BRILLIANT TUTORIALS

PAPER-1: MATHEMATICS, PHYSICS & CHEMISTRY

Code: C

SOLUTIONS TO AIEEE - 2009

Time : 3 hours **Maximum Marks: 432**

Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.

INSTRUCTIONS

1. The test is of **3 hours** duration.
2. The Test Booklet consists of 90 questions. The maximum marks are **432.**
3. There are ***three*** parts in the question paper. The distribution of marks subjectwise in each part is as under for each correct response.

   Part A – MATHEMATICS (144 Marks) – Questions No. 1 to 10 and 17 to 30 consist **FOUR (4)** marks each and Question No. 11 to 16 consist **EIGHT (8)** marks each for each correct response.

   Part B – PHYSICS (144 marks) – Question No. 31 to 39 and 46 to 60 consist **FOUR (4)** marks each and Question No. 40 to 45 consist **EIGHT (8)** marks each for each correct response.

   Part C – CHEMISTRY (144 marks) – Question No. 61 to 62 and 69 to 90 consist **FOUR (4)** marks each and Question No. 63 to 68 consist **EIGHT (8)** marks each for each correct response.
4. Candidate will be awarded marks as stated above in instructions No. 3 for correct response of each question. ¼ (one fourth) marks will be deducted for indicating incorrect response of each question. No deduction from the total score will be made if no response is indicated for an item in the answer sheet.
5. Rough work is to be done on the space provided for this purpose in the Test Booklet only. This space is given at the bottom of each page and in 2 pages at the end of the booklet.

Name of the Candidate (in Capital letters):_____

Roll Number: in figures | | | | | | |

: in words _____

Examination Centre Number: | | | | | | |

Name of Examination Centre (in Capital letters) :_____

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

SOLUTIONS TO AIEEE 2009
MATHEMATICS (Code: C)
PART – A

Note: Questions with (*) mark are from syllabus of class XI.

***1.** If the roots of the equation $bx^2+cx+a=0$ be imaginary, then for all real values of *x*, the expression $3b^2x^2+6bcx+2c^2$ is

(1) less than $-4ab$ (2) greater than $4ab$ (3) less than $4ab$ (4) greater than $-4ab$

Sol.: Given $c^2<4ab$

$3b^2x^2+6bcx+2c^2=3(bx+c)^2-c^2$

Now, $3(bx+c)^2-c^2\geq -c^2>-4ab$

Correct choice: (4)

2. For real *x*, let $f(x)=x^3+5x+1$, then

(1) *f* is neither one-one nor onto **R** (2) *f* is one-one but not onto **R**

(3) *f* is onto **R** but not one-one (4) *f* is one-one and onto **R**

Sol.: $f'(x)=3x^2+5$, which is positive.

$\Rightarrow$ $f(x)$ is strictly increasing hence it is one-one.

Also, $f(\infty)\to\infty$ and $f(-\infty)\to-\infty$

Therefore range of $f(x)$ is **R**.

Correct choice: (4)

3. Let *a, b, c* be such that $b(a+c)\neq 0$. If $\begin{vmatrix} a & a+1 & a-1 \\ -b & b+1 & b-1 \\ c & c-1 & c+1 \end{vmatrix}+\begin{vmatrix} a+1 & b+1 & c-1 \\ a-1 & b-1 & c+1 \\ (-1)^{n+2}a & (-1)^{n+1}b & (-1)^n c \end{vmatrix}=0$, then the value of *n* is

(1) any integer (2) zero (3) any even integer (4) any odd integer

Sol.: The given equation can be written as

$$\begin{vmatrix} a & a+1 & a-1 \\ -b & b+1 & b-1 \\ c & c-1 & c+1 \end{vmatrix}+(-1)^n\begin{vmatrix} a & a+1 & a-1 \\ -b & b+1 & b-1 \\ c & c-1 & c+1 \end{vmatrix}=0$$

$\Rightarrow$ *n* has to be any odd integer.

Correct choice: (4)

***4.** The lines $p(p^2+1)x-y+q=0$ and $(p^2+1)^2x+(p^2+1)y+2q=0$ are perpendicular to a common line for

(1) more than two values of *p* (2) no value of *p*

(3) exactly one value of *p* (4) exactly two values of *p*

Sol.: $p(p^2+1)=-\dfrac{(p^2+1)^2}{(p^2+1)}$ as the given lines will be parallel.

$\Rightarrow$ $p=-1$

Correct choice: (3)

5. In a binomial distribution $B\left(n,\ p=\dfrac{1}{4}\right)$, if the probability of at least one success is greater than or equal to $\dfrac{9}{10}$, then *n* is greater than

(1) $\dfrac{4}{\log_{10}4-\log_{10}3}$ (2) $\dfrac{1}{\log_{10}4-\log_{10}3}$ (3) $\dfrac{1}{\log_{10}4+\log_{10}3}$ (4) $\dfrac{9}{\log_{10}4-\log_{10}3}$

Sol.: P(at least 1 success) = 1–P(all failures)

Given that $1-\left(\frac{3}{4}\right)^n \geq \frac{9}{10}$ [P(at least 1 success) = $1-\left(\frac{3}{4}\right)^n$]

$\Rightarrow \frac{1}{10} \geq \left(\frac{3}{4}\right)^n \Rightarrow -1 \geq n\left(\log_{10}^3 - \log_{10}^4\right) \Rightarrow n \geq \frac{1}{\log_{10}^4 - \log_{10}^3}$

Correct choice: (2)

6. The differential equation which represents the family of curves $y = c_1 e^{c_2 x}$, where c_1 and c_2 are arbitrary constants, is

(1) $yy'' = (y')^2$ (2) $y' = y^2$ (3) $y'' = y'y$ (4) $yy'' = y'$

Sol.: $y = c_1 e^{c_2 x} \Rightarrow y' = c_1 c_2 e^{c_2 x} = c_2 y \Rightarrow \frac{y'}{y} = c_2$

Differentiating again we get $y''y = (y')^2$

Correct choice: (1)

***7.** If the mean deviation of the numbers $1, 1+d, 1+2d,$ ...., $1+100d$ from their mean is 255, then the d is equal to

(1) 20.2 (2) 10.0 (3) 20.0 (4) 10.1

Sol.: Mean of given numbers, $\bar{x} = \frac{1+(1+d)+\ldots\ldots\ldots\ldots(1+100d)}{101} = 1+50d$

Mean deviation $= \frac{\sum |x_i - \bar{x}|}{n} = \frac{\sum_{r=0}^{100} |(1+rd-(1+50d))|}{101}$

$\Rightarrow \frac{\sum_{r=0}^{100} |(r-50)d|}{101} = \frac{d50\times 51}{101}$

Given that mean deviation is 255

$\Rightarrow \frac{d50\times 51}{101} = 255 \Rightarrow d = 10.1$

Correct choice: (4)

***8.** Let A and B denote the statements

$A: \cos\alpha + \cos\beta + \cos\gamma = 0$, $B: \sin\alpha + \sin\beta + \sin\gamma = 0$. If $\cos(\beta-\gamma) + \cos(\gamma-\alpha) + \cos(\alpha-\beta) = -\frac{3}{2}$, then

(1) both A and B are false (2) A is true and B is false (3) A is false and B is true (4) both A and B are true

Sol.: $\cos(\alpha-\beta) + \cos(\beta-\gamma) + \cos(\gamma-\alpha) = -\frac{3}{2}$

$\Rightarrow 3 + 2(\cos(\alpha-\beta) + \cos(\beta-\gamma) + \cos(\gamma-\alpha)) = 0 \Rightarrow (\cos\alpha + \cos\beta + \cos\gamma)^2 + (\sin\alpha + \sin\beta + \sin\gamma)^2 = 0$

Correct choice: (4)

Directions: Questions number 9 to 13 are Assertion-Reason type questions. Each of these questions contains two statements:

Statement-1 : (Assertion) and

Statement-2 : (Reason).

Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select the correct choice.

***9.** **Statement-1:** $\sim(p \leftrightarrow \sim q)$ is equivalent to $p \leftrightarrow q$.

Statement-2: $\sim(p \leftrightarrow \sim q)$ is a tautology.

(1) Statement-1 is false, Statement-2 is true.

(2) Statement-1 is true, Statement-2 is true; Statement-2 is a correct explanation for Statement-1.

(3) Statement-1 is true, Statement-2 is true; Statement-2 is **not** a correct explanation for Statement-1.

(4) Statement-1 is true, Statement-2 is false.

Sol.: Statement-1: $\sim(p \leftrightarrow \sim q)$ means $\sim p \leftrightarrow q$

Let us break statement-1 in two parts: (A) $\sim p \leftrightarrow q$ and (B) $p \leftrightarrow q$

(A) $\sim p \leftrightarrow q$ gives us two statements

(1) $\sim p$ – True $\Rightarrow$ q – True

(2) q – True $\Rightarrow$ $\sim p$ – True

(B) $p \leftrightarrow q$ gives us following two statements

(i) p – True $\Rightarrow$ q – True

(ii) q – True $\Rightarrow p$ – True

Observing the above statements we find statement (ii) of (A) and (B) contradict each other. So, statement-1 is false.

Again, in statement-2 we have

(1) $\sim p$ – True $\Rightarrow$ q – True

And q – True $\Rightarrow$ $\sim p$ – True

(2) q – True $\Rightarrow$ $\sim p$ – True

And $\sim p$ – True $\Rightarrow$ q – True

The above two statements clearly show tautology.

Correct choice: (1)

10. Let A be a 2×2 matrix.

Statement-1: $adj(adj\,A) = A$.

Statement-2: $|adj\ A| = |A|$.

(1) Statement-1 is false, Statement-2 is true.

(2) Statement-1 is true, Statement-2 is true; Statement-2 is a correct explanation for Statement-1.

(3) Statement-1 is true, Statement-2 is true; Statement-2 is **not** a correct explanation for Statement-1.

(4) Statement-1 is true, Statement-2 is false.

Sol.: Consider $A = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$ $adjA = \begin{bmatrix} d & -b \\ -c & a \end{bmatrix}$ $\Rightarrow$ $adj(adj\,A) = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$

Also $|adj\,A| = |A|$ but this does not explain the statement-1.

Correct choice: (3)

***11.** **Statement-1:** The variance of first n even natural numbers is $\frac{n^2-1}{4}$.

Statement-2: The sum of first n natural numbers is $\frac{n(n+1)}{2}$ and the sum of squares of first n natural numbers is $\frac{n(n+1)(2n+1)}{6}$.

(1) Statement-1 is false, Statement-2 is true.

(2) Statement-1 is true, Statement-2 is true; Statement-2 is a correct explanation for Statement-1.

(3) Statement-1 is true, Statement-2 is true; Statement-2 is **not** a correct explanation for Statement-1.

(4) Statement-1 is true, Statement-2 is false.

Sol.: Variance, $\sigma = \frac{\sum (x_i - \bar{x})^2}{n}$, where $\bar{x}$ is the mean. Let 2, 4, 6, ... $2n$ be the numbers.

$\Rightarrow$ $\bar{x} = \frac{2(n)(n+1)}{2n} = n+1$

$$\sigma = \frac{\sum 4r^2 - 4r(n+1) + (n+1)^2}{n} = \frac{4n(n+1)(2n+1)}{6n} - \frac{4n(n+1)^2}{2n} + (n+1)^2$$

$$= \frac{2(2n^2+3n+1)}{3} - (n+1)^2 = \frac{4n^2+6n+2-3n^2-6n-3}{3} = \frac{n^2-1}{3}$$

Correct choice: (1)

***12.** Let $f(x)=(x+1)^2-1,\ x\geq -1$.

Statement-1: The set $\{x: f(x)=f^{-1}(x)\}=\{0,\ -1\}$.

Statement-2: f is a bijection.

(1) Statement-1 is false, Statement-2 is true.

(2) Statement-1 is true, Statement-2 is true; Statement-2 is a correct explanation for Statement-1.

(3) Statement-1 is true, Statement-2 is true; Statement-2 is **not** a correct explanation for Statement-1.

(4) Statement-1 is true, Statement-2 is false.

Sol.: $f(x)=y=(x+1)^2-1,\ x\geq -1,\ y\geq -1$

$f^{-1}(x)=-1+\sqrt{1+x},\ x\geq -1$ [$f^{-1}(x)$ exists only if $f(x)$ is bijective]

Also, $f^{-1}(x)=f(x)$

$\Rightarrow (x+1)^2-1=-1+\sqrt{1+x} \Rightarrow x=0,\ -1$

Correct choice: (3)

13. Let $f(x)=x|x|$ and $g(x)=\sin x$.

Statement-1: gof is differentiable at $x = 0$ and its derivative is continuous at that point.

Statement-2: gof is twice differentiable at $x = 0$.

(1) Statement-1 is false, Statement-2 is true.

(2) Statement-1 is true, Statement-2 is true; Statement-2 is a correct explanation for Statement-1.

(3) Statement-1 is true, Statement-2 is true; Statement-2 is **not** a correct explanation for Statement-1.

(4) Statement-1 is true, Statement-2 is false.

Sol.: $h(x)=g(f(x))=\sin x^2,\ x\geq 0$

$=-\sin x^2,\ x<0$

$h'(x)=2x\cos x^2,\ x\geq 0$

$=-2x\cos x^2,\ x<0$

$\Rightarrow h'(0^+)=h'(0^-)=0$

$h''(x)=-4x^2\sin x^2+2\cos x^2,\ x\geq 0$

$=-[-4x^2\sin x^2+2\cos x^2],\ x<0$

$\Rightarrow h''(0^+)=2$

$h''(0^-)=-2$

Correct choice: (4)

14. Given $P(x)=x^4+ax^3+bx^2+cx+d$ such that $x=0$ is the only real root of $P'(x)=0$. If $P(-1)<P(1)$, then in the interval $[-1, 1]$

(1) neither $P(-1)$ is the minimum nor $P(1)$ is the maximum of P

(2) $P(-1)$ is the minimum and $P(1)$ is the maximum of P

(3) $P(-1)$ is not minimum but $P(1)$ is the maximum of P

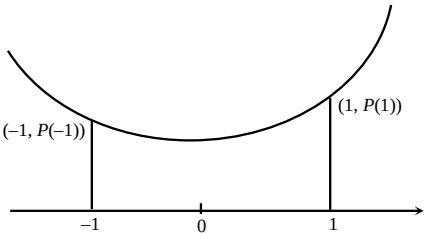
(4) $P(-1)$ is the minimum but $P(1)$ is not the maximum of P

Sol.: $P(x) = x^4 + ax^3 + bx^2 + cx + d$

Now $P'(0) = 0 \Rightarrow c = 0$

$\Rightarrow P(x) = x^4 + ax^3 + bx^2 + d$

Clearly $P(1)$ is maximum but $P(-1)$ is not minimum.



Correct choice: (3)

***15.** The shortest distance between the line $y - x = 1$ and the curve $x = y^2$ is

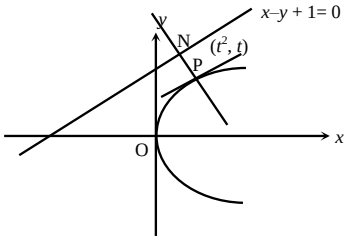
(1) $\frac{\sqrt{3}}{4}$ (2) $\frac{3\sqrt{2}}{8}$ (3) $\frac{2\sqrt{3}}{8}$ (4) $\frac{3\sqrt{2}}{5}$

Sol.: $x = y^2$

$\Rightarrow y' = \frac{2}{2y}$

$m = \frac{1}{2t} = 1 \Rightarrow t = \frac{1}{2}$; $P\left(\frac{1}{4}, \frac{1}{2}\right)$

So, $PN = \frac{\left|\frac{1}{4} - \frac{1}{2} + 1\right|}{\sqrt{2}} = \frac{3}{4\sqrt{2}} = \frac{3\sqrt{2}}{8}$



Correct choice: (2)

16. The area of the region bounded by the parabola $(y-2)^2 = x - 1$, the tangent to the parabola at the point (2, 3) and the *x*-axis is

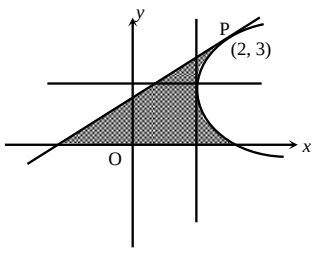
(1) 12 (2) 3 (3) 6 (4) 9

Sol.: $(y-2)^2 = x - 1$

$2(y-2)y' = 1 \Rightarrow y' = \frac{1}{2(y-2)} \Rightarrow y' = \frac{1}{2}$ at $y = 3$

Equation of tangent $y - 3 = \frac{1}{2}(x-2)$

$\Rightarrow 2y - 6 = x - 2 \Rightarrow x = 2y - 4$



$A = \int_0^3 \left((y-2)^2 + 1 - (2y-4)\right) dy = \int_0^3 \left(y^2 - 6y + 9\right) dy = \frac{27}{3} = 9$

Correct choice: (4)

***17.** The sum to infinity of the series $1 + \frac{2}{3} + \frac{6}{3^2} + \frac{10}{3^3} + \frac{14}{3^4} + \ldots\ldots\ldots\ldots$ is

(1) 6 (2) 2 (3) 3 (4) 4

Sol.: $S = 1 + \frac{2}{3} + \frac{6}{3^2} + \frac{10}{3^3} + \frac{14}{3^4} + \ldots\ldots\ldots\ldots$ …(i)

$\frac{S}{3} = \frac{1}{3} + \frac{2}{3^2} + \frac{6}{3^3} + \frac{10}{3^4} + \ldots\ldots\ldots\ldots\ldots\ldots$ …(ii)

Subtracting (ii) from (i) we get, $S\frac{2}{3} = 1 + \frac{1}{3} + \frac{4}{3^2} + \frac{4}{3^3} + \ldots\ldots\ldots\ldots\ldots\ldots$

$= \frac{4}{3} + \frac{4}{3^2}\left(\frac{1}{1 - \frac{1}{3}}\right) = \frac{4}{3} + \frac{4}{3^2} \times \frac{3}{2} = 2$

$S = 3$

Correct choice: (3)

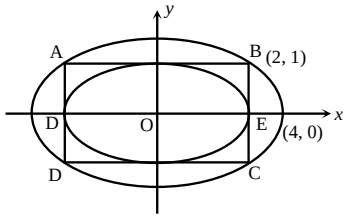
***18.** The ellipse $x^2+4y^2=4$ is inscribed in a rectangle aligned with the coordinate axes, which in turn is inscribed in another ellipse that passes through the point (4, 0). Then the equation of the ellipse is

(1) $4x^2+64y^2=48$ (2) $x^2+16y^2=16$ (3) $x^2+12y^2=16$ (4) $4x^2+48y^2=48$

Sol.: Let the new ellipse be $\frac{x^2}{16}+\frac{y^2}{b^2}=1$

Satisfying (2, 1) we get $b^2=\frac{16}{12}$

Correct choice: (3)



19. The projections of a vector on the three coordinate axis are 6, –3, 2 respectively. The direction cosines of the vector are

(1) $\frac{-6}{7}, \frac{-3}{7}, \frac{2}{7}$ (2) $6, -3, 2$ (3) $\frac{6}{5}, \frac{-3}{5}, \frac{2}{5}$ (4) $\frac{6}{7}, \frac{-3}{7}, \frac{2}{7}$

Sol.: Direction ratios are: $6, -3, 2$

Direction cosines are: $\frac{6}{7}, \frac{-3}{7}, \frac{2}{7}$

Correct choice: (4)

***20.** From 6 different novels and 3 different dictionaries, 4 novels and 1 dictionary are to be selected and arranged in a row on a shelf so that the dictionary is always in the middle. Then the number of such arrangements is

(1) at least 1000 (2) less than 500

(3) at least 500 but less than 750 (4) at least 750 but less than 1000

Sol.: Required number of arrangement $= {}^6C_4 \times {}^3C_1 \times {}^4C_2(2!)^2 = 15\times3\times6\times4 = 1080$

Correct choice: (1)

21. If $\vec{u}, \vec{v}, \vec{w}$ are non-coplanar vectors and p, q are real numbers, then the equality $[3\vec{u}\ \ p\vec{v}\ \ p\vec{w}]-[p\vec{v}\ \ \vec{w}\ \ q\vec{u}]-[2\vec{w}\ \ q\vec{v}\ \ q\vec{u}]=0$ holds for

(1) all values of (p, q) (2) exactly one value of (p, q)

(3) exactly two values of (p, q) (4) more than two but not all values of (p, q)

Sol.: $(3p^2-pq+2q^2)[\vec{u}\,\vec{v}\,\vec{w}]=0$

$\Rightarrow\ 3p^2-pq+2q^2=0$ for real p

$D\geq 0$

$\Rightarrow\ q^2-4\times2\times3q^2\geq0\ \Rightarrow\ -23q^2\geq0\ \Rightarrow\ q=0$

$\Rightarrow\ p=0$

So exactly one value of (p, q)

Correct choice: (2)

22. Let the line $\frac{x-2}{3}=\frac{y-1}{-5}=\frac{z+2}{2}$ lie in the plane $x+3y-\alpha z+\beta=0$. Then (α, β) equals

(1) $(-5, 5)$ (2) $(6, -17)$ (3) $(-6, 7)$ (4) $(5, -15)$

Sol.: $(2, 1, -2)$ lies on $x+3y-\alpha z+\beta=0$

$\Rightarrow\ 2\alpha+\beta=-5$

Also $3-15-2\alpha=0\ \Rightarrow\ \alpha=-6,\ \beta=7$

$(\alpha, \beta)\equiv(-6, 7)$

Correct choice: (3)

***23.** If $\left| Z - \frac{4}{z} \right| = 2$, then the maximum value of $|Z|$ is equal to

(1) $2+\sqrt{2}$ (2) $\sqrt{3}+1$ (3) $\sqrt{5}+1$ (4) 2

Sol.: $\big||Z_1|-|Z_2|\big| \le |Z_1 - Z_2|$

$\Rightarrow |Z| - \frac{4}{|Z|} \le 2$

$\Rightarrow |Z|^2 - 2|Z| - 4 \le 0 \Rightarrow |Z|_{\max} = \sqrt{5}+1$

Correct choice: (3)

***24.** The remainder left out when $8^{2n} - (62)^{2n+1}$ is divided by 9 is

(1) 8 (2) 0 (3) 2 (4) 7

Sol.: $8^{2n} - (62)^{2n+1}$

$\Rightarrow (9-1)^{2n} - (63-1)^{2n+1} \Rightarrow \left({}^{2n}C_0 9^{2n} - {}^{2n}C_1 9^{2n-1} + \ldots\ldots + 1\right) - \left({}^{2n+1}C_0 63^{2n+1} - {}^{2n+1}C_1 63^{2n} + \ldots\ldots\ldots\ldots - 1\right) \Rightarrow 9K + 2$

So remainder is 2

Correct choice: (3)

***25.** If *A*, *B* and *C* are three sets such that $A \cap B = A \cap C$ and $A \cup B = A \cup C$, then

(1) $A \cap B = \phi$ (2) $A = B$ (3) $A = C$ (4) $B = C$

Sol.: $A \cap B = A \cap C$ and $A \cup B = A \cup C$

$\Rightarrow B = C$

Correct choice: (4)

26. $\int_0^{\pi} [\cot x]\, dx$, where [.] denotes the greatest integer function, is equal to

(1) $-\frac{\pi}{2}$ (2) $\frac{\pi}{2}$ (3) 1 (4) –1

Sol.: $I = \int_0^{\pi} [\cot x]\, dx$

$I = \int_0^{\pi} [-\cot x]\, dx \Rightarrow 2I = \int_0^{\pi} ([\cot x] + [-\cot x])\, dx = -\pi \Rightarrow I = -\frac{\pi}{2}$

Correct choice: (1)

***27.** If *P* and *Q* are the points of intersection of the circles $x^2 + y^2 + 3x + 7y + 2p - 5 = 0$ and $x^2 + y^2 + 2x + 2y - p^2 = 0$, then there is a circle passing through *P*, *Q* and $(1, 1)$ for

(1) exactly one value of *p*
(2) all values of *p*
(3) all except one value of *p*
(4) all except two values of *p*

Sol.: Let the circle be $S_1 + \lambda S_2 = 0$

$x^2 + y^2 + 3x + 7y + 2p - 5 + \lambda\left(x^2 + y^2 + 2x + 2y - p^2\right) = 0$ passes through (1, 1)

$7 + 2p + \lambda\left(6 - p^2\right) = 0$, when $p = \pm\sqrt{6}$ required circle become $S_2 = 0$

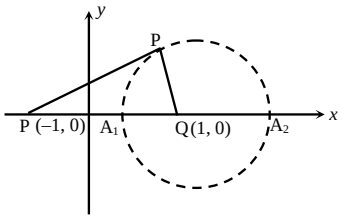
Correct choice: (2)

***28.** Three distinct points *A*, *B* and *C* are given in the 2-dimensional coordinate plane such that the ratio of the distance of any one of them from the point $(1, 0)$ to the distance from the point $(-1, 0)$ is equal to $\frac{1}{3}$. Then the circumcentre of the triangle *ABC* is at the point

(1) $\left(\frac{5}{3}, 0\right)$ (2) $(0, 0)$ (3) $\left(\frac{5}{4}, 0\right)$ (4) $\left(\frac{5}{2}, 0\right)$

Sol.: $A_1 \equiv \left(\frac{1}{2}, 0\right)$; $A_2 \equiv (2, 0)$

Circumcentre $\equiv \left(\frac{5}{4}, 0\right)$



Correct choice: (3)

29. One ticket is selected at random from 50 tickets numbered 00, 01, 02, ……., 49. Then the probability that the sum of the digits on the selected ticket is 8, given that the product of these digits is zero, equals

(1) $\frac{1}{50}$ (2) $\frac{1}{14}$ (3) $\frac{1}{7}$ (4) $\frac{5}{14}$

Sol.: 00 10 20 30 40

01 11 21 31 40

: : : : :

09 19 29 39 49

$n(S) = 14, n(A) = 1$

$\Rightarrow \; P(A) = \frac{1}{14}$

Correct choice: (2)

30. Let y be an implicit function of x defined by $x^{2x} - 2x^x \cot y - 1 = 0$. Then $y'(1)$ equals

(1) $-\log 2$ (2) -1 (3) 1 (4) $\log 2$

Sol.: At $x = 1 \;\Rightarrow\; \cot y = 0$

$y' = \frac{2(\cot y - 1)}{2\,\text{cosec}^2\, y} = \frac{-2}{2} = -1$

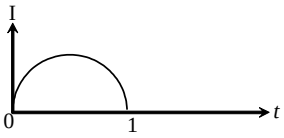
Correct choice: (2)

SOLUTIONS TO AIEEE 2009
PHYSICS (Code: C)
PART – B

***31.** Three sound waves of equal amplitudes have frequencies $(v - 1)$, v, $(v + 1)$. They *superpose* to give beats. The number of beats produced per second will be:

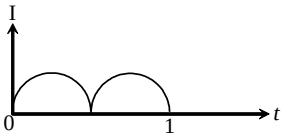
(1) 1 (2) 4 (3) 3 (4) 2

Sol.: Variation of intensity due to superposition of waves having frequencies v -1 & v and v & $v + 1$ is as shown



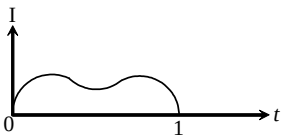
(a)

Variation of intensity due to superposition of waves having frequencies $v - 1$ and $v + 1$ is as shown



(b)

Resultant of (a) and (b) be as shown



So number of beats/s = 2

Correct choice: (4)

***32.** The height at which the acceleration due to gravity becomes $\frac{g}{9}$ (where g = the acceleration due to gravity on the surface of the earth) in terms of R, the radius of the earth is:

(1) $\sqrt{2}\,R$ (2) 2R (3) $\frac{R}{\sqrt{2}}$ (4) R/2

Sol.: $g' = \frac{g}{\left(1+\frac{h}{R}\right)^2}$; $\frac{g}{9} = \frac{g}{\left(1+\frac{h}{R}\right)^2}$; $1+\frac{h}{R} = 3$; $h = 2R$

Correct choice: (2)

***33.** One kg of a diatomic gas is at a pressure of 8×10^4 N/m^2. The density of the gas is 4 kg/m^3. What is the energy of the gas due to its thermal motion?

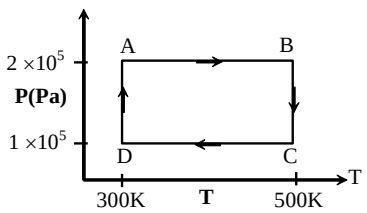
(1) 7×10^4 J (2) 3×10^4 J (3) 5×10^4 J (4) 6×10^4 J

Sol.: $K = \frac{5}{2}pV = \frac{5}{2} \times 8 \times 10^4 \times \frac{1}{4} = 5 \times 10^4$ J

Correct choice: (3)

***Directions**: Question numbers 34, 35 and 36 are based on the following paragraph.*

Two moles of helium gas are taken over the cycle ABCDA, as shown in the P-T diagram.



***34.** Assuming the gas to be ideal the work done on the gas in taking it from A to B is:

(1) 500 R (2) 200 R (3) 300 R (4) 400 R

***35.** The work done on the gas in taking it from D to A is:

(1) + 690 R (2) – 414 R (3) + 414 R (4) – 690 R

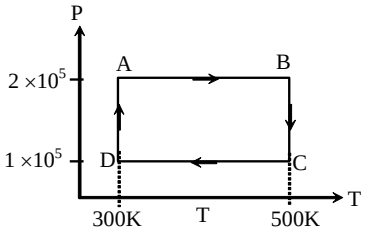
***36.** The net work done on the gas in the cycle ABCDA is:

(1) 1904 R (2) Zero (3) 276 R (4) 1076 R

Sol.:

34. $W_{AB} = P\Delta V = nR\Delta T = 2\times R\times(500-300) = 400R$

Correct choice: (4)



35. $W_{DA} = 2.3nRT\log\frac{P_1}{P_2} = (2.302)(2)(R)(300)\log\left(\frac{1\times10^5}{2\times10^5}\right)$

$= -(2.3)(600R)(0.3) = -414R$

Correct choice: (2)

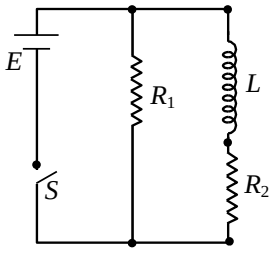
36. $W_{BC} = (2.3)(2)(R)(500)\log 2 = 690R$

$W_{CD} = -400R$

$W_{total} = (690-414)R = 276R$

Correct choice: (3)

37. An inductor of inductance L = 400 mH and resistors of resistances $R_1 = 2\Omega$ and $R_2 = 2\Omega$ are connected to a battery of emf 12V as shown in the figure. The internal resistance of the battery is negligible. The switch S is closed at t = 0. The potential drop across L as a function of time is:



(1) $12\ e^{-5t}$ V (2) $6\ e^{-5t}$ V

(3) $\frac{12}{t}\ e^{-3t}$ V (4) $6\left(1-e^{-t/0.2}\right)$V

Sol.: Current in LR_2 branch

$i = \frac{E}{R_2}\left[1-e^{-R_2t/L}\right]$; $\frac{di}{dt} = \frac{E}{R_2}\frac{R_2}{L}e^{-R_2t/L}$

Drop across $L = \left(\frac{E}{L}e^{-R_2t/L}\right)L = 12e^{-2t/400\times10^{-3}} = 12e^{-5t}$ V

Correct choice: (1)

38. A mixture of light, consisting of wavelength 590 nm and an unknown wavelength, illuminates Young's double slit and gives rise to two overlapping interference patterns on the screen. The central maximum of both lights coincide. Further, it is observed that the third bright fringe of known light coincides with the 4th bright fringe of the unknown light. From this data, the wavelength of the unknown light is:

(1) 776.8 *nm* (2) 393.4 *nm* (3) 885.0 *nm* (4) 442.5 *nm*

Sol.: $\frac{3\lambda_1 D}{d} = \frac{4\lambda_2 D}{d}$; $3\times590 = 4\times\lambda_2$; $\lambda_2 = 442.5\ nm$

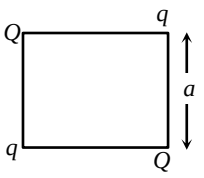
Correct choice: (4)

39. A charge Q is placed at each of the opposite corners of a square. A charge q is placed at each of the other two corners. If the net electric force on Q is zero, then Q/q equals:

(1) $-\frac{1}{\sqrt{2}}$ (2) $-2\sqrt{2}$ (3) -1 (4) 1

Sol.: $\frac{Q^2}{4\pi\in_0(2a^2)} + \frac{qQ\sqrt{2}}{4\pi\in_0 a^2} = 0$

$\frac{Q}{q} = -2\sqrt{2}$



Correct choice: (2)

40. In an optics experiment, with the position of the object fixed, a student varies the position of a convex lens and for each position, the screen is adjusted to get a clear image of the object. A graph between the object distance *u* and the image distance *v*, from the lens, is plotted using the same scale for the two axes. A straight line passing through the origin and making an angle of 45^0 with the x-axis meets the experimental curve at *P*. The coordinates of *P* will be

(1) $(4f, 4f)$ (2) $(2f, 2f)$ (3) $\left(\frac{f}{2}, \frac{f}{2}\right)$ (4) (f, f)

Sol.: $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$; $\frac{1}{|v|}+\frac{1}{|u|}=\frac{1}{f}$; $|v|=|u|$; $|v|=|u|=2f$

Coordinates are $(2f,2f)$

Correct choice: (2)

***41.** A thin uniform rod of length *l* and mass *m* is swinging freely about a horizontal axis passing through its end. Its maximum angular speed is ω. Its centre of mass rises to a maximum height of :

(1) $\frac{1}{6}\frac{l^2\omega^2}{g}$ (2) $\frac{1}{3}\frac{l^2\omega^2}{g}$ (3) $\frac{1}{6}\frac{l\omega}{g}$ (4) $\frac{1}{2}\frac{l^2\omega^2}{g}$

Sol.: $\frac{1}{2}\frac{Ml^2}{3}\omega^2=Mg\Delta h$; $\Delta h=\frac{\omega^2 l^2}{6g}$

Correct choice: (1)

42. Let $P(r)=\frac{Q}{\pi R^4}r$ be the charge density distribution for a solid sphere of radius R and total charge Q. For a point 'p' inside the sphere at distance r_1 from the centre of the sphere, the magnitude of electric field is:

(1) $\frac{Q r_1^2}{3\pi\in_0 R^4}$ (2) 0 (3) $\frac{Q}{4\pi\in_0 r_1^2}$ (4) $\frac{Q r_1^2}{4\pi\in_0 R^4}$

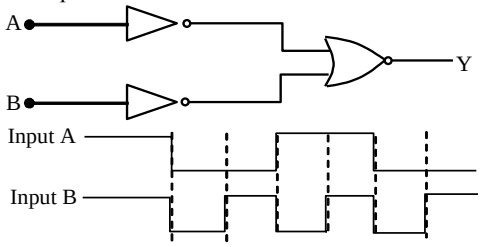
Sol.: Charge enclosed in a radius r_1 $=\int_0^{r_1}\frac{Q}{\pi R^4}r.4\pi r^2 dr$ $=\frac{Qr_1^4}{R^4}$

Using Gauss's law $E.4\pi r_1^2=\left(\frac{Qr_1^4}{R^4}\right)\frac{1}{\in_0}$

$E=\frac{Qr_1^2}{4\pi\in_0 R^4}$

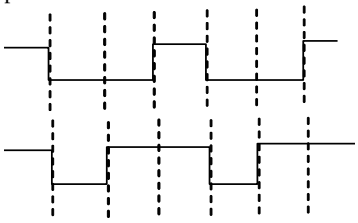
Correct choice: (4)

43. The logic circuit shown below has the input waveforms 'A' and 'B' as shown. Pick out the correct output waveform.

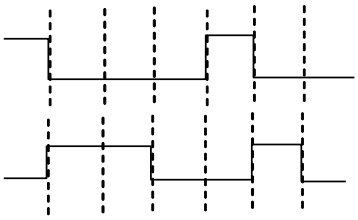


Output is:

(1)



(2)



(3)

(4)

Sol.: **Correct choice: (2)**

44.** If *x*, *v* and *a* denote the displacement, the velocity and the acceleration of particle executing simple harmonic motion of time period *T*, then, which of the following does ***not change with time?

(1) aT/v (2) $a^2T^2+4\pi^2v^2$ (3) aT/x (4) $aT+2\pi v$

Sol.: $x=A\sin(\omega t+\phi)$; $v=A\omega\cos(\omega t+\phi)$

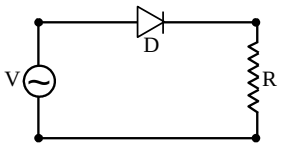
$a=-A\omega^2\sin(\omega t+\phi)$;

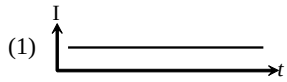
$aT=-A\omega^2 T\sin(\omega t+\phi)=-A\omega^2\frac{2\pi}{\omega}\sin(\omega t+\phi)=-2\pi A\omega\sin(\omega t+\phi)$.

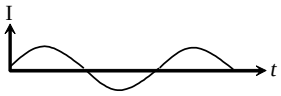
$\frac{aT}{x}=-2\pi\omega=$ constant.

Correct choice: (3)

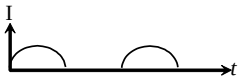
45. A *p-n* junction (D) shown in the figure can act as a rectifier. An alternating current source (V) is connected in the circuit. The current (I) in the resistor (R) can be shown by



(1) 

(2) 

(3) 

(4) 

Sol.: Current will flow when diode is forward biased.

Correct choice: (4)

***46.** A motor cycle starts from rest and accelerates along a straight path at 2 m/s^2. At the starting point of the motor cycle there is a stationary electric siren. How far has the motor cycle gone when the driver hears the frequency of the siren at 94% of its value when the motor cycle was at rest? (Speed of sound = 330 ms^{-1})

(1) 196 m (2) 49 m (3) 98 m (4) 147 m

Sol.: $\frac{94}{100}v = \frac{V - V_0}{V}v$; $0.94V = V - V_0$

$V_0 = 0.06V = 0.06 \times 330 = 19.8\,\text{m/s}$

$V_0^2 = u^2 + 2as$

$(19.8)^2 = 0^2 + (2)(2)s$

s = 98 m

Correct choice: (3)

47. Two points P and Q are maintained at the potentials of 10V and – 4V, respectively. The work done in moving 100 electrons from P to Q is :

(1) 2.24×10^{-16} J (2) -9.60×10^{-17} J (3) 9.60×10^{-17} J (4) -2.24×10^{-16} J

Sol.: $W_{ext} = q(V_f - V_i) = (-100 \times 1.6 \times 10^{-19})(-4-10) = -1.6 \times 10^{-17} \times (-14) = 2.24 \times 10^{-16}\,\text{J}$

Correct choice: (1)

***48.** In an experiment the angles are required to be measured using an instrument. 29 divisions of the main scale exactly coincide with the 30 divisions of the vernier scale. If the smallest division of the main scale is half-a- degree (= 0.5^0), then the least count of the instrument is:

(1) half degree (2) one minute (3) half minute (4) one degree

Sol.: Least count = 1 MSD – 1 VSD

$= 1\text{MSD} - \frac{29}{30}\text{MSD} = \frac{1}{30}\text{MSD} = \frac{0.5^0}{30} = \frac{30\,\text{minutes}}{30}$ = one minute

Correct choice: (2)

49. The surface of a metal is illuminated with the light of 400 *nm*. The kinetic energy of the ejected photoelectrons was found to be 1.68 eV. The work function of the metal is: (hc = 1240 eV.nm)

(1) 1.68 eV (2) 3.09 eV (3) 1.41 eV (4) 1.51 eV

Sol.: $W = \frac{hc}{\lambda} - K_{\max} = \frac{1240}{400} - 1.68 = 1.42\,\text{eV}$

Correct choice: (3)

***50.** A particle has an initial velocity of $3\hat{i}+4\hat{j}$ and an acceleration of $0.4\hat{i}+0.3\hat{j}$. Its speed after 10 s is:

(1) 8.5 units (2) 10 units (3) $7\sqrt{2}$ units (4) 7 units

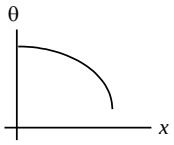
Sol.: $V_x = 3+(0.4)(10) = 7\,\text{units}$

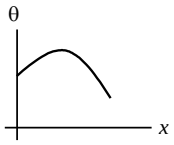
$V_y = 4+(0.3)(10) = 7\text{units}$

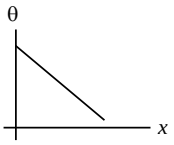
Speed $= 7\sqrt{2}$ units

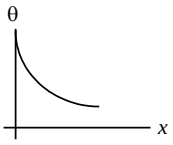
Correct choice: (3)

***51.** A long metallic bar is carrying heat from one of its ends to the other end under steady-state. The variation of temperature θ along the length *x* of the bar from its hot end is best described by which of the following figures?

(1) 

(2) 

(3) 

(4) 

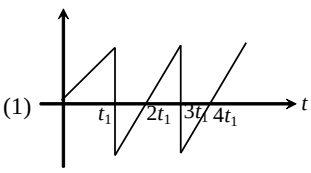
Sol.: $r = -KA\dfrac{d\theta}{dx}$

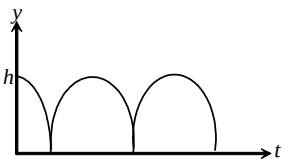
In steady state r = constant

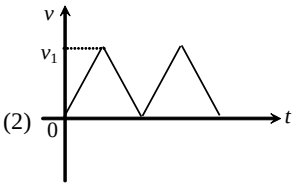
$\dfrac{d\theta}{dx} = -\dfrac{KA}{r}$; $d\theta = -\dfrac{KA}{r}dx$; $\theta = C - \dfrac{KA}{r}x$

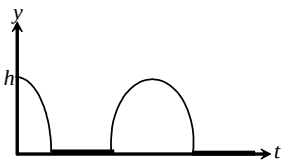
Correct choice: (3)

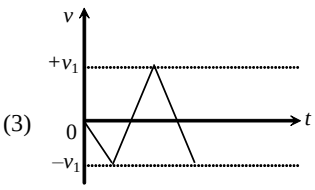
***52.** Consider a rubber ball freely falling from a height h = 4.9 *m* onto a horizontal elastic plate. Assume that the duration of collision is negligible and the collision with the plate is totally elastic. Then the velocity as a function of time and the height as a function of time will be

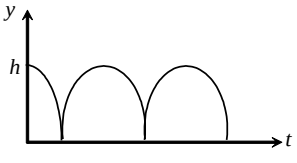
(1) 

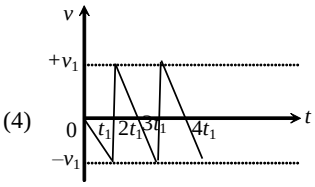


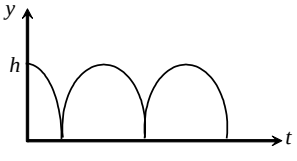
(2) 



(3) 



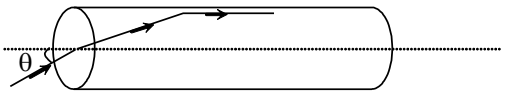
(4) 



Sol.: Slope of velocity-time graph will remain constant except during collision where it will not be defined. Also variation of height with time will be parabolic.

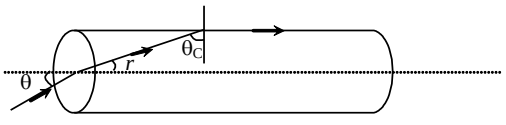
Correct choice: (4)

53. A transparent solid cylindrical rod has a refractive index of $\frac{2}{\sqrt{3}}$. It is surrounded by air. A light ray is incident at the mid point of one end of the rod as shown in the figure. The incident angle θ for which the light ray grazes along the wall of the rod is :



(1) $\sin^{-1}\left(\frac{1}{\sqrt{3}}\right)$ (2) $\sin^{-1}\left(\frac{1}{2}\right)$ (3) $\sin^{-1}\left(\frac{\sqrt{3}}{2}\right)$ (4) $\sin^{-1}\left(\frac{2}{\sqrt{3}}\right)$

Sol.: $\sin\theta_C = \frac{\sqrt{3}}{2}$



$1\sin\theta = \mu\sin r = \frac{2}{\sqrt{3}}\sin(90-\theta_C) = \frac{2}{\sqrt{3}}\sqrt{1-\frac{3}{4}} = \frac{2}{\sqrt{3}}\times\frac{1}{2}$

$\theta = \sin^{-1}\frac{1}{\sqrt{3}}$

Correct choice: (1)

This question contains Statement-1 and Statement -2. Of the four choices given after the statements, choose the one that best describes the two statements.

54. **Statement –1**: For a charged particle moving from point P to point Q, the net work done by an electrostatic field on the particle is independent of the path connecting point P to point Q.
Statement –2: The net work done by a conservative force on an object moving along a closed loop is zero.

(1) Statement –1 is false, Statement- 2 is true

(2) Statement –1 is true, Statement- 2 is false

(3)) Statement –1 is true, Statement- 2 is true; Statement -2 is the correct explanation for Statement-1

(4) Statement –1 is true, Statement- 2 is true; Statement -2 is not the correct explanation for Statement-1

Sol.: **Correct choice: (3)**

55. The transition from the state $n = 4$ to $n = 3$ in hydrogen like atom results in ultraviolet radiation. Infrared radiation will be obtained in the transition from:

(1) $5 \to 4$ (2) $2 \to 1$ (3) $3 \to 2$ (4) $4 \to 2$

Sol.: Energy of I – R radiation < energy of U – V radiation

Correct choice: (1)

This question contains Statement-1 and Statement -2. Of the four choices given after the statements, choose the one that best describes the two statements.

56. **Statement –1**: The temperature dependence of resistance is usually given as $R = R_0 (1+ \alpha \Delta t)$. The resistance of a wire changes from 100 Ω to 150 Ω when its temperature is increased from 27^0C to 227^0C. This implies that $\alpha = 2.5 \times 10^{-3}/^0$C.
Statement –2: $R = R_0 (1+ \alpha \Delta t)$ is valid only when the change in the temperature ΔT is small and $\Delta R = (R - R_0) << R_0$.

(1) Statement –1 is false, Statement- 2 is true

(2) Statement –1 is true, Statement- 2 is false

(3)) Statement –1 is true, Statement- 2 is true; Statement -2 is the correct explanation for Statement-1

(4) Statement –1 is true, Statement- 2 is true; Statement -2 is not the correct explanation for Statement-1

Sol.: **Correct choice: (1)**

***57.** Two wires are made of the same material and have the same volume. However wire 1 has cross-sectional area A and wire 2 has cross-sectional area 3A. If the length of wire 1 increases by Δx on applying force F, how much force is needed to stretch wire 2 by the same amount?

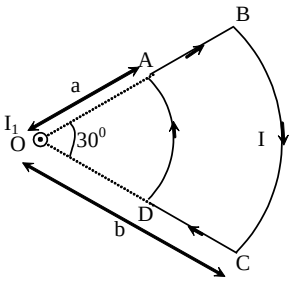
(1) 9 F (2) F (3) 4 F (4) 6 F

Sol.: $Y = \frac{\frac{F}{A}}{\frac{\Delta l}{l}} \Rightarrow Y\frac{\Delta l}{l} = \frac{F}{A}$; $\Delta l = \frac{Fl}{AY}$; $\frac{F_1 l_1}{A_1 Y_1} = \frac{F_2 l_2}{A_2 Y_2} \Rightarrow \frac{F(l)}{AY} = \frac{F'\left(\frac{l}{3}\right)}{3AY} \Rightarrow F' = 9\,\text{F}$

Correct choice: (1)

Directions: *Question numbers 58 and 59 are based on the following paragraph*

A current loop ABCD is held fixed on the plane of the paper as shown in the figure. The arcs BC (radius = b) and DA (radius =a) of the loop are joined by two straight wires AB and CD. A steady current I is flowing in the loop. Angle made by AB and CD at the origin O is 30^0. Another straight thin wire with steady current I_1 flowing out of the plane of the paper is kept at the origin.



58. The magnitude of the magnetic field (B) due to the loop ABCD at the origin (O) is:

(1) $\frac{\mu_0 I}{4\pi}\left[2(b-a)+\frac{\pi}{3}(a+b)\right]$ (2) zero (3) $\frac{\mu_0 I(b-a)}{24ab}$ (4) $\frac{\mu_0 I}{4\pi}\left[\frac{b-a}{ab}\right]$

Sol.: $B_{\text{due to ABCD}} = \left[\frac{\mu_0 I}{2a}-\frac{\mu_0 I}{2b}\right]\times\frac{1}{12}=\frac{\mu_0 I(b-a)}{24ab}$

Correct choice: (3)

59. Due to the presence of the current I_1 at the origin :

(1) The magnitude of the net force on the loop is given by $\frac{\mu_0 I I_1}{24ab}(b-a)$

(2) The forces on AB and DC are zero

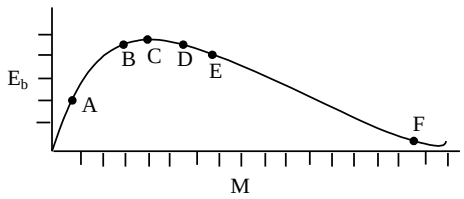
(3) The forces on AD and BC are zero

(4) The magnitude of the net force on the loop is given by $\frac{I_1 I}{4\pi}\mu_0\left[2(b-a)+\frac{\pi}{3}(a+b)\right]$

Sol.: Due to current I_1, force on DA and BC will be zero

Correct choice: (3)

60. The above is a plot of binding energy per nucleon E_b, against the nuclear mass M; A, B, C, D, E, F correspond to different nuclei. Consider four reactions:



(i) $A + B \rightarrow C + \varepsilon$

(ii) $C \rightarrow A + B + \varepsilon$

(iii) $D + E \rightarrow F + \varepsilon$ and

(iv) $F \rightarrow D + E + \varepsilon$

Where ε is the energy released? In which reactions is ε positive?

(1) (ii) and (iii) (2) (i) and (iv) (3) (i) and (iii) (4) (ii) and (iv)

Sol.: **Correct choice: (2)**

SOLUTIONS TO AIEEE 2009
CHEMISTRY: (Code: C)
PART – C

***61.** Arrange the carbanions, $(CH_3)_3\bar{C}$, $\bar{C}Cl_3$, $(CH_3)_2\bar{C}H$, $C_6H_5\bar{C}H_2$ in order of their decreasing stability:

(1) $(CH_3)_3\bar{C} > (CH_3)_2\bar{C}H > C_6H_5\bar{C}H_2 > \bar{C}Cl_3$ (2) $C_6H_5\bar{C}H_2 > \bar{C}Cl_3 > (CH_3)_3\bar{C} > (CH_3)_2\bar{C}H$

(3) $(CH_3)_2\bar{C}H > \bar{C}Cl_3 > C_6H_5\bar{C}H_2 > (CH_3)_3\bar{C}$ (4) $\bar{C}Cl_3 > C_6H_5\bar{C}H_2 > (CH_3)_2\bar{C}H > (CH_3)_3\bar{C}$

Sol.: $\bar{C}Cl_3 > C_6H_5\bar{C}H_2 > (CH_3)_2\bar{C}H > (CH_3)_3\bar{C}$ ($\bar{C}Cl_3$ is stabilized due to –I effect of Cl and pπ–dπ delocalization).

Correct choice: (4)

62. In Cannizzaro reaction given below

$2PhCHO \xrightarrow{:\overset{\ominus}{O}H} PhCH_2OH + PhCO_2^{\ominus}$ the slowest step is:

(1) the deprotonation of $PhCH_2OH$ (2) the attack of $:\overset{\ominus}{O}H$ at the carboxyl group

(3) the transfer of hydride of the carbonyl group (4) the abstraction of proton from the carboxylic group

Sol.: Cannizzaro reaction involves hydride transfer as the rate limiting step.

Correct choice: (3)

63. Two liquids X and Y form an ideal solution. At 300 K, vapour pressure of the solution containing 1 mol of X and 3 mol of Y is 550 mmHg. At the same temperature, if 1 mol of Y is further added to this solution, vapour pressure of the solution increases by 10 mmHg. Vapour pressure (in mmHg) of X and Y in their pure states will be, respectively:

(1) 500 and 600 (2) 200 and 300 (3) 300 and 400 (4) 400 and 600

Sol.: $\chi_X = \frac{1}{4}$, $\chi_Y = \frac{3}{4}$ $\quad P = p_x^o\chi_x + p_y^o\chi_y$

$550 = \frac{p_x^o}{4} + p_y^o \times \frac{3}{4}$ …(1)

After addition of 1 mole of Y further,

$560 = \frac{p_x^o}{5} + p_y^o \times \frac{4}{5}$ …(2) ; By solving equation (1) and (2) ; p_X^o = 400 mm Hg ; p_y^o = 600 mm Hg

Correct choice: (4)

***64.** In a fuel cell, methanol is used as fuel and oxygen gas is used as an oxidizer. The reaction is

$CH_3OH(l) + 3/2O_2(g) \longrightarrow CO_2(g) + 2H_2O(l)$; At 298 K standard Gibb's energies of formation for $CH_3OH(l)$, $H_2O(l)$ and $CO_2(g)$ are –166.2, –237.2 and –394.4 kJ mol^{-1} respectively. If standard enthalpy of combustion of methanol is –726 kJ mol^{-1}, efficiency of the fuel cell will be

(1) 97% (2) 80% (3) 87% (4) 90%

Sol.: Efficiency of fuel cell (η) = $\frac{\Delta G^o}{\Delta H^o} = \frac{-702.6}{-726} \times 100 \simeq$ **97%**.

Correct choice: (1)

***65.** On the basis of the following thermochemical data: $(\Delta_f G^o H^+_{(aq)} = 0)$

$H_2O(l) \longrightarrow H^+(aq) + OH^-(aq)$; $\Delta H = 57.32$ kJ

$H_2(g) + ½O_2(g) \longrightarrow H_2O(l)$; $\Delta H = -286.20$ kJ

The value of enthalpy of formation of OH^- ion at 25°C is:

(1) –343.52 kJ (2) –22.88 kJ (3) –228.88 kJ (4) +228.88 kJ

Sol.: $\Delta_r^oH = \Delta_f^oOH^- - \Delta_f^oH_2O$; $57.32 = \Delta_f^oOH^- + 286.20$; $\Delta_f^oOH^- = 57.32 - 286.20 =$ **–228.88 kJ**.

Correct choice: (3)

66. The half life period of a first order chemical reaction is 6.93 minutes. The time required for the completion of 99% of the chemical reaction will be (log 2 = 0.301):

(1) 460.6 minutes (2) 230.3 minutes (3) 23.03 minutes (4) 46.06 minutes

Sol.: $k = \frac{0.693}{6.930} = 0.1$; $t_{99} = \frac{2.303}{0.1}\log\frac{100}{1} = \frac{2.303 \times 2}{0.1}$ = **46.06 minutes**.

Correct choice: (4)

67. Copper crystallises in fcc with a unit cell length of 361 pm. What is the radius of copper atom?

(1) 181 pm (2) 108 pm (3) 127 pm (4) 157 pm

Sol.: For FCC, $4r = \sqrt{2}\,a$ or $r = \frac{a}{2\sqrt{2}} = \frac{361}{2\times1.414} = \frac{361}{2.828} =$ **127.6 pm**.

Correct choice: (3)

68. Given: $E^{o}_{Fe^{3+}/Fe} = -0.036$ V. $E^{o}_{Fe^{2+}/Fe} = -0.439$ V. The value of standard electrode potential for the change, $Fe^{3+}(aq) + e^{-} \longrightarrow Fe^{2+}(aq)$ will be:

(1) –0.270 V (2) –0.072 V (3) 0.385 V (4) 0.770 V

Sol.: $Fe^{3+} + 3e^{-} \longrightarrow Fe$; $E^{o}_1 = -0.036$ V ; $\Delta G^{o}_1 = +0.108F$

$Fe \longrightarrow Fe^{2+} + 2e^{-}$; $E^{o}_2 = +0.439$ V ; $\Delta G^{o}_2 = -0.878$ F

$Fe^{3+} + e^{-} \longrightarrow Fe^{2+}$; $\Delta G^{o}_3 = -0.77$ F

$\because\ \Delta G° = -nF\,E°$; $\therefore\ E^{o}_3 = \frac{0.77F}{F} =$ **0.770 V**.

Correct choice: (4)

69. In which of the following arrangements, the sequence is ***not*** strictly according to the property written against it?

(1) B < C < O < N; increasing first ionization enthalpy

(2) $CO_2 < SiO_2 < SnO_2 < PbO_2$: increasing oxidising power

(3) HF < HC*l* < HBr < HI: increasing acid strength

(4) $NH_3 < PH_3 < AsH_3 < SbH_3$: increasing basic strength

Sol.: On moving down the group, the basic tendency of hydrides of group 15 decreases.

Correct choice: (4)

70. Knowing that the chemistry of lanthanoids (Ln) is dominated by its +3 oxidation state, which of the following statements is ***incorrect***?

(1) Ln (III) hydroxides are mainly basic in character.

(2) Because of the large size of the Ln (III) ions the bonding in its compounds is predominantly ionic in character.

(3) The ionic sizes of Ln (III) decrease in general with increasing atomic number.

(4) Ln (III) compounds are generally colourless.

Sol.: **Correct choice: (4)**

71.** The set representing the ***correct order of ionic radius is:

(1) $Mg^{2+} > Be^{2+} > Li^{+} > Na^{+}$ (2) $Li^{+} > Be^{2+} > Na^{+} > Mg^{2+}$ (3) $Na^{+} > Li^{+} > Mg^{2+} > Be^{2+}$ (4) $Li^{+} > Na^{+} > Mg^{2+} > Be^{2+}$

Sol.: On moving down the group, the ionic radius increases. In case of isoelectronic ions, more the charge on the ion, smaller will be its size.

Correct choice: (3)

72. Buna–N synthetic rubber is a copolymer of:

(1) $H_2C{=}CH{-}CN$ and $H_2C{=}CH{-}\underset{\displaystyle CH_3}{\underset{|}{C}}{=}CH_2$ (2) $H_2C{=}CH{-}\overset{\displaystyle Cl}{\overset{|}{C}}{=}CH_2$ and $H_2C{=}CH{-}CH{=}CH_2$

(3) $H_2C{=}CH{-}CH{=}CH_2$ and $H_5C_6{-}CH{=}CH_2$ (4) $H_2C{=}CH{-}CN$ and $H_2C{=}CH{-}CH{=}CH_2$

Sol.: Buna–N is a copolymer of buta–1,3–diene and acrylonitrile.

Correct choice: (4)

73. Which of the following statements is ***incorrect*** regarding physiosorption?

(1) Enthalpy of adsorption ($\Delta H_{adsorption}$) is low and positive.

(2) It occurs because of Van der Waal's forces.

(3) More easily liquefiable gases are adsorbed readily.

(4) Under high pressure it results into multi molecular layer on adsorbent surface.

Sol.: ΔH for adsorption is negative. Adsorption is a spontaneous process, so ΔG is negative and ΔS in case of adsorption is also negative. $\therefore\ \Delta G = \Delta H - T\Delta S$. Therefore, ΔH is –ve.

Correct choice: (1)

***74.** The number of stereoisomers possible for a compound of the molecular formula $CH_3{-}CH{=}CH{-}\underset{\displaystyle OH}{\underset{|}{CH}}{-}Me$ is:

(1) 6 (2) 3 (3) 2 (4) 4

Sol.: $CH_3{-}CH{=}CH{-}\underset{\displaystyle OH}{\underset{|}{CH}}{-}Me$

Isomer 1: cis d ; Isomer 2: cis *l* ; Isomer 3: trans d ; Isomer 4: trans *l*

Correct choice: (4)

75. The two functional groups present in a typical carbohydrate are:

(1) –OH and –CHO (2) –OH and –COOH (3) –CHO and –COOH (4) $\rangle$C=O and –OH

Sol.: Carbohydrate is a polyhydroxy aldehyde or polyhydroxy ketone or any compound which give these on hydrolysis. $\rangle$C=O group includes aldehydic as well as ketonic group.

Correct choice: (4)

***76.** Calculate the wavelength (in nanometer) associated with a proton moving at 1.0×10^3 ms^{-1} (Mass of proton = 1.67×10^{-27} kg and h = 6.63×10^{-34} Js):

(1) 14.0 nm (2) 0.032 nm (3) 0.40 nm (4) 2.5 nm

Sol.: $\lambda = \frac{h}{mv} = \frac{6.63\times10^{-34}\text{Js}}{1.67\times10^{-27}\text{kg}\times1\times10^{3}\text{ms}^{-1}} = 3.97 \times 10^{-10}$ m = **0.397 nm**.

Correct choice: (3)

***77.** The bond dissociation energy of B–F in BF_3 is 646 kJ mol^{-1} whereas that of C–F in CF_4 is 515 kJ mol^{-1}. The correct reason for higher B–F bond dissociation energy as compared to that of C–F is

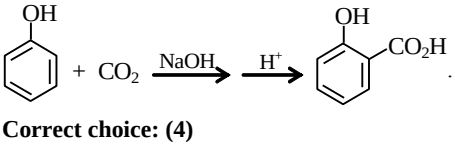
(1) lower degree of pπ–pπ interaction between B and F in BF_3 than that between C and F in CF_4.
(2) smaller size of B atoms as compared to that of C atom.
(3) stronger σ bond between B and F in BF_3 as compared to that between C and F in CF_4
(4) significant pπ–pπ interaction between B and F in BF_3 whereas there is no possibility of such interaction between C and F in CF_4.

Sol.: Boron in BF_3 has a vacant p–orbital, allowing pπ–pπ back bonding while carbon in CF_4 has no vacant orbital, so no back bonding is feasible. Thus, B–F bond is stronger than CF_4.

Correct choice: (4)

78. The major product obtained on interaction of phenol with sodium hydroxide and carbon dioxide is:

(1) phthalic acid (2) benzoic acid (3) salicylaldehyde (4) salicylic acid

Sol.:  . This is Kolbe's synthesis.

Correct choice: (4)

***79.** Solid $Ba(NO_3)_2$ is gradually dissolved in 1.0×10^{-4} M Na_2CO_3 solution. At what concentration of Ba^{2+} will a precipitate begin to form? (K_{sp} for Ba CO_3 = 5.1×10^{-9}):

(1) 8.1×10^{-7} M (2) 4.1×10^{-5} M (3) 5.1×10^{-5} M (4) 8.1×10^{-8} M

Sol.: Concentration of Ba^{2+} needed to precipitate $BaCO_3 = \frac{K_{sp}\text{ of }BaCO_3}{[CO_3^{2-}]} = \frac{5.1\times10^{-9}}{1.0\times10^{-4}} =$ **5.1×10^{-5} M**.

Correct choice: (3)

80. Which one of the following reactions of xenon compounds is ***not*** feasible?

(1) $XeF_6 + RbF \rightarrow Rb[XeF_7]$ (2) $XeO_3 + 6HF \rightarrow XeF_6 + 3H_2O$
(3) $3XeF_4 + 6H_2O \rightarrow 2Xe + XeO_3 + 12HF + 1.5O_2$ (4) $2XeF_2 + 2H_2O \rightarrow 2Xe + 4HF + O_2$

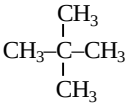
Sol.: XeF_6 reacts violently with water and gets hydrolysed to give highly explosive XeO_3.

$XeF_6 + 6H_2O \longrightarrow XeO_3 + 3H_2O$; Reaction (2) is reverse of this, so it is not feasible.

Correct choice: (2)

***81.** The IUPAC name of neopentane is:

(1) 2,2–dimethylbutane (2) 2–methylbutane (3) 2,2-dimethylpropane (4) 2–methylpropane

Sol.:  2,2-dimethylpropane

Correct choice: (3)

82. In context with the transition elements, which of the following statements is ***incorrect***?

(1) Once the d^5 configuration is exceeded, the tendency to involve all the 3*d* electrons in bonding decreases.
(2) In addition to the normal oxidation states, the zero oxidation state is also shown by these elements in complexes.
(3) In the highest oxidation states, the transition metal show basic character and form cationic complexes.
(4) In the highest oxidation states of the first five transition elements (Sc to Mn), all the 4*s* and 3d electrons are used for bonding.

Sol.: In highest oxidation state, the transition metal will form complexes which will have large degree of covalent character, which shows acidic behaviour.

Correct choice: (3)

83. Which of the following pairs represents linkage isomers?

(1) $[PtCl_2(NH_3)_4]Br_2$ and $[PtBr_2(NH_3)_4]Cl_2$ (2) $[Cu(NH_3)_4][PtCl_4]$ and $[Pt(NH_3)_4]$ $[CuCl_4]$

(3) $[Pd(PPh_3)_2(NCS)_2]$ and $[Pd(PPh_3)_2(SCN)_2]$ (4) $[Co(NH_3)_5NO_3]SO_4$ and $[Co(NH_3)_5SO_4]NO_3$

Sol.: Linkage isomerism is shown by ambidentate ligands. (SCN^- and NCS^- are ambidentate groups).

Correct choice: (3)

***84.** In an atom, an electron is moving with a speed of 600 m/s with an accuracy of 0.005%. Certainity with which the position of the electron can be located is ($h = 6.6 \times 10^{-34}$ kg m^2 s^{-1}, mass of electron, $e_m = 9.1 \times 10^{-31}$ kg):

(1) 3.84×10^{-3} m (2) 1.52×10^{-4} m (3) 5.10×10^{-3} m (4) 1.92×10^{-3} m

Sol.: $\Delta v = 600 \times 5 \times 10^{-5}$ m/s. ; $\Delta x \geq \frac{h}{4\pi m.\Delta v} \geq \frac{6.6\times10^{-34}}{4\times3.14\times9.1\times10^{-31}\times600\times5\times10^{-5}} \simeq$ **1.92×10^{-3} m**.

Correct choice: (4)

85. Which of the following on heating with aqueous KOH, produces acetaldehyde?

(1) CH_3CHCl_2 (2) CH_3COCl (3) CH_3CH_2Cl (4) CH_2ClCH_2Cl

Sol.: $CH_3CHCl_2 \xrightarrow[\Delta]{\text{aq. KOH}} CH_3CH(OH)_2 \xrightarrow{-H_2O} CH_3CHO$

gem diol

Correct choice: (1)

86. A liquid was mixed with ethanol and a drop of concentrated H_2SO_4 was added. A compound with a fruity smell was formed. The liquid was:

(1) CH_3COOH (2) CH_3OH (3) HCHO (4) CH_3COCH_3

Sol.: $CH_3COOH + C_2H_5OH \xrightarrow{\text{Conc.}H_2SO_4} CH_3COOC_2H_5 + H_2O$

Ethyl acetate (ester) has fruity smell.

Correct choice: (1)

***87.** Using MO theory predict which of the following species has the shortest bond length?

(1) O_2^{2-} (2) O_2^{2+} (3) O_2^+ (4) O_2^-

Sol.: The bond order of O_2^{2-}, O_2^{2+}, O_2^+ and O_2^- is 1, 3, 2.5 and 1.5 respectively. Since, O_2^{2+} has highest bond order, so it has shortest bond length.

Correct choice: (2)

88. A binary liquid solution is prepared by mixing n-heptane and ethanol. Which one of the following statements is ***correct*** regarding the behaviour of the solution?

(1) n–heptane shows +ve deviation while ethanol shows –ve deviation from Raoult's Law.

(2) The solution formed is an ideal solution.

(3) The solution is non-ideal, showing +ve deviation from Raoult's law.

(4) The solution is non-ideal, showing –ve deviation from Raoult's Law.

Sol.: When n–heptane is added to ethanol, the H-bonding interaction between ethanol molecules is loosened, so weaker interaction among molecules leads to higher vapour pressure. Thus, it forms a non-ideal solution with positive deviation from Raoult's law.

Correct choice: (3)

***89.** The alkene that exhibits geometrical isomerism is:

(1) 2–methyl–2–butene (2) propene (3) 2–methyl propene (4) 2–butene

Sol.: Terminal alkenes never show geometrical isomerism and non–terminal alkene with 2 different groups attached to each atom having restricted rotation is capable of showing geometrical isomerism.

Correct choice: (4)

90. Which of the following has an optical isomer?

(1) $[Co(en)_2(NH_3)_2]^{3+}$ (2) $[Co(NH_3)_3Cl]^+$ (3) $[Co(en)(NH_3)_2]^{2+}$ (4) $[Co(H_2O)_4(en)]^{3+}$

Sol.: Square planar complexes can not show optical isomerism. So, option (2) and (3) are ruled out. Compound in option (4) i.e. $[Co(H_2O)_4(en)]^{3+}$ has a plane of symmetry, so it is also optically inactive.

Correct choice: (1)