MasterJEE

IIT-JEE | Medical | Foundations

Master JEE CLASSES

Kukatpally, Hyderabad.

JEE-ADVANCE-2013-P1-Model

Max. Marks: 180

PAPER-I

IMPORTANT INSTRUCTIONS:

1) This booklet is your Question Paper.
2) Use the Optical Response Sheet (ORS) provided separately for answering the questions
3) Blank spaces are provided within this booklet for rough work.
4) Write your name, roll number and sign in the space provided on the back cover of this booklet.
5) You are allowed to take away the Question Paper at the end of the examination.

OPTICAL RESPONSE SHEET:

6) Darken the appropriate bubbles on the ORS by applying sufficient pressure. This will leave an impression at the corresponding place on the Candidate's sheet.
7) The ORS will be collected by the invigilator at the end of the examination.
8) Do not tamper with or mutilate the ORS. **Do not use the ORS for rough work**.
9) Write your name, roll number and code of the examination center, and sign with pen in the space provided for this purpose on the ORS. **Do not write any of these details anywhere else** on the ORS. Darken the appropriate bubble under each digit of your roll number.

DARKENING THE BUBBLES ON THE ORS

10) Use a **BLACK BALL POINT PEN** to darken the bubbles on the ORS.
11) Darken the bubble **COMPLETELY**.
12) The correct way of darkening a bubble is as :
13) The ORS is machine-gradable. Ensure that the bubbles are darkened in the correct way.
14) Darken the bubbles ONLY IF you are sure of the answer. There is NO WAY to erase or

JEE-ADVANCE-2013-P1-Model

Time: 07:30 AM – 10:30 AM **IMPORTANT INSTRUCTIONS** **Max Marks: 180**

PHYSICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 1 – 10)	Questions with Single Correct Choice	2	0	10	20
Sec – II(Q.N : 11 – 15)	Questions with Multiple Correct Choice	4	-1	5	20
Sec – III(Q.N : 16 – 20)	Questions with Integer Answer Type	4	-1	5	20
Total				**20**	**60**

CHEMISTRY:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 21 – 30)	Questions with Single Correct Choice	2	0	10	20
Sec – II(Q.N : 31 – 35)	Questions with Multiple Correct Choice	4	-1	5	20
Sec – III(Q.N : 36 – 40)	Questions with Integer Answer Type	4	-1	5	20
Total				**20**	**60**

MATHEMATICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 41 – 50)	Questions with Single Correct Choice	2	0	10	20
Sec – II(Q.N : 51 – 55)	Questions with Multiple Correct Choice	4	-1	5	20
Sec – III(Q.N : 56 – 60)	Questions with Integer Answer Type	4	-1	5	20
Total				**20**	**60**

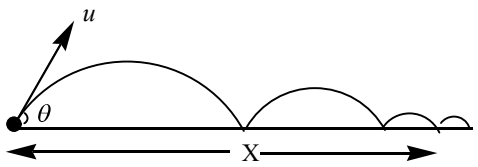
space for rough work

PHYSICS: **Max. Marks: 60**

SECTION - I
Single Correct Answer Type

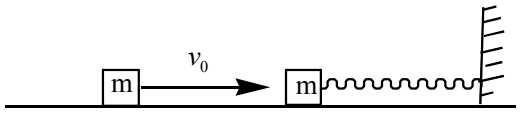
This section contains **10 multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

1. A ball is projected with initial velocity u at an angle θ to the horizontal. Then horizontal displacement covered by ball as it collides third time to the ground would be, if coefficient of restitution is e:



A) $(1+e)\frac{u^2\sin 2\theta}{g}$ B) $e\frac{u^2\sin 2\theta}{g}$ C) $(1-e)\frac{u^2\sin 2\theta}{g}$ D) $\left(1+e+e^2\right)\frac{u^2\sin 2\theta}{g}$

2. In the figure shown surface is frictionless and spring is in natural condition. If x_1, x_2 and x_3 are the maximum compression in spring for elastic, completely inelastic and inelastic (e=0.5) respectively then:

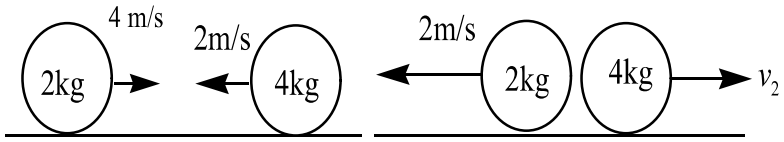


A) $x_1 > x_2 > x_3$ B) $x_2 > x_3 > x_1$ C) $x_1 > x_3 > x_2$ D) $x_2 > x_1 > x_3$

3. A smooth sphere is moving on a horizontal surface with a velocity vector $\left(2\hat{i}+2\hat{j}\right)m/s$ immediately before it hit a vertical wall. The wall is parallel to y-z plane and coefficient of restitution between the sphere and the wall is $e=\frac{1}{2}$. The velocity of the sphere after it hits the wall is:

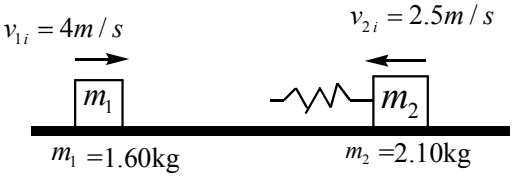
A) $\hat{i}-\hat{j}$ B) $-\hat{i}+2\hat{j}$ C) $-\hat{i}-\hat{j}$ D) $2\hat{i}-\hat{j}$

4. Two balls of masses 2 kg and 4 kg are moved towards each other with velocities 4 m/s and 2 m/s respectively on a frictionless surface .After colliding the 2 kg balls returns back with velocity 2 m/s. Then find, coefficient of restitution of collision



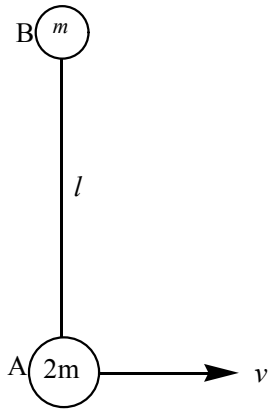
A) 0.5 B) 0.8 C) 1 D) 0.4

5. An elastic collision takes place between two masses m_1 and m_2, moving on a frictionless surface as shown in fig: The spring constant is k=600 N/m. What is the magnitude of velocity of block 2 at the instant block 1 is moving to right with a velocity 3 m/s? (i:initial)



A) $1.64\ m/s$ B) $1.74\ m/s$ C) $1.44\ m/s$ D) $1.34\ m/s$

6. Two masses A and B connected with an inextensible string of length l lie on a smooth horizontal plane. A is given a velocity of $v\ m/s$ along the ground perpendicular to line AB as shown in Fig .Find the tension in string during their subsequent motion.

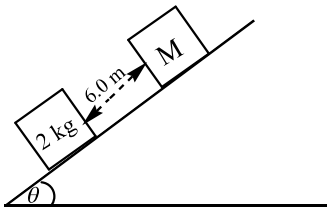


A) $\frac{2mv^2}{3l}$ B) $\frac{3mv^2}{2l}$ C) $\frac{2mv^2}{l}$ D) $\frac{mv^2}{3l}$

7. In an elastic head-on collision of bodies of mass m and $\left(x^2-9x+21\right)m$, the second body is at rest and the maximum transfer of momentum takes place. Find the value of x

A) 7 B) 6 C) 5 D) None of these

8. Two blocks of mass $2\,kg$ and Mkg are at rest on an inclined plane and are separated by a distance of $6.0\,m$ as shown. The coefficient of friction between each block and the inclined plane is 0.25. The 2 kg block is given a velocity of $10.0ms^{-1}$ up the inclined plane. It collides with M , comes back and has velocity of $1.0\,ms^{-1}$ when it reaches its initial position. The other block M after the collision moves 0.5 m up and comes to rest. Take $\sin\theta \cong \tan\theta = 0.05$ and $g = 10\,ms^{-2}$ .Then the approximate value of M is



A) 2.5 kg B) 5 kg C) 10 kg D) 15 kg

9. A rocket, with an initial mass of 1000 kg, is launched vertically upwards from rest under gravity. The rocket burns fuel at the rate of $10kgs^{-1}$. The burnt matter is ejected vertically downwards with a speed of $2000ms^{-1}$ relative to the rocket. If burning ceases

after one minute, find the maximum velocity of the rocket.(Assume g to be constant and have a value $10ms^{-2}$)($l\,n(2.5) = 0.9162$)

A) $1232.6\ m/s$ B) $1332.6\ m/s$ C) $1032.6\ m/s$ D) $932.6\ m/s$

10. A rocket set for vertical firing weights 50 kg and contains 450 kg of fuel. It can have a maximum exhaust velocity of $2kms^{-1}$ with respect to rocket. What should be its minimum rate of fuel consumption to give an acceleration of $20\ m/s^2$

A) $7.5kg/s$ B) $8.5kg/s$ C) $6.5kg/s$ D) $9.5kg/s$

SECTION - II
Multiple Correct Answer(s) Type

This section contains **5 multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE are correct.**

11. A particle of mass m makes a head-on elastic collision with another particle of mass 2m initially rest. The velocity of the first particle before and after collision is given to be u_1 and v_1 and the velocity of second particle after the collision is v_2. Which of the following statements is true in respect of this collision ?

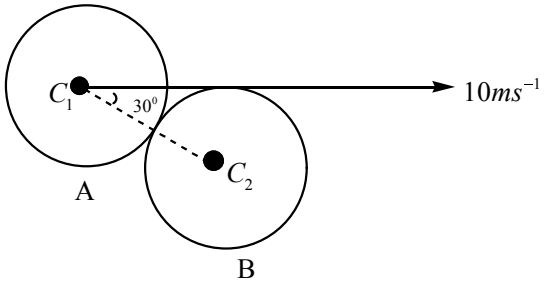
A) For all values of u_1,$v_1$will always be less than u_1 in magnitude.

B) The fractional loss in kinetic energy of the first particle is $\frac{8}{9}$

C) The gain in kinetic energy of the second particle is $\left(\frac{8}{9}\right)^{th}$ of the initial kinetic energy the first particle.

D) There is a net loss in the kinetic energy of the two particle system in the collision.

12. A ball A collides elastically with another identical ball B with a velocity of $10\ ms^{-1}$ making an angle with the line joining their centres C_1 and C_2. select correct statement(s) (there is no friction anywhere)



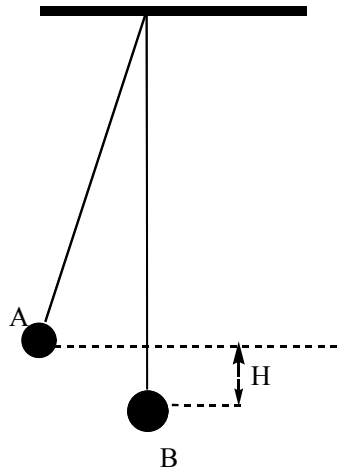
A) Velocity of ball A after collision is $5\ ms^{-1}$

B) Velocity of ball B after collision is $5\sqrt{3}\ ms^{-1}$

C) Kinetic energy will not be conserved here, because collision is not head on.

D) Both the balls move at right angles after collision

13. Two small balls A and B of mass M and 3M hang from the ceiling by strings of equal length. The ball A is drawn aside so that it is raised to a height H. Now the ball A is released such that it collides with ball B. select the correct statement (s)



A) If collision is perfectly elastic, ball B will rise upto a height $\frac{H}{4}$

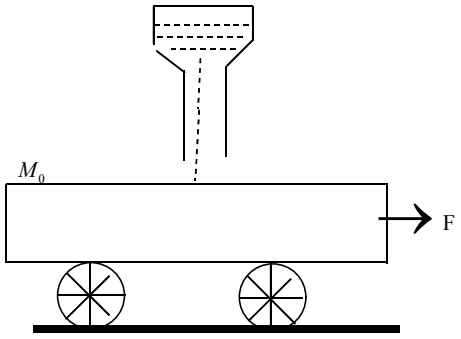
B) If the collision is perfectly elastic, ball A will rise upto a height $\frac{H}{4}$

C) If the collision is perfectly inelastic, the combined mass will rise to a height $\frac{15H}{16}$

D) If the collision is perfectly inelastic, the combined mass will rise to a height $\frac{H}{16}$

14. The figure shows a long cart moving on a smooth horizontal surface due to an external constant force of magnitude F. Initial mass of the cart is M_0 and its initial velocity is zero when the force F started to act. At $t = 0$, sand starts falling from a stationary hopper onto the cart at constant rate μkgs^{-1} and sticks to the cart .After time t_0 the sand

starts leaking from the bottom at the same constant rate μkgs^{-1}.Eventually at time $t = 2t_0$, the sand stops falling from the hopper on to the cart and force F also stops acting. Based on above information, which of the following statement(s) is/are correct



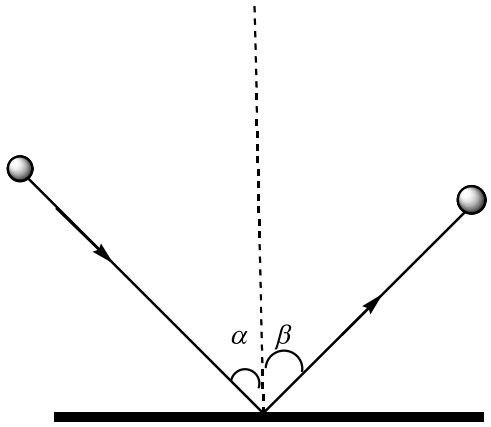
A) The velocity of the cart at time $t(<t_0)$ is $V = \dfrac{Ft}{M_0 + \mu t}$

B) In the same model of above option if the cart is to be moved with constant velocity v, then the power supplied by external agent applying that force is μv^2

C) In the same model of above option B rate of increase of the kinetic energy of the cart (with sand) is $\frac{1}{2}\mu v^2$

D) In the same model of above option B the rate of increase of the kinetic energy of the cart (with sand) is $\frac{1}{3}\mu v^2$

15. A ball strikes the ground at an angle α and rebound at an angle β with the vertical as Shown in the figure. Then (all surfaces are frictionless)



A) coefficient of restitution is $\frac{\tan\alpha}{\tan\beta}$

B) if $\alpha < \beta$ the collision in inelastic

C) if $\alpha = \beta$ the collision is elastic

D) if $\alpha > \beta$ the collision is inelastic

SECTION - III

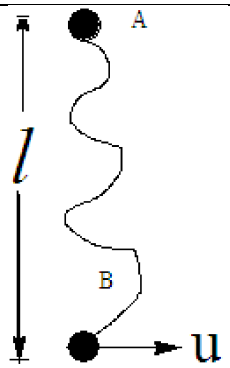
Integer Answer Type

This section contains **5 questions.** The answer to each question is single digit integer, ranging from 0 to 9 (*both inclusive*).

16. A 6000 kg rockets is set for vertical firing. If the exhaust speed is $1000ms^{-1}$, the amount of gas that must be ejected per second to supply the thrust needed to overcome the weight of the rocket is $\left(g=10ms^{-2}\right)10\times x\,kg$ the value of x is.... $\left(g=10m/s^{2}\right)$

17. A sphere of mass m is moving with a velocity $3\hat{i}+4\hat{j}+5\hat{k}$ hits a smooth wall and rebounds with velocity $2\hat{i}+3\hat{j}+2\hat{k}$. Then the coefficient of restitution between the sphere and the wall is n/6. Find n=?

18. Two particles A and B each of mass m are attached by a light inextensible string of length $2l$ .The whole system lies on a smooth horizontal table with B initially at a distance l from A. The particle at end B is projected across the table with speed u perpendicular to AB. Velocity of ball A just after the string is taut is $\frac{u\sqrt{x}}{4}$, the value of x is…



19. A particle of mass m having collided a stationary particle of mass $M = 5m$ deviate by an angle $\frac{\pi}{2}$ where as the particle M recoiled at angle $\theta = 30^0$ to the direction of the initial motion of the particle m .The percentage change in kinetic energy of this system after collision is $8 \times x\%$, the value of x is……

20. A 1 kg ball, moving at $12ms^{-1}$, collides head-on with a 2kg ball moving in the opposite direction at $24ms^{-1}$. If the coefficient of restitution is $\frac{2}{3}$, then the energy lost in the collision is $60 \times x$ joule, the value x is…

CHEMISTRY: **Max. Marks: 60**

SECTION - I
Single Correct Answer Type

This section contains **10 multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

21. Which of the following is false ?

A) VanderWaals forces are responsible for the formation of molecular crystals.

B) Branching lowers the boiling point of isomeric organic compounds due to reduction of Van der Waals forces of attraction

C) In graphite, Van der Waals forces act between the hexagonal.

D) Diamond has layered structure of carbon atoms with VanderWaals forces between the carbon layers.

22. Which of the following statement(s) is/are true ?

i) In N_2 , the doubly degenerate π_{2p} orbitals are completely filled .

ii) In O_2 , the energy of σ_{2p_z} orbital is lower than the doubly degenerate π_{2p} orbitals .

iii) Different molecular species with the same configuration have the same energy.

iv) A π^*_{2p} orbital has two nodal planes.

A) i, ii and iv B) i and ii only

C) i, ii, iii and iv D) ii, iii, iv

23. Correct bond order for $\underset{(1)}{NO^-}, \underset{(2)}{NO^+}, \underset{(3)}{NO},$

A) $1 > 2 > 3$ B) $3 > 2 > 1$ C) $2 > 3 > 1$ D) $2 < 1 < 3$

24. s-p orbitals mixing is seen in

A) F_2 B) C_2 C) O_2^+ D) O_2^-

25. Which of the following species is paramagnetic ?

A) N_2 B) B_2 C) O_2^{2-} D) C_2

26. Which of the following statement is false ?

A) The crystal lattice of ice does not form hydrogen bonds.

B) The density of water increases when heated from 0^0C to 4^0C due to the change in the structure of the cluster of water molecules.

C) Above 4^0C, the thermal agitation of water molecules increases. Therefore, intermolecular distance increases and water starts expanding.

D) The density of water increases from 0^0C to a maximum at 4^0C because the entropy of the system increases.

27. Bond order of which of the following is equal to that of O_2 ?

A) CO B) NO C) CN^+ D) CN^-

28. Metallic lustre is explained by

A) diffusion of metal ions B) oscillation of loose electrons

C) excitation of free protons D)existence of bcc lattice

29. In the compounds of the type ECl_3 where $E = B, P, As (or) Bi$ the angles $Cl - E - Cl$ for different elements E are in the order

A) $B > P = As = Bi$ B) $B > P > As > Bi$ C) $B < P = As = Bi$ D) $B < P < As < Bi$

30. Amongst the following statements

I : The structure of $[BrF_4]^+$ is regular tetrahedral.

II : Bond order of O_2 decreases by the removal of an electron.

III : Br_3^- and Br_3^+ are having same shape and same structure.

IV : The hybrid orbital of phosphorous in PCl_5 is sp^3d_{xy} .

The incorrect statements is/are

A) only II B) I, III, IV

C) I, II, III D) I, II, III, IV

SECTION - II

Multiple Correct Answer(s) Type

This section contains **5 multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE are correct.**

31. Select the correct statement (s) about the compound $NO[BF_4]$:

A) It has $5\sigma \, and \, 2\pi$ bond

B) Nitrogen-oxygen bond length in this compound is longer than nitric oxide (NO)

C) It is a diamagnetic species

D) B – F bond length in this compound is lower than in BF_3

32. Which of the following statement is/are correct ?

A) O_2 is paramagnetic, N_2 is also paramagnetic

B) O_2 is paramagnetic, N_2 is diamagnetic

C) O_2 is paramagnetic, O_2^{2-} is also paramagnetic

D) In $O_2 \rightarrow O_2^+$ and $NO \rightarrow NO^+$, bond length decreases.

33. Which of the following species have identical bond order ?

A) CN^- B) O_2^- C) NO^+ D) Cl_2

34. Which of the following molecular orbital(s) has two nodal planes?

A) Π_{2Py} B) Π^*_{2Px} C) σ^*_{2Pz} D) Π^*_{2Py}

35. Which of the following is/are correct with respect to hydrogen bonding ?

A) It creates infinite chains for HF_2^-.

B) It creates hydrogen bonded chains for molecules like HF, HSO_4^- etc.

C) It is responsible for creating 3_D network in compounds like $H_2O, H_2PO_4^-$.

D) It helps in the dimerization of carboxylic acids.

SECTION - III

Integer Answer Type

This section contains **5 questions.** The answer to each question is single digit integer, ranging from 0 to 9 (*both inclusive*).

36. Maximum number of hydrogen bonds a water molecule can form in ice ?

37. Number of hydrogen bonds in $H_9O_4^+$ species is

38. The sum of number of sigma and pi bonds formed between two carbon atoms in CaC_2 are:

39. Number of pi-bonds in B_2 is:

40. How many of the following statement(s) is/are true ?

1) During N_2^+ formation, from N_2 one electron is removed from the bonding molecular orbitals

2) During O_2^+ formation, from O_2 one electron is removed from the antibonding molecular orbital.

3) During O_2^- formation, from O_2 one electron is added to the bonding molecular orbital.

4) During CN^- formation, one electron is added to the bonding molecular orbital.

5) $\sigma 1s$ molecular orbital has only one nodal plane.

6) $\sigma^* 1s$ molecular orbital has only one nodal plane.

MATHS: **Max. Marks: 60**

SECTION - I
Single Correct Answer Type

This section contains **10 multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

41. Number of values of x for which $\sqrt{1+\cos 2x} = \sqrt{2}\cos^{-1}(\cos x)$ for $x \in \left(\frac{\pi}{2}, \pi\right)$, is

A) 2 B) 0 C) 3 D) ∞

42. If α, β are the solutions of $Tan^{-1}\sqrt{x(x+1)} + \sin^{-1}\sqrt{x^2+x+1} = \frac{\pi}{2}$ then $\cos^{-1}\alpha + \cos^{-1}\beta =$

A) $\frac{\pi}{2}$ B) $-\frac{\pi}{2}$ C) $\frac{3\pi}{2}$ D) $\frac{-3\pi}{2}$

43. $Tan^{-1}\frac{2}{4} + Tan^{-1}\frac{2}{9} + Tan^{-1}\frac{2}{16} + ... + Tan^{-1}\frac{2}{(n+1)^2} + ...$ to $\alpha =$

A) $\cot^{-1}2$ B) $\cot^{-1}2 + \frac{\pi}{4}$ C) $\frac{\pi}{4} - \cot^{-1}2$ D) $\frac{\pi}{2} + \cot^{-1}2$

44. Number of solutions of $2Tan^{-1}(\tan x) = 6 - x$ is

A) 4 B) 2 C) 3 D) 6

45. The least integral value of k for which

$(K-2)x^2 + 8x + k + 4 > \sin^{-1}(\sin 12) + \cos^{-1}(\cos 12) \forall x \in R,$ is

A) -7 B) -5 C) -3 D) 5

46. Let $f(x)=\frac{2}{\pi}\left(\sin^{-1}[x]+Tan^{-1}[x]+\cot^{-1}[x]\right)$ (where [.] denotes G.I.F), if A and B denote the domain and range of $f(x)$ respectively then the number of integers in $A\cup B$ is

A) 1 B) 2 C) 3 D) 4

47. If $\cot^{-1}\left(\frac{n^2-10n+26}{2\sqrt{3}}\right)>\frac{\pi}{6}, n\in N$, then the minimum value of n is

A) 3 B) 5 C) 6 D) 7

48. The number of real solutions of the equation $3\cos^{-1}x-\pi x-\frac{\pi}{2}=0$ is

A) 0 B) 1 C) 2 D) infinitely

49. The value of $\sin^{-1}\frac{1}{\sqrt{2}}+\sin^{-1}\left(\frac{\sqrt{2}-1}{\sqrt{6}}\right)+....+\sin^{-1}\left(\frac{\sqrt{n}-\sqrt{n-1}}{\sqrt{n(n+1)}}\right)+.....to\ \infty\ is\ equal\ to\ (n\in N)$

A) π B) $\frac{\pi}{2}$ C) $\frac{\pi}{4}$ D) $\frac{3\pi}{2}$

50. If $\left(\sin^{-1}a\right)^2+\left(\cos^{-1}b\right)^2+\left(\sec^{-1}c\right)^2+\left(\cos ec^{-1}d\right)^2=\frac{5\pi^2}{2}$ (a, b, c, d ∈ R) then the value of $\left(\sin^{-1}a\right)^2-\left(\cos^{-1}b\right)^2+\left(\sec^{-1}c\right)^2-\left(\cos ec^{-1}d\right)^2$ is

A) $-\pi^2$ B) $\frac{-\pi^2}{2}$ C) 0 D) $\frac{\pi^2}{2}$

SECTION - II

Multiple Correct Answer(s) Type

This section contains **5 multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE are correct.**

51. If

$$Sin^{-1}(\sin 8) - Tan^{-1}(tan 10) + Cos^{-1}(\cos 12) - Sec^{-1}(\sec 9) + Cot^{-1}(\cot 6) - Cosec^{-1}(\operatorname{cosec} 7) = a\pi + b$$

Then which of the following is/are correct?

A) $a-b=53$ B) $3a+b=-1$ C) $4a+b=12$ D) $a-b=27$

52. If $\left(\sin^{-1}x\right)^2+\left(\sin^{-1}y\right)^2+\left(\sin^{-1}z\right)^2=\frac{3\pi^2}{4}$ then the possible value of $x-y+z$ is equal to

A) 1 B) -1 C) 3 D) -3

53. If $\sin^{-1}\left(a-\frac{a^2}{3}+\frac{a^3}{9}-.....\right)+\cos^{-1}\left(1+b+b^2+....\right)=\frac{\pi}{2}\left(|a|<3 \text{ and } |b|<1\right)$, then which of the following is/are correct?

A) $b=\frac{3a-2}{2a}$ B) $b=\frac{2a-3}{3a}$ C) $a=\frac{2}{3-2b}$ D) $a=\frac{3}{2-3b}$

54. If $s_n=\cot^{-1}3+\cot^{-1}7+\cot^{-1}13+\cot^{-1}21+.....$ to n terms then which of the following is/are correct?

A) $s_{10}=Tan^{-1}\frac{5}{6}$ B) $s_\infty=\frac{\pi}{4}$ C) $s_6=\sin^{-1}\frac{3}{5}$ D) $s_{20}=\cot^{-1}(101)$

55. If $\sin^{-1}\left(x^2+2x+2\right)+Tan^{-1}\left(x^2-3x-k^2\right)>\frac{\pi}{2}$ (x ∈ R), then k contains the set

A) (-1,0) B) (0,1) C) (1,2) D) (0,2)

SECTION - III

Integer Answer Type

This section contains **5 questions.** The answer to each question is single digit integer, ranging from 0 to 9 (*both inclusive*).

56. If the equation $\sin^{-1}\left(x^2+x+1\right)+\cos^{-1}\left(\lambda x+1\right)=\frac{\pi}{2}$ has exactly two solutions, then the range of $\lambda is[a,b)$ where $a+b=$

57. If $r=x+y+z$ (x, y, z >0) and $Tan^{-1}\sqrt{\frac{xr}{yz}}+Tan^{-1}\sqrt{\frac{yr}{xz}}+Tan^{-1}\sqrt{\frac{zr}{xy}}=K\pi$ then K=

58. Let $f:[0,4\pi]\to[0,\pi]$ be defined as $f(x)=\cos^{-1}(\cos x)$. The number of values of x satisfying the equation $f(x)=\frac{10-x}{10}$ is

59. If $\cot^{-1}\left(2^2+\frac{1}{2}\right)+\cot^{-1}\left(2^3+\frac{1}{2^2}\right)+\cot^{-1}\left(2^4+\frac{1}{2^3}\right)+....to\ \infty=\cot^{-1}k$, then K=

60. If $\sin\left\{2\left[\sin^{-1}\frac{\sqrt{5}}{3}-\cos^{-1}\frac{\sqrt{5}}{3}\right]\right\}=\frac{k\sqrt{5}}{81}$, then the value of k is equal to

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KEY SHEET

PHYSICS

1	D	2	C	3	B	4	A	5	B	6	A
7	C	8	D	9	A	10	A	11	ABC	12	ABD
13	ABD	14	ABC	15	ABC	16	6	17	3	18	3
19	5	20	4								

CHEMISTRY

21	D	22	A	23	C	24	B	25	B	26	A
27	C	28	B	29	B	30	D	31	AC	32	BD
33	AC	34	BD	35	BCD	36	4	37	3	38	3
39	1	40	4								

MATHS

41	B	42	C	43	B	44	C	45	D	46	D
47	A	48	B	49	B	50	C	51	ABC	52	ABCD
53	BD	54	ABC	55	ABCD	56	1	57	1	58	3
59	2	60	8								

SOLUTIONS
PHYSICS

1. After each collision vertical velocity become e times whereas horizontal velocity remain same . So after each collision time of flight become e times of previous one.

   So that horizontal displacement $= R + eR + e^2R = \left(1 + e + e^2\right)\frac{u^2 \sin 2\theta}{g}$

2. For elastic collision Velocity is interchanged

   $\therefore \frac{1}{2}mv_0^2 = \frac{1}{2}kx_1^2 \Rightarrow x_1 = \frac{\sqrt{mv_0}}{k}$

   For completely inelastic collision

   $mv_0 = 2mv \Rightarrow v = \frac{v_0}{2}$

   Now $\frac{1}{2}kx_2^2 = \frac{1}{2}xmv^2 \Rightarrow x_2 = \sqrt{\frac{mv_0}{2k}}$

   For $e = 0.5$

   $-0.5 = \frac{v_2 - v_1}{0 - v_0}$

   $v_2 - v_1 = \frac{v_0}{2}$

   Also $mv_2 + mv_1 = mv_0$

   $v_2 = 0.75v_0 \Rightarrow x_3 = \sqrt{\frac{3mv_0}{4k}}$

3. Along wall momentum is conserved

4. $e = \frac{velocity\ of\ separation}{velocity\ of approach} = \frac{1-(-2)}{4-(-2)} = \frac{3}{6} = 0.5$

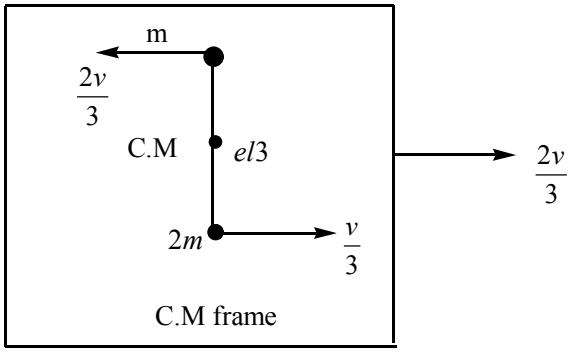
5. From momentum conservation, we obtain $m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$

   $(1.60)(4.00) + (2.10)(-2.50) = (1.60)(3.00) + (2.10)v_{2f}$

   $v_{2f} = -1.74 m/s$

   Negative sign implies that block 2 is still continuing in the same direction

6. Solve the problem in CM frame. In CM frame particles A and B moving along circular path with same ω



Velocity of $2m$ mass $= v - \frac{2v}{3} = \frac{v}{3}$

Angular velocity of particle A

$\omega = \frac{v/3}{l/3} = \frac{v}{l}$

$T = M\omega^2 r = 2m.\frac{v^2}{l^2}.\frac{l}{3}$

$or\ T = \frac{2mv^2}{3l}$

7 For maximum momentum transfer $m_1 = m_2$

8. Conceptual

9. Since, we know that

$v = (u - gt) + v, In\left(\frac{m_0}{m}\right)$

According to the problem we have $u = 0, t = 60s, g = 10ms^2, v_r = 2000ms^{-1}, m_0 = 1000kg$

and $m = 1000 - 10 \times 60 = 400kg$

$\Rightarrow v = 0 - 600 + 2000In\left(\frac{1000}{400}\right)$

$\Rightarrow v = 2000In(2.5) - 600$

The maximum velocity of the rocket is

$v = 200(10In.2.5 - 3) = 1232.6ms^{-1}$

10. Net acceleration $a = 20ms^{-2}$

Since we have $ma = F_1 - mg$

$\Rightarrow a = \frac{F_1}{m} - g$

$\Rightarrow a = \frac{v_r}{m}\left(\frac{-dm}{dt}\right) - g$

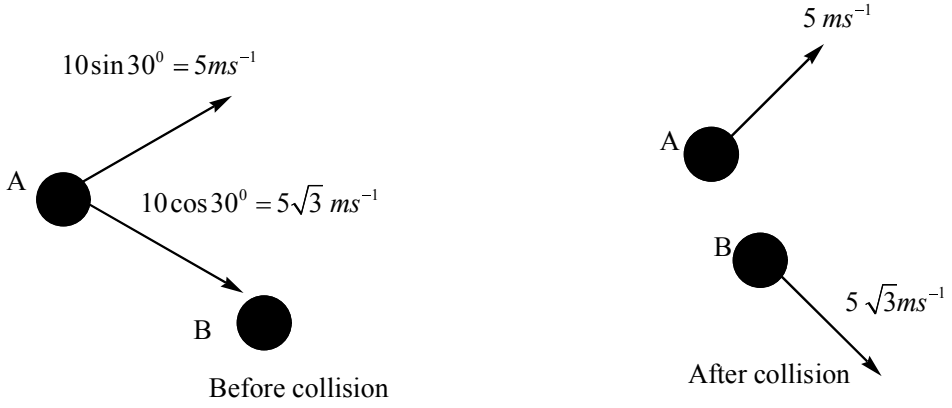
$\Rightarrow \left(-\frac{dm}{dt}\right) = \frac{m(g+a)}{v_r}$

$\Rightarrow \left(-\frac{dm}{dt}\right) = \frac{(450+50)(10+20)}{2\times10^3} = 7.5kgs^{-1}$

11. Impulse $j = \frac{m(v+4)}{t}$

Coefficient of restitution $e = \frac{v_2 - v_1}{u_1 - u_2} = \frac{v}{u}$

12.



Velocity components in common tangent direction will remain unchanged while velocity components in common normal direction are interchanged in case of an elastic

collision Hence both A and B move at right angles after collision with $v_A = 5ms^{-1}$ and $v_B = 5\sqrt{3}ms^{-1}$. Kinetic energy is conserved in an elastic collision. Whether it a head on or an oblique collision

13. Before collision $v_A = \sqrt{2gH}$ and $v_B = 0$

$$v_A = \left(\frac{m_A - m_B}{m_A + m_B}\right)v_A$$

$$\Rightarrow v_A = \left(\frac{M - 3M}{M + 3M}\right)\sqrt{2gH} = -\frac{\sqrt{2gh}}{2}$$

and $v_B = \left(\frac{2m_A}{m_A + m_B}\right)v_A$

$$\Rightarrow v_B = \left(\frac{2M}{M + 3M}\right)\sqrt{2gH} = \frac{\sqrt{2gH}}{2}$$

So, $h_A = \frac{v_A^2}{2g} = \frac{H}{4}$ and $h_B = \frac{v_B^2}{2g} = \frac{H}{4}$

$$v_A = \frac{m_A v_A}{m_A + m_B} = \frac{M\sqrt{2gH}}{M + 3M} = \frac{\sqrt{2gH}}{4}$$

The combined mass will rise to height

$$h = \frac{v^2}{2g} = \frac{H}{16}$$

14. By Newton's Law

$$F - \mu v = (M + \mu t)\frac{dv}{dt}$$

$$\Rightarrow \int_0^v \frac{dv}{F - \mu V} = \int_0^t \frac{dt}{M + \mu t}$$

$$\Rightarrow v = \frac{Ft}{M_0 + \mu t}$$

For constant velocity $\frac{dv}{dt} = 0$

So, from (1) we get $F = \mu v^2$

$$K = \frac{1}{2}Mv^2$$

For constant velocity v= constant

$$\Rightarrow \frac{dk}{dt} = \frac{v^2}{2}\frac{dn}{dt}$$

Since $M = M_0 + \mu t$

$$\Rightarrow \frac{dM}{dt} = \mu$$

$$\Rightarrow \frac{dk}{dt} = \frac{1}{2}\mu v^2$$

15. Let velocity of ball before collision and after collision be u and v respectively, then

$$e = \frac{v\cos\beta}{u\cos\alpha}$$

And by law of conservation of momentum along horizontal direction we get

$u\sin\alpha = v\sin\beta$

From (1) and (2) we get

$$e = \frac{\tan\alpha}{\tan\beta}$$

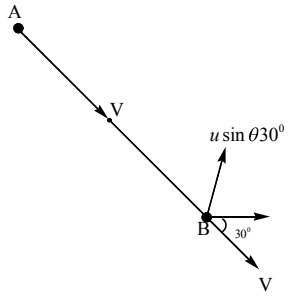
16. $M_0 g = Thrust = v\frac{dM}{dt}$

$$\Rightarrow \frac{dM}{dt} = \frac{M_0 g}{v}$$

$$\Rightarrow \frac{dM}{dt} = \frac{60000}{1000} = 60 kgs^{-1}$$

17. $$\frac{\vec{V}.\left(\vec{V} - \vec{U}\right)}{\vec{U}.\left(\vec{V} - \vec{U}\right)} = e$$

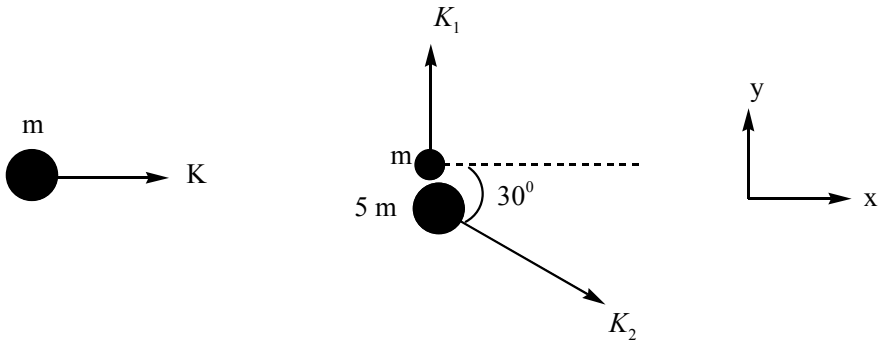
18. when the string becomes taut both particle begin to move with velocity components v in the direction AB. Applying Law of conservation of liner momentum in the direction AB we get $mu\cos 30^0 = mv + mv$



$\Rightarrow v = \frac{u\sqrt{3}}{4}$

Hence the velocity of ball A just after the string becomes taut is $\frac{u\sqrt{3}}{4}$

19. Let K be the initial kinetic energy of mass m and K_1 and K_2 the kinetic energy after collision in the direction shown in figure initial momentum of the particle is $\sqrt{2mK}$
So applying conservation of liner momentum in vector from, we get



$\sqrt{2mK}\,\hat{i} = \sqrt{2mK_1}\,\hat{j} + \sqrt{2MK_2}\left(\cos 30\hat{i} - \sin 30\hat{j}\right)$

$\Rightarrow \sqrt{2mK} = \sqrt{10mK_2}\,\frac{\sqrt{3}}{2}$

$\sqrt{2mK_1} = \sqrt{10mK_2}\,\frac{1}{2}$

Solving we get $K_2 = \frac{4}{15}K$ and $K_1 = \frac{K}{3}$

$\Rightarrow K_1 + K_2 = \frac{9}{15}K = 0.6K$

So. Loss in $KE = K - 0.6K = 0.4K$

Hence, KE will be decreased by 40%

20. $(1)(12) + (2)(-24) = 1v_1 + 2v_2$

$\Rightarrow v_1 + 2v_2 = -36$

Further

$e = -\left(\frac{v_2 - v_1}{u_2 - u_1}\right)$

$\Rightarrow \frac{2}{3} = -\left(\frac{v_2 - v_1}{-24-12}\right)$

$\Rightarrow \frac{2}{3} = \frac{v_2 - v_1}{36}$

$\Rightarrow v_2 - v_1 = 24$

Add(1) and (2)

$3v_2 = -12$

$\Rightarrow v_2 = -4ms^{-1}$

$\Rightarrow v_1 = -28ms^{-1}$

$\Rightarrow$ Loss= Total initial – Total final

Since

Total initial $= \frac{1}{2}(1)(144) + \frac{1}{2}(2)(16)$

$\Rightarrow E_1 = 72 + 576 = 648J$

Similarly

$E_f = \frac{1}{2}(1)(784) + \frac{1}{2}(2)(16)$

$\Rightarrow E_f = 392 + 16$

$\Rightarrow E_f = 408J$

$\Rightarrow Loss = 648 - 408$

$\Rightarrow Loss = 240J$

CHEMISTRY

21. Diamond a is crystalline covalent solid.

22. The σ_{2p_z} orbital in O_2 is than the doubles degenerate π_{2p} orbitals and more than π_{2p} orbitals in in N_2 from MOT.

23. $B.O \Rightarrow NO = 2.5$

$NO^+ = 3.0\,;\, NO^- = 2.0$

$NO^+ > NO > NO^-$

24. $s-p$ mixing is observed in B_2, C_2, N_2 or in species with total electrons $\leq$ 14

25. B_2 has two unpaired electron

26. Ice also has hydrogen bonds, a water molecule in ice is surrounded by 4 more water molecules through H-bonds

27. Bond order of $CN^+ = \frac{Nb - Na}{2}$

$$= \frac{8-4}{2} = 2$$

Bond order of $O_2 = 2$

28. Metallic lustre is due to free valancy electrons.

29. With decrease in electronegativity of central atom, bond angle decreases. BCl_3 has trigonal planar structure with 120^o angles

30. I : BrF_4^+ : Trigonal bipyramidal structure and see-saw shape

II : Bond order of O_2 increases by the removal of e^-, thus bond order increases.

III : Br_3^- and Br_3^+ are of different shape and structure.

IV : In PCl_5, hybrid orbital of P is $sp^3d_{z^2}$

31. Bond order of NO^+ is = 3, one sigma bond and two pie bonds.

No of pie bonds = 2

No of sigma bonds = 5

B.O. of NO^+ = 3

B.O. of NO = 2.5

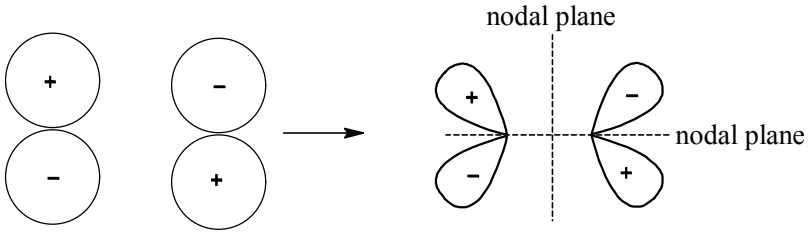
NO^+ is the diamagnetic cation and BF_4^- is also a diamagnetic anion.

B – F bonds are longer in BF_4^- than in BF_3 due to absence of $P\pi - d\pi$ back bonding in $[BF_4]^-$.

32. O_2 is paramagnetic due to 2 unpaired electrons while N_2 & O_2^{2-} are diamagnetic. In conversion of $O_2 \rightarrow O_2^+$ and $NO \rightarrow NO^+$, e^- from antibonding orbital $\left(CN^-, N_2, NO^+, C_2^{2-}\right)$ is removed, thus bond order increases & bond length decreases.

33. Isoelectronic species has same bond order

34.

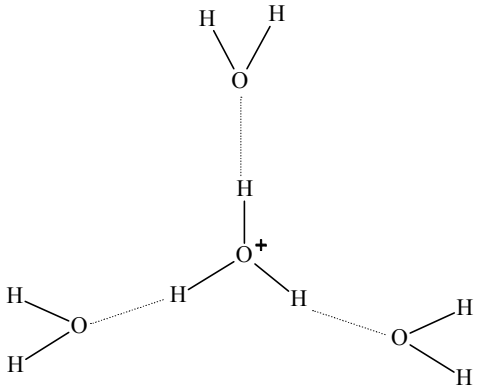


Π^* overlap

35. $HF_2^{(-)}$ exists in discrete form as salt, KHF_2 .

36. A water molecule can form 4 hydrogen bonds in ice.

37.



38. C_2^{2-} has one sigma and two pi bonds

39. B_2 has two pi electrons in bonding MO's, so it translates into one π-bond

40. During O_2^- formation, one electron is added to the antibonding molecular orbital.

$\sigma^* 1s$ molecular orbital has only one nodal plane.

MATHEMATICS

41. $\sqrt{1+\cos 2x} = \sqrt{2}\cos^{-1}|\cos x| \Rightarrow \cos x = x$ for $x \in \left(\frac{\pi}{2}, \pi\right)$

42. $x(x+1) \geq 0$ & $x^2 + x + 1 \leq 1 \Rightarrow x(x+1) = 0 \Rightarrow x = -1, 0$

43. $s_n = \sum Tan^{-1}\left(\frac{2}{n^2+2n+1}\right) = Tan^{-1}(n+1) + Tan^{-1}(n+2) - Tan^{-1}1 - Tan^{-1}2$

$s_\infty = \frac{\pi}{4} + \cot^{-1}2$

44. $Tan^{-1}\tan(x) = 3 - \frac{x}{2}$

No. of solutions is equal to no. of points of integer of $y = Tan^{-1}(\tan x)$ and $y = 3 - \frac{x}{2}$

45. $\cos^{-1}\cos 12 + \sin^{-1}\sin 12 = 0$

$\therefore (k-2)x^2 + 8x + k + 4 > 0 \forall x \in R$

$\Rightarrow K - 2 > 0 \;\&\; 64 - 4(K-2)(K+4) < 0$

$\Rightarrow K > 4$

46. $A = [-1, 2), B = \{0, 1, 2\}$

47. $\frac{n^2 - 10n + 26}{2\sqrt{3}} < \sqrt{3}$

48. $\cos^{-1}x=\frac{\pi}{3}x+\frac{\pi}{6}$ Draw the graph

49. $s_n=\sin^{-1}\left[\frac{\sqrt{n}-\sqrt{n-1}}{\sqrt{n(n+1)}}=\sum Tan^{-1}\frac{\sqrt{n}-\sqrt{n-1}}{1+\sqrt{n}\sqrt{n-1}}=\sum\left(Tan^{-1}\sqrt{n}-Tan^{-1}\sqrt{n-1}\right)\right.$

$s_\infty=\frac{\pi}{2}-0=\frac{\pi}{2}$

50. $\left(\sin^{-1}a\right)^2=\frac{\pi}{4},\left(\cos^{-1}b\right)^2=\pi^2,\left(\sec^{-1}c\right)^2=\pi^2,\left(\cos e^{-1}d\right)^2=\frac{\pi^2}{4}$

51. $\sin^{-1}\sin 8=3\pi-8,\tan^{-1}\left(Tan10\right)=10-3\pi,\cos^{-1}\cos 12=4\pi-12$

$\cot^{-1}\cot^6=6-\pi,\sec^{-1}\sec 9=9-2\pi,\cos ec^{-1}\cos ec7=7-2\pi$

52. $\sin^{-1}x=\pm\frac{\pi}{2},\sin^{-1}y=\pm\frac{\pi}{2},\sin^{-1}z=\pm\frac{\pi}{2}$

53. $a-\frac{a^2}{3}+\frac{a^3}{9}.....=1+b+b^2+.....$

54. $s_n=\sum_{r=1}^{n}\left(Tan^{-1}\left(r+1\right)-Tan^{-1}r\right)$

55. Domain $=\{-1\}$

$\therefore\frac{\pi}{2}+Tan^{-1}\left(4-K^2\right)>\frac{\pi}{2}$

$4-K^2>0$

56. $x^2+x+1=\lambda x+1\Rightarrow x=0,\lambda-1$

$-1\le\lambda x+1\le 1\Rightarrow\lambda\in[0,1)$

57. Take $x=y=z$

58. Draw the graph of $y=\cos^{-1}\cos x$ and $y=\frac{10-x}{10}$

59. $\sum_{r=1}^{\infty}Let^{-1}\left(2^{2+1}+\frac{1}{2^2}\right)=\sum_{r=1}^{\infty}\left(Tan^{-1}\left(2^{r+1}\right)-Tan\left(2^2\right)\right)=\cot^{-1}2$

60. $2\left\{\left[\sin^{-1}\frac{\sqrt{5}}{3}-\cos^{-1}\frac{\sqrt{5}}{3}\right]\right\}$

$=\sin\left\{2\left(\frac{\pi}{2}-2\cos^{-1}\frac{\sqrt{5}}{3}\right)\right\}$

$=\sin\left(4\cos^{-1}\left(\frac{\sqrt{5}}{3}\right)\right)$

$=\frac{8\sqrt{5}}{81}$