SECTION - I

This section contains 10 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which ONLY ONE is correct.

MATHEMATICS

01. What is the correct order

$2^{800}, 3^{600}, 5^{400}, 6^{200}$

(A) $2^{800} < 3^{600} < 5^{400} < 6^{200}$

(B) $6^{200} < 2^{800} < 5^{400} < 3^{600}$

(C) $6^{200} < 5^{400} < 3^{600} < 2^{800}$

(D) $3^{600} < 2^{800} < 5^{400} < 6^{200}$

Sol:

$2^{800} = \left(2^8\right)^{100} = 256^{100}$

$3^{600} = \left(3^6\right)^{100} = 729^{100}$

$5^{400} = \left(5^4\right)^{100} = 625^{100}$

$6^{200} = \left(6^2\right)^{100} = 36^{100}$

$\therefore 36^{100} < 256^{100} < 625^{100} < 729^{100}$

$6^{200} < 2^{800} < 5^{400} < 3^{600}$

02 If a polynomial $f(x)$ is divided by $(x-a)(x-b)$, the remainder is

(A) $\dfrac{(x-a)f(b)-(x-b)f(a)}{a-b}$

(B) $\dfrac{(x-a)f(b)-(x-b)f(a)}{b-a}$

(C) $\dfrac{(x-a)f(b)-(x-b)f(a)}{a-b}$

(D) $\dfrac{(x-a)f(a)-(x-b)f(b)}{b-a}$

Sol:

Let remainder be $px+q$

By division algorithm

$\therefore f(x) = (x-a)(x-b)g(x) + px + q$

$f(a) = pa + q$ - (1)

$f(b) = pb + q$ - (2)

Eq (1) - Eq (2) $\Rightarrow f(a) - f(b) = p(a-b)$

$\Rightarrow p = \dfrac{f(a)-f(b)}{a-b}$

$(1)\times b - (2)\times a \quad b f(a) - a f(b) = bq - aq = (b-a)q$

$\therefore q = \dfrac{b f(a) - a f(b)}{b-a}$

$px + q = \dfrac{f(a)-f(b)}{a-b}.x + \dfrac{b f(a) - a\ f(b)}{b-a}$

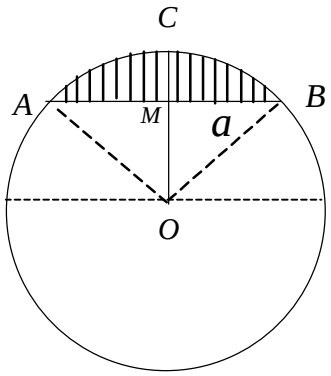
$= \dfrac{-(f(a)-f(b))}{b-a}x + \dfrac{b f(a) - af(b)}{b-a}$

$= \dfrac{-f(a)x + f(b)x + f(a)b - f(b)a}{b-a}$

$= \dfrac{f(b)x - f(b)a - f(a)x + f(a)b}{b-a}$

$= \dfrac{f(b)(x-a) - f(a)(x-b)}{b-a}$

03. The shaded region is segment of a circle. AB is a chord of the circle, M is mid point of AB, C is on the cirumference and CM perpendicular AB. If MB = a and $CM = a\left(2-\sqrt{3}\right)$, what is the area of the shaded region ?

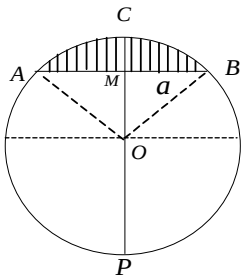


(A) $\frac{1}{4}\pi a^2$ (B) $\frac{1}{6}\pi a^2$

(C) $\frac{1}{6}\left(\pi^2+\sqrt{3}\right)a^2$ (D) $\frac{a^2}{3}\left(2\pi-3\sqrt{3}\right)$

Sol:

Let r be the radius of the circle



$AM \times MB = CM \times MP$

$MB \times MB = CM \times MP$

$a \times a = a\left(2-\sqrt{3}\right) \times MP$

$$MP = \frac{a}{2-\sqrt{3}}$$

$$2r = CP = CM + MP = a\left(2-\sqrt{3}\right) + \frac{a}{\left(2-\sqrt{3}\right)}$$

$$= \frac{a\left(2-\sqrt{3}\right)^2 + a}{\left(2-\sqrt{3}\right)}$$

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

$$= \frac{a\left(8-4\sqrt{3}\right)}{\left(2-\sqrt{3}\right)} = \frac{4a\cancel{\left(2-\sqrt{3}\right)}}{\cancel{\left(2-\sqrt{3}\right)}}$$

$2r = 4a \Rightarrow r = 2a$

So $OA = OB = OC = r = 2a$

$OM = OC - CM$

$= 2a - a\left(2-\sqrt{3}\right)$

$= 2a - 2a + a\sqrt{3} = a\sqrt{3}$

In ΔOMB

$$\tan \angle MOB = \frac{MB}{OM}$$

$$= \frac{a}{a\sqrt{3}} = \frac{1}{\sqrt{3}} = \tan 30^\circ$$

$\angle MOB = 30^\circ$

$\Rightarrow \angle AOB = 2\angle MOB = 2\left(30^\circ\right) = 60^\circ$

Area of the sector AOB

$$= \pi r^2 \times \frac{\theta}{360^\circ} = \pi\left(2a\right)^2 \times \frac{60^\circ}{360^\circ}$$

$$= \pi\, 4a^2 \frac{1}{6} = \frac{2\pi a^2}{3}$$

Area of $\Delta AOB = \frac{1}{2} \times AB \times OM = \frac{1}{\cancel{2}} \times \cancel{2}a \times a\sqrt{3}$

$\therefore$ Area of the shaded region

= Area of the sector AOB – Area of ΔAOB

$$= \frac{2\pi a^2}{3} - \sqrt{3}a^2 = \frac{2\pi a^2}{3} - \frac{3\sqrt{3}a^2}{3}$$

$$= = \frac{a^2}{3}\left(2\pi - 3\sqrt{3}\right)$$

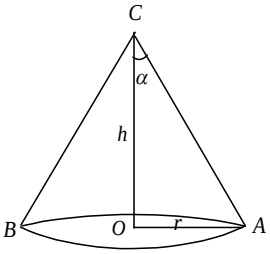
04. If h be the height and α be the semi vertical angle of a right circular cone, then its volume is

(A) $\frac{1}{3}\pi h^3 \tan^2\alpha$ (B) $\frac{1}{3}\pi h^2 \tan^2\alpha$

(C) $\frac{1}{3}\pi h^2 \tan^3\alpha$ (D) $\frac{1}{3}\pi h^3 \tan^3\alpha$

Sol:

In triangle OAC



$$\tan\alpha = \frac{OA}{OC} = \frac{r}{h}$$

$$r = h\tan\alpha$$

Volume $= \frac{1}{3}\pi r^2 h$

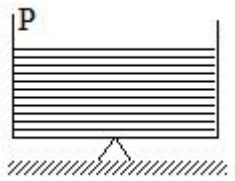
$$= \frac{\pi h}{3} \times r^2$$

$$= \frac{\pi h}{3} \times h^2 \tan^2\alpha$$

$$= \frac{\pi h^3}{3} \tan^2\alpha$$

SCIENCE

05. A beaker containing water is just supported by a sharp support as shown in figure . If a cork is gently dropped into the water at P to keep the beaker in equilibrium.



(A) the support is to be shifted towards left

(B) the support is to be shifted towards right

(C) the support can be shifted in any direction

(D) the support need not be shifted

06. A 10 kg block is dropped from a height of 10 m. If the kinetic energy of the body while reaching the ground is 800 J, the loss in energy due to the air resistance is (g = 10 m/s^2)

(A) 800 J (B) 400 J

(C) 1000 J (D) 200 J

Sol:

PE at top = mgh = $10\times10\times10 = 1000$ J

KE at bottom = 800 J – Loss = 1000 – 800 = 200 J.

07. Two bulbs B_1 of 40 W and B_2 of 100 W are connected across mains . Consider the following statements

Statement - 1 : If the bulbs are connected in series 40 W bulb glows brighter than 100 W bulb

Statement - 2 : If the bulbs are connected in parallel 100 W bulb glows brighter than 40 W bulb .

(A) Statement 1 is TRUE and 2 is FALSE

(B) Both the statements are WRONG

(C) Statement 1 is FALSE and 2 is TRUE

(D) Both the statements are 'TRUE'

Sol:

In series connection,

Bulb with lower wattage slows more brighter i.e. 40 watt.

and zero parallel connection,

Bulb with higher wattage glows more brighter i.e. 100 W.

08. The angle between the incident and reflected rays using a plane mirror is 100^0. The mirror is turned thorugh an angle of 20^0. The angle between the two rays is now

(A) 80^0 (B) 120^0

(C) 80^0 or 120^0 (D) 60^0 or 140^0

Sol:

If mirror is rotated through θ, than cube blows $\rightarrow 2\theta = 2\times 20 = 40°$

For anticlockwise rotation $100 - 2\theta$ = $100 - 40 = 60°$

For clockwise rotation 100 + 20 = 100 + 40 = 140°

$60°$ or $140°$

$(100 - 2\times 20)$ (or) $(100 + 2\times 20)$

$= 100 - 40$ $100 + 40$

$= 60$ 140

09. How many moles of e^- weigh one Kg

(A) 6.023×10^{23} (B) $\frac{1}{9.108} \times 10^{31}$

(C) $\frac{6.023}{9.108} \times 10^{54}$

(D) $\frac{1}{9.108\times 6.023} \times 10^{8}$

Sol :

Mass of $1e^- = 9.108\times 10^{-31}$ kg

then number of e^-, that weigh

$$1 \text{ kg} = \frac{1}{9.108\times 10^{-31}} \text{ kg}$$

number of moles of e^-, weigh

$$1 \text{ kg} = \frac{10^{31}}{9.108\times 6.023\times 10^{23}}$$

$$= \frac{10^8}{9.108\times 6.023}$$

10. Which of the following compounds will show geometrical isomerism ?

(I) 2–butene (II) Propene

(III) 1–phenylpropene

(IV) 2–methyl–2–butene

Choose the correct option

(A) I and III (B) I and IV

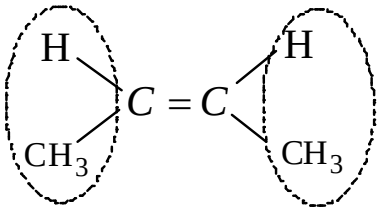
(C) II and III (D) III and IV

Sol :

Alkenes with double bond 'c' containing different group can exhibit geometrical isomersim.

i) 2 – butene

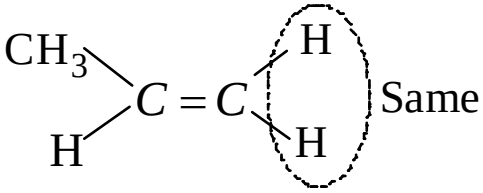
$CH_3 - CH = CH - CH_3$



It can exhibit

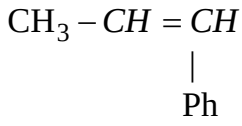
ii) Propene

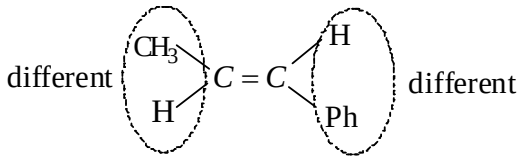
$CH_3 - CH = CH_2$



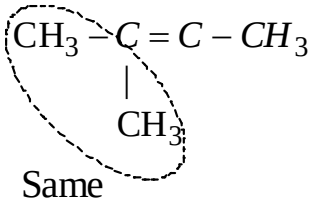
Cannot exhibit

iii) 1-phenyl propene :





iv) 2-methyl-2-butene



Cannot exhibit

11. **Assertion :** Oxygen is more electronegative than sulphur, yet H_2S is acidic, while H_2O is neutral.

Reason : H–S bond is weaker than O–H bond.

(A) both (A) and (R) are true and (R) is the correct explanation of (A)

(B) both (A) and (R) are true but (R) is not correct explanation of (A)

(C) (A) is true but (R) is false

(D) (A) is false and (R) is true

Sol :

"H_2S is more acidic than H_2O" ____ true. because 'S – H' bond is longer than 'O – H' bond.

$$\text{bond strength} \propto \frac{1}{\text{bond length}}$$

$\therefore$ 'S – H' bond is weaker than 'O – H' bond thus it will dissociate more readily than 'O – H' bond.

12. The quantum numbers of four electrons (e1 to e4) are given below

	n	***l***	**m**	**s**
e1	3	0	0	+1/2
e2	4	0	0	1/2
e3	3	2	2	–1/2
e4	3	1	–1	1/2

The correct order of decreasing energy of these electrons is:

(A) e4 > e3 > e2 > e1

(B) e2 > e3 > e4 > e1

(C) e3 > e2 > e4 > e1

(D) e3 > e2 > e1 > e4

Sol :

Energy of orbital $\propto (n+l)$ value.

if $(n+l)$ value is same for two orbitals, then

$\boxed{\text{Energy} \propto \text{n}}$.

	e_1	e_2	e_3	e_4
(n+l)	3+0	4+0	3+2	3+1
	= 3	= 4	= 5	= 4

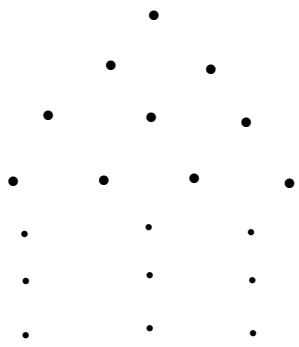
$\therefore$ Order of energy : $e_3 > e_2 > e_4 > e_1$

SECTION - II

Comprehensive type questions :

Passage : 1

Let us look at the following triangular arragements of dots. First row has one dot, second row two dots and so on and nth row will have n dots. Let t_n be total number of dots in such a triangular arrangement of n rows of dots. Answer questions 16 and 17 below:



13. t_n^2 =

(A) $1+2+3+....+n$

(B) $1^2+2^2+3^2+.....+n^2$

(C) $1^3+2^3+3^3+.....+n^3$

(D) $2t_n-1$

Sol:

$$t_n = 1+2+3+...+n = \frac{n(n+1)}{2}$$

$$t_n{}^2 = \frac{n^2(n+1)^2}{4} = 1^3+2^3+...+n^3$$

14. $t_1+t_2+....+t_n$ =

(A) $\frac{1}{6}n(n+1)(2n+1)$

(B) $\frac{1}{6}n(n+1)(n+2)$

(C) $\frac{1}{12}n(n+1)(2n+1)$

(D) $\frac{1}{12}n(n+1)(n+3)$

Sol:

$$t_1+t_2+...+t_n = \sum_1^n \frac{n(n+1)}{2}$$

$$\frac{1}{2}\left(\sum n^2+\sum n\right)$$

$$=\frac{1}{2}\left(\frac{n(n+1)(2n+1)}{6}+\frac{n(n+1)}{2}\right)$$

$$=\frac{1}{2}\frac{n(n+1)}{2}\left(\frac{2n+1}{3}+1\right)=\frac{n(n+1)(2n+1+3)}{2.2.3}$$

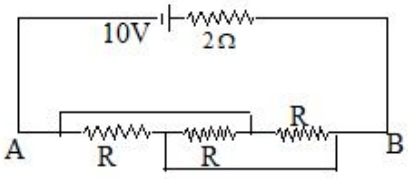
$$=\frac{n(n+1)(2n+4)}{12}$$

$$=\frac{n(n+1)\cancel{2}(n+2)}{\cancel{12}_6}$$

$$=\frac{n(n+1)(n+2)}{6}$$

Passage - 2

Consider the circuit shown in figure



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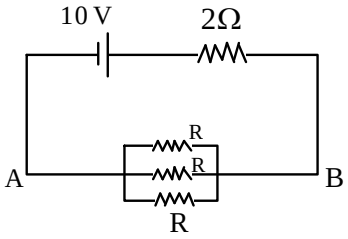

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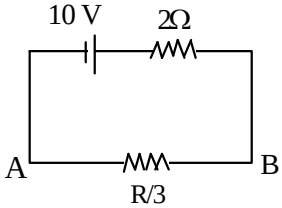


$$\frac{1}{R_e}=\frac{1}{R}+\frac{1}{R}+\frac{1}{R}$$

$$\frac{1}{R_e}=\frac{3}{R}$$

$$\Rightarrow R_e=\frac{R}{3}$$

15. Find the value of R at which the power generated between A and B points is maximum

(A) 3Ω (B) 2Ω

(C) 4Ω (D) 6Ω

Sol:

For maximum power source resistance = load resistance.

i.e. $2=\frac{R}{3}\Rightarrow R=6\Omega$

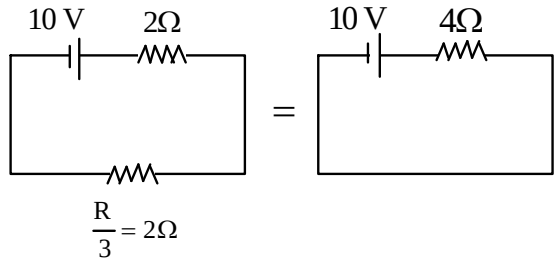
16. Maximum power supplied by the battery is

(A) 100 W (B) 50 W

(C) 25 W (D) 12.5 W

Sol :

Circuit becomes



2 sin series with 2Ω

$R = 2 + 2 = 4\Omega$

$$P=\frac{V^2}{R}=\frac{10^2}{4}=\frac{100}{4}=25\text{ W}$$

Passage - *3 :*

Four elements P, Q, R & S have ground state electronic configuration as:

$P \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$

$Q \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$

$R \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^3$

$S \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^1$

Sol:

$P \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$ - phosphorous (P)

$Q \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$ - Aluminium (Al)

$R \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^3$ - Arsenic (As)

$S \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^1$ - Gallium (Ga)

17. Comment which of the following option represent the correct order of true (T) & false (F) statement.

I size of P < size of Q

II size of R < size of S

III Element P can form oxides like P_4O_6 and P_4O_{10}.

IV Element Q can form oxides like Q_2O.

(A) TTTT (B) TTTF

(C) FFTT (D) TTFF

Sol:

(I) Al is bigger than P, because in a period left to right Atomic size decreases

(II) Ga is bigger than As

(III) P can form P_4O_6 , P_4O_{10}

(IV) Al can form oxide (Al_2O_3).

18. Order of IE_1 values among the following is

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

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

Sol:

Al		P
Ga		As

* IE of Ga is more than Al due to poor screening effect of d-orbitals of 'Ga'.

* IE decreases down the group

$\therefore$ IE of As < IE of P

SECTION - III

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. Any given statement in Column I can have correct matching with ONE statement in Column II.

M1) The centres of the two circles are r_1 and r_2 and 'd' is the distance between the centres

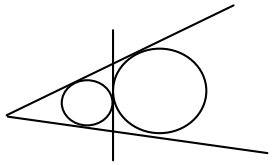
Column - I	***Column - II***
values of r_1, r_2, d	number of common tangents to the circles
19. $r_2 = 1,\ r_1 = 4,\ d = 5$	(A) 1
20. $r_2 = 2,\ r_1 = 7,\ d = 5$	(B) 4
21. $r_2 = 3,\ r_1 = 5,\ d = 12$	(C) 2
22. $r_2 = 3,\ r_1 = 2,\ d = 4$	(D) 3

Sol:

19. $r_2 = 1, r_1 = 4,\ d = 5$

$d = r_1 + r_2$

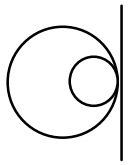
$\therefore$ No. of common tangents = 3



20. $r_2 = 2, r_1 = 7,\ d = 5$

$d = r_1 - r_2$

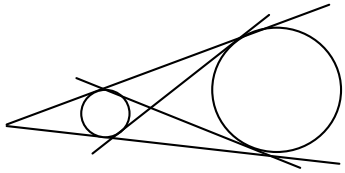
$\therefore$ No. of common tangents = 1



21. $r_2 = 3, r_1 = 5,\ d = 12$

$d > r_1 + r_2$

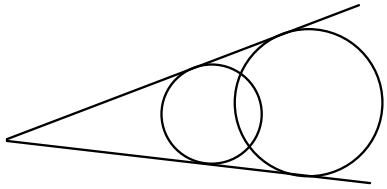
$\therefore$ No. of common tangents = 4



22. $r_2 = 3, r_1 = 2,\ d = 4$

$r_2 - r_1 < d < r_1 + r_2$

$\therefore$ No. of common tangents = 2



S2) **Column I**	**Column II**
(23) Magnesium sulphate	(A) Epsom salt
(24) Calcium hydroxide	(B) Gypsum
(25) Calcium carbonate	(C) Dolomite
(26) Calcium sulphate	(D) Slaked lime

Sol:

23) $MgSO_4 \cdot 7H_2O$ - Epsom Salt

24) $Ca(OH)_2$ - Slaked lime

25) $CaCO_3 \cdot MgCO_3$ - Dolomite

26) $CaSO_4 \cdot 2H_2O$ - Gypsom

SECTION - IV

Reasoning Type Questions :

27. Choose the word which is least like the other words in the group.

(A) Biscuits (B) Chocolates (C) Cake (D) Bread

28. Clever is to Beautiful as Sour is to .....

(A) Lemon (B) Cunning (C) Loathing (D) Taste

29. In a certan code language, the word 'RECTANGLE' is coded as TGEVCPING, then how is the word 'RHOMBUS' coded ?

(A) TJOQDWV (B) UVWTJQN (C) TJQODWU (D) JTQOEWN

Sol:

R E C T A N G L E $\rightarrow$ T G E V C P I N G

R H O M B U S $\rightarrow$ T J Q O D W U

30. A bus for Delhi leaves every 30 minutes from a bus stand. An enquiry clerk told a passenger that the bus had already left 10 minutes ago and the next bus will leave at 9:35 am. At what time did the enquiry clerk give this information to the passenger ?

(A) 9.10 am (B) 9.15 am (C) 8.55 am (D) 8.08 am

Sol:

Next bus is at 9:35

Already 10 minutes are over

Time = 9:15 am

KEY

01.B 02.B 03.D 04.A 05.D 06.D 07.D 08.D 09.D 10.A 11.A 12.C 13.C 14.B
15.D 16.C 17.B 18.A **M1 : 19-D ; 20-A;21-B;22-C S1 : 23-A 24-D 25-C 26- B**
27.B 28.B 29.C 30.B