JEE (Advanced) 2013 Paper-1 Key

PART I : PHYSICS

Section-1

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

1. The work done on a particle of mass *m* by a force

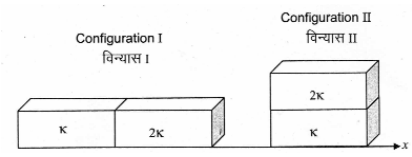
$$K\left[\frac{x}{(x^2+y^2)^{3/2}}\hat{i}+\frac{y}{(x^2+y^2)^{3/2}}\hat{j}\right]$$

(*K* being a constant of appropriate dimensions), when the particle is taken from the point (a, 0) to the point (*0, a*) along *a* circular path of radius a about the orgin in the *x-y* plane is

A) $\frac{2K\pi}{a}$ B) $\frac{K\pi}{a}$ C) $\frac{K\pi}{2a}$ D) 0

Ans: D

2. Two rectangular blocks, having identical dimensions, can be arranged either in configuration I or in configuration II as shown in the figure. One of the blocks has thermal conductivity *k* and the other *2k*. The temperature di-fference between the ends along the *x*-axis is the same in both the configurations. It takes 9 *s* to transport a certain amount of heat from the hot end to the cold end in the configuration I. The time to transport the same amount of heat in the configu-ration II is



A) 2.0s B) 3.0s C) 4.5s D) 6.0s

Ans: A

3. Two non-reactive monoatomic ideal gases have their atomic masses in the ratio 2:3. The ratio of their partial pressures, when enclosed in a vessel kept at a constant temperature, is 4:3. The ratio of their densities is

A) 1:4 B) 1:2 C) 6:9D) 8:9

Ans: D

4. A particle of mass *m* is projected from the ground with an initial speed u_0 at an angle α with the horizontal. At the highest point of its trajectory, it makes a completely inelastic collision with another identical particle, which was thrown vertically upward from the ground with the same intial speed u_0. The angle that the composite system makes with the horizontal immediately after the collision is.

A) $\frac{\pi}{4}$ B) $\frac{\pi}{4}+\alpha$ C) $\frac{\pi}{2}-\alpha$ D) $\frac{\pi}{2}$

Ans: A

5. A pulse of light of duration 100 *ns* is absorbed completely by a small object initially at rest. Power of the pulse is 30 *mW* and the speed of light is $3\times10^8 ms^{-1}$. The final momentum of the object is

A) 0.3×10^{-17} *Kg* ms^{-1}

B) 1.0×10^{-17} *Kg* ms^{-1}

C) 3.0×10^{-17} *Kg* ms^{-1}

D) 9.0×10^{-17} *Kg* ms^{-1}

Ans: B

6. In the Youngs double slit exper-iment using a monochromatic light of wavelenth λ, the path difference (in terms of an integ-er *n*) corresponding to any point having half the peak intensity is

A) $(2n+1)\frac{\lambda}{2}$ B) $(2n+1)\frac{\lambda}{4}$

C) $(2n+1)\frac{\lambda}{8}$ D) $(2n+1)\frac{\lambda}{16}$

Ans: B

7. The image of an object, formed by a plano-convex lens at a distance of 8 *m* behind the lens, is real and is one-third the size of the object. The wavelength of light inside the lens is 2/3 times the wavelength in free space. The radius of the curved surface of the lens is

A) 1*m* B) 2*m* C) 3*m* D) 6*m*

Ans: C

8. One end of a horizontal thick copper wire of length 2*L* and radius 2*R* is welded to an end of another horizontal thin copper wire of length *L* radius *R*. When the arrangement is stretched by applying forcess at two ends, the ratio of the elongation in the thin wire to that in the thick wire is

A) 0.25 B) 0.50 C) 2.00 D) 4.00

Ans: C

9. A ray of light travelling in the direction $\frac{1}{2}(\hat{i}+\sqrt{3}\hat{j})$ is incident on a plane mirror. After reflection, it travels along the direction $\frac{1}{2}(\hat{i}-\sqrt{3}\hat{j})$. The angle of incidence is

A) 30^0 B) 45^0 C) 60^0 D) 75^0

Ans: A

10. The diameter of a cylinder is measured using a Vernier callipers with no zero error. It is found that the zero of the Vernier scale lies between 5.10 cm and 5.15 cm of the main scale. The Vernier scale has 50 divisions equivalent to 2.45cm. The 24^{th} division of the Vernier scale exactly coincides with one of the main scale divisions. The diameter if the cylinder is

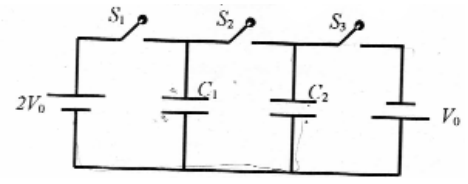
A) 5.112 cm B) 5.124cm
C) 5.136cm D) 5.148cm

Ans: B

Section-2

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

11. In the circuit shown in the figure, there are two parell plate capacitors each of capacitance C. The switch S_1 is pressed first to fully charge the capacitor C_1 and then released. The switch S_2 is then pressed to charge the capacitor C_2. After some time, S_2 is released and then S_3 is pressed. After some time,



A) the charge on the upper plate of C_1 is $2CV_0$
B) the charge on the upper plate of C_1 is CV_0
C) the charge on the upper plate of C_2 is 0
D) the charge on the upper plate of C_2 is $-CV_0$

Ans: B, D

12. A particcle of mass M and positive charge Q, moving with a constant velocity $\vec{u_1} = 4\hat{i}\, ms^{-1}$, enters a region of uniform static magnetic field normal to the X-Y plane. The region of the magnetic field extends from x=0 to x=L for all values of y. After passing through this region, the particle emerges on the other side after 10 milliseconds with a velocity $\vec{u_2} = 2(\sqrt{3}\hat{i} + \hat{j})\, ms^{-1}$. The state ment(s) is(are)

A) The direction of the magn-etic field is –z direction
B) The direction of the magn-etic field is +z direction
C) The magnitude of the magn-etic field $\frac{50\pi M}{3Q}$ Units
D) The magnitude of the Magn-etic Field is $\frac{100\pi M}{3Q}$ Units

Ans: A, C

13. A horizontal stretched string, fixed at two ends, is vibrating in its fifth harmonic according to the equation, y(x,t)=(0.01m) sin [(62.8 m^{-1})x] cos [(628 s^{-1})t]. Assuming π=3.14, the correct statement(s) is(are)

A) The number of nodes is 5.
B) The length of the string is 0.25m
C) The maximum displacement of the midpoint of the string, from its equilibrium position is 0.01m.
D) The fundamental frequency is 100 *Hz*

Ans: B, C

14. A solid sphere of radius *R* and density *ρ* is attached to one end of a mass-less spring of force constant k. The other end of the spring is connected to another solid sphere of radius *R* and density 3*ρ*. The complete arrangement is placed in a liquid of density 2*ρ* and is allowed to reach equilibrium. The correct statement(s) is(are)

A) The net elongation of the spring is $\frac{4\pi R^3 \rho g}{3k}$
B) The net elongation of the spring is $\frac{8\pi R^3 \rho g}{3k}$
C) The light sphere is partially submerged
D) The light sphere is completely submerged

Ans: A, D

15. Two non-conducting solid sph-eres of radii R and 2R, having uniform volume charge densit-ies ρ_1 and ρ_2 respectively, touch each other. The net electric field at a distance 2R from the centre of the smaller sphere, along the line joining the centres of the spheres, is zero.

The ratio $\frac{\rho_1}{\rho_2}$ can be

A) – 4 B) $-\frac{32}{25}$ C) $\frac{32}{25}$ D) 4

Ans: B, D

Section-3

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

16. A bob of mass m, suspended by a string of length l_1, is given a minimum velocity required to complete a full circle in the vertical plane. At the highest point, it collides elastically with another bob of mass m suspended by a string of length l_2, which is initally at rest. Both the strings are mass-less and inextensible. If the second bob, after collision acquires the minimum speed required to complete a full circle in the

vertical plane, the ratio $\frac{l_1}{l_2}$ is

Ans: 5

17. A particle of mass 0.2 kg is moving in one dimension under a force that delivers a constant power 0.5 *W* to the particle. If the initial speed (in ms^{-1}) of the particle is zero, the speed (in ms^{-1}) after 5 s is

Ans: 5

18. The work functions of silver and sodium are 4.6 and 2.3 eV, respectively. The ratio of the slope of the stopping potential versus frequency plot for silver to that of sodium is

Ans: 1

19. A freshly prepared sample of a radioisotope of half-life 1386 s has activity 10^3 disintegrations per second. Given that *l*n 2 = 0.693, the fraction of the intial number of nuclei (expressed in nearest integer percentage) that will decay in the first 80 s after preparation of the sample is

Ans: 4

20. A uniform circular disc of mass 50 kg and radius 0.4 m is rota-ting with an angular velocity of 10 *rads* s^{-1} about its own axis, which is vertical. Two uniform circular rings, each of mass 6.25 kg and radius 0.2 m, are gently placed symmetrically on the disc in such a manner that they are touching each other along the axis of the disc and are horizo-ntal. Assume that the friction is large enough such that the rings are at rest relative to the disc and the system rotates about the orginal axis. The new angular velocity (in *rads* s^{-1}) of the system is

Ans: 8

PART II : CHEMISTRY

Section-1

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

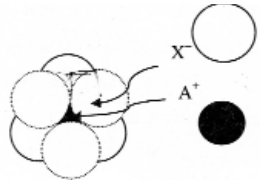
21. Consider the following complex ions, P, Q and R. P=$[FeF_6]^{3-}$, Q= $[V(H_2O)_6]^{2+}$ and R= $[Fe(H_2O)_6]^{2+}$ The correct order of the complex ions, according to their spin-only magnetic moment values (in B.M) is

A) R<Q<P B) Q<R<P

C) R<P<Q D) Q<P<R

Ans: B

22. The arrangement of x^- ions around A^+ ion in solid AX is given the figure (not drawn to scale). If the radius of x^- is 250 pm, the radius of A^+ is



A) 104 pm B) 125 pm

C) 183 pm D) 57 pm

Ans: A

23. Sulfide ores are common for the metals

A) Ag, Cu and Pb

B) Ag, Cu and Sn

C) Ag, Mg and Pb

D) A*l*, Cu and Pb

Ans: A

24. The standrd enthalpies of formation of $CO_2(g)$, $H_2O(l)$ and glucose(s) at 25^0C are – 400 kJ/mol, – 300 kJ/mol and – 1300 kJ/mol, respectively. The standard enthalpy of combustion per gram of glucose at 25^0C is

A) +2900 kJ B) – 2900 kJ

C) – 16.11 kJ D) +16.11 kJ

Ans: C

25. Upon treatment with ammonia-cal H_2S, the metal ion that precipitates as a sulfide is

A) Fe(III) B) Al(III)

C) Mg(II) D) Zn(II)

Ans: D

26. Methylene blue, from its aque-ous solution, is adsorbed on ac-tivated charcoal at 25^0C. For this process, the correct statment is

A) The adsorption requires activation at 25^0C

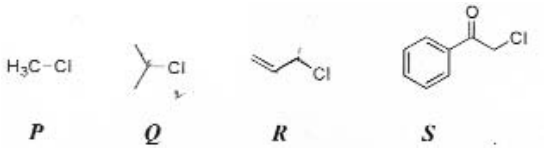
B) The adsorption is accompan-ied by a decrease in enthalpy

C) The adsorption increases with increase of temperature

D) The adsorption is irreversible

Ans: B

27. KI in acetone, undergoes S_N2 reaction with each of P, Q, R and S. The rates of the reaction vary as



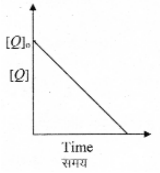
A) P>Q>R>S B) S>P>R>Q

C) P>R>Q>S D) R>P>S>Q

Ans: B

28. In the reaction, P+Q → R+S

The time taken for 75% reaction of P is twice the time taken for 50% reaction of P. The concen-tration of Q caries with reaction time as shown in the figure. The overall order of the reaction is



A) 2 B) 3 C) 0 D) 1

Ans: D

29. Concentrated nitric acid, upon long standing, turns yellow-brown due to the formation of

A) NO B) NO_2

C) N_2O D) N_2O_4

Ans: B

30. The compound that does NOT liberate CO_2, on treatment with aqueous sodium bicarbonate solution, is

A) Benzoic acid

B) Benzenesulphonic acid

C) Salicylic acid

D) Carbolic acid (Phenol)

Ans: D

Section-2

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

31. The initial rate of hydrolysis of methyl acetate (1M) by a weak acid (HA, 1M) is $1/100^{th}$ of that of a strong acid (HX, 1M), at 25^0C. The K_a of HA is

A) 1×10^{-4} B) 1×10^{-5}

C) 1×10^{-6} D) 1×10^{-3}

Ans: A

32. The hyperconjugative stabilities of tert-butyl cation and 2-butene, respectively, are due to

A) $\sigma\rightarrow p$ (empty) and $\sigma\rightarrow\pi^*$ electron delocalisations

B) $\sigma\rightarrow\sigma^*$ and $\sigma\rightarrow\pi$ electron delocalisations

C) $\sigma\rightarrow p$ (filled) and $\sigma\rightarrow\pi$ electron delocalisations

D) p (Filled)$\rightarrow\sigma^*$ and $\sigma\rightarrow\pi^*$ electron delocalisations

Ans: A

33. The pairs(s) of coordination complexes/ions exhibiting the same kind of isomerism is (are)

A) $[Cr(NH_3)_5Cl]Cl_2$ and $[Cr(NH_3)_4Cl_2]Cl$

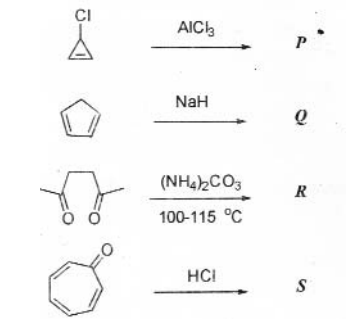
B) $[Co(NH_3)_4Cl_2]^+$ and $[Pt(NH_3)_2(H_2O)Cl]^+$

C) $[CoBr_2Cl_2]^{2-}$ and $[PtBr_2Cl_2]^{2-}$

D) $[Pt(NH_3)_3(NO_3)]Cl$ and $[Pt(NH_3)_3Cl]Br$

Ans: B, D

34. Among P, Q, R and S, the aromatic compound(s) is/are



A) P B) Q C) R D) S

Ans: A, B, C, D

35. Benzene and naphthalene form an ideal solution at room temp-erature. For this process, the true statment(s) is(are)

A) ΔG is positive

B) ΔS_{system} is positive

C) $\Delta S_{surroundings} = 0$

D) $\Delta H=0$

Ans: B, C, D

Section-3

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

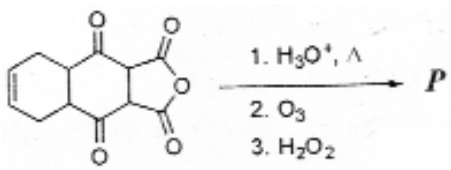
36. The atomic masses of He and Ne are 4 and 20 a.m.u., respectively. The value of the de Broglie wavelength of He gas at -73^0C is "M" times that of the de Broglie wavelength of Ne 727^0C. M is

Ans: 5

37. $EDTA^{4-}$ is ethylenediaminetetr- aacetate ion. The total number of N-Co-O bond angles in $[Co(EDTA)]^{1-}$ complex ion is

Ans: 8

38. The total number of carboxylic acid groups in the product P is



Ans: 2

39. A tetrapeptide has –COOH group on alanine. This produces glycine (Gly), valine (Val), phenyl alanine (Phe) and alanine (ala), on complete hydrolysis. For this tetrapeptide, the number of possible sequences (primary structures) with $-NH_2$ group attached to a chiral centre is

Ans: 4

40. The total number of lone-pairs of electrons in melamine is

Ans: 6

PART III : MATHEMATICS

Section-1

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

41. For a>b>c>0, the distance between (1,1) and the point of intersection of the lines ax+by+c=0 and bx+ay+c=0 is less than $2\sqrt{2}$. then

A) a+b–c>0 B) a–b+c<0
C) a–b+c>0 D) a+b–c<0

Ans: A

42. The area enclosed by the curves y=sin x+ cos x and y = $|\cos x - \sin x|$ over the interval [0, $\pi/2$] is

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

Ans: B

43. The number of points in $(-\infty,\infty)$, for which $x^2-x\sin x - \cos x = 0$, is

A) 6 B) 4 C) 2 D) 0

Ans: C

44. The value of $\cot\left(\sum_{n=1}^{23} \cot^{-1}\left(1+\sum_{k=1}^{n} 2k\right)\right)$ is

A) $\frac{23}{25}$ B) $\frac{25}{23}$ C) $\frac{23}{24}$ D) $\frac{24}{23}$

Ans: B

45. A curve passes through the point $\left(1,\frac{\pi}{6}\right)$. Let the slope of the curve at each point (x,y) be $\frac{y}{x}+\sec\left(\frac{y}{x}\right)$, x>0. Then the equation of the curve is

A) $\sin\left(\frac{y}{x}\right)=\log x+\frac{1}{2}$

B) $\operatorname{cosec}\left(\frac{y}{x}\right)=\log x+2$

C) $\sec\left(\frac{2y}{x}\right)=\log x+2$

D) $\cos\left(\frac{2y}{x}\right)=\log x+\frac{1}{2}$

Ans: A

46. Let f:[½,1] →R (the set of all real numbers) be a positive, non-constant and differentible funct-ion such that $f^1(x)<2f(x)$ and $f(½)=1$. Then value of $\int_{1/2}^{1} f(x)\,dx$ lies in the interval

A) (2e−1, 2e) B) (e-1, 2e−1)

C) $\left(\frac{e-1}{2},e-1\right)$ D) $\left(0,\frac{e-1}{2}\right)$

Ans: D

47. Let $\overrightarrow{PR}=3\hat{i}+\hat{j}-2\hat{k}$ and $\overrightarrow{SQ}=\hat{i}-3\hat{j}-4\hat{k}$ determine diagonals of a parallelogram PQRS and $\overrightarrow{PT}=\hat{i}+2\hat{j}+3\hat{k}$ be another vector. Then the volume of the parallelepiped determined by the vectors $\overrightarrow{PT},\overrightarrow{PQ}$ and $\overrightarrow{PS}$ is

A) 5 B) 20 C) 10 D) 30

Ans: C

48. Perpendiculars are drawn from points on the line $\frac{x+2}{2}=\frac{y+1}{-1}=\frac{z}{3}$ to the plane x+y+z=3. The feet of perpendiculars lie on the line

A) $\frac{x}{5}=\frac{y-1}{8}=\frac{z-2}{-13}$ B) $\frac{x}{2}=\frac{y-1}{3}=\frac{z-2}{-5}$ C) $\frac{x}{4}=\frac{y-1}{3}=\frac{z-2}{-7}$ D) $\frac{x}{2}=\frac{y-1}{-7}=\frac{z-2}{5}$

Ans: D

49. Four persons independently sol-ve a certain problem correctly with probabilities $\frac{1}{2},\frac{3}{4},\frac{1}{4},\frac{1}{8}$. Then the probability that the problem is solved corr-ectly by at least one of them is

A) $\frac{235}{256}$ B) $\frac{21}{256}$ C) $\frac{3}{256}$ D) $\frac{253}{256}$

Ans: A

50. Let complex numbers α and $\frac{1}{\alpha}$ lie on circles $(x-x_0)^2+(y-y_0)^2 = r^2$ and $(x-x_0)^2+(y-y_0)^2= 4r^2$, respectively. If $z_0=x_0+iy_0$ satisfies the equation $2|z_0|^2=r^2+2$, then $|\alpha|=$

A) $\frac{1}{\sqrt{2}}$ B) $\frac{1}{2}$ C) $\frac{1}{\sqrt{7}}$ D) $\frac{1}{3}$

Ans: C

Section-2

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

51. A line *l* passing through the orig-in is perpendicular to the lines

$l_1:(3+t)\hat{i}+(-1+2t)\hat{j}+(4+2t)\hat{k},-\infty<t<\infty$

$l_2:(3+2s)\hat{i}+(3+2s)\hat{j}+(2+s)\hat{k},-\infty<s<\infty$

Then, the coordinate(s) of the points(s) on l_2 at a distance of $\sqrt{17}$ from the point of intersection of *l* and l_1 is (are)

A) $\left(\frac{7}{3},\frac{7}{3},\frac{5}{3}\right)$ B) (–1, –1, 0)

C) (1, 1, 1) D) $\left(\frac{7}{9},\frac{7}{9},\frac{8}{9}\right)$

Ans: B, D

52. Let $f(x) = x \sin \pi x$, $x > 0$. Then for all natural numbers n, $f'(x)$ vanishes at

A) A unique point in the interval $\left(n, n+\frac{1}{2}\right)$

B) A unique point in the interval $\left(n+\frac{1}{2}, n+1\right)$

C) A unique point in the interval $(n, n + 1)$

D) Two point in the interval $(n, n + 1)$

Ans: B, C

53. Let $S_n = \sum_{k=1}^{4n} (-1)^{\frac{k(k+1)}{2}} k^2$. Then S_n can take value(s)

A) 1056 B) 1088

C) 1120 D) 1332

Ans: A, D

54. For 3 × 3 matrices M and N, whi-ch of the following statements(s) is (are) NOT correct?

A) $N^T M N$ is symmetric or skew symmetric, according as M is symmetric or skew symmetric

B) $M N - N M$ is skew symmetric for all symmetric matrices M and N

C) $M N$ is symmetric for all symmetric matrices M and N

D) $(adj\ M)\ (adj\ N) = adj\ (M N)$ for all invertible matrices M and N

Ans: C, D

55. A rectangular sheet of fixed per-imeter with sides having their lengths in the ratio 8:15 is con-verted into an open rectangular box by folding after removing squares of equal area from all four corners. If the total area of removed squares is 100, the resulting box has maximum volume. Then the lengths of the sides of the rectangular sheet are

A) 24 B) 32

C) 45 D) 60

Ans: A, C

Section-3

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

56. Consider the set of eight vectors $V = \left\{ \{a\hat{i} + b\hat{j} + c\hat{k} : a,b,c \in \{-1,1\} \right\}$. **Three non-coplanar vectors can be chosen from V in 2^p ways. Tehn p is**

Ans: 5

57. Of the three independent events E_1, E_2 and E_3, the probability that only E_1 occurs is α, only E_2 occurs is β and only E_3 occurs is γ. Let the probability *p* that none of events E_1, E_2 or E_3.occurs satisfy the equations $(\alpha - 2\beta)p = \alpha\beta$ *and* $(\beta - 3\gamma)p = 2\beta\gamma$.

All the given probabilities are assumed to lie in the interval (0,1).
Then
Probability of occurrence of E_1
———————————
Probability of occurrence of E_3 =

Ans: 6

58. The coefficients of three consecutive terms of $(1+x)^{n+5}$ are in the ratio 5:10:14. Then *n* =

Ans: 6

59. A pack contains *n* cards numbe-red from 1 to *n*. Two consecutive numbered cards are removed from the pack and the sum of the numbers on the remaining cards is 1224. If the smaller of the numbers on the removed cards is *k*, then *k* – 20=

Ans: 5

60. A vertical line passing through the point (*h*, 0) intersects the ellipse $\frac{x^2}{4} + \frac{y^2}{3} = 1$ at the points *P* and *Q*. Let the tangents to the ellipse at *P* and *Q* meet at the point *R*. If Δ(h) = area of the triangle PQR,

$\Delta_1 = \max_{\frac{1}{2} \le h \le 1} \Delta(h)$ and

$\Delta_2 = \min_{\frac{1}{2} \le h \le 1} \Delta(h)$, then

$\frac{8}{\sqrt{5}}\Delta_1 - 8\Delta_2 =$

Ans: 9