KVPY – CLASS-XI
PART TEST – 1
(OLTS-1819-T1-PT-1-KVPY-XI)

PART – I

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 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. $f(\alpha)=g(\alpha)$ (where α is common root)
$(a-2)\alpha=(a-2)$
$\alpha=1$
Now : $f(\alpha)=0$
$\Rightarrow f(1)=0 \quad \Rightarrow \quad a=-3$
$f(x)+g(x)=2x^2+(a+2)x+(a+2)$
Sum of roots $=\frac{-(a+2)}{2}=\frac{1}{2}$

2. A certain 12 hour digital clock displays the hour and the minute of a day. Due to a defect in the clock whenever the digit 1 is supposed to be displayed it displays 7. What fraction of the day will the clock show the correct time?

(A) $\frac{1}{2}$ (B) $\frac{5}{8}$

(C) $\frac{3}{4}$ (D) $\frac{5}{6}$

Ans. A

Sol. The clock will show the incorrect time (between 1 – 2, 10 – 11, 11 – 12, 12 – 1 day and night both)
$\therefore$ in correct time $8\times60=480$ (each minute it will display 1)
Remaining 20 hours it will show the incorrect time $16\times15=240$
Total incorrect time $=240+480=720$
correct time = 1 – incorrect time
$=1-\frac{720}{24\times60}=\frac{1}{2}$

3. The number of positive integral solutions $\frac{x^2(3x-4)^3(x-2)^4}{(x-5)^5(2x-7)^6}\le0$ is

(A) four (B) three
(C) two (D) only one

Ans. B

Sol. Since, $\frac{x^2(3x-4)^3(x-2)^4}{(x-5)^5(2x-7)^6} \le 0$

$\therefore \quad x \in \left[\frac{4}{3}, \frac{7}{2}\right) \cup \left(\frac{7}{2}, 5\right)$

$\therefore \quad x = 2, 3, 4$

4. On each face of a cuboid, the sum of its perimeter and its area is written. Among the six numbers so written, there are three distinct numbers and they are 16, 24, and 31. The volume of the cuboid lies between

(A) 7 and 14 (B) 14 and 21

(C) 21 and 28 (D) 28 and 35

Ans. D

Sol. $2(a+b)+ab=16$ .....(1)

$2(b+c)+bc=24$ .....(2)

$2(c+a)+ca=21$ .....(3)

From equation (2), equation (3) $\Rightarrow (a-b)(2+c)=7$ .....(4)

From equation (2) and equation (4) $\Rightarrow 4a=2+5b$ .....(5)

Solve equation (1) and (5)

b = 2 a = 3, c = 5

Volume = 30

5. Suppose the height of a pyramid with a square base is decreased by p% and the lengths of the sides of its square base are increased by p% (where p > 0). If the volume remains the same, then

(A) $50 < p < 55$ (B) $55 < p < 60$

(C) $60 < p < 65$ (D) $65 < p < 70$

Ans. C

Sol. $\frac{1}{3}(x^2)y = \frac{1}{3}x^2\left(\frac{100+p}{100}\right)^2\left(\frac{100-p}{100}\right)$

$\Rightarrow p^2+100p-100^2=0$

$p=\sqrt{12500}-50$

$60 < p < 65$

6. There are three kinds of liquids X, Y, Z. Three jars J_1, J_2, J_3 contain 100 ml of liquids X, Y, Z respectively. By an operation we mean three steps in the following order:

- stir the liquid in J_1 and transfer 10 ml from J_1 into J_2;
- stir the liquid in J_2 and transfer 10 ml from J_2 into J_1;
- stir the liquid in J_3 and transfer 10 ml from J_3 into J_1;

After performing the operation four times, let x, y, z be the amounts of X, Y, Z, respectively, in J_1. Then

(A) $x > y > z$ (B) $x > z > y$

(C) $y > x > z$ (D) $z > x > y$

Ans. B

Sol. After one operation amount of x, y, z in J, respectively are

$90+10\times\left(\frac{1}{11}\right)^2, 100\left(\frac{1}{11}\right)^2, \frac{100}{11}$

Similarly we can find after four operations amount of x, y, z in J_1.

7. Two workers A and B are engaged to do a piece of work. Working alone, A takes 8 hours more to complete the work than if both worked together. On the other hand, working alone, B would need $4\frac{1}{2}$ hours more to complete the work than if both worked together. How much time would they take to complete the job working together?

(A) 4 hours (B) 5 hours

(C) 6 hours (D) 7 hours

Ans. C

Sol. Let A take x

B take y has together is hours $=\left(\frac{1}{x}+\frac{1}{y}\right)$ in of work

Let time be t

$t\left(\frac{1}{x}+\frac{1}{y}\right)+8=\frac{t+8}{x}$

$\frac{t}{y}=\frac{8}{x}$

$t\left(\frac{1}{x}+\frac{1}{y}\right)=\frac{t+4.5}{y}$

$\frac{t}{x}=\frac{4.5}{y}$

$\frac{x}{y}=\frac{8}{t};\ \frac{x}{y}=\frac{t}{4.5}$

$\frac{8}{t}=\frac{t}{4.5}$

$\Rightarrow t^2=36$

t = 6 hours.

8. Suppose a, b, c are three distinct real numbers. Let $P(x)=\frac{(x-b)(x-c)}{(a-b)(a-c)}+\frac{(x-c)(x-a)}{(b-c)(b-a)}+\frac{(x-a)(x-b)}{(c-a)(c-b)}$. When simplified, P (x) becomes

(A) 1 (B) x

(C) $\frac{x^2+(a+b+c)(ab+bc+ca)}{(a-b)(b-c)(c-a)}$ (D) 0

Ans. A

Sol. $P(x)=\frac{(x-b)(x-c)}{(a-b)(a-c)}+\frac{(x-c)(x-a)}{(b-c)(b-a)}+\frac{(x-a)(x-b)}{(c-a)(c-b)}$

Let $P(a)=1+0+0=1$

$P(b)=0+1+0=1$

$P(c)=0+0+1=1$

$\therefore\ P(x)=1$ for all $x\in R$.

9. Let $p(x)=x^2-5x+a$ and $q(x)=x^2-3x+b$, where a and b are positive integers. Suppose $\text{hcf}\left(p(x), q(x)=x-1\right)$ and $k(x)=\text{lcm}\left(p(x), q(x)\right)$. If the coefficient of the highest degree terms of $k(x)$ is 1, the sum of the roots of $(x-1)+k(x)$ is.

(A) 4 (B) 5
(C) 6 (D) 7

Ans. D

Sol. $\therefore$ HCF = x – 1

$\Rightarrow p(x)=x^2-5x+a$

$=x^2-5x+4$

$=(x-1)(x-4)$ and $q(x)x^2-3x+b=x^2-3x+2$ ……..(1)

$(x-1)(x-2)$

$\Rightarrow\ k(x)=(x-1)(x-2)(x-4)$

Hence

$(x-1)+R(x)=(x-1)+(x-1)(x-2)(x-2)(x-4)$

$=(x-1)(x-3)^2$

Hence sum of roots = 7

10. The contents of two vessels containing water and milk in the ratio 1 : 2 and 2 : 5 are mixed in the ratio 1 : 4. The resulting mixture will have water and milk in the ratio _____

(A) $\frac{21}{76}$ (B) $\frac{31}{75}$
(C) $\frac{31}{74}$ (D) $\frac{32}{75}$

Ans. C

Sol.

	Water	Milk
Vessel I	$\frac{1}{3}$	$\frac{2}{3}$
Vessel II	$\frac{2}{7}$	$\frac{5}{7}$

The ratio of the water to milk in the mixture is

$\left(\frac{1}{3}.\frac{1}{5}+\frac{2}{7}.\frac{4}{5}\right):\left(\frac{2}{3}.\frac{1}{5}+\frac{5}{7}.\frac{4}{5}\right)=31:74$

11. Observe that at any instant the minute and hour hands of a clock makes two angles between them whose sum is 360^o. At 6 : 15 the difference between these two angles is

(A) 165^o (B) 170^o
(C) 175^o (D) 180^o

Ans. A

Sol. Say acute angle is α

$\alpha=(90)^o+\left(\frac{30}{4}\right)^o$

$2\alpha=180^o+15^o$

$=195^o$

Now $\beta=360^o$

$\beta-\alpha=360^o-2\alpha$

$=360^o-195^o=165^o$

12. When x, y, z are real, the minimum value of $2x^2+2y^2+5z^2-2xy-4yz-4x-2z+15$ is

(A) 18 (B) 25
(C) 10 (D) 15

Ans. C

Sol. We have $2x^2+2y^2+5z^2-2xy-4yz-4x-2z+15$

$=\left(x^2-2xy+y^2\right)+\left(x^2-4x+4\right)+\left(z^2-2z+1\right)+\left(y^2-4yz+4z^2\right)+10$

$=\left(x-y\right)^2+\left(x-2\right)^2+\left(y-2z\right)^2+10$

Since the minimum value of a square is 0, follows that the minimum value of the given expression is 10.

13. A sphere is inscribed in a cube that has a surface area of 24 cm^2. A second cube is then inscribed within the sphere. The surface area of the inner cube in square centrimeters is

(A) 3 (B) 8
(C) 6 (D) 9

Ans. B

Sol. Surface area of the original cube = 24 cm^2 and hence the length of its side is 2 cm. If a cube is inscribed inside this sphere, then the length of the diagonal of the cube is equal to the diameter of the sphere. Thus if x is the length of a side of this inner cube, then $3x^2=4$ and hence $x=\frac{2}{\sqrt{3}}$. The surface area is $6x^2=8cm^2$.

14. A number of workers in their tea time went to a tea shop and took tea and snacks. At the end they decided to split the bill evenly among them. If each contributes Rs. 16, they found that they were 4 Rs. short, while if each contributes Rs. 19, they had enough to pay the bill, 15% for the tip and Rs. 2 left over. The number of workers is

(A) 10 (B) 12
(C) 15 (D) 11

Ans. D

Sol. Let n be the number of workers in the party and Rs b be the bill amount. Given that 16n = b – 4 and 19n = 1.15b + 2. Solving for n, we get n -= 11.

15. The combined age of a man and his wife is six times the combined ages of their children. Two years ago their united ages were ten times the combined ages of their children. Six years hence their combined age will be there times the combined age of the children. The number of children they have is _____

(A) 4 (B) 5
(C) 3 (D) 6

Ans. C

Sol. Let x be the combined age of the man and his wife.
Let there be n children and y be their combined age.
As per problem, x = 6y ….(1)

$x-4=10\left(y-2n\right)$ ….(2)

(This equation is valid only if Ten years ago is replaced by Two years ago)

$x+12=3\left(y+6n\right)$ ….(3)

Using (1) and (2) $\Rightarrow 6y-4=10\left(y-2n\right)\Rightarrow 3y-2=5\left(y-2n\right)$

$\Rightarrow 2y=10n-2$ ….(4)

Using (1) and (3) $6y+12=3\left(y+6n\right)\Rightarrow 2y+4=y+6n$

$\Rightarrow y=6n-4$ ….(5)

Using (5), (4) $\Rightarrow 2(6n-4)=10n-2$

$6n-4=5n-1\Rightarrow n=3$

Number of children = 3

PHYSICS

16. If $\vec{R}_1=\vec{A}+\vec{B}$ and $\vec{R}_2=\vec{A}-\vec{B}$, then $\frac{\vec{R}_1+\vec{R}_2}{\left|\vec{R}_1+\vec{R}_2\right|}$ will be along

(A) $\vec{A}$ (B) $\vec{B}$

(C) $\vec{A}+\vec{B}$ (D) $\vec{A}-\vec{B}$

Ans. A

Sol. $\frac{\vec{R}_1+\vec{R}_2}{\left|\vec{R}_1+\vec{R}_2\right|}=\frac{\vec{A}}{\left|\vec{A}\right|}$

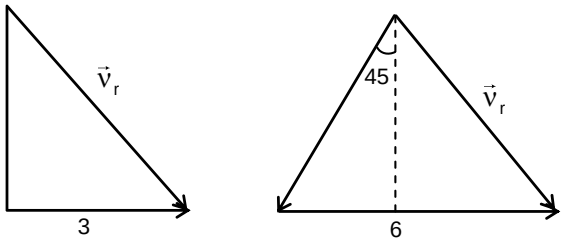
17. A person walking at the rate of 3km/hour, the rain appears to fall vertically. When he increase his speed to 6 km/hr it appears to meet him at angle of 45^0 with vertical. The speed of rain is

(A) $3\sqrt{2}$ km/hr (B) $\frac{3}{\sqrt{2}}$ km/hr

(C) $6\sqrt{2}$ km/hr (D) $2\sqrt{3}$ km/hr

Ans. A

Sol.



v_r is same in both cases.

18. A particle is projected with a velocity v, so that its range on a horizontal plane is twice the greatest height attained. If g is acceleration due to gravity, then its range is:

(A) $\frac{4v^2}{5g}$ (B) $\frac{4g}{5v^2}$

(C) $\frac{4v^3}{5g^2}$ (D) $\frac{4v}{5g^2}$

Ans. A

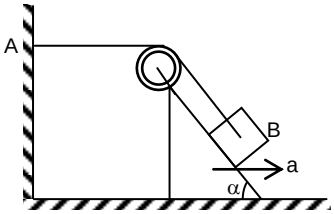
Sol. $R=\frac{v^2\sin 2\theta}{g}, H=\frac{V^2\sin^2\theta}{2g}$

$R=2H$

$R=\frac{4}{5}\frac{v^2}{g}$

$\Rightarrow \sin 2\theta=\frac{4}{5}$

19. A weightless inextensible rope rests on a stationary wedge forming an angle α with the horizontal. One end of the rope is fixed to the wall at point A. A small load is attached to the rope at point B. The wedge starts moving to the right with a constant acceleration a. The magnitude of acceleration of the load is given by:

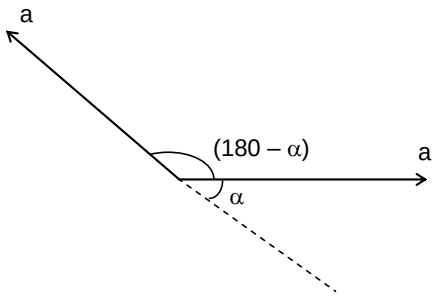


(A) a
(B) $2a \sin\frac{\alpha}{2}$
(C) $a \sin \alpha$
(D) $g \sin \alpha$

Ans. B

Sol. $a_{res} = \sqrt{a^2 + a^2 + 2a^2 \cos(180 - \alpha)}$

$= 2a \sin\frac{\alpha}{2}$



20. A stone is projected vertically upward to reach maximum height h. The ratio of its KE to its potential energy at a height $\frac{4}{5}$h, will be:

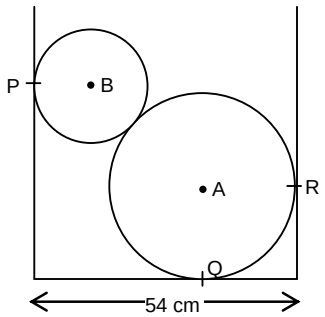
(A) 5 : 4
(B) 4 : 5
(C) 1 : 4
(D) 4 : 1

Ans. C

Sol. $E_k = \frac{1}{2}mv^2 = \frac{mgh}{5}$

Potential Energy = $mg\frac{4h}{5}$

21. Two steel balls A and B are placed inside a right circular cylinder of diameter 54 cm making contacts at point P, Q and R as shown. The radius r_A = 12 cm and r_B = 18 cm. The masses are $m_A = 60kg$ and m_B = 15 kg. The forces exerted by the floor at the point Q and the wall at R are respectively (taking g = 10 m/s^2)(all the surfaces are smooth)



(A) 600N, 150N
(B) 750N, 100N
(C) 600N, 120N
(D) 750N, 200N

Ans. D

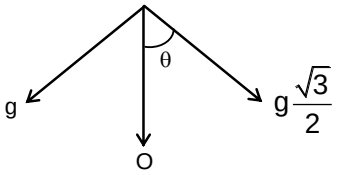
Sol. $N_Q = (60 + 15) \times 10 = 750$ N.
$N_R = 150 \tan 53 = 200$ N

22. A bob is hung from the ceiling of a train compartment. The train moves on an incline track of inclination 30^0 with horizontal. Acceleration of the train up the plane is g/2. The angle which the string supporting the bob makes with normal to the ceiling in equilibrium condition, is

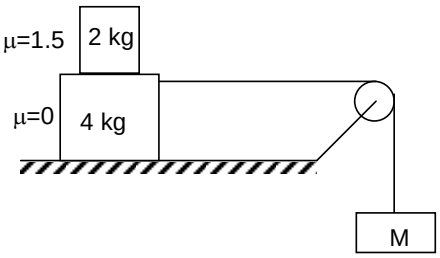
(A) 30^0
(B) $\tan^{-1}(2)$
(C) $\tan^{-1}\left(\frac{2}{\sqrt{3}}\right)$
(D) 45^0

Ans. C

Sol. $\tan\theta = \frac{2}{\sqrt{3}}$



23. Find the minimum value of mass of hanging block so 2 kg block slips over 4 kg block.
(A) 30 kg
(B) 20 kg
(C) 10 kg
(D) will not slip for any mass



Ans. D

Sol. $\mu > 1$

24. Component of $3\hat{i}+4\hat{j}$ perpendicular to $\hat{i}+\hat{j}$ and in the same plane as that of $3\hat{i}+4\hat{j}$ and $(\hat{i}+\hat{j})$ is:

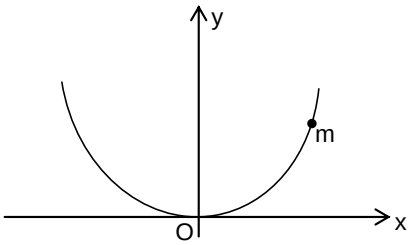
(A) $\frac{1}{2}(\hat{j}-\hat{i})$ (B) $\frac{3}{2}(\hat{j}-\hat{i})$

(C) $\frac{5}{2}(\hat{j}-\hat{i})$ (D) $\frac{7}{2}(\hat{j}-\hat{i})$

Ans. A

Sol. $$= \frac{\left|3\hat{i}+4\hat{j}\right|\left|\left(3\hat{i}+4\hat{j}\right)\times\left(\hat{i}+\hat{j}\right)\right|\left(\hat{j}-\hat{i}\right)}{\left|3\hat{i}+4\hat{j}\right|\left|\hat{i}+\hat{j}\right|}$$
$$= \frac{\left|\left(3\hat{i}+4\hat{j}\right)\times\left(\hat{i}+\hat{j}\right)\right|\left(\hat{j}-\hat{i}\right)}{\left|\hat{i}+\hat{j}\right|\left|\hat{j}-\hat{i}\right|}$$

25. A bead of mass m is located on parabolic wire with its axis vertical and vertex at the origin as shown in figure and whose equation is $x^2 = 4ay$. The wire frame is fixed and bead can slide on it without friction. The bead is released from the point y = 4a on the wire frame from rest. The tangential acceleration of the bead when it reaches the position given by y = a is



(A) $\frac{g}{2}$ (B) $\frac{\sqrt{3}}{2}g$

(C) $\frac{g}{\sqrt{2}}$ (D) $\frac{g}{\sqrt{5}}$

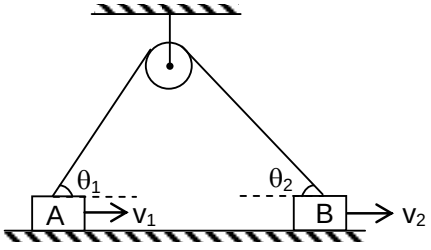
Ans. C

Sol. At y = a, x = 2a, $\frac{dy}{dx} = 1 = 45^\circ$ $a_f = g\cos 45^\circ = \frac{g}{\sqrt{2}}$.

26. Block are moving as shown. The ratio v_1 / v_2 is

(A) $\frac{\sin\theta_1}{\sin\theta_2}$ (B) $\frac{\sin\theta_2}{\sin\theta_1}$

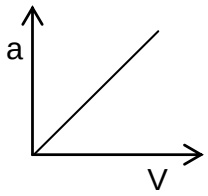
(C) $\frac{\cos\theta_2}{\cos\theta_1}$ (D) $\frac{\cos\theta_1}{\cos\theta_2}$



Ans. C

Sol. $v_1\cos\theta_1 = v_2\cos\theta_2$

27. The acceleration-velocity graph of a particle moving in a straight line is as shown in figure. Then slope of velocity-displacement graph

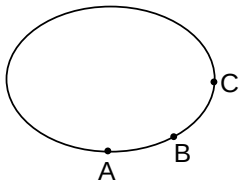


(A) increases linearly (B) decreases linearly
(C) is constant (D) increases parabolically

Ans. C

Sol. $a = \frac{Vdv}{dx}$ $\frac{dv}{dx} = \frac{a}{v}$ = constant.

28. A particle is moving on an elliptical path as shown, speed of the particle is constant. Its acceleration is maximum at



(A) A (B) B
(C) C (D) same everywhere

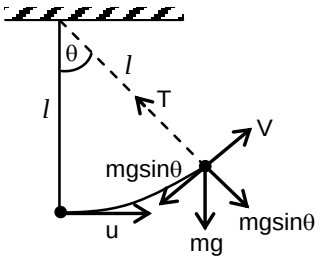
Ans. C

Sol. $a = \frac{v^2}{r}$

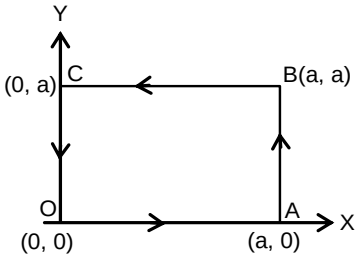
29. A ball is attached to a string and moves in a vertical circle. The string is always taut and there are absolutely no resistive forces. Which of the following statements is most correct:
(A) the net force on the ball is always vertical.
(B) the net force on the ball is always perpendicular to the velocity vector of the ball.
(C) the net force on the ball is always towards centre.
(D) the tension in the string is greatest when the ball is at its lowest point.

Ans. D

Sol. $Mv^2/l = T - mg\cos\theta$
$T = mv^2/l + mg\cos\theta$
At lowest point
$\cos\theta = 1 \Rightarrow \theta = 0$
$v = u$
$T_L = mu^2/l + mg$



30. The work done by the force $\vec{F} = x^2\hat{i} + y^2\hat{j}$ around the path shown in the figure is



(A) $\frac{2}{3}a^3$ (B) zero
(C) a^3 (D) $\frac{4}{3}a^3$

Ans. B

Sol. Force is conservative and displacement zero so work done is zero.

CHEMISTRY

31. How many moles of Na_2SO_4 will be formed from complete reaction of 0.5 moles of H_2SO_4 and 0.8 moles of NaOH.

$$H_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2H_2O$$

(A) 0.5 (B) 0.8
(C) 0.4 (D) 0.25

Ans. C

Sol. $H_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2H_2O$
0.5 0.8
Limiting reagent = NaOH

$$\therefore \frac{n_{NaOH}}{2} = \frac{n_{Na_2SO_4}}{1}$$

$$n_{Na_2SO_4} = \frac{0.8}{2} = 0.4$$

32. Which of the following is correct order of ionic size in water?
(A) $Li^+ > Na^+ > K^+ > Cs^+$ (B) $Li^+ < Na^+ < K^+ < Cs^+$
(C) $Na^+ > K^+ > Rb^+ > Li^+$ (D) None of these

Ans. A

Sol. Due to high hydration Li^+ has maximum size.

33. The volume of 1 N NaOH required to completely neutralize one litre of 0.1 M solution of HCl?
(A) 100 mL (B) 0.1 mL
(C) 10 mL (D) 1000 mL

Ans. A

Sol. Eq of HCl = $1 \times 0.1 = 0.1$
Eq of NaOH = $0.1 = V \times N$
$\therefore$ V = 0.1/1 = 0.1 L or 100 mL

34. If the ionization energy of Na metal is x eV, what will be the ionization energy of Li in eV unit?
(A) x (B) greater than x
(C) smaller than x (D) –x

Ans. B

Sol. The ionization potential of elements decreases down the group.
$\therefore$ $I.E_1$ of Li > $I.E_1$ of Na

35. The disintegration constant of a radioactive decay is 0.693 sec^{-1}. How much time is needed for 75% disintegration of the radioactive element?
(A) 2.5 sec (B) 1 sec
(C) 2 sec (D) 1.5 sec

Ans. C

Sol. $$t_{1/2} = \frac{0.693}{\lambda} = \frac{0.693}{0.693} = 1\,\text{sec}$$

$$t_{75\%} = 2 \times t_{1/2} = 2 \times 1 = 2\,\text{sec}$$

36. What is the n-factor of I_2 in the following reaction?

$I^- \longrightarrow I_2$

(A) 1 (B) 8
(C) 2 (D) 4

Ans. C

Sol. $\overset{-1}{I^-} \longrightarrow \overset{0}{I_2}$

$\therefore$ n-factor = $2 \times 1 = 2$

37. How many lines are observed in visible region when transition occurs from n = 6 $\rightarrow$ n = 1 in hydrogen sample?

(A) 5 (B) 4
(C) 3 (D) 2

Ans. B

Sol. All transitions upto n = 2 lie in visible region.

$6 \rightarrow 2, 5 \rightarrow 2, 4 \rightarrow 2, 3 \rightarrow 2$

Total = 4

38. The kinetic energy of an electron in the 3rd Bohr orbit of a hydrogen atom is [a_0 is Bohr radius]

(A) $\frac{h^2}{4\pi^2 m a_o^2}$ (B) $\frac{h^2}{32\pi^2 m a_o^2}$

(C) $\frac{h^2}{64\pi^2 m a_o^2}$ (D) $\frac{h^2}{72\pi^2 m a_o^2}$

Ans. D

Sol. $\because mvr = \frac{nh}{2\pi} \Rightarrow v = \frac{nh}{2\pi mr} \quad \Rightarrow \because KE = \frac{1}{2}mv^2 = \frac{1}{2}m\left(\frac{nh}{2\pi mr}\right)^2$

$r = \frac{a_o \times n^2}{Z} \Rightarrow r_3 = \frac{a_o \times 3^2}{1} = 9a_o \Rightarrow KE = \frac{1}{2}m\left(\frac{3^2 h^2}{4\pi^2 m^2 (9a_o)^2}\right)$

$= \frac{1}{2}m\left(\frac{9h^2}{4\pi^2 m^2 \times 81 a_o^2}\right) = \frac{h^2}{72\pi^2 m a_o^2}$

39. How many quantum number(s) has/have different values for the valence electrons of calcium?

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

Ans. B

Sol. Valence electron of Ca is present in 4s orbital for which only spin quantum no. is different.

40. What is the binding energy of second excited state of He^+ ion?

(A) 6.04 eV (B) 13.6 eV
(C) 1.51 eV (D) None of these

Ans. A

Sol. $B.E = 13.6 \times \frac{Z^2}{n^2} = 13.6 \times \frac{2^2}{3^2}$

41. The number of α & β-particles respectively in the following radioactive decay is

$_{92}U^{238} \longrightarrow {}_{82}Pb^{206}$

(A) 6, 8 (B) 6, 6
(C) 8, 6 (D) 4, 6

Ans. C

Sol. $_{92}U^{238} \longrightarrow {}_{82}Pb^{206}$

no. of α particles = $\frac{238-206}{4} = 8$

no. of β particles = $8 \times 2 - [92 - 82] = 6$

42. Which of the following is incorrect for 18 g H_2O?
(A) It contains 1 mole molecules of water
(B) It contains 1 mole molecules of hydrogen
(C) It contains 1 mole atoms of hydrogen
(D) It contains 1 mole atoms of oxygen

Ans. C

Sol. Mole of H_2O = 18/18 = 1
Mole of H-atoms = $2 \times 1 = 2$

43. $CaCO_3 \xrightarrow{\Delta} CaO + CO_2$

In order to obtain 22.4 L of CO_2 at STP according to above reaction, how many gram of $CaCO_3$ should be heated?
(A) 200 g (B) 100 g
(C) 50 g (D) 25 g

Ans. B

Sol. Mole of $CO_2 = \frac{22.4}{22.4} = 1$

$\therefore$ 1 mole $CaCO_3$ gives one mole CO_2
1 mole $CaCO_3$ = 100 g

44. What is the n-factor of sulphuric acid in the following reaction?

$KOH + H_2SO_4 \longrightarrow KHSO_4 + H_2O$

(A) 2 (B) 1
(C) 0.5 (D) 0.25

Ans. B

Sol. In the reaction one H^+ ion is released from H_2SO_4. Hence, the n-factor is one.

45. What is the maximum covalency of nitrogen atom?
(A) 3 (B) 5
(C) 4 (D) 6

Ans. C

Sol. Fact based

BIOLOGY

46. Where does protein digestion start in human body?
(A) Stomach (B) Ileum
(C) Rectum (D) Duodenum

Ans. A

Sol. In human body, protein digestion starts in stomach.

47. Wharton's duct is the duct of which salivary gland ?
(A) Parotid gland (B) Sublingual gland
(C) Submandibular gland (D) All of these

Ans. C

Sol. Wharton's duct is the duct of submandibular gland.

48. Liver stores which of the following vitamin / vitamins.
(A) Vitamin A (B) Vitamin B_{12}
(C) Vitamin D (D) All of these

Ans. D

Sol. Liver stores vitamin A, D and B_{12}.

49. Bohr effect is related with
(A) Reduced oxygen level in haemoglobin (B) Reduced CO_2 level in blood
(C) Reduced carbon level in lymph (D) Oxidised phosphorus level in blood

Ans. A

Sol. Bohr effect is related with reduced oxygen level in haemoglobin.

50. Oxyhaemoglobin dissociates under which of following conditions is tissues:
(A) High pO_2 in tissues (B) Low pO_2 in tissues
(C) Equal pO_2 in tissues (D) All times irrespective of pO_2

Ans. B

Sol. Oxhaemoglobin dissociates when there is low pO_2 in tissues.

51. Respiratory quotient (RQ) is less than one in
(A) Carbohydrates (B) Fat
(C) Both A and B (D) Glucose

Ans. B

Sol. Respiratory quotient is less than one in fat.

52. When CO_2 conc. in the blood increases, breathing becomes
(A) Slow and deep (B) Faster and deep
(C) Shallower and slow (D) There is not effect on breathing

Ans. B

Sol. When CO_2 conc. in the blood increases, breathing becomes faster and deep.

53. The P wave of the electrocardiogram is associated with
(A) Relaxation of atria
(B) Depolarization of atria
(C) Contraction of ventricles
(D) Repolarization of S – A node

Ans. B

Sol. The P wave of the electrocardiogram is associated with depolarization of atria.

54. Closed circulatory system occurs in
(A) Cockroach
(B) *Doliolum*
(C) Mosquito
(D) Housefly

Ans. B

Sol. Closed circulatory system occurs in *Doliolum*.

55. Average 1100 mL to 1200mL of air is known to remain inside the human lungs even after forcible expiration. It is described as ___
(A) Inspiratory Reserve Volume
(B) Expiratory Reserve Volume
(C) Residual Volume
(D) Tidal Volume

Ans. C

Sol Average 1100 mL to 1200mL of air is known to remain inside the human lungs even after forcible expiration. It is described as residual volume.

56. Which of the following match is correct?
(A) Emphysema: reduction of surface area of alveoli and bronchi.
(B) Pneumonia: occupational disease due to asbestos
(C) Silicosis: Inflammation of oesophagus
(D) Asthma: Alveoli infection

Ans. A

Sol. Emphysema: reduction of surface area of alveoli and bronchi.

57. One of the factors required for the maturation of erythrocytes is
(A) Vitamin D
(B) Vitamin A
(C) Vitamin B_{12}
(D) Vitamin C

Ans. C

Sol. Vitamin B_{12} is required for the maturation of erythrocytes.

58. Blood clotting is initiated by
(A) Ca^{++} and thromboplastin
(B) Prothrombin and thromboplastin
(C) Fibrinogen and Ca^{++}
(D) Fibrinogen and thromboplastin

Ans. B

Sol. Blood clotting is initiated by prothrombin and thromboplastin.

59. Ornithine cycle operates in which of the following organs?
(A) Stomach
(B) Pancreas
(C) Liver
(D) Oral cavity

Ans. C

Sol. Ornithine cycle operates in the liver.

60. Uric acid is major excretory product of which of the following?
(A) Frog (B) Rabbit
(C) Man (D) Pigeon

Ans. D

Sol. Uric acid is major excretory product of pigeon.

PART – II

MATHEMATICS

61. The number of integers a in the interval [1, 2014] for which the system of equations $x+y=a\dfrac{x^2}{x-1}+\dfrac{y^2}{y-1}=4$ has finitely many solutions is
(A) 0 (B) 1007
(C) 2013 (D) 2014

Ans. C

Sol. $\dfrac{x^2-1+1}{x-1}+\dfrac{y^2-1+1}{y-1}=4$

$x+1+\dfrac{1}{x-1}=y+1+\dfrac{1}{y-1}=4$

$a+2+\dfrac{1}{x-1}+\dfrac{1}{(a-1)-x}=4$

$\dfrac{(a-1)-x+x-1}{(x-1)\left[(a-1)-x\right]}=2-a$

$\because x\neq 2$ [for a = 2 equation have infinitely many solution]

$\therefore (x-1)\left[(a-1)-x\right]=-1$

$(x-1)\left[x-(a-1)\right]=1$

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

$D>0$

$\therefore$ equation have 2 real roots so a can be 1, 3, 4…….2014

62. Let $f(x)=ax^2+bx+c$, where a, b, c are integers. Suppose $f(1)=0$, $40<f(6)<50$, $60<f(7)<70$, and $1000t<f(50)<1000(t+1)$ for some integer t. Then the value of t is
(A) 2 (B) 3
(C) 4 (D) 5 or more

Ans. C

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

given $f(1)=0$

$\Rightarrow a+b+c=0$ and $40<f(6)<50$

$\Rightarrow 40<36a+6b+c<50$

$\Rightarrow 40<35a+5b<50$

$\Rightarrow 8<7a+b<10$

$7a+b=$integer = 9 …….(1)

and $60<f(7)<70$

$\Rightarrow 60<49a+7b+c<70$

$\Rightarrow 60<48a+6b<70$

$\Rightarrow 10 < 8a + b < 11.6$

$8a + b = \text{integer} = 11$ ……..(2)

Solving (1) and (2)

$a = 2, b = -5, c = 3$

$\therefore\ f(x) = 2x^2 - 5x + 3$

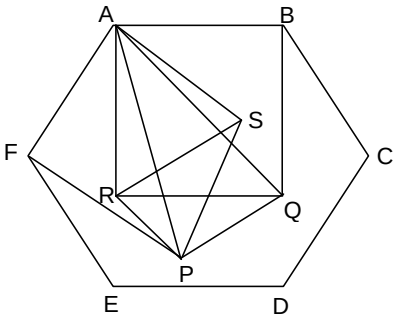
$f(50) = 4753$

$1000t < f(50) < 1000(t+1)$

$(1000 \times 4) < 4753 < 1000(4+1)$

$\therefore t = 4$

63. In the figure given below, ABCDEF is a regular hexagon of side length 1, AFPS and ABQR are squares. Then the ratio Area (APQ)/Area (SRP) equals



(A) $\frac{\sqrt{2}+1}{2}$ (B) $\sqrt{2}$

(C) $\frac{3\sqrt{3}}{4}$ (D) 2

Ans. D

Sol. In ΔAPQ

$AP = AQ = \sqrt{2},\ \angle APQ = 30^o$

In ΔSRP

$SR = SP = 1,\ \angle RSP = 30^o$

$\angle FAB = 120^o$

$\angle BAS = \angle FAB - \angle FAS = 120^o - 90^o = 30^o$

$\angle SAR = \angle BAR - \angle BAS = 60^o$

$\cos 60^o = \frac{1+1-SR^2}{2.1.1} \left[\because AR = AS = 1\right]$

$\Rightarrow SR = 1$

Now, $\angle RSP = \angle ASP - \angle ASR$

$= 90^o - 60^o = 30^o \left[\because \text{ ASR is equilateral}\right]$

Now, from $\Delta SRP = \frac{\sqrt{3}-1}{2\sqrt{2}}$

In ΔAPR

$\cos \angle RAP = \frac{\left(\sqrt{2}\right)^2 + 1^2 - PR^2}{2\sqrt{2}}$

$\Rightarrow \cos \angle RAP = 15^o$

$\angle PAQ = \angle RAQ - \angle RAP = 45^o - 15^o = 30^o$

Now, $\frac{ar(\Delta APQ)}{ar(\Delta SRP)} = \frac{\frac{1}{2} \times \sqrt{2} \times \sqrt{2} \sin 30^o}{\frac{1}{2} \times 1 \times 1 \times \sin 30^o} = 2$

64. For any real x the expression $2(k-x)\left[x + \sqrt{x^2 + k^2}\right]$ can not exceed

(A) k^2 (B) $2k^2$

(C) $3k^2$ (D) none of these

Ans. B

Sol. Let $y = 2(k-x)\left\{x + \sqrt{(x^2+k^2)}\right\}$

or $\quad x + \sqrt{(x^2+k^2)} = \dfrac{y}{2(k-x)} \qquad$ ……..(i)

$$\frac{\left\{x + \sqrt{(x^2+k^2)}\right\}\left\{\sqrt{(x^2+k^2)} - x\right\}}{\sqrt{(x^2+k^2)} - x} = \frac{y}{2(k-x)}$$

or $\quad \dfrac{k^2}{\sqrt{(x^2+k^2)} - x} = \dfrac{y}{2(k-x)}$

$$\Rightarrow \quad \sqrt{(x^2+k^2)} - x = \frac{2k^2(k-x)^2}{y} \qquad \text{……..(ii)}$$

Subtracting equation (ii) from equation (i),

$$2x = \frac{y}{2(k-x)} - \frac{2k^2(k-x)}{y}$$

$$\Rightarrow \quad 4(y-k^2)x^2 + 4k(2k^2-y)x + y^2 - 4k^4 = 0$$

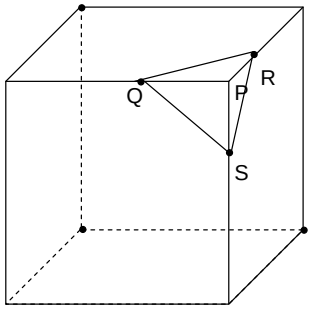
But x is real, $\therefore\ D \geq 0$

Then, we get $y^2(y-2k^2) \leq 0$

$\therefore \quad y \leq 2k^2 \qquad (\because y^2 \geq 0)$

Hence, maximum value of y is $2k^2$

65. P is the vertex of a cuboid Q, R, S are points on the edges shown. If PQ = 4 cm, PR = 4 cm, and PS = 2 cm and the area of triangle QRS is $\sqrt{K}\,cm^2$ then K = _____



(A) 104
(B) 92
(C) 86
(D) 96

Ans. D

Sol. $QR = \sqrt{16+16} = 4\sqrt{2}$

$QS = \sqrt{16+4} = 2\sqrt{5}$

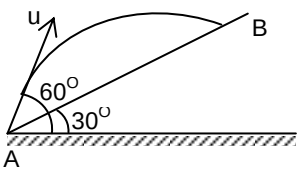
$SR = \sqrt{4+16} = 2\sqrt{5}$

Since QS = SR, the triangle is isosceles and the height h of the triangle to the base QR is given by $h = \sqrt{SR^2 - \left(\dfrac{QS}{2}\right)^2} = \sqrt{28-8} = 2\sqrt{3}$

Hence the area of the triangle is $\dfrac{1}{2} 4\sqrt{2} \times 2\sqrt{3} = 4\sqrt{6} = \sqrt{96}\,cm^2$ and K = 96.

PHYSICS

66. The time taken by the projectile to reach from A to B is t. Then the distance AB is equal to



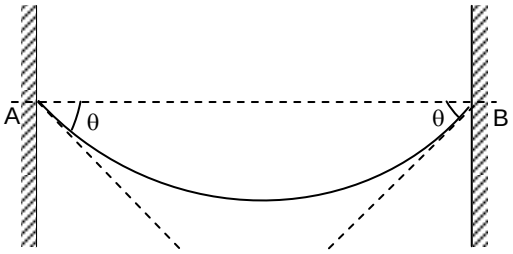
(A) $\dfrac{ut}{\sqrt{3}}$ (B) $\dfrac{\sqrt{3}\ ut}{2}$

(C) $\sqrt{3}\ ut$ (D) 2 ut

Ans. A

Sol. $AB = \dfrac{u\cos 60° t}{\cos 30°}$

67. A heavy string of mass m hangs between two fixed points A and B at an angle θ with the horizontal as shown in the figure. The tension at the lowest point in the string is

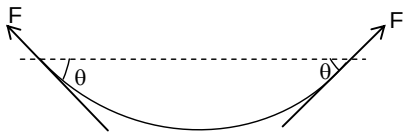


(A) mg/(2 sin θ)
(B) mg/(2 cos θ)
(C) mg/(2 tan θ)
(D) mg/(2 cot θ)

Ans. C

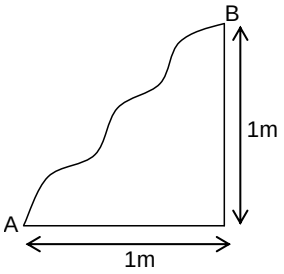
Sol. $2F\sin\theta = mg$

$T = F\cos\theta$



68. A particle of mass 1 kg moved slowly up a hill by a force which is tangential to trajectory. Work performed by this force (0.5 is friction coefficient)

(A) 15 J (B) 25 J
(C) 20 J (D) 10 J



Ans. A

Sol. $N = mg\cos\theta$

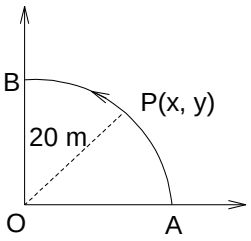
$f = \mu mg\cos\theta$

$\text{work.done.by.friction} = \int(\mu mg\cos\theta)dx$

$= \mu mg\int dx\ \cos\theta$

$= 5\times 10\times 1\times 1 = 5J$

69. A point P moves in counter- clockwise direction in a circular path as shown in the figure. The movement of P is such that it sweeps out a length $S = t^3 + 5$, where S is in metres and t is in sec. The radius of the path is 20 m. The acceleration of 'P' when t = 2s is nearly.



(A) 14 m/s^2 (B) 13 m/s^2
(C) 12 m/s^2 (D) 7.2 m/s^2

Ans. A

Sol. $S = t^3 + 5$

$v = \dfrac{ds}{dt} = 3t^2$

$a_t = \dfrac{dv}{dt} = 6t$, At t = 2sec, v = 12 ms^{-1}

$a_t = 12ms^{-2}\quad a_n = \dfrac{v^2}{R} = \dfrac{12^2}{20} = \dfrac{144}{20} = 7.2ms^{-2}$

$a = \sqrt{a_t^2 + a_n{}^2}$

$a = 14ms^{-2}$

70. A bob of mass m is suspended with a string from a fixed point, when it is projected with a velocity which is just required to loop the circle completely. At what angle with the horizontal, tension in the string will be equal to 2 mg.

(A) $\sin^{-1}\left(\frac{1}{3}\right)$ (B) $\sin^{-1}\left(\frac{2}{3}\right)$

(C) $\cos^{-1}\left(\frac{1}{3}\right)$ (D) $\tan^{-1}\left(\frac{1}{3}\right)$

Ans. A

Sol. $T + mg\sin\theta = \frac{mv_P^2}{r}$

$T = \frac{mv_P^2}{r} - mg\sin\theta = 2mg$

$v_P^2 = 2gr + gr\sin\theta$ .....(1)

From w – E theorem

$\frac{1}{2}mv_P^2 - \frac{1}{2}mv_B^2 = -mgr(1+\sin\theta)$

Also, $v_B = \sqrt{5gr}$ to loop circle.

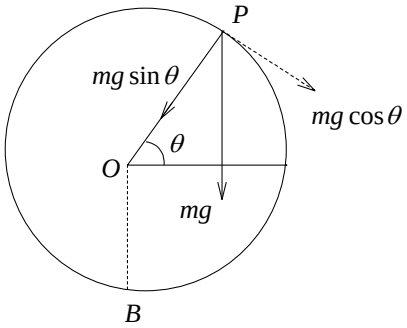
$\Rightarrow v_P^2 = 5gr - 2gr(1+\sin\theta)$

$v_P^2 = 3gr - 2gr\sin\theta$ .....(2)

From (1) and (2)

$2gr + gr\sin\theta = 3gr - 2gr\sin\theta$

$\sin\theta = \frac{1}{3}$; $\theta = \sin^{-1}\left(\frac{1}{3}\right)$



CHEMISTRY

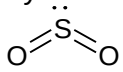
71. Which of the following do NOT have linear structure?

(A) CO_2 (B) I_3^-

(C) SO_2 (D) All are linear

Ans. C

Sol. Hybridization = sp^2 (2 σ bond + 1lp)



Bent or V-shape

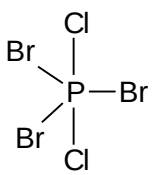
72. Which has zero dipole moment?

(A) PCl_2F_3 (B) PBr_2Cl_3

(C) PBr_3Cl_2 (D) SO_2

Ans. C

Sol.



It has zero dipole moment

73. Which has the highest value of second I.E?
(A) Oxygen (B) Nitrogen
(C) Carbon (D) Fluorine

Ans. A

Sol. $N = 1s^2 2s^2 2p^3$, $O = 1s^2 2s^2 2p^4$, $C = 1s^2 2s^2 2p^2$, $F \rightarrow 1s^2 2s^2 2p^5$
$N^+ = 1s^2 2s^2 2p^2$, $O^+ = 1s^2 2s^2 2p^3$, $C^+ = 1s^2 2s^2 2p^1$, $F^+ \rightarrow 1s^2 2s^2 2p^4$
For $I.E_2$ of O is maximum due to it's half-filled electron configuration.

74. Which has the largest bond angle?
(A) NH_3 (B) NF_3
(C) H_2O (D) OF_2

Ans. A

Sol. Bond angle: $NH_3 > NF_3 > H_2O > OF_2$

75. Which has the highest value of electron affinity?
(A) P (B) O
(C) S (D) N

Ans. C

Sol. E.A. order: S > O > P > N

BIOLOGY

76. Reabsorption of water in PCT part of nephron is
(A) Passive, 80% (B) Active, 40%
(C) Active, 80% (D) Passive, 40%

Ans. A

Sol. 80% reabsorption of water occurs in PCT and by passive transport.

77. Mark the correct statement:
(A) Calcium ions have no role in blood clotting
(B) Inspiration can occur if the pressure within the lungs (intra – pulmonary pressure) is less than the atmospheric pressure
(C) 100% of starch is digested in the mouth
(D) All of these

Ans. B

Sol. Inspiration can occur if the pressure within the lungs (intra – pulmonary pressure) is less than the atmospheric pressure.

78. Flame cells is the excretory organ of:
(A) Annelids (B) Arthropods
(C) Echinoderms (D) Platyhelminthes

Ans. D

Sol. Flame cells is the excretory organ of Platyhelminthes.

79. To synthesise 1 molecule of glucose during dark reaction, the number of ATP and NADPH molecules required are respectively:
(A) 12 ATP and 18 NADPH
(B) 18 ATP and 12 NADPH
(C) 6 ATP and 18 NADPH
(D) 18 ATP and 36 NADPH

Ans. B

Sol. To synthesise 1 molecule of glucose during dark reaction, the number of ATP and NADPH molecules required are respectively 18 ATP and 12 NADPH.

80. Which of the following does not pertain to facilitated transport?
(A) High selectivity
(B) Shows saturation
(C) Uphill transport
(D) Requirement of special carrier proteins

Ans. C

Sol. Uphill transport does not pertain to facilitated transport.