FT-IV-KVPY-CLASS-XI
FULL TEST – IV

PART – I
MATHEMATICS

1. If length of one diagonal of a parallelogram is 4 units and Area of parallelogram is 8 sq. units. Then length of other diagonal is (if angle between the diagonal is $\tan^{-1}\frac{3}{4}$).

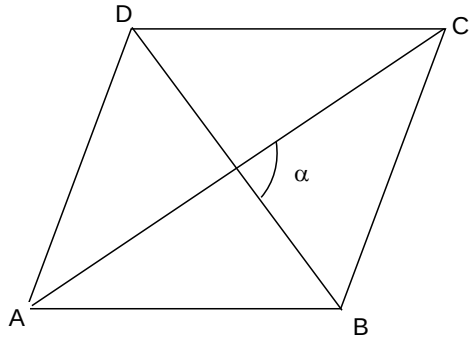
(A) $\frac{10}{3}$ (B) $\frac{20}{3}$

(C) 2 (D) 5

Ans. B

Sol. Area of parallelogram ABCD is $= \left|\frac{1}{2}AC.BD.\sin\alpha\right|$

Length of other diagonal is $\frac{20}{3}$ units



2. An agricultural field is in the form of a rectangle having length x_1 metres and Breadth x_2 metres. If $x_1 + x_2 = 40$ metres and Breadth x_2 metres. If $x_1 + x_2 = 40$ metres, then the area of the agricultural field will not exceed which one of the following values?

(A) 400 sq. m. (B) 300 sq. m.

(C) 200 sq. m. (D) 80 sq. m.

Ans. A

Sol. Area of field $= x_1x_2$

By $AM \geq GM$

$\frac{x_1 + x_2}{2} \geq \sqrt{x_1x_2} \Rightarrow x_1x_2 \leq 400$

3. In an acute angled triangle ABC, AA_1 and AA_2 area the median and altitude respectively. Length A_1A_2 is equal to:

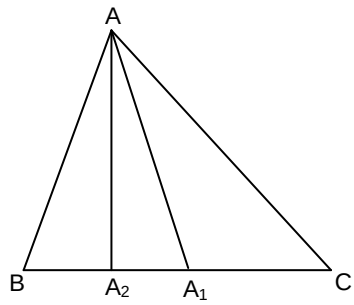
(A) $\frac{\left|a^2 - c^2\right|}{2b}$ (B) $\frac{\left|a^2 - b^2\right|}{2c}$

(C) $\frac{\left|b^2 - c^2\right|}{2a}$ (D) None of these

Ans. C

Sol. $BA_2 = cCOSB = \dfrac{a^2 + c^2 - b^2}{2a}$

$A_1A_2 = \left|\dfrac{a}{2} - \dfrac{a^2 + c^2 - b^2}{2a}\right| = \left|\dfrac{b^2 - c^2}{2a}\right|$



4. If $x = \sin\left(\theta + \dfrac{7\pi}{12}\right) + \sin\left(\theta - \dfrac{\pi}{12}\right) + \sin\left(\theta + \dfrac{3\pi}{12}\right)$ and

$y = \cos\left(\theta + \dfrac{7\pi}{12}\right) + \cos\left(\theta - \dfrac{\pi}{12}\right) + \cos\left(\theta + \dfrac{3\pi}{12}\right)$ then value of $\dfrac{x}{y} - \dfrac{y}{x}$ is

(A) $2\tan 2\theta$ (B) $2\cot 2\theta$

(C) $\tan 2\theta$ (D) $\cot 2\theta$

Ans. A

Sol. $X = \sin\left(\theta + \dfrac{7\pi}{12}\right) + \sin\left(\theta - \dfrac{\pi}{12}\right) + \sin\left(\theta + \dfrac{\pi}{4}\right)$

$= 2\sin\left(\theta + \dfrac{\pi}{4}\right)\cos\left(\dfrac{\pi}{3}\right) + \sin\left(\theta + \dfrac{\pi}{4}\right)$

$= 2\sin\left(\theta + \dfrac{\pi}{4}\right)$

Similarly, $y = 2\cos\left(\theta + \dfrac{\pi}{4}\right)$

$\dfrac{x}{y} - \dfrac{y}{x} = \dfrac{x^2 - y^2}{xy}$

$= \dfrac{4\sin^2\left(\theta + \dfrac{\pi}{4}\right) - 4\cos^2\left(\theta + \dfrac{\pi}{4}\right)}{4\sin\left(\theta + \dfrac{\pi}{4}\right)\cos\left(\theta + \dfrac{\pi}{4}\right)}$

$= \dfrac{-2\cos 2\left(\theta + \dfrac{\pi}{4}\right)}{\sin 2\left(\theta + \dfrac{\pi}{4}\right)} = \dfrac{2\sin 2\theta}{\cos 2\theta}$

$= 2\tan 2\theta$

5. If $x = \sqrt[3]{7+5\sqrt{2}} - \dfrac{1}{\sqrt[3]{7+5\sqrt{2}}}$, then the value of $x^3 + 3x - 14$ is equal to

(A) 1 (B) 0
(C) 2 (D) 4

Ans. B

Sol. $x^3 = \left(7+5\sqrt{2}\right) - \dfrac{1}{\left(7+5\sqrt{2}\right)} - 3\left(\sqrt[3]{7+5\sqrt{2}} - \dfrac{1}{\sqrt[3]{7+5\sqrt{2}}}\right)$

$\Rightarrow x^3 = \left(7+5\sqrt{2}\right) - \dfrac{1}{\left(7+5\sqrt{2}\right)} - 3x$

$\Rightarrow x^2 + 3x = \left(7+5\sqrt{2}\right) - \left(5\sqrt{2}-7\right)$

$\Rightarrow x^3 + 3x = 14$

$\Rightarrow x^3 + 3x - 14 = 0$

6. If the roots of the equation $x^3 - 5x^2 + qx + 8 = 0$ are real and are in Geometric Progression, then q is equal to

(A) –9 (B) –10
(C) 9 (D) 10

Ans. B

Sol. Let roots be $\dfrac{a}{r}$, a, ar

Product of roots = –8

$\Rightarrow a^3 = -8 \Rightarrow a = -2$ (a is real)

Sum of roots = 5

Also, $q = \dfrac{a^2}{r} + a^2 r + a^2$

$= a\left(\dfrac{a}{r} + a + ar\right)$

$= a(5)$

= –10

7. The sequence $S_1, S_2, S_3, \ldots\ldots S_{10}$ has the property that every term beginning with the third is the sum of the previous two. That is $S_n = S_{n-2} + S_{n-1}$ for $n \geq 3$. Suppose that $S_9 = 110$ and $S_7 = 42$. What is S_4?

(A) 4 (B) 6
(C) 10 (D) 12

Ans. C

Sol. $S_9 = 110, S_7 = 42$

$S_8 = S_9 - S_7 = 110 - 42 = 68$

$S_6 = S_8 - S_7 = 68 - 42 = 26$

$S_5 = S_7 - S_6 = 42 - 26 = 16$

$S_4 = S_6 - S_5 = 26 - 16 = 10$

8. Total number of divisors of $n = 2^5 . 3^4 . 5^{10} . 7^6$ that are of the form $4\lambda + 2, \lambda \geq 1$ is equal to:

(A) 385 (B) 55

(C) 384 (D) 54

Ans. C

Sol. $4\lambda + 2 = 2(2\lambda + 1) =$ odd multiple of two.

$\therefore$ Total divisors = 1 . 5 .11 . 7 – 1 = 384

(One is subtracted because there will be case when selected powers of three, five and seven are zero each and this will make $\lambda = 0$)

9. Let P be a cubic polynomial with P (0) = k, P (1) = 2k, and P (–1) = 3k. What is P (2) + P (–2)?

(A) 0 (B) k

(C) 7k (D) 14k

Ans. D

Sol. Let $P(x) = Ax^3 + Bx^2 + Cx + D$. Plugging in 0 for x, we find $D = k,$ and plugging in 1 and –1 for x, we obtain the following equations: A + B + C + k = 2k – A + B – C + k = 3k Adding these two equations together, we get $2B = 3k$. If we plug in 2 and –2 in for x, we find the $P(2) + P(-2) = 8A + 4B + 2C + k + (-8A + 4B - 2C + k) = 8B + 2k$ multiplying the third equation by 4 and adding 2k gives us our desired result, so $P(2) + P(-2) = 12k + 2k = D \rightarrow \boxed{14k}$

10. If $|z| = 1,$ then $\left(\frac{1+z}{1+\bar{z}}\right)^n + \left(\frac{1+\bar{z}}{1+z}\right)^n$ is equal to

(A) $2\cos n(\arg(z))$ (B) $2\sin(\arg(z))$

(C) $2\cos 2\left(\arg\left(\frac{z}{2}\right)\right)$ (D) $2\sin n\left(\arg\left(\frac{z}{2}\right)\right)$

Ans. A

Sol. If $|z| = 1, \left(\frac{1+z}{1+\bar{z}}\right)^n + \left(\frac{1+\bar{z}}{1+z}\right)^n$

$$= \left(\frac{z(1+z)}{z+z\bar{z}} \right)^n + \left(\frac{z+z\bar{z}}{z(1-z)} \right)^n$$

$$= \left(\frac{z(1+z)}{z+|z|^2} \right)^n + \left(\frac{z+|z|^2}{z(1+z)} \right)^n$$

$$= \left(\frac{z(1+z)}{z+1} \right)^n + \left(\frac{(z+1)}{z(1+z)} \right)^n$$

$$= z^n + \frac{1}{z^n}$$

11. Let a, b, c be positive real numbers, such that
$bx^2 + \left(\sqrt{(a+c)^2 + 4b^2} \right) x + (a+c) \geq 0, \forall x \in R,$ then a, b, c then

(A) GP (B) AP
(C) HP (D) none of these

Ans. B

Sol. $bx^2 + \sqrt{(a+c)^2 + 4b^2}\, x + (a+c) \geq 0$

$\therefore \quad B^2 - 4AC \leq 0$

$\Rightarrow (a+c-2b)^2 \leq 0$

Its possible only when $a+c-2b=0$

$\therefore \quad b = \frac{a+c}{2}$

Hence a, b, c are in A.P.

12. The number of selections of four letters from the letters of the word ASSASSINATION is
(A) 72 (B) 71
(C) 66 (D) 52

Ans. A

Sol. There are 13 letters A, A, A; S, S, S, S; I, I, ; N, N, T; O

Coefficient of x^4 in $\left(1+x+x^2+x^3\right)\left(1+x+x^2+x^3+x^4\right) \times \left(1+x+x^2\right)^2 (1+x)^2$

(∵ 3A' s, 4S' s, 2I' s, 2N', s, 1, T and 1O)

$\Rightarrow$ Coefficient of x^4 in

$$\frac{\left(1-x^4\right)\left(1-x^5\right)\left(1-x^3\right)^2}{(1-x)(1-x)(1-x)^2}(1+x)^2$$

$\Rightarrow$ Coefficient of x^4 in

$\left(1+2x+x^2-2x^3-5x^4\right)(1-x)^{-4}$

$\therefore$ Coefficient of $x^4 = 35+40+10-8-5=72$

13. If $(1+x)^n = \sum_{r=0}^{n} a_r x^r$ and $b_r = 1 + \frac{a_r}{a_{r-1}}$ and $\prod_{r=1}^{n} b_r = \frac{(101)^{100}}{100!}$, then n is

(A) 99 (B) 100
(C) 101 (D) 102

Ans. B

Sol. $(1+x)^n = \sum_{r=0}^{n} {}^nC_r\, x^r = \sum_{r=0}^{n} a_r x^r$ (given)

$\therefore \quad a_r = {}^nC_r$

Also, $b_r = 1 + \frac{a_r}{a_{r-1}} = \frac{a_r}{a_{r-1}} = 1 + \frac{{}^nC_r}{{}^nC_{r-1}} = \frac{{}^{n+1}C_r}{{}^nC_{r-1}}$

$b_r = \left(\frac{n+1}{r}\right)$

$\because \quad \prod_{r=1}^{n} b_r = \prod_{r=2}^{n} \left(\frac{n+1}{r}\right) = \frac{(n+1)^n}{n!}$

$= \frac{(101)^{100}}{100!}$ (given)

$\therefore$ n = 100

14. The circle passing through the distinct points (1, t), (t, 1) and (t, t) for all values of t, passes through the point

(A) (1, 1) (B) (–1, –1)
(C) (1, –1) (D) (–1, 1)

Ans. A

Sol. Let circle $x^2 + y^2 + 2gx + 2fy + c = 0$

It passes through (1, t), (t, 1) and (t, 1) …(A)

then $1 + t^2 + 2g + 2ft + c = 0$

$t^2 + 1 + 2gt + 2f + c = 0$ ….(i)

$2t^2 + 2gt + 2ft + c = 0$ ….(ii)

Subtracting Equation (i) and (ii) and Equation (ii) from (iii)

then $2g(t-1) + 2f(1-t) = 0$

or $g - f = 0$

and $t^2 - 1 + 2f(t-1) = 0$

$\therefore \quad f = -\frac{(t+1)}{2} = g$

From equation (iii), $2t^2 - t(t+1) - t(t+1) + c = 0$

$\therefore \quad c = 2t$

From (A),

$x^2 + y^2 - (t+1)x - (t+1)y + 2t = 0$

$\Rightarrow (x^2 + y^2 - x - y) - t(x + y - 2) = 0$

$\Rightarrow \quad p + \lambda Q = 0$

$\therefore \quad P = 0$ and $Q = 0$,

then $x^2 + y^2 - x - y = 0$ and $x + y - 2 = 0$

after solving we get $x = 0$ and $y = 1$

15. If A and B are two fixed points and P is a variable point such that PA + PB = 4, the locus of P is given AB = 2 is

(A) a parabola (B) an ellipse

(C) a hyperbola (D) none of these

Ans. B

Sol. $\because PA + PB = 4$

$\Rightarrow \sqrt{(x+a)^2} + \sqrt{(x-a)^2 + y^2} = 4 \quad \ldots(i)$

Let $(x+a)^2 + y^2 = l$

and $(x-a)^2 + y^2 = m$

$\therefore \; l - m = 4ax$, from equation (i) $\quad \ldots(ii)$

$\sqrt{l} + \sqrt{m} = 4$

$\left(\sqrt{l} + \sqrt{m}\right)\left(\sqrt{l} - \sqrt{m}\right) = 4ax \quad \ldots(iii)$

$\sqrt{l} - \sqrt{m} = ax \quad \ldots(iv)$ [from equation (ii)]

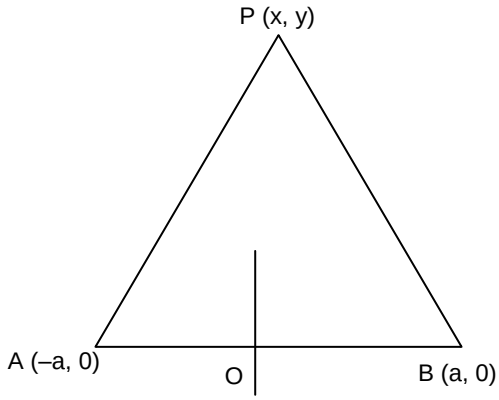
Adding equation (ii) and (iv)

$\therefore \quad 2\sqrt{l} = (4 + ax)$

$\Rightarrow \; 4l = 16 + a^2x^2 + 8ax$

$\Rightarrow \; 4\left[x^2 + y^2 + 2ax + a^2\right] = 16 + a^2x^2 + 8ax$

$\Rightarrow \; \left(4 - a^2\right)x^2 + 4y^2 = 16 - 4a^2$ (ellipse)



PHYSICS

16. The relation between time t and distance x moved by a particle is $t = \alpha x^2 + \beta x$ where α and β are constants. The retardation is (if v represents velocity)

(A) $2\alpha V^3$ (B) $2\beta V^3$

(C) $2\alpha\beta V^3$ (D) $2\beta^2 V^3$

Ans. A

Sol. $\alpha x^2 + \beta x - t = 0 \;\Rightarrow\; x = \dfrac{-\beta \pm \sqrt{\beta^2 + 4\alpha t}}{2\alpha}$

$V = \dfrac{dx}{dt} = \dfrac{4\alpha}{2 \times 2\alpha\sqrt{\beta^2 + 4\alpha t}} = \pm\dfrac{1}{\sqrt{\beta^2 + 4\alpha t}}$

$a = \dfrac{dv}{dt} = \pm\dfrac{}{(\beta^2 + 4\alpha t)^{3/2}}\left(\dfrac{-1}{2}\right) \times 4\alpha = (-2\alpha)V^3$

17. A source of sound is moving towards a stationary observer with a speed of 50 m/s. The observer measures the frequency of the source as 1000 Hz. The speed of sound is 350 m/s. The apparent frequency measured by the observer when the source is moving away after crossing the observer is

(A) 750 Hz (B) 850 Hz

(C) 1150 Hz (D) 1250 Hz

Ans. A

Sol. $1000 = \left(\frac{350}{350-50}\right) f$ …(i)

$f_1 = \left(\frac{350}{350+50}\right) f$ …(ii)

$f_1 = 750$ Hz

18. The surface charge density on a ring of radius 'R' and width 'd' is 'ρ'. If it rotates with frequency 'f' about its own axis; the magnetic induction at the centre is

(A) $\frac{1}{2}\pi\mu_0\rho fd$ (B) $\pi\mu_0\rho fd$

(C) $2\pi\mu_0\rho fd$ (D) $\mu_0\rho fd$

Ans. B

Sol. $T = \frac{2\pi m}{9B}$; $T \propto \frac{m}{q}$

$\frac{T_\alpha}{T_p} = \frac{4}{2} \times \frac{1}{1} = 2$

19. A spring of force constant k is cut into two pieces such that one piece is double the length of the other. Then the long piece will have a force constant of

(A) $\frac{2}{3}k$ (B) $\frac{3}{2}k$

(C) 3k (D) 6k

Ans. B

Sol. $k'2\ell = k3\ell$

$k = \frac{3}{2}k$

20. An object is cooled from 75^0C to 65^0C in 2 minutes in a room at 30^0C. The time taken to cool another identical object from 55^0C to 45^0C in the same room in minutes is

(A) 4 (B) 5

(C) 6 (D) 7

Ans. A

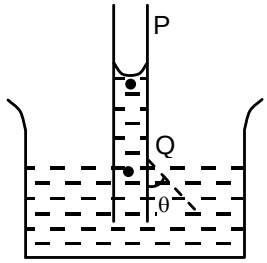
Sol. Neutron law for cooling
Rate of decrease of temperature $\propto$ temperature difference between object and surrounding.

21. The magnetic flux linked with a coil is ϕ and the emf induced in it is e
(A) If $\phi = 0$; e must be 0 (B) If $\phi \neq 0$; e can not be 0
(C) If e is not 0, ϕ may or may not be 0 (D) none of the above is correct

Ans. C

Sol. Lenz law:
$$e = \frac{-d\theta}{dt}$$
If ϕ = constant
e = 0

22. Liquid reaches an equilibrium as shown, in a capillary tube of internal radius r. If the surface tension of the liquid is T, the angle of contact θ and density of liquid ρ, then the pressure difference between P and Q is



(A) $\left(\frac{2T}{r}\right)\cos\theta$ (B) $\frac{T}{r\cos\theta}$
(C) $\frac{2T}{r\cos\theta}$ (D) $\left(\frac{4T}{r}\right)\cos\theta$

Ans. A

Sol. Radius of meniscus $R = \frac{r}{\cos\theta}$
$$\Delta P = \frac{2T}{R}$$
$$\Delta P = \frac{2T\cos\theta}{r}$$

23. The minimum force required to punch a hole of diameter 'd' in a plate of thickness 't' when the ultimate shear stress of steel = 's' is given by
(A) π d s t (B) $\pi\left(\frac{d}{2}\right)^2$ s t
(C) 2π d s t (D) $\pi \frac{d}{2}$ s t

Ans. A

Sol. Shear stress = $\frac{F_{tangential}}{A} = \frac{F}{2\pi rh}$ = s

24. A stone thrown into still water, creates a circular wave pattern moving radially outwards. If r is the distance measured from the centre of the pattern, the amplitude of the wave varies as

(A) $r^{-1/2}$ (B) r^{-1}

(C) r^{-2} (D) $r^{-3/2}$

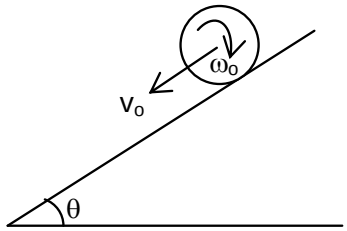
Ans. A

Sol. If energy associated with dropping of stone spreads symmetrically to all sides following a cylindrical pattern of depth 'h' on surface.

Intensity (I) = $\frac{E}{A(t)} = \frac{\text{Power}}{A} \Rightarrow I = \frac{P}{2\pi rh}$

$\Rightarrow I \propto \frac{1}{r} \quad \Rightarrow$ Amplitude $\propto \frac{1}{r^{1/2}}$

25. A hollow cylinder of mass M, length L and radius R spinned about its centre with angular velocity ω_o as shown and placed on a smooth inclined plane. Which of the following is correct?



(A) v_o and w_o both always increase

(B) v_o always decreases, ω_o keeps on changing

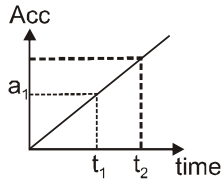
(C) v_o always increases and ω_o keeps on changing

(D) v_o always increases and ω_o is constant

Ans. D

Sol. Due to Mg sin θ, V_o will increase. Net torque about centre of mass is zero. So, ω_o remains constant.

26. Acceleration time graph of a particle is shown. Work done by all the forces acting on the particle on the particle of mass m in time interval from t_1 to t_2 while a_1 is the acceleration at time t_1, is given by :



(A) $\frac{ma_1^2}{4t_1}(t_2^3 - t_1^3)$ (B) $\frac{ma_1^2}{8t_1^2}(t_2^4 - t_1^4)$

(C) $\frac{ma_1^2}{4t_1^2}(t_2^4 - t_1^4)$ (D) $\frac{ma_1}{2t_1}(t_2^2 - t_1^2)$

Ans. B

Sol. $W = K_f - K_i = \frac{1}{2}m\left(v_f^2 - v_i^2\right)$

$= \frac{1}{2}m\left[\left(\frac{1}{2}a_2t_2\right)^2 - \left(\frac{1}{2}a_1t_1\right)^2\right]$

$= \frac{1}{8}m\left[\frac{t_2^4}{t_1^2}a_1^2 - a_1^2t_1^2\right]\left(\text{Since, } a_2 = \frac{t_2}{t_1}a_1\right) = \frac{ma_1^2}{8t_1^2}(t_2^4 - t_1^4)$

27. A point source is emitting sound in all directions. The ratio of distance of two points from the point source where the difference in loudness levels is 3 dB is: ($\log_e 2 = 0.3$)

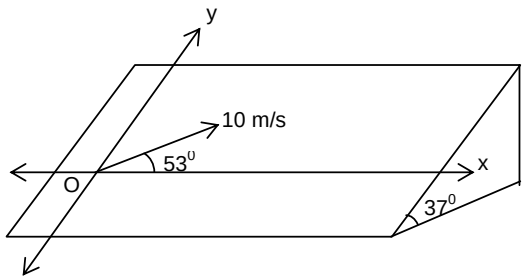
(A) $\frac{1}{2}$ (B) $\frac{1}{\sqrt{2}}$

(C) $\frac{1}{4}$ (D) $\frac{2}{3}$

Ans. B

Sol. $3 = 20 \log \left(\frac{r_2}{r_1} \right)^2$

28. Taking y – axis along line of greatest slope of the given inclined plane and x – axis perpendicular to it as shown in figure. A body is projected along the inclined plane with speed 10 m/s at an angle 53^0 with x – axis from origin O (g = 10 m/s^2). Time after which body is moving perpendicular to initial direction is (approx)



(A) 2.1 sec (B) 1.8 sec

(C) 3 sec (D) 3.6 sec

Ans. A

Sol. Question number 8, 9: Take components of $\vec{V}$ and $\vec{a}$ along X and Y axis. If at time 't', velocity is $\vec{V}_t$. Then, if $\vec{V}_t$ is $\perp$ to $\vec{V}_i$. We have $\vec{V}_t \cdot \vec{V}_i = 0$.

29. A body of mass m which is initially at rest at a height R above the surface of the earth of radius R, falls freely towards the earth, then its K.E. on reaching the surface of the earth is

(A) 2mgR (B) mgR/2

(C) 3mgR/2 (D) 4mgR

Ans. B

Sol. By COE

$$-\frac{GMm}{2R} = -\frac{GMm}{R} + kE, \qquad kE = \frac{GMm}{2R} = \frac{mgR}{2}$$

30. A cell of e.m.f. E volt, internal resistance r ohm is being charged with a current of I amp, then the terminal potential difference is:

(A) E (B) E – Ir

(C) E + Ir (D) E $\pm$ Ir

Ans. C

Sol. Use kirchhoff's voltage law.

CHEMISTRY

31. Which of the following gas contains the same member of molecules as 16 gm of oxygen?
(A) 16 g O_3 (B) 16 g SO_2
(C) 32 g SO_2 (D) all the above

Ans. C

Sol. 16 g $O_2 = \frac{16}{32}$ mole $O_2 = \frac{1}{2}$ mole $O_2 = \left(\frac{1}{2} \times N\right)$ molecules

32 g $SO_2 = \frac{32}{64}$ moles of $SO_2 = \frac{1}{2}$ mole $SO_2 = \frac{1}{2} \times$ N molecule

32. How many electrons are gained per nitrogen atom in the reaction $N_2 + 3H_2 \longrightarrow 2NH_3$?
(A) 2 (B) 3
(C) 4 (D) 6

Ans. B

Sol. $N + 3e \longrightarrow N^{3-}$

33. How many maximum number of unpaired electrons will have n = 4 and ℓ = 3?
(A) 5 (B) 10
(C) 7 (D) 14

Ans. C

Sol. n = 4 and l = 3 represent 4f sub-shell which contains 7 unpaired electrons and a total of 14 electrons.

34. Which of the following has the most covalent character?
(A) BaF (B) Ba_3N_2
(C) BaO (D) BaS

Ans. D

Sol. The polarisability order is $S^{2-} > N^{3-} > O^{2-} > F^-$

35. A sodium salt on treatment with $MgCl_2$ gives white precipitate only on heating. The anion of the sodium salt is
(A) HCO_3^- (B) CO_3^{2-}
(C) NO_3^- (D) SO_4^{2-}

Ans. A

Sol. $2NaHCO_3 + MgCl_2 \longrightarrow Mg(HCO_3)_2 + 2NaCl$

$Mg(HCO_3)_2 \xrightarrow{\Delta} MgCO_3 + CO_2 + H_2O$

36. How many different types of radiations are emitted if an electron is de–excited from fourth energy shell to ground state of hydrogen atom?
(A) 4 (B) 6
(C) 8 (D) 10

Ans. B

Sol. $n_2 = 4$, $n = 1$

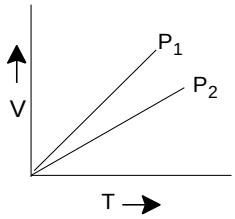
$\therefore$ Total no. of radiations = $\frac{(n_2 - n_1)(n_2 - n_1 + 1)}{2} = 6$

37. What is the hybridisation of boron in BO_3^{3-} ?
(A) sp (B) sp^2
(C) sp^3 (D) sp^3 d

Ans. B

Sol. Boron forms three sigma bonds in BO_3^{3-}, hence it undergoes sp^2 hybridization.

38. V versus T curves at constant pressure P_1 and P_2 for an ideal gas are shown below. Which of the given relation is correct?
(A) $P_1 > P_2$ (B) $P_1 < P_2$
(C) $P_1 = P_2$ (D) none of these



Ans. B

Sol. P α T at constant V

$P \alpha \frac{1}{V}$ at constant T

39. Molecular mass of FeC_2O_4 is M. The equivalent weight of FeC_2O_4 during its reaction with acidified $KMnO_4$ is
(A) $\frac{M}{3}$ (B) $\frac{M}{1}$
(C) $\frac{M}{2}$ (D) $\frac{M}{4}$

Ans. A

Sol. $MnO_4^- + FeC_2O_4 + H^+ \longrightarrow Mn^{2+} + Fe^{3+} + CO_2 + H_2O$

40. A cylinder was filled with gaseous mixture containing CO and N_2 (equal masses). The ratio of their partial pressure in cylinder is
(A) 1:1 (B) 1:2
(C) 2:1 (D) 1:3

Ans. A

Sol. $\frac{p_{CO_2}}{p_{N_2}} = \frac{X_{CO} \times P_T}{X_{N_2} \times P_T} = \frac{W/28}{W/28} = 1:1$

41. For A + B + C $\rightarrow$ Product, the rate expression is given by
Rate = k[A] [B]
What is the rate of initial reaction if the reaction is started with 1 mole/litre each of A, B and C. K = 1×10^{-6} $mole^{-1}$ lit sec^{-1}.
(A) 10^{-6} mole lit^{-1} sec^{-1} (B) 10^{-3} mole lit^{-1} sec^{-1}
(C) 10^{-2} mole lit^{-1} sec^{-1} (D) 10^{-4} mole lit^{-1} sec^{-1}

Ans. A

Sol. Rate = k[A][B] = $1 \times 10^{-6} \times 1 \times 1 = 10^{-6}$ mol $L^{-1}s^{-1}$

42. Which of the following gaseous reaction will be favored by low pressure?
(A) $H_2 + I_2 \rightleftharpoons 2HI$ (B) $PCl_5 \rightleftharpoons PCl_3 + Cl_2$
(C) $N_2 + 3H_2 \rightleftharpoons 2NH_3$ (D) $N_2 + O_2 \rightleftharpoons 2NO$

Ans. B

Sol. Low pressure makes the reaction proceed towards more no. moles.

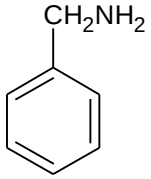
43. Which of the following will not resist the change in pH
(A) CH_3COOH & CH_3COONa mixture (B) CH_3COONH_4
(C) NH_4CN (D) NH_4Cl

Ans. D

Sol. NH_4Cl is not a buffer.

44. Amongst the following the most basic compound is
(A) Benzyl amine (B) Aniline
(C) Acetanilide (D) p-nitro aniline

Ans. A

Sol. Benzyl amine, 

45. In the hydrolytic equilibrium

$A^- + H_2O \rightleftharpoons HA + OH^-$

$K_a = 1.0 \times 10^{-5}$, the degree of hydrolysis of 0.001M solution of the salt is

(A) 10^{-3} (B) 10^{-4}

(C) 10^{-5} (D) 10^{-6}

Ans. A

Sol. $K_a = 1 \times 10^{-5}$, $C = 10^{-3}$ M

$$h = \sqrt{\frac{K_h}{C}} = \sqrt{\frac{K_w / K_a}{C}} = \sqrt{\frac{10^{-14} / 10^{-5}}{10^{-3}}} = 10^{-3}$$

BIOLOGY

46. Many of the people suffer from the problem of acnes and feel annoyed of the ugly skin texture caused due to the acne spots. Can you guess the microorganism causing these acne?

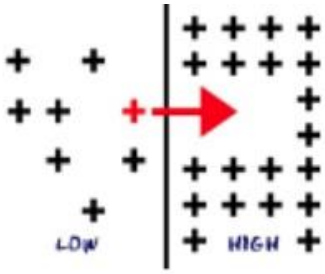
(A) H1N1 virus (B) Trypanosoma

(C) Leishmania (D) Staphylococcus

Ans. D

Sol. Staphylococcus causes acne.

47. The picture is an example of _____.



(A) active transport (B) passive transport

(C) diffusion (D) osmosis

Ans. A

Sol. The picture is an example of **active transport.**

48. Plants with vascular tissue are differentiated into two groups based on _____.

(A) whether flowers are present (B) whether they show true roots

(C) their ability to bear seeds (D) their life span

Ans. C

Sol. Plants with vascular tissue are differentiated into two groups based on **their ability to bear seeds**.

49. What is the Function of Hydrochloric Acid?
(i) It makes pepsin enzyme effective.
(ii) It kills bacteria which may enter in stomach with food.
Which of the following statements is/are correct?
(A) Only (i) (B) Only (ii)
(C) Both (i) and (ii) (D) Neither (i) nor (ii)

Ans. C

Sol. The Function of Hydrochloric acid is to make pepsin enzyme effective and kills bacteria which may enter in stomach with food.

50. The exchange of gases in the alveoli of the lungs takes place by
(A) Osmosis (B) Simple diffusion
(C) Passive transport (D) Active transport

Ans. B

Sol. The exchange of gases in the alveoli of the lungs takes place by **Simple diffusion**.

51. High milk yielding cross breed Frieswal cow is produced from
(A) Friesian and Sahiwal (B) Holstein and Tharparkar
(C) Brown Swiss and Sahiwal (D) Brown Swiss and Red Sindhi

Ans. A

Sol. High milk yielding cross breed Frieswal cow is produced from **Friesian** and **Sahiwal**.

52. Corn and beans are often cited as representative examples of _____, respectively.
(A) Ferns and mosses (B) Cycads and conifers
(C) Monocots and dicots (D) Whisk ferns and horsetails

Ans. C

Sol. Corn and beans are often cited as representative examples of **Monocots and dicots**, respectively.

53. The food stored in the liver in the form of carbohydrate is called:
(A) pulp (B) glucose
(C) glycogen (D) carbohydrate

Ans. C

Sol. The food stored in the liver in the form of carbohydrate is called **glycogen**.

54. If a man takes large amount of protein, he is likely to excrete more amount of
(A) glucose (B) urea and uric acid
(C) water (D) salts

Ans. B

Sol. If a man takes large amount of protein, he is likely to excrete more amounts of **urea and uric acid**.

55. Which of the following statement is not true for Homologous chromosome pairs?
(A) They come from only one of the individual's parents
(B) They usually contain slightly different versions of the same genetic information
(C) They segregate from each other during meiosis I
(D) They synapse during meiosis

Ans. A

Sol. They come from only one of the individual's parents.

56. A Planaria worm is cut horizontally in the middle into two halves P and Q such that the part P contains the whole head of the worm. Another Planaria worm is cut vertically into two halves R and S in such a way that both the cut pieces R and S contain half head each. Which of the cut pieces of the two Planaria worms could regenerate to form the complete respective worms?
(A) Only P (B) Only R and S
(C) P, Rand S (D) P, Q, R and S

Ans. D

Sol. **P**, **Q**, **R** and **S** could regenerate to form the complete respective worms.

57. A growing seedling is kept in a dark room. A burning lamp is placed near to it for a few days. The top part of seedling bends towards the burning candle. This is an example of:
(A) Chemotropism (B) Hydrotropism
(C) Phototropism (D) Geotropism

Ans. C

Sol. The top part of seedling bends towards the burning candle is an example of **Phototropism**.

58. Which of the following statements is not true about blood plasma?
(A) It is a faint yellow in color (B) It contains corpuscles
(C) It contains proteins (D) It is the fluid part of blood

Ans. B

Sol. It contains corpuscles is not true about blood plasma.

59. Due to which reaction PGA is changed into phosphoglyceraldehyde in photosynthesis process?
(A) Oxidation (B) Reduction
(C) Electrolysis (D) Hydrolysis

Ans. B

Sol. Due to reduction reaction PGA is changed into phosphoglyceraldehyde in photosynthesis process.

60. Central dogma of protein synthesis is

(A) DNA $\rightarrow$ RNA $\rightarrow$ Protein (B) DNA $\rightarrow$ DNA $\rightarrow$ Protein

(C) RNA $\rightarrow$ DNA $\rightarrow$ Protein (D) DNA $\rightarrow$ protein $\rightarrow$ RNA

Ans. B

Sol. Central dogma of protein synthesis is DNA $\rightarrow$ DNA $\rightarrow$ Protein.

PART – II

MATHEMATICS

61. The product of two of the four roots of $x^4 - 20x^3 + kx^2 + 590x - 1992 = 0$ is 24. The value of k is

(A) 41 (B) 40

(C) 42 (D) 43

Ans. A

Sol. Let the given equation be written as $f(x) = 0$, and let the roots of the equation be r_1, r_2, r_3, r_4 with $r_1 r_2 = 24$. Now $r_1 r_2 r_3 r_4 = -1992$, so $r_3 r_4 = \frac{-1992}{24} = -83$. Also,

$f(x) = (x - r_1)(x - r_2)(x - r_3)(x - r_4)$

$= (x^2 - cx + r_1 r_2)(x^2 - dx + r_3 r_4)$

$= (x^2 - cx + 24)(x^2 - dx - 83)$,

with $c = r_1 + r_2$, $d = r_3 + r_4$. Comparing coefficients of x^3 and x we get $c + d = 20$ and $83c - 24d = 590$. This gives $c = 10, d = 10$. Comparing coefficients of

$x^2, k = cd - 83 + 24 = 100 - 83 + 24 = 41$.

62. The first four terms in an arithmetic sequence are $x + y, x - y, xy$ and $\frac{x}{y}$, in that order. What is the fifth term?

(A) $-\frac{6}{5}$ (B) 0

(C) $\frac{27}{20}$ (D) $\frac{123}{40}$

Ans. D

Sol. The difference between consecutive terms is $(x - y) - (x + y) = -2y$. Therefore we can also express the third and fourth terms as $x - 3y$ and $x - 5y$. Then we can set them equal to xy and $\frac{d}{y}$ because they are the same thing $xy = x - 3y$

$xy - x = -3y$

$x(y - 1) = -3y$

$x = \frac{-3y}{y - 1}$

Substitute into our other equation.

$\frac{x}{y} = x - 5y \frac{-3}{y - 1} = \frac{-3y}{y - 1} 5y - 3$

$= -3y - 5y(y-1)0 = 5y^2 - 2y - 30 = (5y+3)(y-1)\, y = -\frac{3}{5}, 1$

But y cannot be 1 because then every term would be equal to x. Therefore $y = -\frac{3}{5}$.

Substituting the value for y into any of the equations, we get $x = -\frac{9}{8}$ Finally.

$\frac{x}{y} - 2y = \frac{9.5}{8.3} + \frac{6}{5} = \frac{123}{40}$

63. If ${}^nC_{r-1} = 36$, ${}^nC_r = 84$ and ${}^nC_{r+1} = 126$, then r =

(A) 1 (B) 2

(C) 3 (D) 4

Ans. C

Sol. Given $\frac{{}^nC_r}{{}^nC_{r-1}} = \frac{84}{36}$

$\Rightarrow \frac{n!}{r!(n-1)!}\frac{(r-1)!n-r+1}{n!} = \frac{7}{3}$

$\Rightarrow \frac{n-r+1}{r} = \frac{7}{3} \Rightarrow 3n - 10r = 3$ …(i)

Again $\frac{{}^nC_{r+1}}{{}^nC_r} = \frac{126}{84} \Rightarrow \frac{n-r}{r+1} = \frac{3}{2}$

$\therefore \quad 2n - 5r = 3$ …(ii)

From equation (i) and (ii), r = 3

64. The solution of the equation $\log_{\cos x} \sin x + \log_{\sin x} \cos x = 2$ is given by

(A) $x = 2n\pi + \frac{\pi}{4}, n \in I$ (B) $x = n\pi + \frac{\pi}{2}, n \in I$

(C) $x = n\pi + \frac{\pi}{8}, n \in I$ (D) none of these

Ans. A

Sol. $\log_{\cos x} \sin x + \log_{\sin x} \cos x = 2$

$\Rightarrow \quad \log_{\cos x} \sin x + \frac{1}{\log_{\cos x} \sin x} = 2$

$\Rightarrow \quad (\log_{\cos x} \sin x - 1)^2 = 0$

$\Rightarrow \quad \log_{\cos x} \sin x = 1 \qquad \because \sin > 0, \cos x > 0, \sin x \neq 1, \cos x \neq 1)$

$\Rightarrow \quad \sin x = \cos x$

$\tan x = 1$

$x = 2n\pi + \frac{\pi}{4}, n \in I$

65. The number of six digit numbers that can be formed from the digits 1, 2, 3, 4, 5, 6 and 7, so that digits do not repeat and the terminal digits are even is

(A) 144 (B) 72

(C) 288 (D) 720

Ans. D

Sol. Terminal digits are the first and last digits.

$\because$ Terminal digits are even

$\therefore$ 1st place can be filled in 3 ways and last place can be filled in 2nd ways and remaining places can be filled in ${}^5P_4 = 120$ ways

Hence, the number of six digit numbers, the terminal digits are even, is

$= 3 \times 120 \times 2 = 720$

PHYSICS

66. The critical angle for a prism and its surrounding interface is 36°. The minimum angle of prism for which no emergent ray is possible is

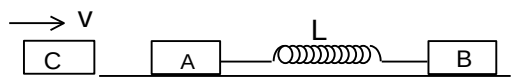
(A) 18° (B) 36°

(C) 72° (D) 144°

Ans. C

Sol. $A > 2\theta_C$

67. Two blocks A and B each of mass m are connected by a massless spring of natural length L and spring constant k. the blocks are initially resting on a smooth horizontal floor with the spring at its natural length as shown in figure.



A third identical block C, also of mass m moves on the floor with a speed v along the line joining A and B and collides with A elastically, then

(A) the kinetic energy of AB system at maximum compression of the spring is zero.

(B) The kinetic energy of the AB system at maximum compression of the spring is $\frac{mv^2}{8}$.

(C) The maximum compression of the spring is $v\sqrt{m/k}$.

(D) The maximum compression of the spring is $v\sqrt{m/2k}$.

Ans. D

Sol. Conservation linear momentum for collision between blocks C and A, the velocities get intercharged, hence at maximum compression, the blocks A and B will move at same velocity

$\therefore mv = 2mv'$

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

conservation of total mechanical energy.

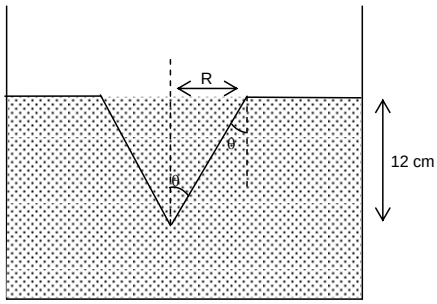
$$\frac{1}{2}mv^2 + 0 = \frac{1}{2}2m\left(\frac{v}{2}\right)^2 + \frac{1}{2}kx^2$$

$$\Rightarrow \frac{1}{4}mv^2 = \frac{1}{2}kx^2$$

$$\Rightarrow x = v\sqrt{\frac{m}{2k}}$$

$$KE = \frac{1}{2}2m\left(\frac{v}{2}\right)^2 = \frac{mv^2}{4}$$

68. A fish looking up through the water sees the outside world contained in a circular horizon. If the refractive index of water is 4/3 and the fish is 12 cm below the surface, the radius of this circle in cm is



(A) $36\sqrt{5}$

(B) $4\sqrt{5}$

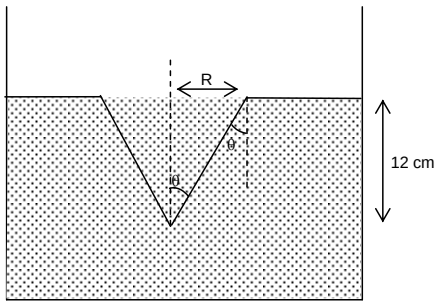
(C) $36\sqrt{7}$

(D) $36 / \sqrt{7}$

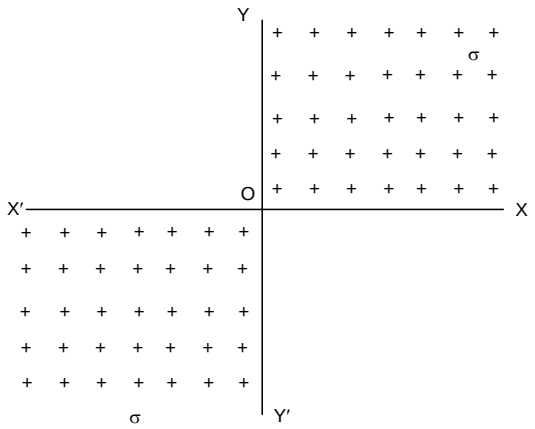
Ans. D

Sol. $\theta = \theta_C$ (critical angle)

$$\frac{R}{12} = \tan\theta_C$$



69. Two rectangular infinite charged sheet each has surface charge density σ are placed as shown in figure, then magnitude of electric field at point (0, 0, d) d is small, be



(A) $\frac{\sigma}{\epsilon_0}$

(B) $\frac{\sigma}{2\epsilon_0}$

(C) $\frac{\sigma}{4\epsilon_0}$

(D) none of these

Ans. C

Sol. If all quadrant have same surface charged density σ then electric field be $\frac{\sigma}{2\epsilon_o}$. Hence, the required electric field be $\frac{1}{2}\times\frac{\sigma}{2\epsilon_o}$.

70. Find the torque of a force $\vec{F}=-3\ \hat{i}+\hat{j}+5\ \hat{k}$ acting at the point $\vec{r}=7\ \hat{i}+3\ \hat{j}+\hat{k}$ about origin:

(A) $14\ \hat{i}-38\ \hat{j}+16\ \hat{k}$ (B) $4\ \hat{i}+4\ \hat{j}+6\ \hat{k}$

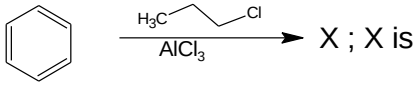
(C) $-21\ \hat{i}+4\ \hat{j}+4\ \hat{k}$ (D) $-14\ \hat{i}+38\ \hat{j}-16\ \hat{k}$

Ans. A

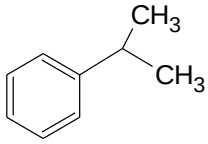
Sol. $\vec{\tau}=\vec{r}\times\vec{F}=\left(7\hat{i}+3\hat{j}+\hat{k}\right)\times\left(-3\hat{j}+\hat{j}+5\hat{k}\right)$

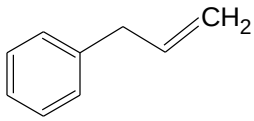
$= 14\hat{i}-38\hat{j}+16\hat{k}$

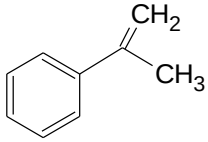
CHEMISTRY

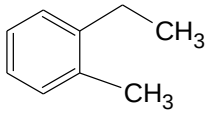
71. 

X ; X is

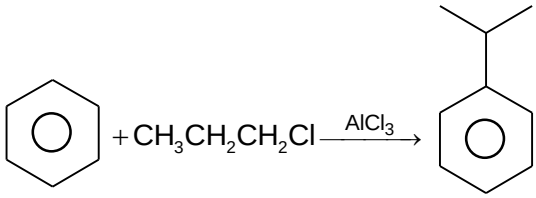
(A) 

(B) 

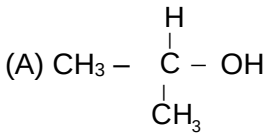
(C) 

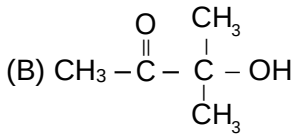
(D) 

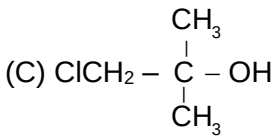
Ans. A

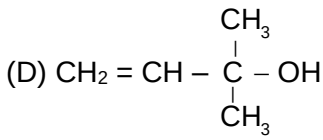
Sol. 

72. Which one of the following will most readily be dehydrated in acidic condition?

(A) 

(B) 

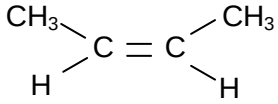
(C) 

(D) 

Ans. D

Sol. The carbocation is stabilized by resonance.

73. Which of the following Hydrocarbon has the lowest dipole moment?

(A) 

(B) $CH_3-C\equiv C-CH_3$

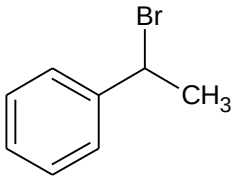
(C) $CH_3CH_2CH=CH_2$

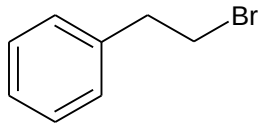
(D) $CH_2=CH-C\equiv CH$.

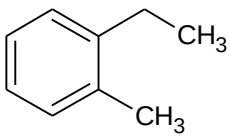
Ans. B

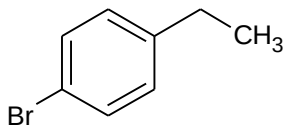
Sol. Both the vectors cancel with each other.

74. The major product in the monobromination of ethyl benzene with Br_2 in presence light

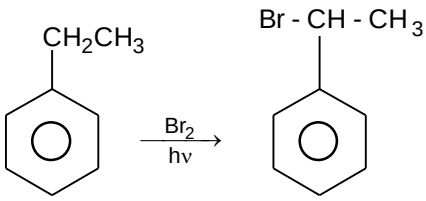
(A) 

(B) 

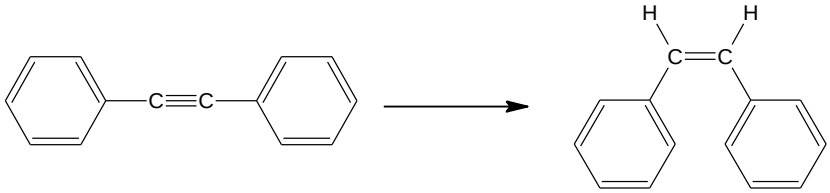
(C) 

(D) 

Ans. A

Sol. 

75. Choose the reagent for the following process



(A) sodamide
(B) liquid ammonia
(C) $LiAlH_4$
(D) Lindlars catalyst

Ans. D

Sol. Lindlar's catalyst forms cis-alkene.

BIOLOGY

76. The amount of energy given by one mole of ATP is:
(A) 721 kcal
(B) 7600 kcal
(C) 7.3 kcal
(D) 1000 kcal

Ans. C

Sol. The amount of energy given by one mole of ATP is **7.3 kcal**.

77. Homologous organs indicate the
(A) Convergent evolution
(B) Parallel evolution
(C) Common descendent
(D) Natural selection

Ans. C

Sol. Homologous organs indicate the **common descendent**.

78. The most abundant prokaryotes helpful to humans in making curd from milk and in production of antibiotics are the ones categorized as
(A) Chemosynthetic autotrophs
(B) Heterotrophic bacteria
(C) Cyanobacteria
(D) Archaebacteria

Ans. A

Sol. The most abundant prokaryotes helpful to humans in making curd from milk and in production of antibiotics are the ones categorized as Chemosynthetic autotrophs.

79. DNA has equal number of adenine and thymine residues (A = T) and equal number of guanine and cytosine (G = C). These relationships are known as
(A) Chargaff's rule
(B) Coulomb's law
(C) Le-Chatelier's principle
(D) Van't Hoff plot

Ans. A

Sol. These relationships are known as **Chargaff's rule**.

80. I. In this reaction light energy is absorbed by chlorophyll pigments and converted into chemical energy.
II. Energy is stored in the form of ATP
III. $NADPH_2$ is generated

Options are:

(A) Both I and II are correct
(B) Both I and III are correct'
(C) Only II is correct
(D) All I, II and III are correct

Ans. D

Sol. All I, II and III are correct.