VMC Vidyamandir Classes SINCE 1986

IIT JEE | MEDICAL | FOUNDATION

CODE A

# JEE Advanced Booster Test - 5 | 2024

**Date: 27/12/2022** **Maximum Marks: 177**

**Timing: 04:00 PM - 07:00 PM** **Duration: 3.0 Hrs**

## General Instructions

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

2. **Section 1** contains **3 types** of questions **[Type A, Type B and Type C].**

   **Type A** contains **Five (05) Multiple Choice Questions**. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE CHOICE** is correct.

   **Type B** contains **Five (05) 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.

   **Type C** contains **ONE (01) paragraph**. Based on the paragraph, there are **TWO (02)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.

3. **Section 2** contains **6 Numerical Value Type Questions**. The answer to each question is a **NUMERICAL VALUE**. For each question, enter the correct numerical value of the answer. If the answer is a decimal numerical value, then round-off the value to TWO decimal places. If the answer is an Integer value, then do not add zero in the decimal places. *In the OMR, do not bubble the ⊕ sign for positive values. However, for negative values, Θ sign should be bubbled*. (Example: 6, 81, 1.50, 3.25, 0.08)

4. 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:** Energy & Momentum, Rotational Motion (Sec-1, 2 & 4 Only)

**Chemistry:** States of Matter, Thermochemistry

**Mathematics:** Complex Number, Straight Line

# MARKING SCHEME

**SECTION-1 | Type A**

- This section contains **Five (05)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the 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-1 | Type B**

- This section contains **Five (05)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the 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, 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 Marks : 0 If unanswered;
  Negative Marks : –2 In all other cases.
- For example, in a question, if (A), (B) and (D) are the ONLY three options corresponding to correct answers, then
  choosing ONLY (A), (B) and (D) will get +4 marks; choosing ONLY (A) and (D) will get +2 marks;
  choosing ONLY (A) will get +1 mark;
  choosing no option(s) (i.e. the question is unanswered) will get 0 marks and
  choosing any other option(s) will get –2 marks.

**SECTION-1 | Type C**

- This section contains **ONE paragraphs**. Based on each paragraph, there are **TWO** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** 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 - 2**

- This section contains **6 Integer Type Questions**. The answer to each question is a **NUMERICAL VALUE**. For each question, enter the correct numerical value of the answer. If the answer is a decimal numerical value, then round-off the value to TWO decimal places. If the answer is an Integer value, then do not add zero in the decimal places. *In the OMR, do not bubble the ⊕ sign for positive values. However, for negative values, Θ sign should be bubbled*. (Example: 6, 81, 1.50, 3.25, 0.08)
- Answer to each question will be evaluated according to the following marking scheme:
  **Full Marks:** +3 If ONLY the correct Integer value is entered. There is **NO negative marking.**
  **Zero Marks:** 0 In all other cases.

## SUBJECT I : PHYSICS — 59 MARKS

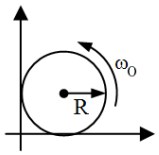
### SECTION-1 | Type A

**This section consists of 5 Multiple Choice Questions**. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE CHOICE** is correct.

**1.** A slender rod of mass $M$ and length $L$ is hinged about one of its ends. Its density is non-uniform and varies linearly, doubling its value from hinged end to free end. Its moment of inertia about the hinge is:

**(A)** $\frac{3ML^2}{16}$ **(B)** $\frac{2ML^2}{9}$ **(C)** $\frac{7ML^2}{18}$ **(D)** $\frac{7ML^2}{12}$

**2.** A uniform solid cylinder of radius $R$ is spinned about its axis to the angular velocity $\omega_0$ and then placed into a corner, see the figure. The coefficient of kinetic friction between the cylinder and the two surfaces (wall and floor) are same and equal to $\mu_k$. Calculate the angular acceleration of the cylinder.



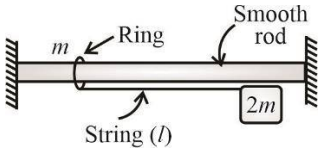

**(A)** $\frac{\mu_k(1+\mu_k)g}{(1+\mu_k^2)R}$ in clockwise direction **(B)** $\frac{\mu_k(1+\mu_k)g}{(1+\mu_k^2)R}$ in anticlockwise direction

**(C)** $\frac{2\mu_k(1+\mu_k)g}{(1+\mu_k^2)R}$ in clockwise direction **(D)** $\frac{2\mu_k(1+\mu_k)g}{(1+\mu_k^2)R}$ in anticlockwise direction

**3.** In given figure, the small block of mass $2m$ is released from rest when the string is in horizontal position. Maximum possible velocity of ring of mass '$m$' is: (Assuming zero friction).

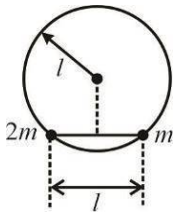
**(A)** $\sqrt{2gl}$ **(B)** $\sqrt{\frac{4gl}{3}}$

**(C)** $\sqrt{\frac{8gl}{3}}$ **(D)** $2\sqrt{2gl}$




**SPACE FOR ROUGH WORK**

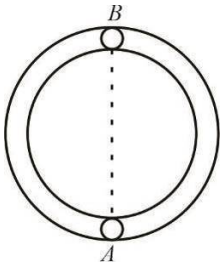
**4.** Two beads of mass 2 *m* and *m*, connected by a rod of length *l* and of negligible mass are free to move in a smooth vertical fixed circular wire frame of radius *l* as shown. Initially the system is held in horizontal position (Refer figure).




The velocity that should be given to mass 2*m* (when rod is in horizontal position) in counter-clockwise direction so that the rod just becomes vertical is:

**(A)** $\sqrt{\frac{5gl}{3}}$ **(B)** $\sqrt{\left(\frac{3\sqrt{3}-1}{3}\right)gl}$ **(C)** $\sqrt{\frac{3}{2}gl}$ **(D)** $\sqrt{3gl}$

**5.** Two identical spheres *A* and *B* lie on a smooth horizontal circular groove at opposite ends of a diameter. At time $t = 0$, *A* is projected along the groove and it first impinges on *B* at time $t = T_1$ and again at time $t = T_2$. If *e* is the coefficient of restitution, the ratio of $T_2/T_1$ is:




**(A)** $\frac{2}{e}$ **(B)** $\frac{(2+e)}{2}$

**(C)** $\frac{2(e+1)}{e}$ **(D)** $\frac{(2+e)}{e}$

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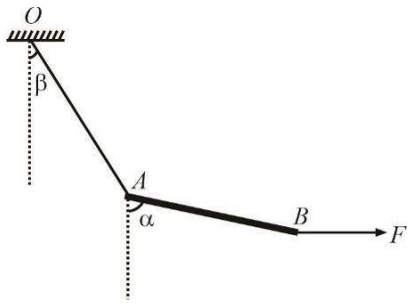
## SECTION-1 | Type B

**This section consists of 5 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.

**6.** A stick *AB* of mass *M* is tied at one end to a light string *OA*. A horizontal force $F = Mg$ is applied at end *B* of the stick and its remains in equilibrium in position shown. Then angles $\alpha$ and $\beta$ are:




**(A)** $\alpha = \tan^{-1}\left[\frac{1}{2}\right]$ **(B)** $\beta = 60°$

**(C)** $\alpha = \tan^{-1}[2]$ **(D)** $\beta = \tan^{-1}\left[\frac{1}{2}\right]$

**7.** Disc *A* of radius *r* moving with speed 5 *m*/*s* on a smooth horizontal surface hits another disc *B* of radius 2*r* lying at rest. At the moment of impact, the velocity vector of centre of disc *A* is at a perpendicular distance 1.8*r* from centre of disc *B*. It is observed that discs move perpendicular to each other after impact. Mass of *A* is 1 kg and mass of B is 4 kg, both discs are smooth. Choose the correct options.

**(A)** Velocities of A and B after impact are $V_A = 4\,m/s$ and $V_B = 0.75\ m/s$

**(B)** Velocities of A and B after impact are $V_A = 3\,m/s$ and $V_B = 1\ m/s$

**(C)** The collision is perfectly elastic

**(D)** The collision is not elastic with coefficient of restitution 0.25

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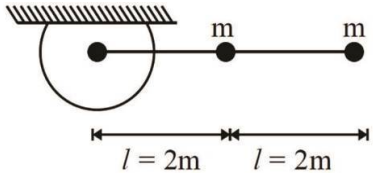
**8.** A light rod of length 4 m is connected rigidly with two identical particles each of mass $m$ = 2 $kg$. The free end of the rod is smoothly pivoted. The rod is released from rest from its horizontal position. Which of these options is (are) correct ? (Take $g = 10\ m/s^2$.)




**(A)** The moment of inertia of the system about the pivot is 40 $kg\text{-}m^2$

**(B)** The horizontal component of the reaction force just after release of the system is 6 $N$

**(C)** The vertical component of the reaction force just after release of the system is 4 $N$

**(D)** The direction of the force applied by the rod on the particle at the outer end of the rod is upward (just after release)

**9.** A uniform disc of radius $R$ is given angular speed $\omega_0$ and then gently placed with its flat face on a horizontal surface. The coefficient of friction is $(\mu)$. Which of these options is (are) correct?

**(A)** The time in which disc will stop is $\dfrac{3\omega_0 R}{4\mu g}$

**(B)** The angular retardation of disc is $\dfrac{4}{3}\dfrac{\mu g}{R}$

**(C)** Torque on disc due to friction is $\dfrac{3}{4}\mu mgR$

**(D)** The disc cannot be stopped

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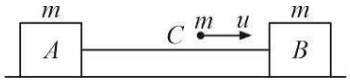
**10.** Two identical blocks *A* and *B*, connected by a massless string are placed on a frictionless horizontal plane. A bullet having same mass, moving with speed *u* strikes block *B* from behind as shown. If the bullet gets embedded into the block *B* then choose the correct statements.




**(A)** The velocity of *A*, *B*, *C* after collision is $\frac{u}{3}$

**(B)** Impulse on *A* due to tension in the string $\frac{2mu}{3}$

**(C)** Impulse on *C* due to normal force of collision $\frac{-mu}{3}$

**(D)** Impulse on *B* due to normal force of collision $\frac{2mu}{3}$

**SPACE FOR ROUGH WORK**

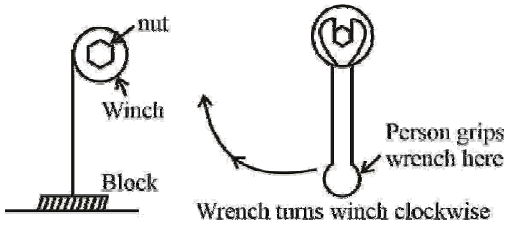
## SECTION-1 | Type C

**This section consists of ONE (01) paragraph**. Based on each paragraph, there are **TWO (02)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.

**PARAGRAPH FOR Q-11 & 12**

In figure, the winch is mounted on an axle, and the 6-sided nut is welded to the winch. By turning the nut with a wrench, a person can rotate the winch. For instance, turning the nut clockwise lifts the block off the ground, because more and more rope gets wrapped around the winch.

Three students agree that using a longer wrench makes it easier to turn the winch. But they disagree about why. All three students are talking about the case where the winch is used, over a 10*s* time interval, to lift the block one metre of the ground. Assume the winch and nut to have negligible mass.




**Student 1:** By using a longer wrench, the person decreases the average force he must exert on the wrench, in order to lift the block one metre in 10*s*.

**Student 2:** Using a longer wrench reduces the work done by the person as he uses the winch to lift the block 1*m* in 10s.

**Student 3:** Using a longer wrench reduces the power that the person must exert to lift the block 1*m* in 10*s*.

**11.** Student 1 is:

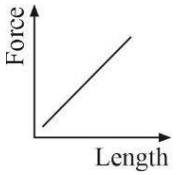
**(A)** Correct, because the torque that the wrench must exert to lift the block doesn't depend on the wrenchs length

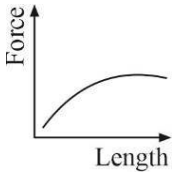
**(B)** Correct, because using a longer wrench decreases the torque it must exert on the winch

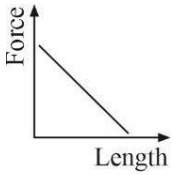
**(C)** Incorrect, because the torque that the wrench must exert to lift the block doesn't depend on the wrenchs length

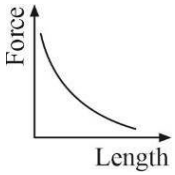
**(D)** Incorrect, because using a longer wrench decreases the torque it must exert on the winch

**12.** If several wrenches all apply the same torque to a nut, which graph best expresses the relationship between the force the person must apply to the wrench, and the length of the wrench:

**(A)** 


**(B)** 


**(C)** 

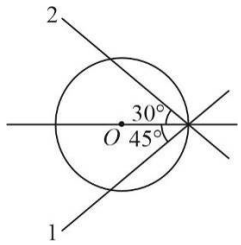

**(D)** 


**SPACE FOR ROUGH WORK**

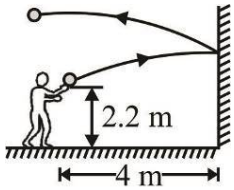
## SECTION-2

**This section consists of 6 Numerical Value Type Questions**. The answer to each question is a **NUMERICAL VALUE**. For each question, enter the correct numerical value of the answer. If the answer is a decimal numerical value, then round-off the value to TWO decimal places. If the answer is an Integer value, then do not add zero in the decimal places. *In the OMR, do not bubble the ⊕ sign for positive values. However, for negative values, Θ sign should be bubbled*. (Example: 6, 81, 1.50, 3.25, 0.08)

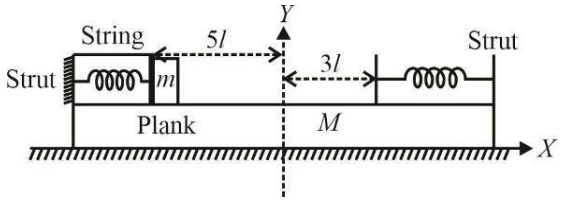
**1.** Calculate the ratio of moment of inertia of a thin uniform disc about axis 1 and 2 marked in the figure. *O* is the centre of the disc. If the ratio is *m*/*n*, where *m* and *n* are co-primes then report answer as $m \times n$.




**2.** A boy stands $l = 4m$ away from a vertical wall and throws a ball. The ball leaves the boy's hand at $h = 2.2\ m$ above the ground with initial velocity $v_0 = 10\sqrt{2}\ m/\sec$ at an angle of 45° from the horizontal. After striking the wall elastically the ball rebounds. Where does the ball hit the ground? $(g = 10\ m/s^2)$ (write the distance from wall in *m*).

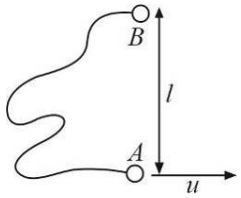



**3.** A plank of mass *M* is placed on a smooth horizontal surface. Two light identical springs each of stiffness *k* are rigidly connected to struts at the end of the plank as shown in the figure. When springs are in its natural length, their free ends are at a distance of $3l$ from *y*-axis. A block of mass *m* is placed on the plank and pressed against left spring so that it is compressed by $2l$. To keep the block at rest it is connected to the strut by means of a light string. Initially the system is at rest. The right spring is in its natural length. Now the string is burnt. The maximum displacement of plank is $\frac{xml}{M+m}$ write *x*.

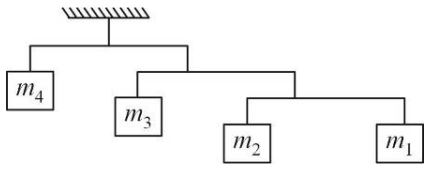



**SPACE FOR ROUGH WORK**

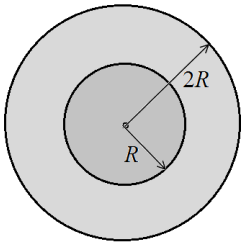
**4.** Two identical balls *A* and *B* each of mass *m* are connected by a light inextensible string of length 2*l*. The whole system is kept on a frictionless horizontal table with an initial distance of *l* between *A* and *B*. A is imparted with speed *u* perpendicular to *AB* while *B* is at rest. The speed of ball *B* after string becomes taut is _____ *m/s*. (Take : *m* = 1 *kg* and $u = 8\sqrt{3}$ *m/s*).




**5.** In the arrangement as shown in figure, which is hanging from a ceiling in equilibrium, each rod is horizontal, has negligible mass and extends three times as far to the right of the wire supporting it as to the left. If mass $m_4$ is 48 *kg*, then $m_3/m_2$ is _____.




**6.** From a thin, uniform circular disc of radius 2*R* and mass per unit area $\sigma_0$, a smaller concentric disc of radius *R* is cut out. Now a disc of radius *R* and mass per unit area $2\sigma_0$ is fixed inside the space created, resulting in the composite disc shown in the figure. If the composite disc is rotated about a diameter with angular velocity $\omega$, its kinetic energy is $\frac{X}{8}(\pi\sigma_0 R^4\omega^2)$. The value of *X* is _____.




**SPACE FOR ROUGH WORK**

## SUBJECT II : CHEMISTRY 59 MARKS

### SECTION-1 | Type A

**This section consists of 5 Multiple Choice Questions**. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE CHOICE** is correct.

**1.** White phosphorus is a tetra atomic solid $P_4$ (s) at room temperature. Find average (P – P) bond enthalpy (in kJ/mol).

Given: $\Delta H_{Sublimation}$ of $P_4(s) = 59$ kJ/mol

$\Delta H_{Atomisation}$ of $P_4(s) = 1265$ kJ/mol

**(A)** 201 **(B)** 1206 **(C)** 301.5 **(D)** 210.83

**2.** Which is not correct?

**(A)** In an exothermic reaction, the enthalpy of products is less than that of reactants

**(B)** $\Delta H_{fusion} = \Delta H_{sublimation} - \Delta H_{vaporisation}$

**(C)** Heat of atomisation is same as heat of sublimation for solid monoatomic molecule

**(D)** $\Delta H$ is less than $\Delta U$ for the reaction, $C(s) + (1/2)O_2(g) \rightarrow CO(g)$

**3.** A mixture of methane $(CH_4)$ and Ethylene $(C_2H_4)$ is in volume ratio X : Y and has a total volume of 30 ml. On complete combustion, it gave 40 ml of $CO_2$. If the ratio becomes Y : X the volume of $CO_2$ obtained would be:

**(A)** 100 ml **(B)** 50 ml **(C)** 75 ml **(D)** 120 ml

**SPACE FOR ROUGH WORK**

**4.** Consider the following four reactions.

**I.** $C(\text{Diamond}) + O_2(g) \longrightarrow CO_2(g)$ **II.** $C(g) + O_2(g) \longrightarrow CO_2(g)$

**III.** $C(s) + 2O(g) \longrightarrow CO_2(g)$ **IV.** $C(\text{graphite}) + O_2(g) \longrightarrow CO_2(g)$

Out of the above reactions, identify the reactions for formation of $CO_2(g)$ under standard conditions:

**(A)** I **(B)** II and IV **(C)** IV **(D)** II, III and IV

**5.** Enthalpy of hydrogenation of cyclohexene is –119 kJ/mole and resonance enthalpy for benzene is –152 kJ/mole. The observed value of enthalpy of hydrogenation of benzene (in kJ/mole) is:

**(A)** –205 **(B)** –152 **(C)** –357 **(D)** –238

**SPACE FOR ROUGH WORK**

## SECTION-1 | Type B

**This section consists of 5 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.

**6.** From the following data, mark the option(s) where $\Delta H$ is correctly written for the given reaction

Given: $H^+(aq) + OH^-(aq) \longrightarrow H_2O(l)$ ; $\Delta H = -57.3$ kJ / mole

$\Delta H_{solution}$ of $HA(g) = -70.7$ kJ/mole

$\Delta H_{solution}$ of $BOH(g) = 20$ kJ/mole

$\Delta H_{Ionisation}$ of HA=15 kJ/mol and BOH is a strong base.

| | **Reaction** | **$\Delta_r H$ (kJ/mol)** |
|---|---|---|
| **(A)** | $HA(aq) + BOH(aq) \longrightarrow BA(aq) + H_2O$ | – 42.3 |
| **(B)** | $HA(g) + BOH(g) \longrightarrow BA(aq) + H_2O$ | – 93 |
| **(C)** | $HA(g) \longrightarrow H^+(aq) + A^-(aq)$ | – 55.7 |
| **(D)** | $B^+(aq) + OH^-(aq) \longrightarrow BOH(aq)$ | – 20 |

**7.** $X_2$, XY and $Y_2$ are diatomic molecules if $\Delta H_{X-X}$, $\Delta H_{Y-Y}$ and $\Delta H_{X-Y}$ are in the ratio of 2 : 1 : 2 and enthalpy of formation of XY from $X_2$ and $Y_2$ is –100 kJ/mol. The value of $\Delta H_{X-X}$ is:

[Take: 1 cal = 4.18 J]

**(A)** 95.6 Kcal/mol **(B)** 23.92 Kcal/mol

**(C)** 100 Kcal/mol **(D)** 400 kJ/mol

**8.** Select the correct observation for a 8.21 lit. container, filled with 2 moles of He at 300 K.

[R = 0.0821 atm-L/mol-K]

**(A)** It has pressure equal to 6 atm at 300 K

**(B)** It has pressure equal to 9 atm at 400 K

**(C)** If it is in a container with movable piston then its volume increases to 16.42 lit. on heating to 600 K under isobaric conditions

**(D)** When connected with another similar empty container maintained at 150 K while maintaining original container at 300 K, pressure reduces to 2/3 atm

**SPACE FOR ROUGH WORK**

**9.** Select the incorrect statement(s).

**(A)** At Boyle's temperature a real gas behaves like an ideal gas irrespective of pressure

**(B)** At critical condition, a real gas behaves like an ideal gas

**(C)** On increasing the temperature four times, collision frequency (Z) becomes double at constant volume

**(D)** At high pressure term having vander Waal's constant 'b' dominates over term having 'a' in the equation of molar compressibility factor.

**10.** For a fixed mass of a gas at constant pressure, which of the following statements is/are not correct?

**(A)** Plot of volume versus temperature (°C) is linear with zero y-intercept

**(B)** Plot of volume and absolute temperature is linear with a non-zero intercept

**(C)** Plot of V/T versus T (Kelvin) is linear with a positive slope

**(D)** Plot of V/T versus T (Kelvin) is linear with a zero slope

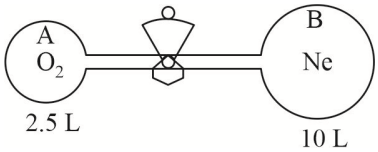
**SPACE FOR ROUGH WORK**

## SECTION-1 | Type C

**This section consists of ONE (01) paragraph**. Based on each paragraph, there are **TWO (02)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.

**PARAGRAPH FOR Q-11 & 12**

Consider the following apparatus of connected vessels.




Initially, flask A contained oxygen gas at 27°C and 950 mm of Hg and flask B contained neon gas at 27°C and 900 mm of Hg. Finally, these two flasks were joined by means of a narrow tube of negligible volume equipped with a stop cork and gases were allowed to diffuse. The final pressure in the combined system was found to be 910 mm of Hg. [R = 0.082 atm-L/mole-K]

**11.** How many moles of gas are present in flask A in the final condition?

**(A)** 0.155 **(B)** 0.122 **(C)** 0.022 **(D)** 0.222

**12.** If flask B were heated to 127°C, maintaining flask A at constant temperature 27°C, final pressure in the combined system would have been.

**(A)** 1037 mm of Hg **(B)** 1250 mm of Hg

**(C)** 1137 mm of Hg **(D)** 990 mm of Hg

**SPACE FOR ROUGH WORK**

## SECTION-2

**This section consists of 6 Numerical Value Type Questions**. The answer to each question is a **NUMERICAL VALUE**. For each question, enter the correct numerical value of the answer. If the answer is a decimal numerical value, then round-off the value to TWO decimal places. If the answer is an Integer value, then do not add zero in the decimal places. *In the OMR, do not bubble the ⊕ sign for positive values. However, for negative values, Θ sign should be bubbled*. (Example: 6, 81, 1.50, 3.25, 0.08)

**1.** The rate of effusion of two gases A and B under identical conditions of T and P are in the ratio of 2 : 1. The ratio of RMS velocity of their molecules is x if $T_A$ and $T_B$ are in the ratio of 2 : 1. Find x?

[Take $\sqrt{2} = 1.4$]

**2.** The standard molar enthalpy of combustion of yellow phosphorous $P_4(s)$ is –9.9 kJ/mol of P and standard molar enthalpy of combustion of an another allotrope of phosphorus $P_2(s)$ is –8.65 kJ/mol of P. The enthalpy change for the following process (in kJ unit) is:

$$2P_2(s) \longrightarrow P_4(s)$$

**3.** A gaseous substance $A_n$ remains partially dissociated as

$$A_n(g) \rightleftharpoons nA(g)$$

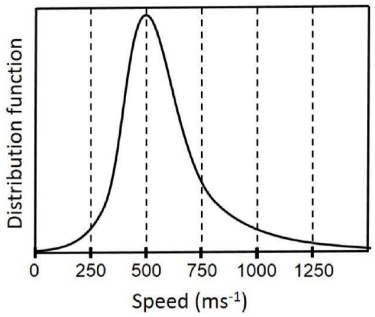
If the given sample of gas has $A_n(g)$ 52% dissociated and the equilibrium mixture diffuses 1.25 times slower than pure oxygen gas under identical condition, determine 'n'. Atomic weight of A is 32.

**SPACE FOR ROUGH WORK**

**4.** The van der Waal's constants for a gas are $a = 0.36\ \text{atm L}^2\ \text{mol}^{-2}$, $b = 0.5\ \text{L mol}^{-1}$. If $R = 0.08\ \text{L atm K}^{-1}\ \text{mol}^{-1}$, what is the Boyle's temperature (in Kelvin) of this gas?

**5.** Calculate magnitude of the enthalpy change (in cal) when 50 mL of 0.01 M $Ca(OH)_2$ reacts with 25 mL of 0.01 M HCl. Given that $\Delta H°$ of a strong acid and strong base is –140 kcal equivalent$^{-1}$.

**6.** The Maxwell distribution of speeds of a gas at 300 K is given below.




The molar mass (in g mol$^{-1}$) of this gas is _____. (Round off to nearest integer)
[Take R = 8.3 J/mole-K]

**SPACE FOR ROUGH WORK**

## SUBJECT III : MATHEMATICS — 59 MARKS

### SECTION-1 | Type A

**This section consists of 5 Multiple Choice Questions**. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE CHOICE** is correct.

**1.** How many complex numbers $z$ satisfy $|(z-2+3i)|=6$ and $|z-4-i|=|z-12-i|$.

**(A)** One **(B)** Two **(C)** Three **(D)** Four

**2.** The complex number $z$ having least positive argument satisfying the condition $|z-25i|\le 15$ is:

**(A)** $25i$ **(B)** $16+25i$ **(C)** $16+12i$ **(D)** $12+16i$

**3.** Let $A$ and $B$ be any two points on $y$-axis and the line $y = 2x$ respectively. Also $P$ and $Q$ be the feet of perpendicular from $A$ and $B$ on the line $y = 2x$ and $y$-axis respectively. If $AB$ passes through the points $(1, 3)$, then the line $PQ$ passes through fixed point $(x_1, y_1)$ such that $y_1/x_1$ is:

**(A)** 5 **(B)** 6 **(C)** 7 **(D)** 8

**4.** If a complex number $z$ satisfying $|z|^2+\frac{4}{|z|^2}-2\left(\frac{z}{\bar{z}}+\frac{\bar{z}}{z}\right)-16=0,$ then the maximum value of $|z|$ is:

**(A)** $\sqrt{6}+1$ **(B)** 4 **(C)** $2+\sqrt{6}$ **(D)** 6

**5.** If for $|z-1|=1,\ z-2=kz\tan(\frac{1}{2}\arg z),$ then $k$ is equal to:

**(A)** $-1$ **(B)** $i$ **(C)** 1 **(D)** 2

**SPACE FOR ROUGH WORK**

## SECTION-1 | Type B

**This section consists of 5 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.

**6.** Possible real ordered pairs $(a, b)$ that satisfy the relation

$(4-3i)a^2+(3+2i)ab=4b^2-\frac{a^2}{2}+(3ab-2b^2)i$ are:

**(A)** (4, –3) **(B)** (6, 9) **(C)** (10, 15) **(D)** (0, 0)

**7.** Two particles start from the same point (2, –1), one moving 2 units along the line $x + y = 1$ and the other 5 units along $x – 2y = 4$. If the particles move towards increasing $y$, then their new positions will be:

**(A)** $(2-\sqrt{2}, \sqrt{2}-1)$ **(B)** $(2\sqrt{5}-2,\ \sqrt{5}-1)$

**(C)** $(2+\sqrt{2}, \sqrt{2}+1)$ **(D)** $(2\sqrt{5}+2, \sqrt{5}-1)$

**8.** Line $\frac{x}{a}+\frac{y}{b}=1$ cut the co-ordinate axes at $A(a, 0)$ and $B(0, b)$ and the line $\frac{x}{a'}+\frac{y}{b'}=-1$ at $A'(-a', 0)$ and $B'(0,-b')$. If the points $A, B, A', B'$ in that order are concyclic then the orthocenter of the triangle $ABA'$ is: (where $a'>0$ and $b'>0$).

**(A)** (0, 0) **(B)** $(0, b')$ **(C)** $\left(0, \frac{aa'}{b}\right)$ **(D)** $\left(0, \frac{bb'}{a}\right)$

**9.** If $z = x + iy$ (where $x, y \in \mathbb{R}$ and $i=\sqrt{-1}$) are complex numbers satisfying $|z-i\,\mathrm{Re}(z)|=|z-\mathrm{Im}(z)|$, then $z$ lies on:

**(A)** $y = x$ **(B)** $y = –x$ **(C)** $y = x + 1$ **(D)** $y = –x + 1$

**10.** If the equation $z^3+(3+i)z^2-3z-(m+i)=0$, where $m \in R$ has at least one real root, then $m$ can have the values equal to:

**(A)** 1 **(B)** 2 **(C)** 5 **(D)** 4

**SPACE FOR ROUGH WORK**

## SECTION-1 | Type C

**This section consists of ONE (01) paragraph**. Based on each paragraph, there are **TWO (02)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.

**PARAGRAPH FOR Q-11 & 12**

Consider two points $A \equiv (1, 2)$ and $B \equiv (3, -1)$. Let $M$ be a point on the straight line $L \equiv x + y = 0$.

**11.** If $M$ be a point on the line $L$ such that $AM + BM$ is minimum, then the reflection of $M$ in the line $x = y$ is:

**(A)** $(1, -1)$ **(B)** $(-1, 1)$ **(C)** $(2, -2)$ **(D)** $(-2, 2)$

**12.** If $M$ be a point on the line $L$ such that $|AM - BM|$ is maximum, then the distance of $M$ from $N \equiv (1, 1)$ is:

**(A)** $5\sqrt{2}$ **(B)** $7$ **(C)** $3\sqrt{6}$ **(D)** $10$

**SPACE FOR ROUGH WORK**

## SECTION-2

**This section consists of 6 Numerical Value Type Questions**. The answer to each question is a **NUMERICAL VALUE**. For each question, enter the correct numerical value of the answer. If the answer is a decimal numerical value, then round-off the value to TWO decimal places. If the answer is an Integer value, then do not add zero in the decimal places. *In the OMR, do not bubble the ⊕ sign for positive values. However, for negative values, Θ sign should be bubbled*. (Example: 6, 81, 1.50, 3.25, 0.08)

**1.** $z_1$, $z_2$ and $z_3$ are complex numbers with $|z_1|=|z_2|=|z_3|=1$, $z_1+z_2+z_3=1$ and $z_1z_2z_3=1$. Then $|(z_1+2)(z_2+2)(z_3+2)|$ is equal to_____.

**2.** Let $z$ be a complex number satisfying $|z-3|\le|z-1|$, $|z-3|\le|z-5|$, $|z-i|\le|z+i|$ and $|z-i|\le|z-5i|$. The area of the region in which $z$ can lies is equal to _____.

**3.** Consider the family of lines $(x-y-6)+\lambda(2x+y+3)=0$ and $(x+2y-4)+\mu(3x-2y-4)=0$. If the lines of these 2 families are at right angle to each other and the locus of their point of intersection is $x^2+y^2+2gx+2fy+c=0$ then $2g+f-c$ is equal to _____.

**4.** The four points $P$, $Q$, $R$ and $S$ are taken on the $x$-axis such that $x$-coordinates of $P$ and $Q$ are the roots of equation $a_1x^2+2b_1x+c_1=0$ and $x$-coordinates of $R$ and $S$ are the roots of $a_2x^2+2b_2x+c_2=0$. Let R and S divide PQ internally and externally in the ratio k : 1, if $a_1c_2+a_2c_1=kb_1b_2$ then the value of $k$ is:

**5.** The ordinate of a point $P$ on the line $6x + y = 9$, which is closest to the point (–3, 1) can be expressed in the form $a/b$, where $a,\ b\in N$ and are in lowest form, then find the value $(a + b)$.

**6.** A ray of light is sent along the line $x - 2y - 3 = 0$. Upon reaching the line $3x - 2y - 5 = 0$, the ray is reflected from it. If the equation of the line containing the reflected ray is expressed in the form of $ax-by-c=0$. Given that $a, b, c$ are positive integers. Find the smallest value of $a + b + c$.

**SPACE FOR ROUGH WORK**

SPACE FOR ROUGH WORK

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