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KISHORE VAIGYANIK PROTSAHAN YOJANA (KVPY) 2015

Date : 01-11-2015 **Time: 3 Hours** **Max. Marks : 100**

STREAM - SA

INSTRUCTIONS

1. Immediately fill the particulars on this page of the Test Booklet with Blue / Black Ball Point Pen. Use of pencil is strictly prohibited.

2. The Test Booklet consists of **80** questions.

3. There are Two parts in the question paper. The distribution of marks subjectwise in each part is as under for each correct response.

MARKING SCHEME :

PART-I :

MATHEMATICS
Question No. **1 to 15** consist of **ONE (1)** mark for each correct response.
PHYSICS
Question No. **16 to 30** consist of **ONE (1)** mark for each correct response.
CHEMISTRY
Question No. **31 to 45** consist of **ONE (1)** mark for each correct response.
BIOLOGY
Question No. **46 to 60** consist of **ONE (1)** mark for each correct response.

PART-II :

MATHEMATICS
Question No. **61 to 65** consist of **TWO (2)** marks for each correct response.
PHYSICS
Question No. **66 to 70** consist of **TWO (2)** marks for each correct response.
CHEMISTRY
Question No. **71 to 75** consist of **TWO (2)** marks for each correct response.
BIOLOGY
Question No. **76 to 80** consist of **TWO (2)** marks for each correct response.

4. Candidates will be awarded marks as stated above in Instructions No. 3 for correct response of each question. for Part-I **0.25** marks will be deducted for indicating incorrect response of each question and for Part-II **0.50** 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. No candidate is allowed to carry any textual material, printed or written, bits of papers, paper, mobile phone, any electronic device, etc., except the Admit Card inside the examination hall/room.

6. 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.

7. On completion of the test, the candidate must hand over the Answer Sheet to the Invigilator on duty in the Room/Hall. However, the candidates are allowed to take away this Test Booklet with them.

8. Do not fold or make any stray marks on the Answer Sheet.

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PART-I
One Mark Questions

MATHEMATICS

1. Two distinct polynomial f(x) and g(x) are defined as follows:

$f(x) = x^2 + ax + 2;$ $\qquad g(x) = x^2 + 2x + a$

If the equation $f(x) = 0$ and $g(x) = 0$ have a common root then the sum of the roots of the equation $f(x) + g(x) = 0$ is

[A] $-\frac{1}{2}$ [B] 0 [C] $\frac{1}{2}$ [D] 1

Ans. **[C]**

Sol. $f(x) = x^2 + ax + 2$

$g(x) = x^2 + 2x + a$

Here a common Roat then

$$\begin{vmatrix} 1 & a \\ 1 & 2 \end{vmatrix} \begin{vmatrix} a & 2 \\ 2 & a \end{vmatrix} = \begin{vmatrix} 2 & 1 \\ a & 1 \end{vmatrix}^2$$

= a = 2, – 3

$f(x) + g(x) = 2x^2 + (a+2)x + a + 2$

Sum of roots = $\frac{-(a+2)}{2}$ if a = – 3 then sum = $\frac{1}{2}$

2. if n is the smallest natural number such that $n + 2n + 3n + ... + 99n$ is a perfect square, then the number of digits in n^2 is

[A] 1 [B] 2 [C] 3 [D] more than 3

Ans. **[C]**

Sol. n + 2n + 3n + ……….. + 99n

n (1 + 2 + 3 + …… + 99)

$n\frac{(99)(100)}{2}$ = 9 × 25 × 22 × n is a perfect square when n = 22

Number of digits in n = 3

3. Let x, y, z be positive reals. Which of the following implies $x = y = z$?

(I) $x^3 + y^3 + z^3 = 3xyz$

(II) $x^3 + y^2z + yz^2 = 3xyz$

(III) $x^3 + y^2z + z^2x = 3xyz$

(IV) $(x + y + z)^3 = 27xyz$

[A] I, IV only [B] I, II, IV only

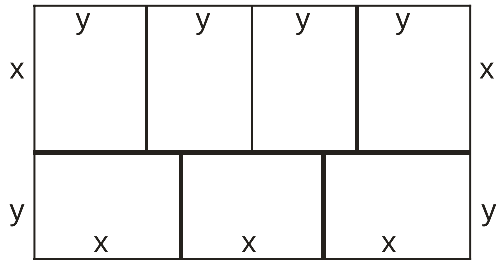
[C] I, II and III only [D] All of them

Ans. **[B]**

Sol. For option (3) if x = z = 1 and y = 2 then option (3) is right.

So by option (3) we can’t say x = y = z. Remaining options implies x = y = z

4. In the figure given below, a rectangle of perimeter 76 units is divided into 7 congruent rectangles.



What is the perimeter of each of the smaller rectangles?

[A] 38 [B] 32 [C] 28 [D] 19

Ans. **[C]**

Sol. Let Sides of Rectangle are x & y

Then

$5x + 6y = 76$

4y = 3x

After solving we get y = 6 , x = 8

Perimeter = 2 (x + y) = 28

5. The largest non-negative integer k such that 24^k divides 13! is.

[A] 2 [B] 3 [C] 4 [D] 5

Ans. **[B]**

Sol. $24^k \to (2^3 \times 3)^k$

Exponent of 2 in 13!

$$\left[\frac{13}{2}\right] + \left[\frac{13}{2^2}\right] + \left[\frac{13}{2^3}\right] = 10$$

Exponent of 3 in 13!

$$\left[\frac{13}{3}\right] + \left[\frac{13}{3^2}\right] = 5$$

So $(2^3 \times 3)^3$ So K = 3

6. In a triangle ABC, points X and Y are on AB and AC, respectively, such that XY is parallel to BC, Which of the two following always hold? (Here [PQR] denotes the area of triangle PQR.)

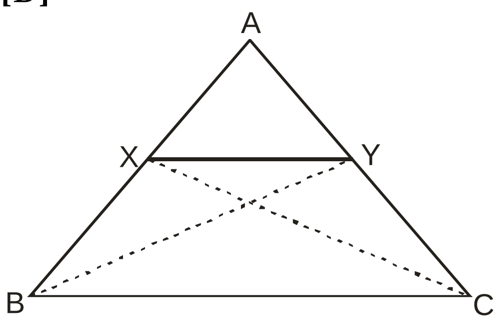
(I) [BCX] = [BCY].

(II) [ACX] $\cdot$ [ABY] = [AXY] $\cdot$ [ABC] $\cdot$

[A] Neither (I) nor (II) [B] (I) only

[C] (II) only [D] both (I) and (II)

Ans. **[D]**



Sol.

$\Delta BCX = \Delta BCY$ (Obvious)

Same base and same height

Now Let $A(\vec{O})$, $\overrightarrow{AB}=\vec{b}$, $\overrightarrow{AC}=\vec{c}$

So $\overrightarrow{AX}=\lambda\vec{b}$, $\overrightarrow{AY}=\lambda\vec{c}$

$\Delta ACX=\frac{1}{2}\lambda|\vec{b}\times\vec{c}|$

$\Delta ABY=\frac{1}{2}\lambda|\vec{b}\times\vec{c}|$

$\Delta AXY=\frac{1}{2}\lambda^2|\vec{b}\times\vec{c}|$

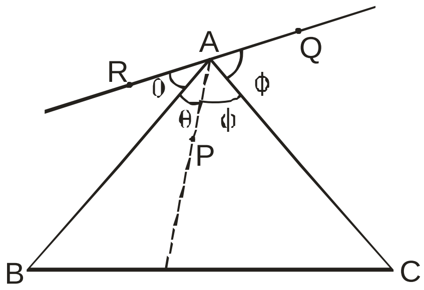
$\Delta ABC=\frac{1}{2}|\vec{b}\times\vec{c}|$

7. Let P be an interior point of a triangle ABC. Let Q and R be the reflections of P in AB and AC, respectively. IF Q, A,R are collinear then $\angle A$ equals.

[A] 30º [B] 60º [C] 90º [D] 120º

Ans. [C]

Sol.



So from Diagram

$\theta+\theta+\phi+\phi=180^o$

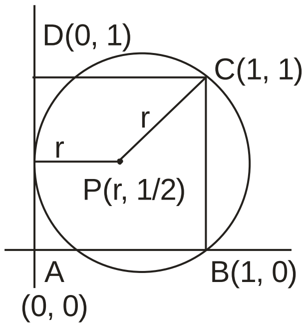
$\angle A=\theta+\phi=90^o$

8. Let ABCD be a square of side length 1, and Γ a circle passing through B and C, and touching AD. The radius of Γ is

[A] $\frac{3}{8}$ [B] $\frac{1}{2}$ [C] $\frac{1}{\sqrt{2}}$ [D] $\frac{5}{8}$

Ans. [D]

Sol.



PC = r

$PC^2 = r^2$

$(r-1)^2 + \left(\frac{1}{2}-1\right)^2 = r^2$

$1-2r+\frac{1}{4}=0$

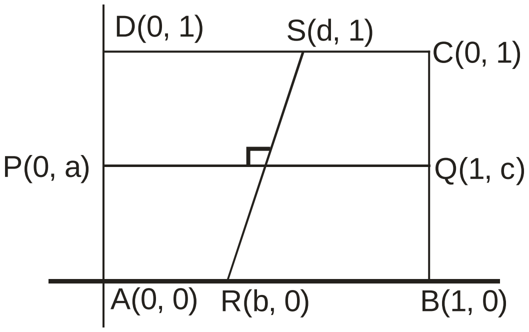
$r=\frac{5}{8}$

9. Let ABCD be a square of a side length l, Let P,Q,R,S be points in the interiors of the sides AD,BC,AB, CD, respectively, such that PQ and RS intersect at right angles. If $PQ = \frac{3\sqrt{3}}{4}$ then RS equals

[A] $\frac{2}{\sqrt{3}}$ [B] $\frac{3\sqrt{3}}{4}$ [C] $\frac{\sqrt{2}+1}{2}$ [D] $4-2\sqrt{2}$

Ans. **[B]**

Sol.



$PQ \perp RS \Rightarrow$

$\boxed{c-a=b-d}$ --------------- (1)

$PQ = \frac{3\sqrt{3}}{4}$

$PQ^2 = \frac{27}{16}$

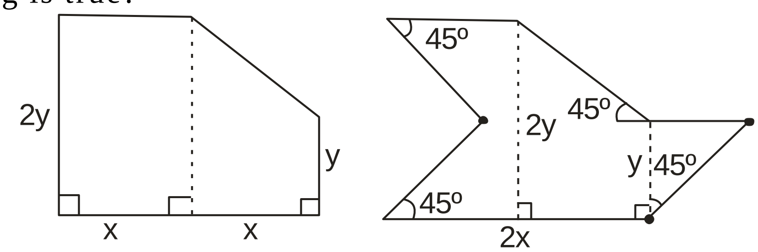
$1+(a-c)^2 = \frac{27}{16}$ …………….. (2)

$RS = \sqrt{(b-d)^2+1}$ ……………… (3)

By equation (1), (2) and (3)

$RS = \frac{3\sqrt{3}}{4}$

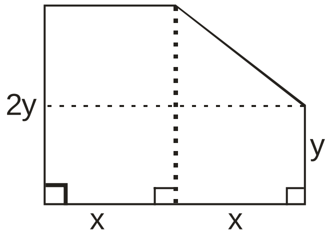
10. In the figure given below, If the areas of the two regions are equal then which of the following is true?



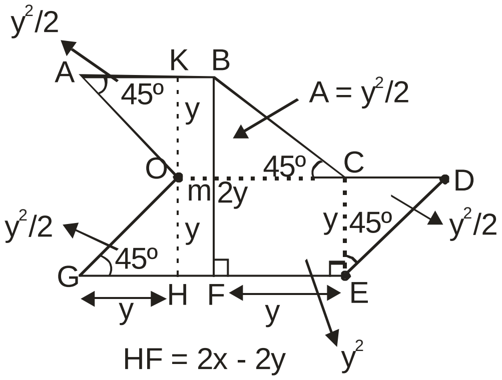
[A] $x=y$ [B] $x=2y$ [C] $2x=y$ [D] $x=3y$

Ans. **[B]**

Sol.



$A_1 = x \times 2y + \frac{1}{2}(y+2y)x = \frac{7}{2}xy$



$A_2 = 4\left(\frac{y^2}{2}\right) + (2x-2y).2y + y^2$

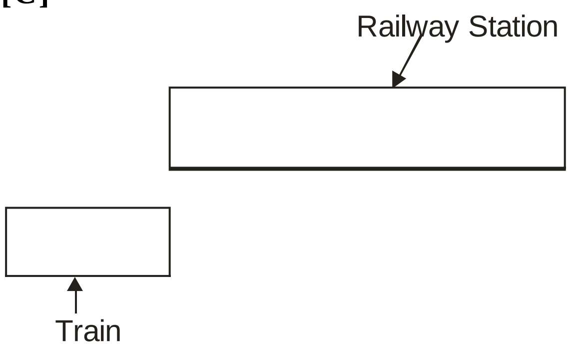
$A_1 = A_2$

x = 2y

11. A man standing on a railway platform noticed that a train took 21 seconds to cross the platform (this means the time elapsed from the moment the engine enters the platform till the last compartment leaves the platform) which is 88 meters long, and that it took 9 seconds to pass him. Assuming that the train was moving with uniform speed, what is the length of the train in metres?

[A] 55 [B] 60 [C] 66 [D] 72

Ans. **[C]**



Sol.

9v + 88 = 21v

12v = 88

V = $\frac{88}{12}$

Required = 9V = $9 \times \frac{88}{12} = 66$

12. The least positive integer n for which $\sqrt[3]{n+1} - \sqrt[3]{n} < \frac{1}{12}$ is

[A] 6 [B] 7 [C] 8 [D] 9

Ans. **[C]**

Sol. $(n+1)^{1/3} - (n)^{1/3} < \frac{1}{12}$

$$(n+1)^{1/3} < (n)^{1/3} + \frac{1}{12}$$

Cube Both side are get

$$(\mathrm{n}^{1/3})\left(\mathrm{n}^{1/3} + \frac{1}{12}\right) > \frac{1727}{432}$$

So n = 8 only possible least positive integer

13. Let n > 1 be an integer. Which of the following sets of numbers necessarily contains a multiple of 3?

[A] $n^{19}-1, n^{19}+1$ [B] $n^{19}, n^{38}-1$

[C] $n^{38}, n^{38}+1$ [D] $n^{38}, n^{19}-1$

Ans. **[B]**

Sol. If n = 3m then n^{19} is multiple of 3

If n = 3m + 1 or 3m + 2 then $n^{38} - 1$ is multiple of 3 by binomial expansion

14. The number of distinct primes dividing 12!+13!+14! is

[A] 5 [B] 6 [C] 7 [D] 8

Ans. **[A]**

Sol. $12!+13!+14!$

$12!(1+13+14\times 13)$

$12!\times 196$

Which is only divided by possible distinct primes

2,3,5,7,11

15. How many ways are there to arrange the letters of the word **EDUCATION** so that all the following three conditions hold?

- the vowels occur in the same order (**EUAIO**);
- the consonants occur in the same order(**DCTN**);
- no two consonants are next to each other.

[A] 15 [B] 24 [C] 72 [D] 120

Ans. **[A]**

Sol. first arrange EUAIO $\rightarrow$ **1**

For consonant $\left.\begin{matrix} |\overline{E}|\overline{U}|\overline{A}|\overline{I}|\overline{O}| \\ {}^6C_4 \times (1) \end{matrix}\right\} \Rightarrow {}^6C_4 = 15$

PHYSICS

16. In an experiment, mass of an object is measured by applying a known force on it, and then measuring its acceleration. IF, in the experiment, the measured values of applied force and the measured acceleration are $F = 10.0 \pm 0.2N$ and $a = 1.00 \pm 0.01$ m/s^2, respectively, the mass of the object is

[A] 10.0 Kg [B]$10.0 \pm$ 0.1 Kg [C] 10.0 ± 0.3 Kg [D] 10.0 ± 0.4Kg

Ans. **[C]**

Sol. F = Ma

$$M = \frac{f}{a}$$

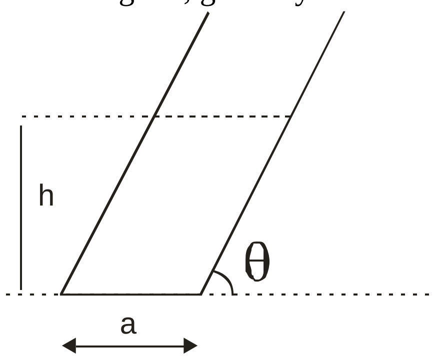
$$\frac{\Delta M \times 100}{M} = \frac{\Delta f}{f} \times 100 + \frac{\Delta a}{a} \times 100$$

$$= \frac{0.2}{10} + \frac{0.01}{1}$$

$$\Delta M = 0.03 \times 10$$

$$\therefore M = 10 \pm 0.3 \text{ kg}$$

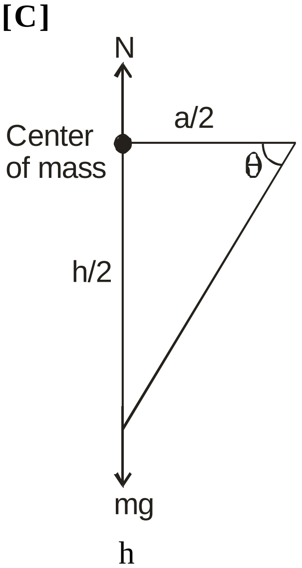
17. A hollow tilted cylindrical vessel of negligible mass rests on a horizontal plane as known. The diameter of the base is a and the side of the cylinder makes an angle θ with the horizontal. Water is then slowly poured into the cylinder. The cylinder topples over when the water reaches a certain height *h*, given by.



[A] $h = 2a\tan\theta$ [B] $h = a\tan^2\theta$ [C] $h = a\tan\theta$ [D] $h = \frac{a}{2}\tan\theta$

Ans. **[C]**

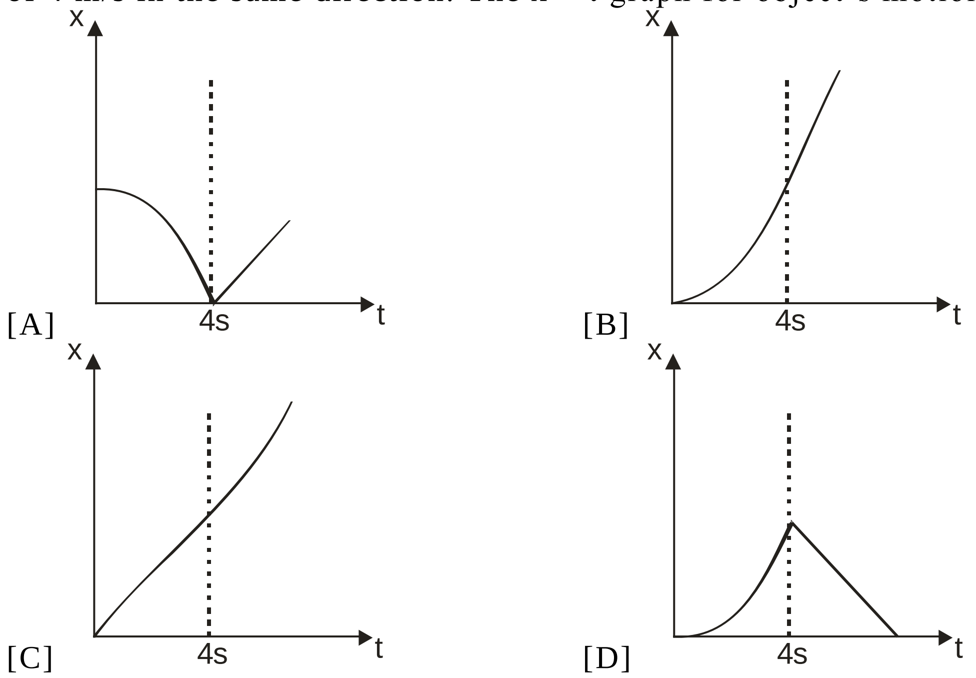
Sol.



$$\tan\theta = \frac{\frac{h}{2}}{a/2}$$

$$h = a\tan\theta$$

18. An object at rest at the origin begins to move in the +x direction with a uniform acceleration of 1 m/s^2 for 4 s and then it continues moving with a uniform velocity of 4 m/s in the same direction. The x – t graph for object's motion will be



Ans. **[B]**

Sol. v = 0 + 1 × t

$\frac{dx}{dt} = t$

$dx = t\,\mathrm{dt}$

$x \propto t^2$ ………………. Parabolic (1)

$\frac{dx}{dt} = 4$

$dx = 4dt$

$x \propto t$ ……………….. Linear (2)

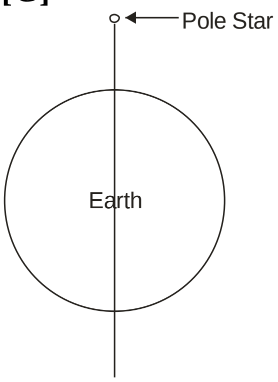
19. If the axis of rotation of the earth were extended into space then it would pass close to

[A] the moon [B] the sun

[C] the pole star

[D] the centre of mass of all the planets in the solar system.

Ans. **[C]**



Sol.

20. Methane is a greenhouse gas because

[A] it absorbs longer wavelengths of the electromagnetic spectrum while transmitting shorter wavelengths

[B] it absorbs shorter wavelengths of the electromagnetic spectrum while transmitting longer wavelengths

[C] it absorbs all wavelengths of the electromagnetic spectrum.

[D] it transmits all wavelengths of the electromagnetic spectrum.

Ans. [A]

Sol.

21. A parachutist with total weight 75 kg drops vertically onto a sandy ground with a speed of 2 ms^{-1} and comes to a halt over a distance of 0.25m. The average force from the ground on her is close to.

[A] 600 N [B] 1200 N [C] 1350 N [D] 1950 N

Ans. [C]

Sol. $0^2 = 2^2 - 2a\frac{1}{4}$

$a = 8m/s^2$

$a_T = 10 + 8 = 18m/s^2$

$f = ma$

$= 75 \times 18$

$= 1350$ N

22. The beta particles of a radioactive metal originate from.

[A] the free electrons in the metal

[B] the orbiting electrons of the metal atoms

[C] the photons released from the nucleus.

[D] the nucleus of the metal atoms.

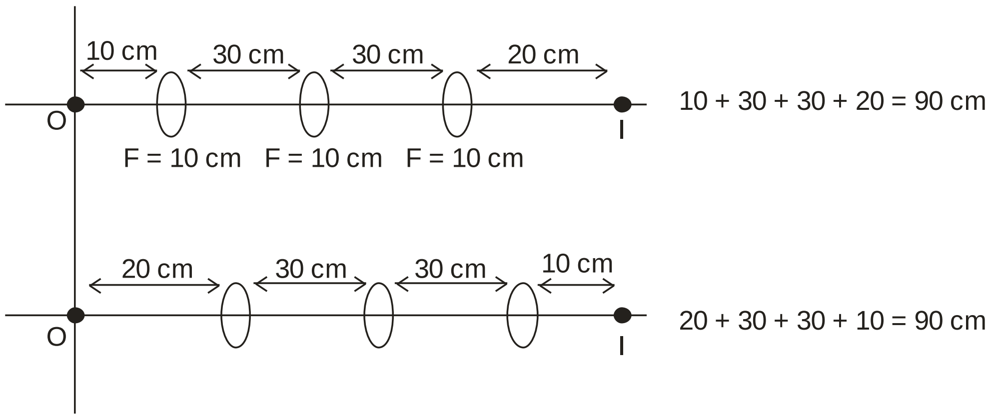
Ans. [D]

Sol. R

23. An optical device is constructed by fixing three identical convex lenses of focal lengths 10 cm each inside a hollow tube at equal spacing of 30 cm each. One end of the device is placed 10 cm away from a point source. How much does the image shift when the device is moved away from the source by another 10 cm?

[A] 0 [B] 5 cm [C] 15 cm [D] 45 cm

Ans. [A]



Sol.

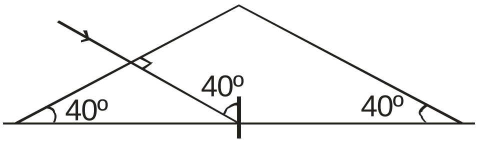
No Shift in image

24. An isosceles glass prism with angles 40º is clamped over a tray of water in a position such that the base is just dipped in water. A ray of light incident normally on the inclined face suffers total internal reflection at the base. If the refractive index of water is 1.33 then the condition imposed on the refractive index μ of the glass is

[A] $\mu < 2.07$ [B] $\mu > 2.07$ [C] $\mu < 1.74$ [D] $\mu > 1.74$

Ans. **[B]**

Sol.



$1.33 \times \sin 90^o = \mu . \sin 40^o$

$= \dfrac{1.33 \times 1}{\sin 40^0} = \mu$

$= \dfrac{1.33}{3/5} \approx \mu$

$= \dfrac{1.33 \times 5}{3} \approx \mu$

$= \mu \approx 2.07$

$= \mu > 2.07$ (For TIR)

25. A point source of light is moving at a rate of 2 cm-s^{-1} towards a thin convex lens of focal length 10 cm along its optical axis. When the source is 15 cm away from the lens the image is moving at

[A] 4 cm-s^{-1} towards the lens [B] 8 cm-s^{-1} towards the lens

[C] 4 cm-s^{-1} away from the lens [D] 8 cm-s^{-1} away from the lens

Ans. **[D]**

Sol. $\dfrac{dv}{dt} = \dfrac{-v^2}{u^2}\dfrac{du}{dt}$

& $\dfrac{1}{v} = \dfrac{1}{F} + \dfrac{1}{u}$

$\dfrac{1}{V} = \dfrac{1}{10} + \dfrac{1}{-15}$

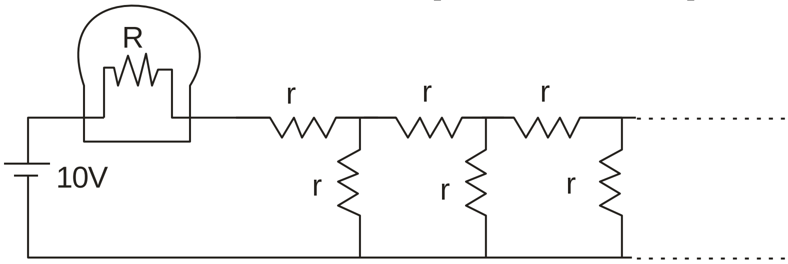
$\dfrac{1}{v} = \dfrac{3-2}{30}$

v = 30 cm

$\dfrac{dv}{dt} = \left(\dfrac{30}{15}\right)^2 \cdot 2$

= 8 cm/s away from lens

26. A light bulb of resistance $R = 16\Omega$ is attached in series with an infinite resistor network with identical resistances r as shown below. A 10 V battery derives current in the circuit. What should be the value of r such that the bulb dissipated about 1 W of power.



[A] 14.8Ω [B] 29.6Ω [C] 7.4Ω [D] 3.7Ω

Ans. **[A]**

Sol. $P_{bulb} = \frac{v^2}{R} = i^2 R$

$1 = \frac{v^2}{16}$

$V_B = 4$ V

$1 = i^2 \times 16$

$I_B = \frac{1}{4}$ Amp.

$6 = \frac{1}{4} \times r_{eq}$ (equivalent of groups of r)

Where

$r_{eq} = r + \frac{r_{eq}.r}{r_{eq} + r}$

27. A ball is launched from the top of Mt. Everest which is at elevation of 9000 m. The ball moves in circular orbit around earth. Acceleration due to gravity near the earth's surface is g. The magnitude of the ball's acceleration while in orbit is

[A] close to g/2 [B] zero

[C] much greater than g. [D] nearly equal to g.

Ans. **[D]**

Sol. $\frac{mv^2}{r} = mg'$ (where g' is nearly equal to g)

28. A planet is orbiting the sun in an elliptical orbit. Let U denote the potential energy and K denote the kinetic energy of the planet at an arbitrary point on the orbit. Choose the correct statement.

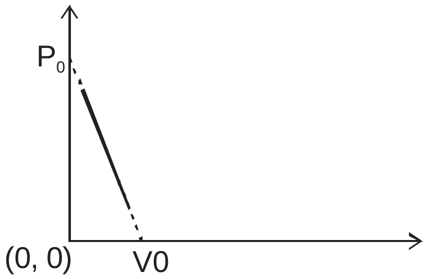
[A] $K < |U|$ always [B] $K > |U|$ always

[C] $K = |U|$ always [D] $K = |U|$ for two positions of the planet in the orbit.

Ans. **[A]**

Sol. Total energy must be less than zero and as potential energy is negative so answer is **A**

29. One mole of ideal gas undergoes a linear process as shown in figure below. Its temperature expressed as a function of volume V is.



[A] $\frac{P_0V_0}{R}$ [B] $\frac{P_0V}{R}$ [C] $\frac{P_0V}{R}\left(1-\frac{V}{V_0}\right)$ [D] $\frac{P_0V}{R}\left(1-\left(\frac{V}{V_0}\right)^2\right)$

Ans. **[C]**

Sol. $P=\frac{-P_0}{V_0}V+P_0$ .... (1)

&

$PV=nRT$ .... (2)

$\therefore T=\frac{P_0V}{R}\left[1-\frac{V}{V_0}\right]$

30. The international space station is maintained in a nearly circular orbit with a mean altitude of 330 km and a maximum of 410 km. An astronaut is floating in the space station's cabin. The acceleration of astronaut as measured from the earth is.

[A] zero

[B] nearly zero and directed towards the earth

[C] nearly g and directed along the line of travel of the station

[D] nearly g and directed towards the earth.

Ans. **[D]**

Sol.

CHEMISTRY

31. The percentage of nitrogen by mass in ammonium sulphate is closest to (atomic masses H = 1, N = 14, O = 16, S = 32)

[A] 21% [B] 24% [C] 36% [D] 16%

Ans. **[A]**

Sol. Ammonium sulphate $(NH_4)_2\ SO_4$ =

% of nitrogen = $\frac{28\times100}{36+96}=\frac{28\times100}{132}\cong 21.21\%$

32. Mendeleev's periodic law states that the properties of elements are a periodic function of their

[A] reactivity of elements [B] atomic size

[C] atomic mass [D] electronic configuration

Ans. **[C]**

Sol. Mendeleev's periodic law states that properties of elements are periodic function of their atomic masses.

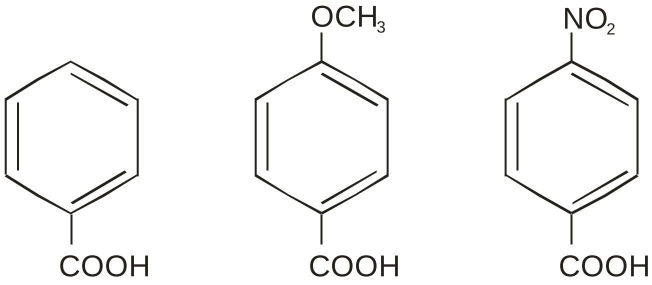
33. Maximum number of electrons that can be accommodated in the subshell with azimuthal quantum number l = 4, is

[A] 10 [B] 8 [C] 16 [D] 18

Ans. **[D]**

Sol. Total number of electrons = $2(2l+1) = 18$

34. The correct order of acidity of the following compounds is



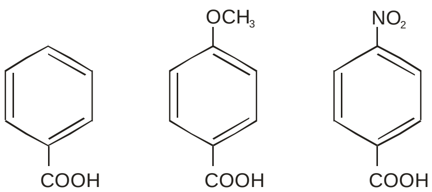
(1) (2) (3)

[A] 1 > 2 > 3 [B] 1 > 3 > 2

[C] 3 > 1 > 2 [D] 3 > 2 > 1

Ans. **[C]**

Sol.



(A) (B) (C)

(B) OCH_3 exerts +M effect destabilizes the conjugate base of the acid.

(C) NO_2 exerts – M effect and stabilizes the conjugate base of the acid

35. Reaction of 2-butane with acidic $KMnO_4$ gives

[A] CH_3CHO [B] HCOOH [C] CH_3CH_2OH [D] CH_3COOH

Ans. **[D]**

Sol. $$CH_3-CH=CH-CH_3 \xrightarrow{KMnO_4\,/\,H^+} 2CH_3COOH$$

36. The gas released when baking soda is mixed with vinegar, is

[A] CO [B] CO_2 [C] CH_4 [D] O_2

Ans. **[D]**

Sol. $$NaHCO_{3(s)} + CH_3COOH_{(l)} \rightarrow CO_{2(g)} + H_2O_{(l)} + CH_3COO^-{}_{(aq)} + Na^+{}_{(aq)}$$

37. The element which readily forms an ionic bond has the electronic configuration.

[A] $1s^2 2s^2 2p^3$ [B] $1s^2 2s^2 2p^1$ [C] $1s^2 2s^2 2p^2$ [D] $1s^2 2s^2 2p^6 3s^1$

Ans. **[D]**

Sol. Metals form ionic bond as they have low ionization energies.

$1s^2\ 2s^2\ 2p^6\ 3s^1$: Sodium metal

38. The major products of the following reaction

$ZnS(s) + O_2(g) \xrightarrow{heat}$

are

[A] ZnO and SO_2 [B] $ZnSO_4$ and SO_3

[C] $ZnSO_4$ and SO_2 [D] Zn and SO_2

Ans. **[A]**

Sol. $2ZnS_{(s)} + 3O_2(g) \xrightarrow{heat} 2ZnO_{(s)} + 2SO_{2(g)}$

39. If Avogadro's number is A_0, the number of sulphur atoms present in 200 mL of 1N H_2SO_4 is

[A] $A_0/5$ [B] $A_0/2$ [C] $A_0/10$ [D] A_0

Ans. **[C]**

Sol. Avogadro's number = A_0

Normality = $n_t \times$ Molarity

$1 = 2 \times M$

$M = \frac{1}{2}$ mol L^{-1}

Moles of $H_2SO_4 = \frac{1}{2} \times 0.2 = 0.1$ moles

Normality = 1; Volume = 200 ml (0.2 litre)

Moles of hydrogen = 0.2 moles

Moles of sulphur = 0.1 moles

Atoms = 0.1 A_0

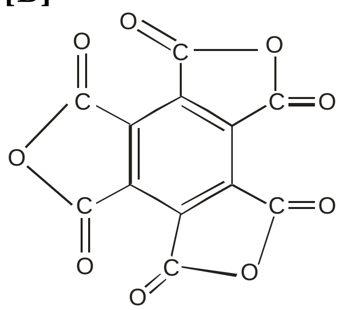
40. The functional group present in a molecule having the formula $C_{12}O_9$ is

[A] carboxylic acid [B] anhydride

[C] aldehyde [D] alcohol

Ans. **[B]**

Sol.



41. A sweet smelling compounds formed by reacting acetic acid with ethanol in the presence of hydrochloric acid is

[A] $CH_3COOC_2H_5$ [B] C_2H_5COOH

[C] $C_2H_5COOH_3$ [D] CH_3OH

Ans. **[A]**

Sol.

$$CH_3-\underset{\underset{O}{\|}}{C}-OH + HOC_2H_5 \xrightarrow{H^+} CH_3-\underset{\underset{O}{\|}}{O}-OC_2H_5$$

Ethyl acetate

42. Among Mg, Cu, Fe, Zn, the metal that does not produce hydrogen gas in reaction with hydrochloric acid is.

[A] Cu [B] Zn [C] Mg [D] Fe

Ans. [A]

Sol. Metals having more standard reduction potential than $H^+/H_2(g)$ can't produce $H_2(g)$ in acidic medium.

43. The maximum number of isomeric ethers with the molecular formula $C_4H_{10}O$ is

[A] 2 [B] 3 [C] 4 [D] 5

Ans. [B]

Sol. $C_4H_{10}O \Rightarrow$ $CH_3-CH_2-CH_2-O-CH_3$

$$\begin{array}{l} CH_3-CH-O-CH_3 \\ \qquad\ \ | \\ \qquad CH_3 \end{array}$$

$CH_3-CH_2-O-CH_2-CH_3$

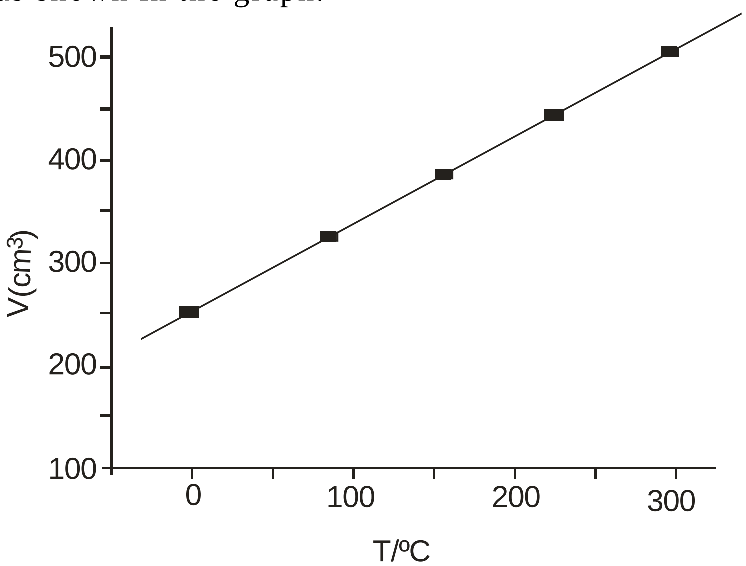
44. The number of electrons required to reduce chromium completely in $Cr_2O_7^{2-}$ to Cr^{3+} in acidic medium, is

[A] 5 [B] 3 [C] 6 [D] 2

Ans. [C]

Sol. $Cr_2O_7^{2-}+14H^++6e^- \rightarrow 2Cr^{3+}+7H_2O$

45. At constant pressure, the volume of a fixed mass of a gas varies as a function of temperature as shown in the graph.

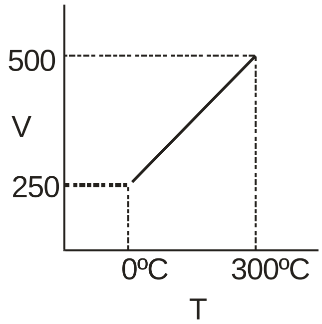


The volume of the gas at 300º C is larger than that at 0ºC by a factor of

[A] 3 [B] 4 [C] 1 [D] 2

Ans. [D]

Sol. From graph.:



$T_1 = 0°C$ $V_1 = 250$

$T_2 = 300°$ $V_2 = 500$

$$\frac{V_2}{V_1} = 2$$

BIOLOGY

46. Excess salt inhibits growth in pickles by

[A] endosmosis [B] exosmosis

[C] oxidation [D] denaturation

Ans. [B]

Sol. Due to hypertonic solution outside the bacterial cell, bacteria will die by plasmolysis

47. Restriction endonucleases are enzymes that are used by biotechnologists to

[A] cut DNA at specific base sequences

[B] join fragments of DNA

[C] digest DNA from the 3' end

[D] digest DNA from the 5' end

Ans. [A]

Sol. Restriction endonucleases cut ds DNA from specific base sequence (Palindromic sequence)

48. Enzyme X extracted from the digestive system hydrolyses peptide bonds. Which of the following are probable candidate to be enzyme X ?

[A] Amylase [B] Lipase [C] Trypsin [D] Maltase

Ans. [C]

Sol. Trypsin is proteolytic enzyme.

49. A person with blood group AB has

[A] antigen A and B on RBCs and both anti-A and anti-B antibodies in plasma

[B] antigen A and B on RBCs but neither anti-A and anti-B antibodies in plasma

[C] no antigen on RBCs but both anti-A and anti-B antibodies present in plasma

[D] antigen A on RBCs and antibodies in plasma

Ans. [B]

Sol. Person with blood group AB having both A and B antigens in membrane of his RBC but lacks antibodies (a, b) in his plasma.

50. Glycolysis is the breakdown of glucose to pyruvic acid. How many molecules of pyruvic acid are formed from one molecule of glucose?
[A] 1 [B] 2 [C] 3 [D] 4

Ans. **[B]**
Sol. In glycolysis one mol. Glucose ($C_6H_{12}O_6$) froms two mol. Of pyruvic acid ($CH_3COCOOH$)

51. The process of transfer of electrons from glucose to molecular oxygen in bacteria and mitochondria is known as
[A] TCA cycle [B] Oxidative phosphorylation
[C] Fermentation [D] Glycolysis

Ans. **[B]**
Sol. ETS or electron transport system is also known as oxidative phosphorylation.

52. Which one of the following cell types is a part of innate immunity?
[A] Skin epithelial cells [B] B cells
[C] T lymphocytes [D] Liver cells

Ans. **[A]**
Sol. Skin, mucus membranes and phagocytes are part of innate immunity.

53. Deficiency of which of the following vitamins can cause impaired blood clotting?
[A] Vitamin B [B] Vitamin C [C] Vitamin D [D] Vitamin K

Ans. **[D]**
Sol. Vit. K is useful in synthesis of prothrombin and fibrinogen is liver which are necessary for blood clotting.

54. Which one of the following is detrimental to soil fertility?
[A] Saprophytic bacteria [B] Nitrosomes
[C] Nitrobacter [D] Pseudomonas

Ans. **[D]**
Sol. Pseudomonas is denitrifying bacterium

55. In Which one of the following phyla is the body segmented?
[A] Porifera [B] Platyhelminthes
[C] Annelida [D] Echinodermata

Ans. **[C]**
Sol. Annelids show metameric segmentation.

56. Widal test is prescribed to diagnose.
[A] Typhoid [B] Pneumonia [C] Malaria [D] Filaria

Ans. **[A]**
Sol. Typhoid is caused by *Salmonella typhi* which is diagnosed by widal test.

57. Which, among grass, goat, tiger and vulture, in a food chain, will have the maximum concentration of harmful chemicals in its body due to contamination of pesticides in the soil?

[A] Grass since it grows in the contaminated soil

[B] Goat since it eats the grass

[C] Tiger since it feed on the goat which feeds on the grass

[D] Vulture since it eats the tiger, which in turns eats the goat, which eats the grass.

Ans. **[D]**

Sol. It is due to biomagnifications.

58. Considering the average molecular mass of a base to be 500 Da, what is the molecular mass of a double stranded DNA of 10 base pairs?

[A] 500 Da [B] 5kDa [C] 10 kDa [D] 1 kDa

Ans. **[C]**

Sol. 1 Base = 500 Da, ds DNA having 10 BP or 20 bases, thus $20 \times 500 = 10\text{kDa}$

59. Which of the following pairs are both polysaccharides?

[A] Cellulose and glycogen [B] Starch and glucose

[C] Cellulose and fructose [D] Ribose and sucrose

Ans. **[A]**

Sol. Cellulose is polymer of β, D-glucose and glycogen of α, D-glucose. Glucose, fructose and ribose are monosaccharides.

60. Which one of the following is a modified leaf?

[A] Sweet potato [B] Ginger

[C] Onion [D] Carrot

Ans. **[C]**

Sol. Onion is bulb forms by fleshy scaly leaves sweet potato and carrot (root), Ginger – rhizome (stem)

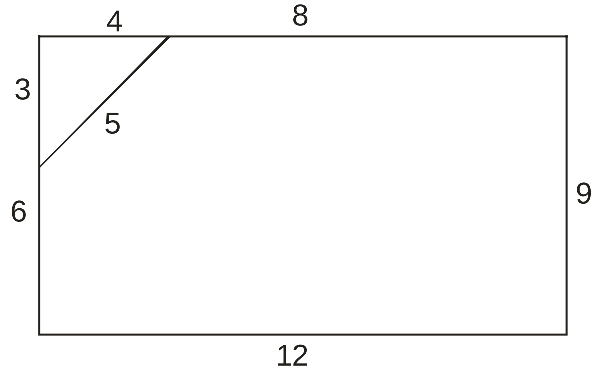
PART-II
Two Marks Questions

MATHEMATICS

61. A triangular corner is cut from a rectangular piece of paper and the resulting pentagon has sides 5, 6, 8, 9, 12 in some order. The ratio of the area of the rectangle is

[A] $\frac{11}{18}$ [B] $\frac{13}{18}$ [C] $\frac{15}{18}$ [D] $\frac{17}{18}$

Ans. [D]



Sol.

Angle of Rectangle = 12×9

Area of pentagon = $12 \times 9 - \frac{1}{2} \times 3 \times 4$

$= 12 \times 9 - 6$

Required = $\frac{12 \times 9 - 6}{12 \times 9} = \frac{17}{18}$

62. For a real number x, let [x] denote the largest integer less than or equal to x, and let {x} = x – [x]. The number of solutions x to be equation [x]{x} = 5 with $0 \le x \le 2015$ is

[A] 0 [B] 3 [C] 2008 [D] 2009

Ans. [D]

Sol. {x} = x – [x]

[x]{x} = 5 $f \neq 0$

I f = 5

0 < f < 1

Possible solutions

$$\left(6+\frac{5}{6}\right), \left(7+\frac{5}{7}\right), ..., \left(2014+\frac{5}{2014}\right) = 2009$$

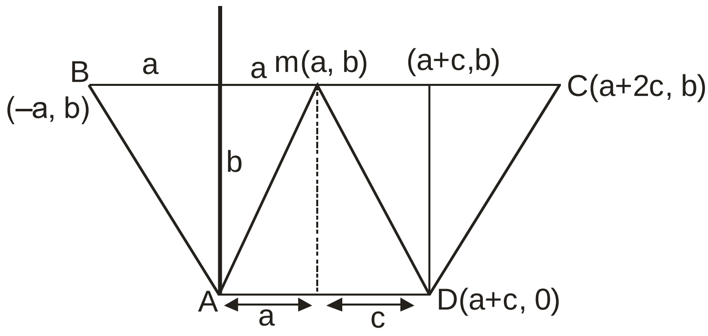
63. Let ABCD be a trapezium with AD parallel to BC. Assume there is a point M is interior of the segment BC such that AB = Am and DC = DM. Then the ratio of the area of the trapezium to the area of triangle AMD is.

[A] 2 [B] 3

[C] 4 [D] not determinable from the data

Ans. [B]

Sol.



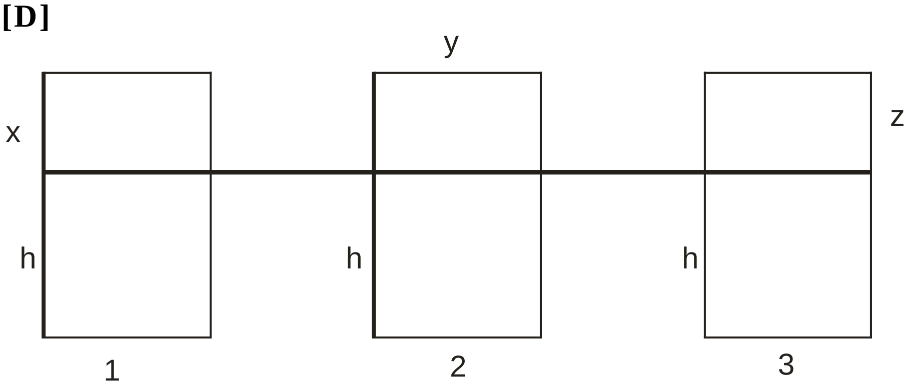
Required = $\dfrac{\frac{1}{2}[(a+c)+2(a+c)]b}{\frac{1}{2}(a+c)b} = 3$

64. Given are three cylindrical buckets X,Y,Z whose circular bases are of radii 1,2,3 units, respectively, Initially water is filled in these buckets upto the same height. Some water is then transferred from Z to Z so that they both have the same volume of water. Some water is then transferred between X and Y so that they both have the same volume of water. If h_y, h_z denote the heights of water at this stage in the buckets Y,Z, respectively, then the ratio $\dfrac{h_y}{h_z}$ equals.

[A] $\dfrac{4}{9}$ [B] 1 [C] $\dfrac{9}{4}$ [D] $\dfrac{81}{40}$

Ans. [D]

Sol.



V =	πh	$\pi 4h$	$\pi 9h$	….. stage (1)
	$5\pi h$	$4\pi h$	$5\pi h$	….. stage (2)
	$4.5\pi h$	$4.5\pi h$	$5\pi h$	…... stage (3)

$4\pi.h_y = \dfrac{9\pi h}{2}$ $\qquad \pi 9h_z = 5\pi h$

$h_y = \dfrac{9h}{8}$ $\qquad h_z = \dfrac{5}{9}h$

$\dfrac{h_y}{h_z} = \dfrac{9h}{8} / \dfrac{5h}{9}$

$= \dfrac{81}{40}$

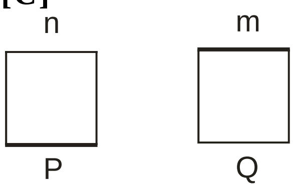
65. The average incomes of the people in two villages are p and Q, respectively. Assume that $P \neq Q$. A person moves from the first village to the second village. The new average incomes are P' and Q' , respectively. Which of the following is not possible?

[A] $P' > P$ and $Q' > Q$ [B] $P' > P$ and $Q' < Q$

[C] $P' = P$ and $Q' = Q$ [D] $P' < P$ and $Q' < Q$

Ans. [C]

Sol.



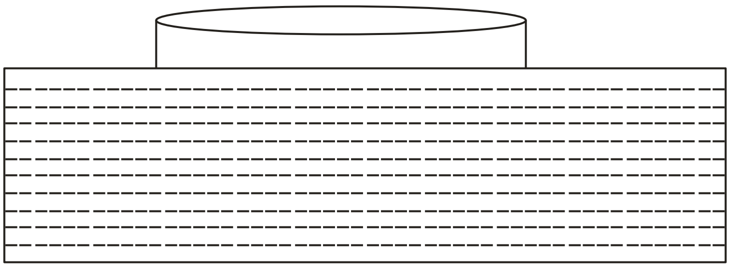
Let number of peoples in two villages are n and m respectively

So nP – P'(n – 1) = (m + 1)Q' – mQ

n(P – P') + P' = m(Q' – Q) + Q'

PHYSICS

66. A girl sees through a circular glass slab(refractive index 1.50 of thickness 20 mm and diameter 60 cm to the bottom of a swimming pol. Refractive index of water is 1.33. The bottom surface of the slab is in contact with the water surface.



The depth of swimming pool is 6m. The area of bottom of swimming pool that can be seen through the slab is approximately.

[A] 100 m^2 [B] 160 m^2 [C] 190 m^2 [D] 220 m^2

Ans. [B]

Sol. For maximum possible area

I should be 90°

$1 \times \sin 90^\circ = \frac{4}{3} \sin r'$

$\sin r' = \frac{3}{4}$

$\tan r' = \frac{3}{\sqrt{7}}$

Total base area $\pi\left(6 \times \frac{3}{\sqrt{7}} + 0.3\right)^2 \approx 160 m^2$

67. 1 Kg of ice at –20°C is mixed with 2 Kg of water at 90°C . Assuming that there is no loss of energy to the environment, what will be the final temperature of the mixture? (Assume latent heat of ice = 334.4 KJ/Kg, specific heat of water and ice are 4.18 kJ/(kg.K) and 2.09kJ/(kg.K), respectively.)

[A] 30°C [B] 0°C [C] 80°C [D] 45°C

Ans. **[A]**

Sol. $m_i s_i(\Delta T) + m_i L + m_i.s_w(T-0) = m_w s_w(90-T)$

$1\times 2.09(20) + 1\times 334.4 + 1\times 4.18\times \text{T} = 2\times 4.18\times(90-\text{T})$

T = 60 – 30 = 30º C

68. A rigid body in the shape of a "V" has two equal arms made of uniform rods. What must the angle between the two rods be so that when the body is suspended from one end, the other arm is horizontal?

[A] $\cos^{-1}\left(\frac{1}{3}\right)$ [B] $\cos^{-1}\left(\frac{1}{2}\right)$ [C] $\cos^{-1}\left(\frac{1}{4}\right)$ [D] $\cos^{-1}\left(\frac{1}{6}\right)$

Ans. **[A]**

Sol. $m_1 r_1 + m_2 r_2 = 0$

$mr_1 = mr_2$

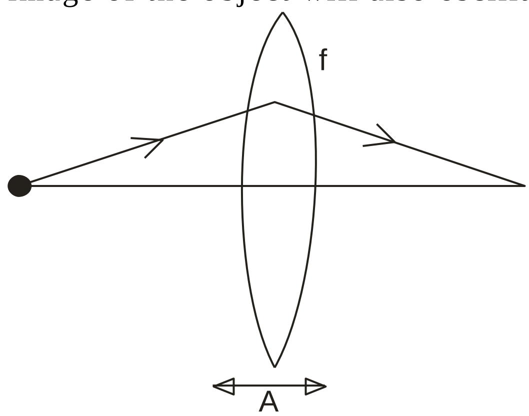
$r_1 = r_2$

$\frac{l}{2}\cos\theta = \frac{l}{2} - l\cos\theta$

$\frac{3l}{2}\cos\theta = \frac{l}{2}$

$\cos\theta = \frac{1}{3}$

69. A point object is placed 20 cm left of a convex lens of focal length f = 5 cm (see the figure). The lens is made to oscillate with small amplitude A along the horizontal axis. The image of the object will also oscillate along the axis with.



[A] amplitude A/9, out of phase with the oscillations of the lens
[B] amplitude A/3, out of phase with the oscillations of the lens
[C] amplitude A/3, in phase with the oscillations of the lens
[D] amplitude A/9, in phase with the oscillations of the lens

Ans. **[A]**

Sol. $\frac{1}{v} + \frac{1}{20} = \frac{1}{5}$

$v = \frac{20}{3}$ cm

$$\Delta x_i = \frac{+v^2}{u^2}\Delta x_o$$

$\Delta x_i = \dfrac{A}{9}$ out of phase with lens

Hence (A) is correct

70. Stoke's law states that the viscous drag force F experience by a sphere of radius a, moving with a speed v through a fluid with coefficient of viscosity η, is given by $F = 6\pi\eta a v$

If this fluid is flowing through a cylindrical pipe of radius r, length l and a pressure difference of P across its two ends, then the volume of water V which flows through the pipe in time t can be written as

$$\frac{v}{t} = k\left(\frac{p}{l}\right)^a \eta^b r^c$$

Where k is a dimensionless constant. Correct values of a,b and c are

[A] a = 1, b = – 1, c = 4
[B] a = – 1, b = 1, c = 4
[C] a = 2, b = – 1, c = 3
[D] a = 1, b = – 2, c = – 4

Ans. **[A]**

Sol. $$\frac{V}{t} = \left(\frac{p}{l}\right)^a \eta^b r^c$$

$$L^3T^{-1} = (ML^{-2}T^{-2})^a L^c (ML^{-1}T^{-1})^b$$

a + b = 0

$-2a - b + c = 3$

$-2a - b = -1$

c = 4, a = 1, b = – 1

Ans (A) is correct

CHEMISTRY

71. When 262 g of xenon (atomic mass = 131) reacted completely with 152 g of fluorine (atomic mass = 19), a mixture of XeF_2 and XeF_6 was produced. The molar ratio $XeF_2 : XeF_6$ is :

[A] 1 : 2 [B] 1 : 4 [C] 1 : 1 [D] 1 : 3

Ans. **[C]**

Sol. $Xe \quad + \quad F_2 \rightarrow \quad XeF_2 \quad + \quad XeF_6$

$\frac{262}{131} \quad \frac{152}{38}$ a mole b mole

= 2 mole 4 mole

Let a mole XeF_2 form and b mole XeF_6 form

Apply POAC

$a \times 1 + b \times 1 = 2$ ….. (1)

$2a + 6b = 8$ ….. (2)

After solving eq. (1) & (2)

a = 1 mole & b = 1 mole

72. Reaction of ethanol with conc. Sulphuric acid at 170°C produces a gas which is then treated with bromine in carbon tetrachloride. The major product obtained in this reaction is :

[A] 1,2-dibromoethane [B] ethylene glycol

[C] bromoethane [D] ethyl sulphate

Ans. **[A]**

Sol.

$$CH_3-CH_2-OH \xrightarrow[170^o]{ConcH_2SO_4} \underset{Ethene}{CH_2=CH_2} \xrightarrow[CCl_4]{Br_2} \underset{Br}{\underset{|}{CH_2}}-\underset{Br}{\underset{|}{CH_2}}$$

$1,2-Dibromoethene$

73. When 22.4 L of C_4H_8 at STP is burnt completely, 89.6 L of CO_2 gas at STP and 72 g of water are produced. The volume of the oxygen gas at STP consumed in the reaction is closest to :

[A] 89.6 L [B] 112 L [C] 134.4 L [D] 22.4 L

Ans. **[C]**

Sol. $C_4H_8 \quad + \quad 6O_2 \quad \rightarrow \quad 4CO_2 \quad + \quad 4H_2O$

22.4 lit 89.6 lit. 72 g

At S.T.P. at S.T.P.

1 mole 4 mole $\frac{72}{18} = 4\text{mole}$

For complete combustion of 1 mole C_4H_8

6 mole O_2 required

$n_{O_2} = 6$ mole

$V_{O_2} = 6 \times 22.4$

$V_{O_2} = 134.4$ lit.

74. The amount of Ag (atomic mass = 108) deposited at the cathode when a current of 0.5 amp is passed through a solution of $AgNO_3$ for 1 hour is closest to :

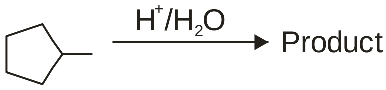
[A] 2 g [B] 5 g [C] 108 g [D] 11 g

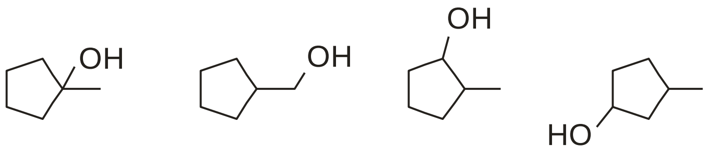
Ans. **[A]**

Sol. $W = \dfrac{E}{96500} \times I \times t$

$$W = \frac{108}{96500} \times 0.5 \times 3600 = 2gm$$

75. The major product of the reaction is :



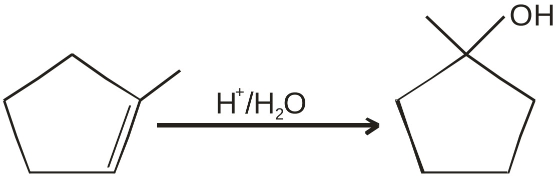


I II III IV

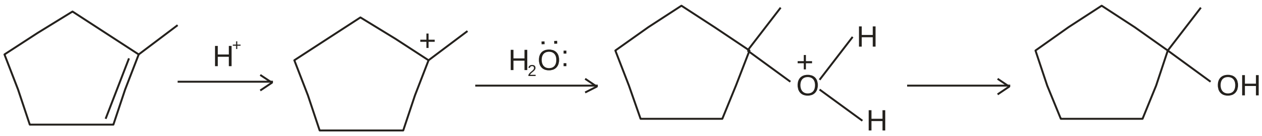
[A] I [B] II [C] III [D] IV

Ans. **[A]**

Sol.



Mechanism electrophilic addition reaction of alkenes.



BIOLOGY

76. Genomic DNA is digested with Alu I, a restriction enzyme which is a four base-pair cutter. What is the frequency with which it will cut the DNA assuming a random distribution of bases in the genome :

[A] 1/4 [B] 1/24 [C] 1/256 [D] 1/1296

Ans. **[C]**

Sol. Alu, I is a restriction endonuclease which is a four base pair cutter its frequency is 1/256 BP, while frequency of 6 cutter Bam HI, ECORI is 1/4096.

77. If rice is cooked in a pressure cooker on the Siachen glacier, at sea beach, and on Deccan plain, which of the following is correct about the time taken for cooking rice :

[A] Gets cooked faster on the Siachen glacier

[B] Gets cooked faster at sea beach

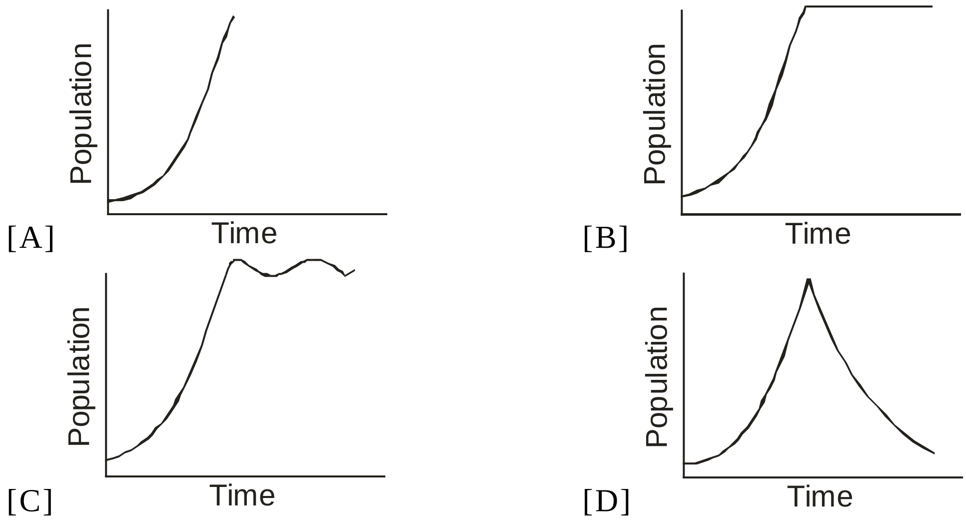
[C] Gets cooked faster on Deccan plain

[D] Gets cooked at the same time at all the three places.

Ans. **[B]**

Sol. Rice cooked faster at sea level than high altitude.

78. A few rabbits are introduced in an un-inhabited island with plenty of food. If these rabbits breed in the absence of any disease, natural calamity and predation, which one of the following graphs best represents their population growth :



Ans. **[A]**
Sol. In absence of disease, natural calamity and predation growth of rabbit is exponential.

79. What is the advantage of storing glucose as glycogen in animals instead of as monomeric glucose :
[A] Energy obtained from glycogen is more than that from the corresponding glucose monomers
[B] Glucose present as monomers within the cell exerts more osmotic pressure than a single glycogen molecule, resulting in loss of water from the cells
[C] Glucose present as monomers within the cell exerts more osmotic pressure than a single glycogen molecule, resulting in excess water within the cells
[D] Glycogen gives more rigidity to the cells.
Ans. **[C]**
Sol. Glucose maintaining high osmotic pressure inside cell.

80. A line is drawn from the exterior of an animal cell to the centre of the nucleus, crossing through one mitochondrion. What is the minimum number of membrane bilayers that the line will cross :
[A] 4 [B] 3 [C] 8 [D] 6
Ans. **[B]**
Sol.