$)

8. A block of mass 1 kg is kept at rest on a rough horizontal surface. The coefficient of friction between the block and surface is 0.5. A horizontal force of 10 N is applied on the block for 6 seconds after which the direction of force is reversed keeping the magnitude same. Find the speed (in m/s) with which the block returns to its starting point. (Take $g = 10\ \text{m/s}^2, \sqrt{3} = 1.732$)

SPACE FOR ROUGH WORK

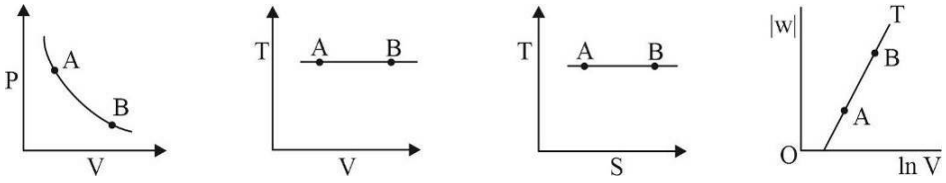
SUBJECT II : CHEMISTRY 60 MARKS

SECTION 1

MULTIPLE CORRECT ANSWERS TYPE

This Section contains **6 Multiple Correct Answers Type Questions**. Each question has 4 choices (A), (B), (C) and (D), out of which **ONE OR MORE THAN ONE CHOICE** is correct.

1. Which of the following diagram is correct for reversible isothermal expansion of an ideal gas from state A to state B?



(A) **(B)** **(C)** **(D)**

Where P = pressure, V = volume, S = entropy, w = work done and T = temperature

2. Which of the following is(are) correct?

(A) HF is more polar than HBr

(B) CuCl is more covalent than NaCl

(C) HF is less polar than HBr

(D) Order of dipole moment is $HF < H_2S < H_2O$

3. Which of the following is(are) correct regarding O, F and Cl?

(A) Fluorine is most electronegative element **(B)** Chlorine has maximum electron affinity

(C) Chlorine can expand its octet **(D)** HOF is acidic while HOCl is basic

4. The equation that is/are true for mixing of two ideal gases at constant temperature and pressure is:

(A) $\Delta U_{mix} = 0$ **(B)** $\Delta S_{mix} = 0$ **(C)** $\Delta H_{mix} = 0$ **(D)** $q_{mix} = 0$

SPACE FOR ROUGH WORK

5. For which of the following reactions would the yield of products at equilibrium DOES NOT increase on increasing pressure?

(A) $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$

(B) $Ti(s) + 2Cl_2(g) \rightleftharpoons TiCl_4(g)$

(C) $2C_2H_4(g) + 2H_2O(g) \rightleftharpoons 2C_2H_6(g) + O_2(g)$

(D) $4HCl(g) + O_2(g) \rightleftharpoons 2H_2O(\ell) + 2Cl_2(g)$

6. For the reaction,

$2Ag_2O(s) \longrightarrow 4Ag(s) + O_2(g),\ \Delta H = 61.17\,kJ/mol$ and $\Delta S = 132\,JK^{-1}mol^{-1}$

Compute the temperature above which the given reaction will be spontaneous?

(A) $T < 190.25°C$ **(B)** $T < 463.4\,K$ **(C)** $T > 190.25°C$ **(D)** $T > 463.4\,K$

SPACE FOR ROUGH WORK

SECTION - 2
MATCHING LIST TYPE

This section contains **4** Matching List sets. Each set has **TWO** lists: **List I** and **List II**. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.

7. Match the molecues/species listed in column I with characteristic(s) listed in column II.

Column I		Column II	
(1)	ClF_5, BrF_4^+, IF_6^-	**(p)**	All molecule/ions are polar
(2)	ClF_3, BrF_2^+, ICl_4^-	**(q)**	All molecules/ion have same number of lone pair(s) and same shape
(3)	XeF_2, ICl_2^-, I_3^-	**(r)**	All molecules/ions have same oxidation state of central atoms
(4)	$ClOF_3$, ClF_4^+, $IO_2F_2^-$	**(s)**	All molecules/ions have same hybridisation of central atoms

(A) [1-p, r]; [2-s]; [3-r, s]; [4-p, q, r, s] **(B)** [1-p, r]; [2-s]; [3-q, r]; [4-p, q, r]
(C) [1-p, r]; [2-r]; [3-p, q]; [4-p, q] **(D)** [1-p, r]; [2-r]; [3-q, s]; [4-p, q, r, s]

8. Match the increasing order given in Column I with the property(ies) given in Column II.

Column I		Column II	
(1)	$Na^+ < F^- < O^{2-} < N^{3-}$	**(p)**	Electronegativity
(2)	$Li^+ < Na^+ < K^+ < Rb^+ < Cs^+$	**(q)**	Mobility of hydrated ions
(3)	$O < S < F < Cl$	**(r)**	Ionic size
(4)	$Cl^- < K^+ < Ca^{2+} < Sc^{3+}$	**(s)**	Electron affinity

(A) [1-r]; [2-q, r]; [3-s]; [4-p, s] **(B)** [1-r]; [2-q, s]; [3-r]; [4-p, r]
(C) [1-s]; [2-q, r]; [3-r]; [4-p, s] **(D)** [1-s]; [2-q, s]; [3-s]; [4-p, r]

SPACE FOR ROUGH WORK

9. Match the following:

Column I		Column II	
(1)	$n = 6 \rightarrow n = 3$ (In H-atom)	**(p)**	10 lines in the spectrum
(2)	$n = 7 \rightarrow n = 3$ (In H-atom)	**(q)**	Spectral lines in visible region
(3)	$n = 5 \rightarrow n = 2$ (In H-atom)	**(r)**	6 lines in the spectrum
(4)	$n = 6 \rightarrow n = 2$ (In H-atom)	**(s)**	Spectral lines in infrared region

(A) [1-r, s]; [2-q, s]; [3-p, r]; [4-p, q] **(B)** [1-r, s]; [2-p, s]; [3-q, r]; [4-p, q]
(C) [1-p, s]; [2-q, s]; [3-r, s]; [4-p, q] **(D)** [1-r, s]; [2-q, r]; [3-p, s]; [4-p, q]

10. Match the following:

Column I		Column II	
(1)	$CO_2(g) + C(s) \longrightarrow 2CO(g)$ $[\Delta_f H^0 : CO_2 = -394$ and $CO = -220\,kJ/mol]$	**(p)**	$\Delta_r S > 0$
(2)	$SO_2Cl_2(g) \longrightarrow SO_2(g) + Cl_2(g)$	**(q)**	$\Delta_r H > \Delta_r U$
(3)	$CO(g) + Cl_2(g) \longrightarrow COCl_2(g)$	**(r)**	$\Delta_r H < \Delta_r U$
(4)	$Cl_2(g) \longrightarrow 2Cl(g)$	**(s)**	$\Delta_r G < 0$

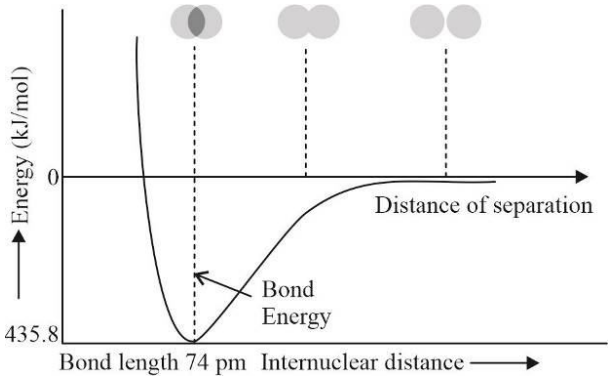
(A) [1-p, q]; [2-p, q, s]; [3-p, r]; [4-p, q] **(B)** [1-p, q, s]; [2-p, s]; [3-p, r]; [4-p, q]
(C) [1-p, q, s]; [2-p, q]; [3-r]; [4-p, q] **(D)** [1-p, s]; [2-q, s]; [3-r, s]; [4-p, q]

SPACE FOR ROUGH WORK

SECTION 3
NUMERICAL VALUE TYPE

This section contains **8 Numerical Value Type Questions**. For each question, enter the correct numerical value of the answer. If the numerical value has more than two decimal places, **truncate/roundoff** the value to **TWO** decimal places.

1. The figure below is the plot of potential energy versus internuclear distance (d) of H_2 molecule in the electronic ground state.



What is the value of energy required in kJ/mol for following gas phase ionization process?

$$H_2(g) \rightarrow 2H^+(g) + 2e^-$$

Use Avogadro constant as $6.023 \times 10^{23}\ mol^{-1}$ and the energy of the ground state of H atom is $= -2.18 \times 10^{-18}\ J / atom.$

2. Tin is obtained from cassiterite (SnO_2) by reduction with coke. Use the data given below to determine the minimum temperature (in K) above which the reduction of cassiterite by coke is spontaneous?

$$SnO_2(s) + C(s) \rightarrow Sn(s) + CO_2(g)$$

At $298\,K : \Delta_f H°(SnO_2(s)) = -581.0\ kJ\ mol^{-1}$, $\Delta_f H°(CO_2(g)) = -394.0\ kJ\ mol^{-1}$,

$S°(SnO_2(s)) = 56.0\ JK^{-1}\ mol^{-1}$, $S°(Sn(s)) = 52.0\ JK^{-1}\ mol^{-1}$,

$S°(C(s)) = 6.0\ JK^{-1}\ mol^{-1}$, $S°(CO_2(g)) = 210.0\ JK^{-1}\ mol^{-1}$.

Assume that the enthalpies and the entropies are temperature independent.

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3. Calculate lattice energy of $MgO(s)$ in kJ/mol if it is given that:

Enthalpy of formation of $MgO(s) = -602\,kJ/mol$

Enthalpy of sublimation of $Mg(s) = 148\,kJ/mol$

1st and 2nd ionization energy of Mg = 738 & 1450 kJ/mol respectively.

Bond dissociation energy of [O = O] = 498 kJ/mol

1st and 2nd electron gain enthalpy of oxygen = – 141, + 844 kJ/mol respectively.

4. A mixture of 1.20 mol of X, 2.10 mol of Y, and 0.950 mol of Z is found at equilibrium in a 1 litre vessel as shown below:

$$X + Y \rightleftharpoons Z$$

What is the value of the equilibrium constant, K_c? [Report upto two decimal places]

5. A solution of a mixture of $CaCl_2$ and NaCl weighing 4.44 g was treated with sodium carbonate solution to precipitate all the calcium ions as calcium carbonate. The calcium carbonate so obtained was heated strongly and 0.56 g of CaO was obtained. The percentage of NaCl in the mixture is _____.

[Given: Atomic Mass of Na = 23, Cl = 35.5, Ca = 40 g/ Mol]

6. The dipole moment of BrF is 1.35 D, and its bond length is 180 pm. What is the percent ionic character of the Br – F bond? [Given : $1D = 3.34\times10^{-30}\,C\,m$, charge of electron $= 1.6\times10^{-19}\,C$]

7. A certain mass of gas occupies 5.50 liters at 300 K and 650 Torr. What will be its volume (liters) if it is cooled at 283 K and its pressure is increased to 980 Torr?

8. A 10 gm mixture of CuS and Cu_2S was treated with 400 mL of 0.4 M MnO_4^- in acid solution producing SO_2, Cu^{2+} and Mn^{2+}. The SO_2 was boiled off and the excess of MnO_4^- was titrated with 200 mL of 1 M Fe^{2+} solution. What is the percentage of CuS in original mixture?

[Atomic mass of Cu is 64 amu; Atomic mass of S is 32 amu]

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SUBJECT III : MATHEMATICS 60 MARKS

SECTION 1
MULTIPLE CORRECT ANSWERS TYPE

This Section contains **6 Multiple Correct Answers Type Questions**. Each question has 4 choices (A), (B), (C) and (D), out of which **ONE OR MORE THAN ONE CHOICE** is correct.

1. The function $f(x) = \cos^{-1}\left(\frac{2[|\sin x| + |\cos x|]}{\sin^2 x + 2\sin x + \frac{11}{4}}\right)$ is defined if x belongs to: (where [.] denotes greatest integer function)

(A) $\left[0, \frac{7\pi}{6}\right]$ **(B)** $\left[0, \frac{\pi}{6}\right]$ **(C)** $\left[\frac{11\pi}{6}, 2\pi\right]$ **(D)** $\left(\frac{7\pi}{6}, \frac{11\pi}{6}\right)$

2. $\lim\limits_{x\to\infty}\left(\frac{ax^2+bx+c}{px^2+qx+r}\right)^{lx^2+mx+n}$, $(a, b, c, p, q, r, \ell, m, n \in R^+)$ **:**

(A) is equal to zero for $a < p$ **(B)** does not exist for $a > p$

(C) is equal to one for $a = p$ **(D)** is equal to $e^{\frac{(b-q)m}{p}}$ for $a = p, \ell = 0$

3. Let $f(x) = \begin{cases} 3^x & ; \quad x \le 0 \\ (x+\lambda) & ; \quad 0 < x < 2 \\ 3+(x-2)^2 & ; \quad x \ge 2 \end{cases}$ is continuous for all $x \in R$, then which of the following is true:

(A) Range of $f(x)$ is $(0, \infty)$ **(B)** $f(x) = 1$ has one solution

(C) $f(x) = |f(x)|$ for all $x \in R$ **(D)** $f(x) = 1$ has two solutions

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4. If a, b, c are in H.P., then which of the following is true?

(A) $\frac{a}{1-2a}, \frac{b}{1-2b}, \frac{c}{1-2c}$ are in H.P. **(B)** $\ln\left(a-\frac{b}{2}\right), \ln\frac{b}{2}, \ln\left(c-\frac{b}{2}\right)$ are in H.P.

(C) $c-\frac{b}{2}, \frac{b}{2}, a-\frac{b}{2}$ are in G.P. **(D)** $e^{1/a}, e^{1/b}, e^{1/c}$ are in G.P.

5. If roots of the quadratic equation $(x+a)(x+1991)+1=0$ are integer, then 'a' is equal to (a is integer):

(A) 1989 **(B)** 1991 **(C)** 1993 **(D)** 1995

6. If in a triangle ABC, $\cos A \cos B + \sin A \sin B \sin C = 1$, then the triangle is:

(A) Isosceles **(B)** Right Angled

(C) Equilateral **(D)** None of these

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SECTION - 2

MATCHING LIST TYPE

This section contains **4** Matching List sets. Each set has **TWO** lists: **List I** and **List II**. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.

7. Match the Following:

	List-I	List-II	
P	The number of solutions of $\lvert\cot x\rvert = \cot x + cosec\ x, 0 \le x \le 2\pi, is$	**1**	1
Q	If m and n ($n > m$) are positive integers, the number of solutions of equation $n\lvert\sin x\rvert = m\lvert\cos x\rvert in [0, 2\pi]$ is	**2**	2
R	If $[\sin x] + \left[\frac{x}{2\pi}\right] + \left[\frac{2x}{5\pi}\right] = \frac{9x}{10\pi}$, then the number of solutions in the interval (30, 40) is (where [.] represents greatest integer function)	**3**	3
S	The value of x in $(0, \pi/4)$ satisfying the equation, $\frac{\sqrt{3}-1}{\sin x} + \frac{\sqrt{3}+1}{\cos x} = 4\sqrt{2}$ is $\frac{\pi}{k}$ then the divisor of k is	**4**	4

Codes:

	P	Q	R	S		P	Q	R	S
(A)	1	4	1	1, 2, 3, 4	**(B)**	1	2	4	1, 3, 4
(C)	2	1	4	1, 2, 3	**(D)**	2	4	1	1, 2, 3, 4

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8. Match the following:

List-I		List-II	
(1)	If $\cos(p\sin x)=\sin(p\cos x)$ then minimum positive value of $\frac{4\sqrt{2}p}{\pi}$ (where $p>0$)	**(p)**	1
(2)	The minimum value of $9^3 27^{\cos 2x} 81^{\sin 2x}$ is	**(q)**	3
(3)	If $\tan 40^\circ + 2\tan 10^\circ = k\cot 40^\circ$ then value of $10-k$ equals	**(r)**	9
(4)	If λ is root of $x^2+5x+1=0$. Value of $\tan^{-1}\lambda+\tan^{-1}\left(\frac{1}{\lambda}\right)$ is $k\pi$. The value of $\frac{2}{k}+5$ is	**(s)**	2

(A) $(1\to r), (2\to s), (3\to p), (4\to q)$ **(B)** $(1\to s), (2\to s), (3\to p), (4\to p)$

(C) $(1\to s), (2\to q), (3\to r), (4\to p)$ **(D)** $(1\to q), (2\to q), (3\to p), (4\to r)$

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9. Match the following:

List-I		List-II	
(1)	$f(x)=\sin^2 2x-2\sin^2 x$	**(p)**	Range contains no natural number
(2)	$f(x)=\frac{4}{\pi}(\sin(\sin^{-1}\pi x))$	**(q)**	Range contains atleast one integer
(3)	$f(x)=\sqrt{\ln(\cos(\sin x))}$	**(r)**	Many one but not even function
(4)	$f(x)=\tan^{-1}\left(\frac{x^2+1}{x^2+\sqrt{3}}\right)$	**(s)**	Both many one and even function
		(t)	Periodic but not odd function

(A) (1-p,q,s,t), (2-q), (3-p,q,s), (4-p,s) **(B)** (1-s), (2-r), (3-p,q), (4-q,s)

(C) (1-q,s,t), (2-q), (3-p,q,s), (4-p,s) **(D)** (1-t), (2-q), (3-p,s), (4-s)

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10. Match the following:

List-I		List-II	
(1)	If three unequal *a, b, c* are in A.P. and *b* – *a*, *c* – *b*, *a* are in G.P., then $\frac{a^3+b^3+c^3}{3abc}$ is equal to	**(p)**	1
(2)	Let *x* be the arithmetic mean and *y*, *z* two geometric means between any two positive numbers, then $\frac{y^3+z^3}{2xyz}$ is equal to	**(q)**	4
(3)	If *a, b, c* be three positive number which form three successive terms of a G.P. and *c* > 4*b* – 3*a*, then the common ratio of the G.P. can be equal to	**(r)**	2
(4)	Number of integral values of *x* satisfying inequality, $-7x^2+8x-9>0$ *is*	**(s)**	0

(A) (1– r), (2 – p), (3 – q), (4 – s) **(B)** (1 – s), (2 – r), (3 – q), (4 – r)

(C) (1 –s, q), (2 – p), (3 – q), (4 – s) **(D)** (1 – r), (2 – p, q), (3 – q), (4 – s)

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SECTION 3
NUMERICAL VALUE TYPE

This section contains **8 Numerical Value Type Questions**. For each question, enter the correct numerical value of the answer. If the numerical value has more than two decimal places, **truncate/roundoff** the value to **TWO** decimal places.

1. If $\sum_{n=1}^{2015} \tan\left(\frac{\theta}{2^n}\right)\sec\left(\frac{\theta}{2^{n-1}}\right) = \tan\left(\frac{\theta}{2^a}\right) - \tan\left(\frac{\theta}{2^b}\right)$ then $(b+a)$ equals:

2. If α and β are roots of equation

$\frac{27}{4}\sin\left(\frac{\theta}{9}\right) = \sin^3\theta + 3\sin^3\left(\frac{\theta}{3}\right) + 9\sin^3\left(\frac{\theta}{9}\right) + \frac{1}{4\sqrt{2}}$ *for* $0 < \theta < \frac{\pi}{2}$, then $\tan\alpha + \tan\beta$ is equal to____.

3. If $T_r = \frac{1^2 + 2^2 + 3^2 + ...r^2}{1^3 + 2^3 + 3^3 + ...r^3}$ and $S_n = \sum_{r=1}^{n} (-1)^r \cdot T_r$, Then $\lim_{n\to\infty} |S_n|$ equals _____.

4. If $e^{f(x)} = \frac{10+x}{10-x}$, $x \in (-10, 10)$ and $f(x) = kf\left(\frac{200x}{100+x^2}\right)$, then $k =$

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5. Let $f : R \to [-8, 8]$ be an onto function which is given by $f(x) = \dfrac{bx}{(a-3)x^3 + x^2 + 4}$, $a, b \in R^+$.

If the set of values of m for which the equation $f(x) = mx$ has 3 distinct real solutions is (p, q), then find the value of $(a + b + p + q)$?

6. Find a, b, c such that $\lim\limits_{x \to 0} \dfrac{axe^x - b\log(1+x) + c \cdot x \cdot e^{-x}}{x^2 \cdot \sin x} = 2$. The value $\dfrac{a+4b}{c}$ is _____.

7. Value of $\lim\limits_{x \to 0} \left(\dfrac{\sin x}{x} \right)^{\frac{\sin x}{x - \sin x}}$ is n. The value of $[n^{-3}]$ is ____. {where [.] denotes greatest integer function}

8. Let 'p' be an integer for which both roots of the quadratic equation $x^2 + 2(p-3)x + 9 = 0$ lies in $(-6, 1)$. If $2, g_1, g_2, \ldots\ldots, g_{19}, g_{20}, p$ are in G.P., then find the value of $g_4 g_{17}$.

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End of JEE Advanced-1_Paper -1| XII PASS [JEE 2024]