KVPY QUESTION PAPER-2015 (STREAM SA)

Part – I

One - Mark Questions

Date : 01 / 11 / 2015

MATHEMATICS

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

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

If the equations f(x) = 0 and g(x) = 0 have a common root then the sum of 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. Let ' ' is the common root

So, $^2 + a\ + 2 = 0$ ....(i)

$^2 + 2\ + a = 0$ ...(ii)

$(a - 2) + 2 - a = 0 = 1$ is common root. $1^2 + a + 2 = 0$ $a = -3$.

$f(x) + g(x) = 0$

$2x^2 + (a + 2)x + (a + 2) = 0$

$2x^2 - x - 1 = 0$

Sum of roots = $1 \cdot \frac{}{2}$

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. $n + 2n + 3n + ... + 99n = k^2$

$n \frac{99.100}{2} = k^2$

$n.99.50 = k^2$

$n.9.11.25.2 = k^2$

So $n = 11.2 = 22$

$n^2 = 484$

No. of digits in $n^2 = 3$.

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

(A) I, IV only (B) I, II, IV only (C) I, II and III only (D) All of them

Ans. **[B]**

Sol. (I) $\frac{x^3 + y^3 + z^3}{3} = (x\ y\ z)^{3 \cdot 1/3}$

Hence x = y = z {AM = GM}

(II) $\frac{x^3 + y^2z + yz^2}{3} \geq (x\ y\ z)^{3 \cdot 1/3}$ (AM = GM)

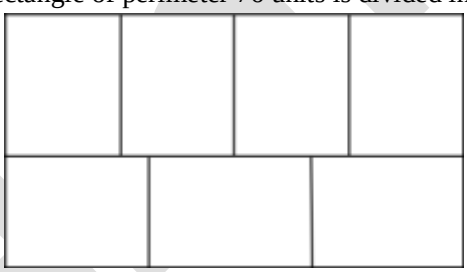
(III) $x^3 + y^2z + z^2x = 3xyz$

$\frac{x^3 + \frac{y^2z}{2} + \frac{y^2z}{2} + z^2x}{5} \geq \sqrt[4]{x^4y^4z^4}$

$3xyz \geq (xyz)$ Not possible

(IV) $\frac{x + y + z}{3} \geq (xyz)^{1/3}$ $(x + y + z)^3 = 27\ xyz$.

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

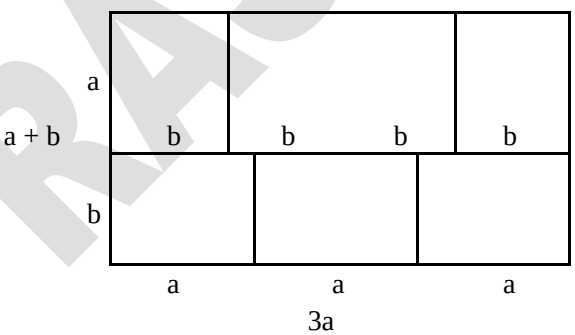


What is the perimeter of each of the smaller rectangles ?

(A) 38 (B) 32 (C) 28 (D) 19

Ans. **[C]**

Sol.



2(3a) + 2(a + b) = 76

$3a + a + b = 38$

$4a + b = 38$ ...(i)

& $3a = 4b$ ...(ii)

Solving (i) & (ii)

$16a + 3a = 38 \times 4$

$19\ a = 38 \times 4$

$a = 8$

$b = 6$

perimeter of smaller rectangle = $2(a + b) = 2(8+6)$

$= 28.$

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. Let $13! = 2^m.3^n$.

When m is maximum possible value

& n is also maximum possible value

So $m = \frac{13}{2} + \frac{13}{4} + \frac{13}{8} + \frac{13}{16} + ...$

$= 6+3+1$

$= 10$

$n = \frac{13}{3} + \frac{13}{9} + \frac{13}{27} + ...$

$= 2 + 1$

$= 3$

$= 2.(2^3.3)\ (2^3.3)\ (2^3.3)$.

$= 2.(24)^3$.

$k = 3$

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 equalities always hold ? (Here [PQR] denotes the area of triangle PQR) -

(I) [BCX] = [BCY]

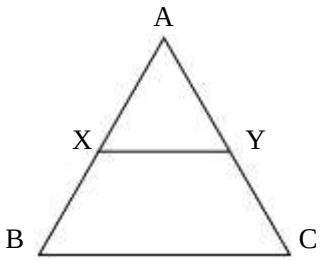
(II) [ACX].[ABY] = [AXY].[ABC]

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

(C) (II) only (D) Both (I) and (II)

Ans. **[D]**

Sol.



Clearly ar (BCX) = ar (BCY) { s between parallel lines & same base}

[BCX] = [BCY]

(I) is true.

Check

(II) ar (ACX) = $\frac{1}{2}$AC.AX sin A

ar(ABY) = $\frac{1}{2}$ AB.AY sin A.

ar (AXY) = $\frac{1}{2}$AX.AY sin A

ar (ABC) = $\frac{1}{2}$ AB.AC sin A.

Clearly [ACX].[ABY] = [AXY].[ABC]

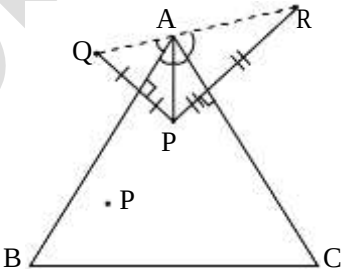
(II) is true.

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 A equals -

(A) 30º (B) 60º (C) 90º (D) 120º

Ans. **[C]**

Sol.



2 +2 =180º

+ =90º

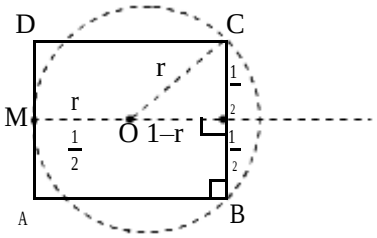
A=90º

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

(A) $\frac{3}{8}$ (B) $\frac{1}{2}$ (C) $\frac{1}{\sqrt{2}}$ (D) $\frac{5}{8}$

Ans. [D]

Sol.



Let O be centre of circle.

OM = radius = r

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

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

$2r = \frac{5}{4}$

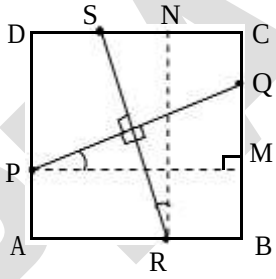
$r = \frac{5}{8}$

9. Let ABCD be a square of side length 1. 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) $\frac{\sqrt{2}}{2}$ (D) $4-2\sqrt{2}$

Ans. [B]

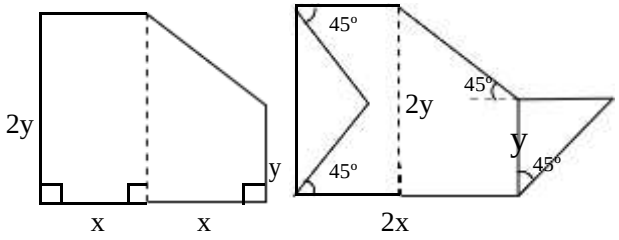
Sol.



$PQM \sim RSN$

So, RS = PQ = $\frac{3\sqrt{3}}{4}$

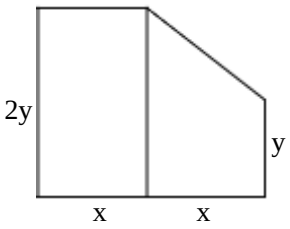
10. In the figure given below, if the areas of the two regions are equal then which of the following is true ?



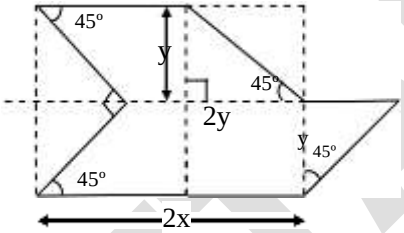
(A) x = y (B) x = 2y (C) 2x = y (D) x = 3y

Ans. [B]

Sol.



(I)



(II)

area (I) = $x.2y + \frac{1}{2}(2y + y)\,x.$

$= 2xy + \frac{3xy}{2}$

$= \frac{7xy}{2}$

area (II) = $2x.2y - \frac{1}{2}\sqrt{2}\,y.\,\sqrt{2}\,y.$

$= 4xy - y^2$

area (I) = area (II)

$\frac{7xy}{2} = 4xy - y^2$

$7xy = 8xy - 2y^2$

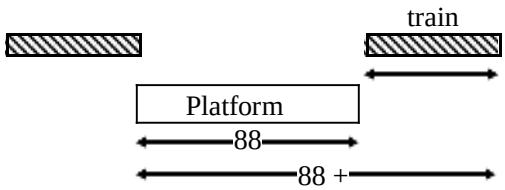
$2y^2 = xy$ $\boxed{2y \quad x}$.

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 metres 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 meters ?

(A) 55 (B) 60 (C) 66 (D) 72

Ans. **[C]**

Sol.



Let speed of train is v m/s.

So $v \times 21 = 88 +$

$21\ v = 88 +$

& also

$v \times 9 =$ 

So $21 \times \frac{}{9} = 88+$

$= 66.$

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

(A) 6 (B) 7 (C) 8 (D) 9

Ans. **[C]**

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

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

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

$(12)^3 - 3.(12)^2 n^{1/3}\, (n + 1)^{1/3} < 1$

$(12)^3 - 1 < 3.(12)^2\, n^{1/3}\, (n + 1)^{1/3}$

$\frac{1727}{3\ 144} < n^{1/3}\, (n + 1)^{1/3}$

$n(n + 1) > \left(\frac{1727}{3\ 144}\right)^3$

$n\,(n + 1) > 63.88$

$n = 8$

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.

	case(I) n = 3k	case(II) n = 2k
(A) $n^{19} - 1, n^{19} + 1$	$(3k)^{19} - 1, (3k)^{19} + 1$ not multiple of 3.	
(B) $n^{19}, n^{38} - 1$	$(3k)^{19}$ = multiple of 3	$(2k)^{38} - 1$ = multiple of 3
(C) $n^{38}, n^{38} + 1$	$(3k)^{38}$ = multiple of 3	$(2k)^{38} + 1$ multiple of 3
(D) $n^{38}, n^{19} - 1$	$(3k)^{38}$ = multiple of 3	$(2k)^{19} - 1$ multiple of 3

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!

= |2!(1+13+14×13)

= 12!(14 + 14 × 13)

= 12! × 196

Prime nos. are 2, 3, 5, 7, 11

Total = 5

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. EDUCATION

Vowels EUAIO

Consonant DCTN

$= 1 \times {}^{6}C_{4} \times 1$

= 15

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 ± 0.2 N and a = 1.00 ± 0.01 m/s^2, respectively, the mass of the object is -

(A) 10.0 kg (B) 10.0 ± 0.1 kg (C) 10.0 ± 0.3 kg (D) 10.0 ± 0.4 kg

Ans. **[C]**

Sol. Force F = 10.0 ± 0.2 N

a = 1.00 ± 0.01 m/s^2

$F = ma \quad m = \frac{F}{a}$

$m = \frac{10.0}{1.00}$

m = 10.0 kg

For error (F = ma)

$m^1a^1F^{-1}$ = const.

$\frac{dm}{m} + \frac{da}{a} - \frac{dF}{F} = 0$ [Take log and differentiate]

$\frac{m}{m} = \left|\frac{F}{F}\ \frac{a}{a}_{max}\right|$

$\frac{m}{m} = \left|\frac{0.2}{10.0}\ \frac{0.01}{1.00}\right|$

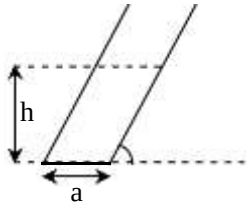
$m = \frac{3}{100}m$

$m = \frac{3}{100} \times 10$ kg

m = 0.3 kg

mass m = (10.0 ± 0.3 kg)

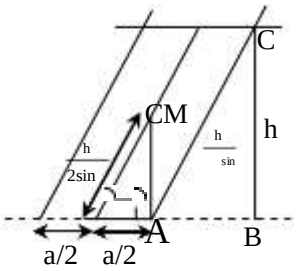
17. A hollow tilted cylindrical vessel of negligible mass rest on a horizontal plane as shown. The diameter of the base is a and the side of the cylinder makes an angle with the horizontal. Water is then slowly poured into the cylinder. The cylinder topples over when the water reaches a certain height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



(A) h = 2a tan (B) h = a tan^2 (C) h = a tan (D) h = $\frac{a}{2}$ tan

Ans. **[C]**

Sol.



(COM at mid pt of filled cylinder)

$\sin = \frac{BC}{AC}$; $AC = \frac{BC}{\sin}$; $AC = \frac{h}{\sin}$

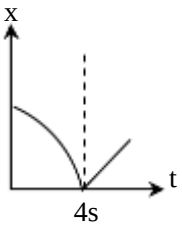
$\cos = \frac{\frac{a}{2}}{\frac{h}{2\sin}}$;

$\cos = \frac{a \sin}{h}$

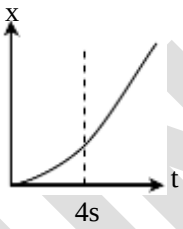
$h = a \tan$

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 4s 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 -

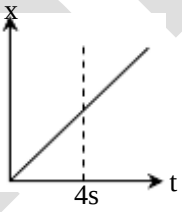
(A)



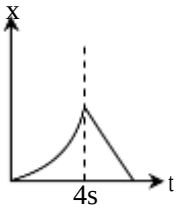
(B)



(C)

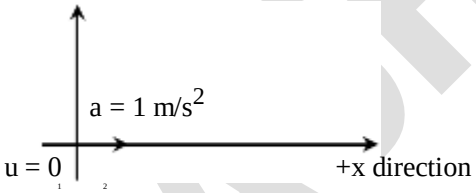


(D)



Ans. [B]

Sol.



x = — at parabolic for 0 to 4 sec

[at t = 4 sec $x = \frac{1}{2} \times (1)(4)^2 = 8m$]

then after (v = 4 m/s)

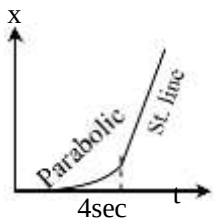
$v = 4$

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

$$\int_{8}^{x} dx = \int_{4}^{t} 4dt$$

$x - 8 = 4(t - 4)$

$x = 4t - 8$ (st. line)



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. Pole star is a visible star preferably a prominent one that is approximately aligned with the axis of rotation of earth.

20. Methane is 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. Absorbs infrared radiation thus it absorbs longer wavelength of EMwave spectrum while transmitting shorter wavelength.

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 0.25 m. 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. K.E.=0– $\frac{1}{2} mv^2$

K.E. = – $\frac{1}{2}$ 75 $(2)^2$

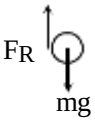
K.E. = – 150 J

Total work done by forces = – 150 J

– F. x = –150 J

F = $\frac{150}{x}$ (avg force)

F = $\frac{150}{0.25}$ F = 600 N (upward direction)



$F_R - mg = F$

$F_R = F + mg$

$F_R = 600 + 750$

$F_R = 1350$ N

(resistive force by ground)

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. From the nucleus of metal atom.

in nucleus

$n \quad P \quad e \quad {}^{-}_{\text{antinutrin o}}$

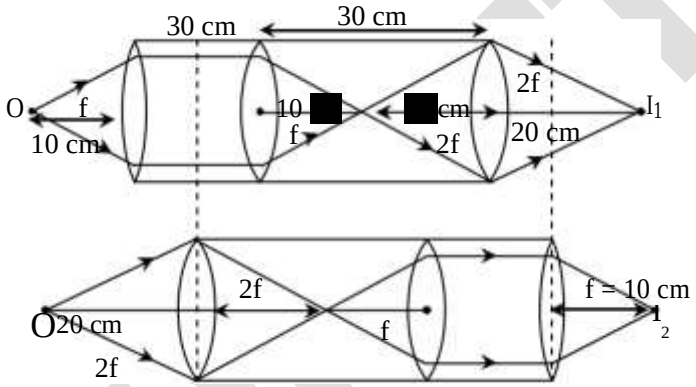
Beta

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.



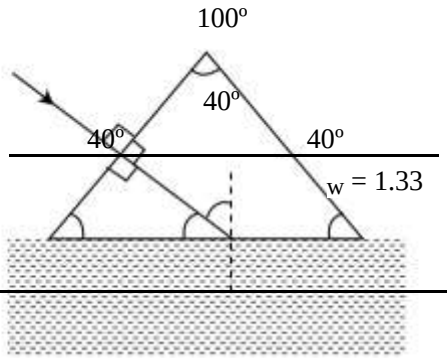
Distance between object to image in both case is 90 cm. Because object is at same position so image also be at same position in both cases.

24. An isosceles glass prism with base angles 40º is champed 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 of the glass is -

(A) < 2.07 (B) > 2.07 (C) < 1.74 (D) > 1.74

Ans. [B]

Sol.



For TIR

$40^o > {}_c$

$\sin 40^o > \sin {}_c$

$$\sin 40^o > \frac{w}{D}$$

$$D > \frac{w}{D}$$

> 2.07

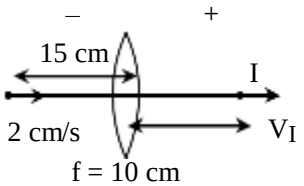
25. A point source of light is moving at a rate of 2 cm-s^{-1} towards a thin convex lens of focal length 10 cm along its optical axis. When the source is 15 cm away from the lens the image is moving at -

(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.



f = 10 cm

u = – 15cm, f = + 10 cm

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f} \quad v = \frac{fu}{u\ f}$$

$$v = \frac{(-10)(-15)}{15\ 10}$$

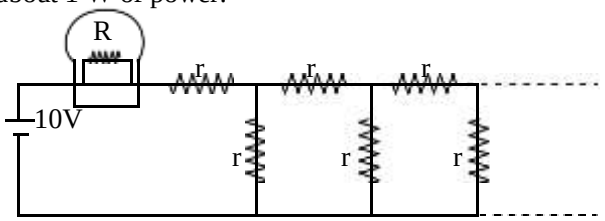
v = + 30 cm

$$\frac{dv}{dt} = \frac{v^2}{u^2}\frac{du}{dt}$$

$$\frac{dv}{dt} = \frac{30}{15}^2 \quad (+ 2 \text{ cm/s})$$

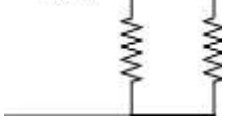
$$\frac{dv}{dt} = + 8 \text{ cm/s} \quad \text{(away from lens)}$$

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



(A) 14.8 (B) 29.4 (C) 7.4 (D) 3.7

Ans. [A]



Q

$R_{eqPQ} = r + \frac{rx}{r \quad x}$

$x = \frac{r^2 \; rx \qquad rx}{r \;\; x}$

$rx + x = r + 2rx$

$x = \frac{r \quad r^2 \sqrt{\quad 4r^2}}{2} \qquad \frac{r(1 \quad 5)}{2}$

Power in bulb = 1 watt

$i\,R = 1$

$i^2 \times 16 = 1$

$i = -$ amp.

$i = \frac{10}{R \; R_{PQ}}$

$\frac{1}{4} = \frac{10}{16 \quad \frac{r}{2}(1 \quad 5)}$

$16 + \; - (1 + \sqrt{5}) = 40$

$r = 14.8$

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. At earth surface acceleration due to gravity $g = \frac{GM}{R^2}$

Radius is almost equal to radius of earth.

(v) orbital velocity of ball = $\sqrt{\frac{GM}{r}}$

Acceleration = $\frac{v^2}{r}$ $\frac{GM}{r^2}$

as r is very near to R

Acceleration = $\frac{GM}{R^2} = g$

28. A planet is orbiting the sun is 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. Planet sun system is bounded system

Total energy of the system is negative

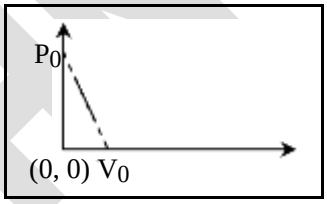
TE=KE+PE

K – | U | {PE is negative here}

as TE is negative

|U|>K

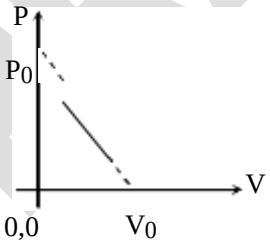
29. One mole of ideal gas undergoes a linear process as shown in figure below. Its temperature expressed as function of volume V is -



(A) $\frac{P V}{R}$ (B) $\frac{P V}{R}$ (C) $\frac{P V}{R} 1 \frac{V}{V}$ (D) $\frac{P V_0 1 V_2 V}{R}$

Ans. [C]

Sol.



$$\frac{RT}{V} = P_0 - \frac{P_0}{V_0} \times V$$

$$T = \frac{P_0 V}{R} \cdot \frac{P_0 V^2}{RV_0}$$

$$= \frac{P_0 V^2}{RV_0}$$

$$T = \frac{P_0 V}{R}\left(1 - \frac{V}{V_0}\right)$$

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. $g = \frac{GM}{(R+h)^2}$

$h << R$

$g \longrightarrow$ towards the earth

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. $\%\ \text{Nitrogen} = \frac{\text{Wt of N}}{\text{Wt of } (NH_4)_2 SO_4}$

$$\%\ N \quad \frac{28}{132} \quad 100$$

$= 21.21\%$

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 table state that the property of elements are a periodic function of their atomic mass

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

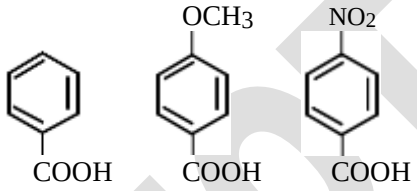
Ans. **[D]**

Sol. $l = 4$ 'g' subshell

no of e^- = $2(2l + 1)$

$= 2(2 \times 4 + 1) = 18e^-$

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

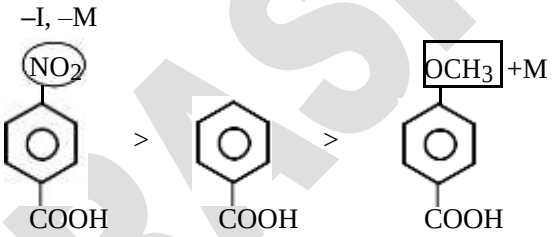


(A)1>2>3 (B)1>3>2 (C)3>1>2 (D)3>2>1

Ans. **[C]**

Sol. Acidic strength – M, –H, –I (EWG)

$\frac{1}{M}$ $\frac{1}{H}$ $\frac{1}{I}$



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

(A) CH_3CHO (B) HCOOH (C) CH_3CH_2OH (D) CH_3COOH

Ans. **[D]**

Sol. $CH_3–CH=CH–CH_3 \xrightarrow[\text{Oxidi sing agent}]{KMnO_4} CH_3COOH$

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

(A) CO (B) CO_2 (C) CH_4 (D) O_2

Ans. **[B]**

Sol. $\underset{\text{Vinegar}}{CH_3COOH} + \underset{\text{Baking soda}}{NaHCO_3} \rightarrow CH_3COO\,Na + H_2O + CO_2(g)$

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. Alkali Metals has highest tendency to form ionic bond

readily $1s^2\ 2s^2\ 2p^6\ 3s^1$ [Na metal]

38. The major products of the following reaction

$ZnS\,(s) + O_2\,(g) \xrightarrow{\text{heat}}$ 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. $ZnS_{(s)} + O_{2(g)} \xrightarrow{\text{heat}} ZnO + SO_2$

Roasting

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. $M_{H_2SO_4}$ 0.5

$V_{H_2SO_4}$ 0.2

$n_{H_2SO_4}$ 0.1

no of mole of 'S' atom = 0.1

no of 's' atom = 0.1 A_0

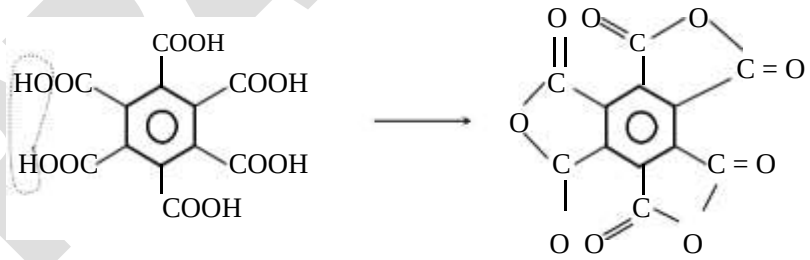
$\frac{A_0}{10}$

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. Carbon(graphite) $\xrightarrow[\text{By } KMnO_4 \text{ with acidic conditions}]{\text{Oxidation}}$



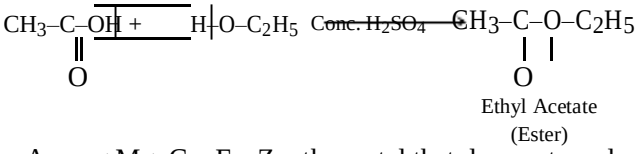
Mellitic Acid Mellitic anhydride

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

(A) $CH_3COOC_2H_5$ (B) C_2H_5COOH (C) $C_2H_5COOCH_3$ (D) CH_3OH

Ans. **[A]**

Sol. Esterification



Ethyl Acetate
(Ester)

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]**

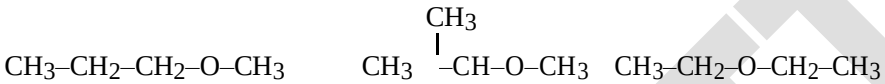
Sol. Cu is present below H_2 in electrochemical series so it can not produce H_2 gas in reaction with HCl

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. $C_4H_{10}O$



Methoxy propane 2 metnoxy propane Ethoxy Ethane

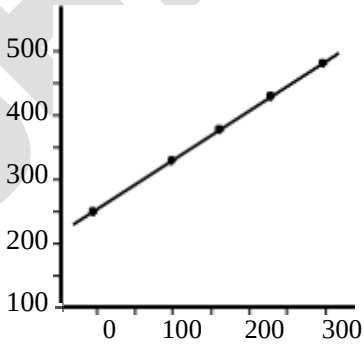
44. The number of electrons required to reduce chromium completely in $Cr_2O_7^{2}$ to Cr^{3+} in acidic medium, is

(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 300°C is larger than that at 0°C by a factor of

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

Ans. **[D]**

Sol. Vg at 0°C = 250 cm^3

Vg at 300°C = 500 cm^3

$\frac{Vg\ (300\ C)}{Vg(0\ C)} = 2$

46. Excess salt inhibits bacterial growth in pickles by -

(A) endosmosis (B) exosmosis (C) oxidation (D) denaturation

Ans. **[B]**

Sol. Excessive salt in pickle inhibits the bacterial growth by exosmosis because external medium become hypertonic.

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

(A) cut DNA at specific base sequence (B) join fragments of DNA

(C) digest DNA from the 3 end (D) digest DNA from the 5 end

Ans. **[A]**

Sol. Restriction endonuclease enzyme breaks the phosphodiester bond on specific pallindromic sequences.

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

(A) Amylase (B) Lipase (C) Trypsin (D) Maltase

Ans. **[C]**

Sol. Enzyme 'X' hydrolyses peptide bond so it is a proteolytic enzyme -

Amylase Starch digesting enzyme

Lipase Fact digesting enzyme

Trypsin Protein digesting enzyme

Maltase Maltose digesting enzyme (Disaccharides)

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 nor anti-B antibodies in plasma

(C) no antigen on RBCs but both anti-A and anti-B antibodies in plasma

(D) antigen A on RBCs and anti-B antibodies in plasma

Ans. **[B]**

Sol.

Blood group	Antigen on R.B.Cs surface	Antibody in plasma
A	A	Anti-B
B	B	Anti-A
AB	A and B	Absent
O	Absent	Anti-A and Anti-B

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. 2 pyruvic acid molecule are formed from one glucose molecule during glycolysis.

51. The process of transfer of electrons from glucose to molecular oxygen in bacteria and mitochondira is known as -

(A) TCA cycle (B) Oxidative phosphorylation

(C) Fermentation (D) Glycolysis

Ans. **[B]**

Sol. The process of electron from glucose to molecular oxygen in bacteria and mitochondrion is occur by electron transport system which leads to 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. Innate immunity is general defense of body

eq. 1. Phagocytosis of invanders by macrophage

2. Restistance of skin to invading micro-organism

3. Destruction of micro-organisms by HCl in digestive juice etc.

53. Deficiency of which one of the following vitamins can cause impaired blood clotting ?

(A) Vitamin B (B) Vitamin C (C) Vitamin D (D) Vitamin K

Ans. **[D]**

Sol. Vitamin K helps in synthesis of blood clotting factor in liver.

54. Which one of the following is detrimental to soil fertility ?

(A) Saprophytic bacteria (B) Nitrosomes (C) Nitrobacter (D) Pseudomonas

Ans. **[D]**

Sol. Pseudomonas denitrificans is involved in formation of elemental N_2 from nitrogen compound (denitrification).

55. In which one of the following phyla is the body segmented ?

(A) Porifera (B) Platyhelminthes (C) Annelida (D) Echinodermata

Ans. **[C]**

Sol. Metameric segmentation is present in

(1) Annelida

(2) Arthropoda

(3) Chordata

56. Widal test is prescribed to diagnose

(A) Typhoid (B) Pneumonia (C) Malaria (D) Filaria

Ans. **[A]**

Sol. Widal test is for Typhoid

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 feeds on the goat which feeds on the grass

(D) Vulture since it eats the tiger, which in turn eats the goat, which eats the grass

Ans. [D]

Sol. Vulture will have the maximum concentration of pesticide because it feeds on tiger which in tern eat the goat which eat the grass.

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) 5 kDa (C) 10 kDa (D) 1 kDa

Ans. [C]

Sol. Molecular Mass of a base = 500 da

Total No. of bases = 10 bp

$= 10 \times 2 = 20$ bases

Molecular mass of 20 bases

$= 20 \times 500$ da

= 10000 dalton

= 10 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 Homopolysaccharide of glucose

Glycogen Homopolysaccharide of glucose

60 Which one of the following is a modified leaf ?

(A) Sweet potato (B) Ginger (C) Onion (D) Carrot

Ans. [C]

Sol. In onion modified leaves are present for food storage

Part – II

Two - Mark Questions

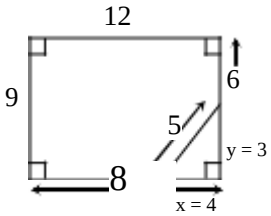
MATHEMATICS

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 pentagon to 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.



Clearly x = 4 = 12 – 8

& y = 3

area of rectangle = 12 × 9 = 108

area of pentagon = 12 × 9 – area of

$= 108 - \frac{1}{2} \times 3 \times 4 = 102$

$\frac{\text{ar(pentagon)}}{\text{ar(rectangle)}} = \frac{102}{108} = \frac{17}{18}$

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 the equation [x] {x} = 5 with 0 x 2015 is -

(A) 0 (B) 3 (C) 2008 (D) 2009

Ans. **[D]**

Sol. [x] . {x} = 5

$\{x\} = \frac{5}{[x]}$

$0 < \frac{5}{[x]} < 1$

$1 < \frac{5}{[x]} <$

$5 < [x] <$

So [x] = 6, 7, 8, ...2015

x = [x] + {x}

$= n \quad \frac{5}{n} \quad n \in \{6,7,....2015\}$

No. of values of 'x' = 2009

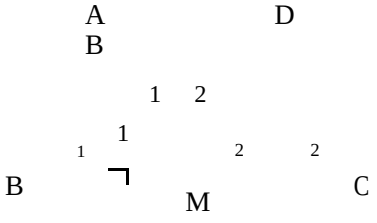
63. Let ABCD be a trapezium with AD parallel to BC. Assume there is a point M in the interior of the segment BC such that AB = AM and DC = DM. Then the ratio of the area of the trapezium to the area of triangle AMD is -

(A) 2 (B) 3

(C) 4 (D) not determinable from the data

Ans. [B]

Sol.



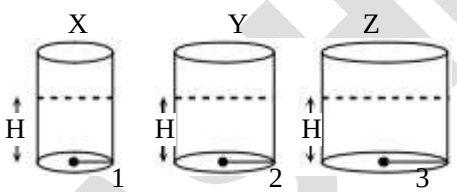
$$\frac{ar(ABCD)}{ar(AMD)} = \frac{3 \; 1 \; 3}{1 \; 2} = \frac{3}{1}$$

64. Given area 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 X 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 $\frac{h_Y}{h_Z}$ equals -

(A) $\frac{4}{9}$ (B) 1 (C) $\frac{9}{4}$ (D) $\frac{81}{40}$

Ans.[D]

Sol.



(V_1,V_2, V_3 are volume of water in X,Y,Z)

(V_1) (V_2) (V_2)

Initially V_1 = H; V_2 = 4 H; V_3 = 9 H

Step-1 : V_1 = 5 H; V_2 = 4 H; V_3 = 5 H

Step-2 : V_1 = 4.5 H; V_2 = 4.5 H; V_3 = 5 H

2

$3^2 h_z = 5$ H

$$\frac{4h_y}{9h_z} = \frac{4.5}{5} \qquad \frac{4h_y}{9h_z} = \frac{81}{40}$$

65. The average incomes of the people in two villages are P and Q, respectively. Assume that P 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. $\frac{x_1 \quad x_2 \quad .... \quad x_n}{n} = P$

$\frac{y_1 \quad y_2 \quad ..... \quad y_m}{m} = Q$

$x_1 + x_2 + ... + x_n = nP$

& $y_1 + y_2 + ...+ y_m = mQ$

Now if a person moves from Ist village to IInd village then

$$\frac{x_1 \quad x_2 \quad .... \quad x_{n-1}}{(n-1)} = P$$

$nP - x_n = (n-1)P \quad P = \frac{n}{n-1} \quad P - \frac{n}{n-1}$

And $\frac{y_1 \quad y_2 \quad .... \quad y_m \quad x_n}{m\ 1} = Q$

$mQ + x_n = (m + 1)Q$

If $P = P \quad P\ 1 - \frac{n}{n-1} = \frac{x_n}{n-1}$

$\frac{-P}{n-1} = -\frac{x_n}{n-1} \qquad P = x_n$

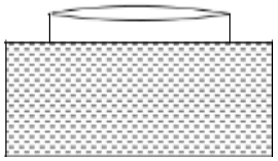
& when Q = Q

$x_n = Q = Q$

In that case P = Q (which is not true)

(C) P = P and Q = Q is not possible

66. A girl sees through a circular glass slab (refractive index 1.5) of thickness 20 mm and diameter 60 cm to the bottom of a swimming pool. Refractive index of water is 1.33. The bottom surface of the slab is in contact with the water surface.

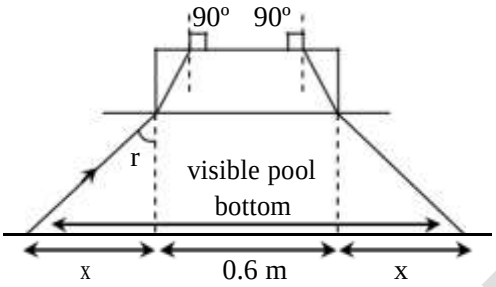


The depth of swimming pool is 6m. The area of bottom of swimming pool that can be seen through the slab is approximately -

(A) 100 m^2 (B) 160 m^2 (C) 190 m^2 (D) 220 m^2

Ans. **[B]**

Sol.



Snell law $1 \times \sin 90 = \frac{4}{3} \sin r$

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

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

$x = 6 \tan r = \frac{6\ 3}{\sqrt{7}} = \frac{18}{\sqrt{7}} = 6.8$

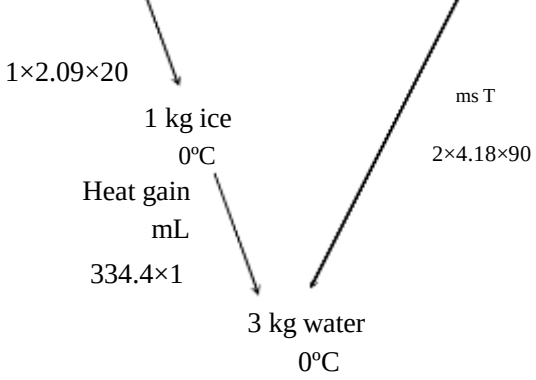
(D) diameter $= 2x + 0.6 = 14.2$

Area $= \frac{D^2}{4} = \frac{3.14\ (14.2)^2}{4}$ ^{2} m $160\ m^2$

67. 1 Kg of ice at – 20ºC is mixed with 2 Kg of water at 90ºC. 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 2.09 kJ/(kg.K), respectively.)

(A) 30ºC (B) 0ºC (C) 80ºC (D) 45ºC

Ans. **[A]**



Total heat gain = 20 × 2.09 + 334.4 KJ = 376.2 kJ

Total heat loss = 752.4 kJ

Heat gain required = 752.4 – 376.2 376.2 kJ

376.2 = ms T

376.2 = 3 × 4.18 × T

T = 30 centigrate

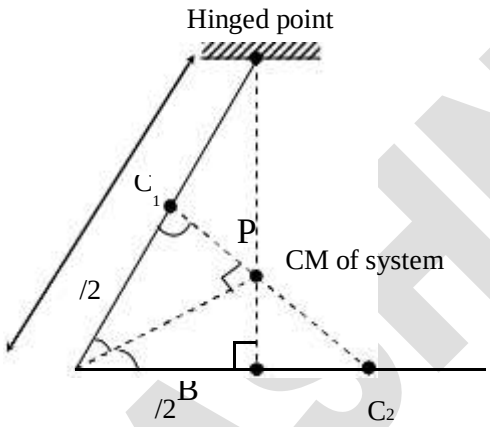
T_{final} = 30ºC

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) $\cos^{-1}\frac{1}{3}$ (B) $\cos^{-1}\frac{1}{2}$ (C) $\cos^{-1}\frac{1}{4}$ (D) $\cos^{-1}\frac{1}{6}$

Ans. [A]

Sol.



When CM of system and Hinged point lie on one line then only system can remain in equilibrium in given position.

AB = cos

— —

2 2

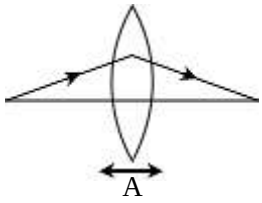
$2\cos = \frac{1 \quad \cos}{}$

$4\cos = 1 + \cos$

$3\cos = 1$

$\cos = \frac{1}{3} = \cos^{-1}\frac{1}{3}$

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 oscillation of the lens.

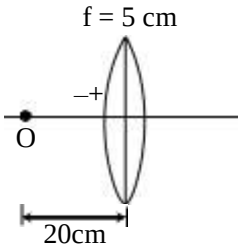
(B) amplitude A/3, out of phase with the oscillations of the lens.

(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.



$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

$\frac{1}{v} = \frac{1}{f} + \frac{1}{u}$

$v = \frac{fu}{f\ u}$

$m = \frac{v}{u} = \frac{f}{f\ u}$

As lens is oscillating with small amplitude A.

Image will oscillate with m^2A

When lens move left then O will come near to lens thus I will go away. Thus image is oscillating out of phase with respect to lens.

$$m = \frac{5}{5\ 20} \qquad \frac{5}{15} = \frac{1}{3}$$

$$\text{Amplitude of image} = \left(\frac{1}{3}\right)^2 A = \frac{A}{9}$$

70. Stoke's law states that the viscous drag force F experienced by a sphere of radius a, moving with a speed v through a fluid with coefficient of viscosity , is given by F = 6 av

If this fluid is flowing through a cylindrical pipe of radius r, length 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

$$\frac{V}{t} = k\frac{p^a}{r^{b\,c}}$$

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. $\frac{V}{t} = k\frac{p^a}{r^{b\,c}}$

V volume

P pressure

coefficient of viscosity

r radius

Using dimensional analysis

$[M^0L^3T^{-1}] = [M^1L^{-2}T^{-2}]^a [M^1L^{-1}T^{-1}]^b [L]^c$

$[M^0L^3T^{-1}] = [M^{a+b} L^{-2a-b+c} T^{-2a-b}]$

$a + b = 0$ ...(1)

$-2a - b + c = 3$ ...(2)

$a = -b$

$-2a - b = -1$ ...(3)

put the value of $-2a - b = -1$ in equation (2)

$-1 + c = 3$

$c = 4$

put $a = -b$ in equation (3)

$2b - b = -1 \quad b = -1$

and $a = 1$

hence option (A) is correct.

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

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

Ans. **[C]**

Sol. $2Xe + 4F_2 \quad XeF_2 + XeF_6$

Initial Mole 2 8 0 0

moles of Xe F_2 formed = 0.5

moles of XeF_6 formed = 0.5

moles ratio = 1 : 1

72. Reaction of ethanol with conc. sulphuric acid at 170 ºC produces a gas which is then treated with bromine is 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. $CH_3–CH_2–OH \xrightarrow[-H_2O]{\text{Conc. } H_2SO_4} CH_2 = CH_2$

Dehydration of Alcohol

Ethene (gas)

Addition reaction Br_2

$CH_2(Br)–CH_2(Br)$

1, 2 dibromo ethane

73. When 22.4 L of C_4H_8 at STP is burnt completely, 89.6 L of CO_2 gas at STP and 72g 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. $C_4H_8(g) + 6O_2(g) 4CO_2(g) + 4H_2O(g)$

$\frac{22.4L}{22.4}$ 89.6 L 72 gm

= 1 mole = 4 mole = 4 mole

n_{O_2} consumed = 6

$V_{O_2} = 6 \times 22.4 = 134.4$ L

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

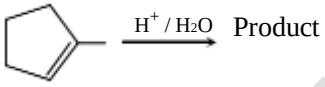
Ans. [A]

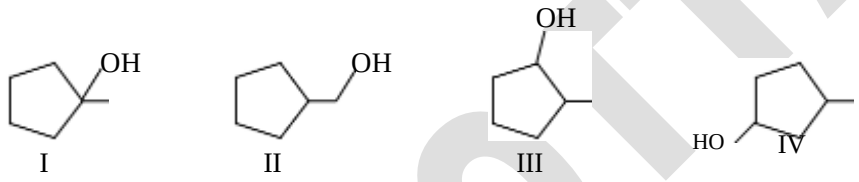
Sol. $W = \frac{Eit}{96500}$

$= \frac{108 \; 0.5 \; 3600}{96500}$

= 2 gm

75. The major produced of the reaction is -

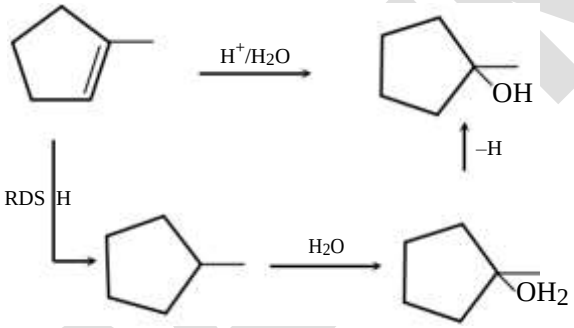




(A) I (B) II (C) III (D) IV

Ans. [A]

Sol.



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. Restriction site for Alu I is made up of four base pair & total four type of N_2 base are present in DNA the frequency of Alu I to cut DNA

$= \frac{1}{44} = \frac{1}{256}$

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 ?

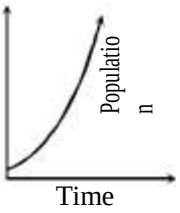
(A) Gets cooked faster on the Siachen glacier (B) Gets cooked faster at sea beach

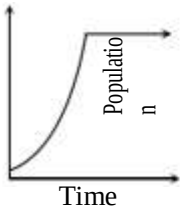
(C) Gets cooked faster on Deccan plain (D) Gets cooked at the same time at all the three places

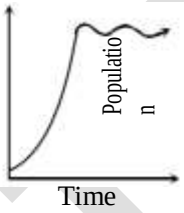
Ans. **[D]**

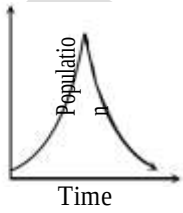
Sol. Pressure cooker is used.

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 ?

(A) 

(B) 

(C) 

(D) 

Ans. **[A]**

Sol.

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 is a monosaccharide and osmotically active molecule which increase osmotic pressure in cell so water enters in cell while glycogen is osmotically inert molecule does not change the osmotic pressure.

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. **[Bonus]**

Sol. There should be five membrane bilayer that line will cross

1-Cell membrane

2-Mitochondrial membrane

2-Nucleus