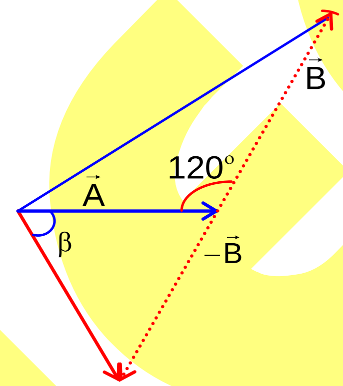
JEE Main- 26-08-2021-Evening
PHYSICS
Section-A

Q1. A refrigerator consumes an average 35 W power to operate between temperature –10°C to 25°C. If there is no loss of energy then how much average heat per second does it transfer?

(A) 350 J/s (B) 298 J/s
(C) 35 J/s (D) 263 J/s

Q2. The angle between vector $(\vec{A})$ and $(\vec{A}-\vec{B})$ is:



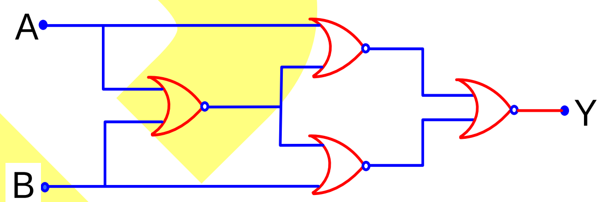
(A) $\tan^{-1}\left(\frac{\sqrt{3}\,B}{2A-B}\right)$

(B) $\tan^{-1}\left(\frac{B\cos\theta}{A-B\sin\theta}\right)$

(C) $\tan^{-1}\left(\frac{A}{0.7\,B}\right)$

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

Q3. Four NOR gates are connected as shown in figure. The truth table for the given figure is:



(A)

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

(B)

A	B	Y
0	0	1
0	1	0
1	0	1
1	1	0

(C)

A	B	Y
0	0	0
0	1	1
1	0	0
1	1	1

(D)

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

Q4. An electric bulb of 500 watt at 100 volt is used in a circuit having a 200 V supply. Calculate the resistance R to be connected in series with the bulb so that the power delivered by the bulb is 500 W.

(A) 20 Ω (B) 5 Ω
(C) 10 Ω (D) 30 Ω

Q5. If you are provided a set of resistances 2Ω, 4Ω, 6Ω and 8Ω.Connect these resistances so as to obtain an equivalent resistance of $\frac{46}{3}\Omega$.

(A) 4 Ω and 6 Ω are in parallel with 2 Ω and 8 Ω in series.
(B) 6 Ω and 8 Ω are in parallel with 2 Ω and 4 Ω in series.
(C) 2 Ω and 4 Ω are in parallel with 6 Ω and 8 Ω in series.
(D) 2 Ω and 6 Ω are in parallel with 4 Ω and 8 Ω in series.

Q6. The de-Broglie wavelength of a particle having kinetic energy E is λ. How much extra energy must be given to this particle so that the de-Broglie wavelength reduces to 75% of the initial value?

(A) $\frac{1}{9}E$ (B) E
(C) $\frac{16}{9}E$ (D) $\frac{7}{9}E$

Q7. Match List-I with List-II:

List – I	List – II	
(a)	Magnetic Induction	(i) $ML^2T^{-2}A^{-1}$
(b)	Magnetic Flux	(ii) $M^0L^{-1}A$
(c)	Magnetic Permeability	(iii) $MT^{-2}A^{-1}$
(d)	Magnetization	(iv) $MLT^{-2}A^{-2}$

Choose the most appropriate answer from the options given below:

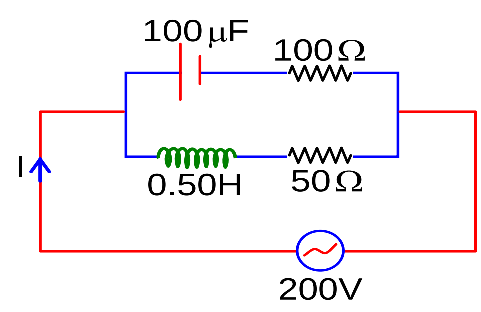
(A) (a) – (ii), (b) – (iv), (c) – (i), (d) – (iii) (B) (a) – (iii), (b) – (ii), (c) – (iv), (d) – (i)
(C) (a) – (ii), (b) – (i), (c) – (iv), (d) – (iii) (D) (a) – (iii), (b) – (i), (c) – (iv), (d) – (ii)

Q8. A cylindrical container of volume 4.0×10^{-3} m^3 contains one mole of hydrogen and two moles of carbon dioxide. Assume the temperature of the mixture is 400 K. The pressure of the mixture of gases is: [Take gas constant as 8.3 J mol^{-1} K^{-1}]

(A) 24.9 Pa (B) 24.9×10^3 Pa
(C) 24.9×10^5 Pa (D) 249×10^1 Pa

Q9. In the given circuit the AC source has ω = 100 rad s^{-1}. Considering the inductor and capacitor to be ideal, what will be the current I flowing through the circuit?

(A) 5.9 A
(B) 4.24 A
(C) 6 A
(D) 0.94 A



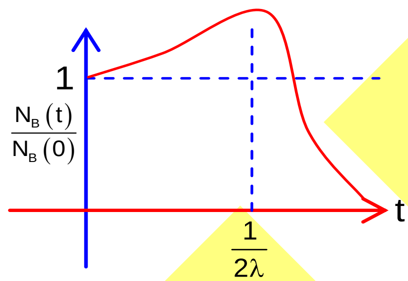
Q10. A particle of mass m is suspended form a ceiling through a string of length L. The particle moves in a horizontal circle of radius r such that $r = \frac{L}{\sqrt{2}}$. The speed of particle will be:

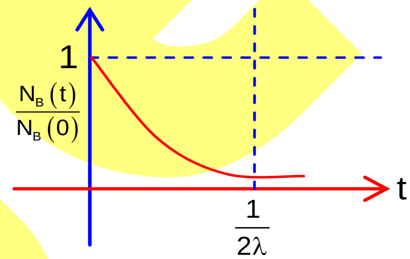
(A) $\sqrt{rg}$ (B) $\sqrt{\frac{rg}{2}}$

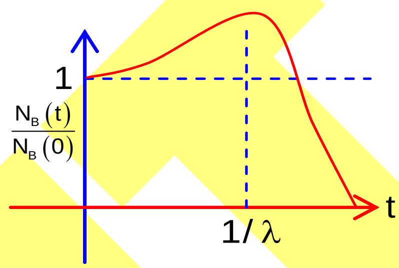
(C) $2\sqrt{rg}$ (D) $\sqrt{2rg}$

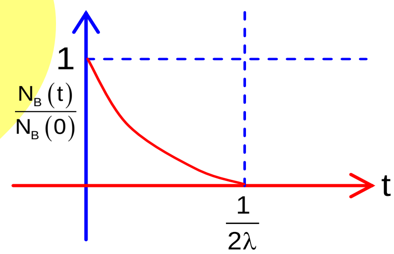
Q11. At time t = 0, a material is composed of two radioactive atoms A and B, where $N_A(0) = 2N_B(0)$. The decay constant of both kind of radioactive atoms is λ. However, A disintegrates to B and B disintegrates to C. Which of the following figures represents the evolution of $N_B(t)/N_B(0)$ with respect to time t ?

$$\begin{bmatrix} N_A(0) = \text{No. of A atoms at } t = 0 \\ N_B(0) = \text{No. of B atoms at } t = 0 \end{bmatrix}$$

(A)


(B)


(C)


(D)


Q12. The two thin coaxial rings, each of radius 'a' and having charges +Q and –Q respectively are separated by a distance of 's'. The potential difference between the centres of the two rings is:

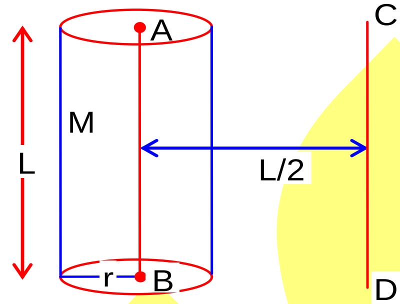
(A) $\frac{Q}{2\pi\varepsilon_0}\left[\frac{1}{a} - \frac{1}{\sqrt{s^2 + a^2}}\right]$ (B) $\frac{Q}{4\pi\varepsilon_0}\left[\frac{1}{a} - \frac{1}{\sqrt{s^2 + a^2}}\right]$

(C) $\frac{Q}{2\pi\varepsilon_0}\left[\frac{1}{a} + \frac{1}{\sqrt{s^2 + a^2}}\right]$ (D) $\frac{Q}{4\pi\varepsilon_0}\left[\frac{1}{a} + \frac{1}{\sqrt{s^2 + a^2}}\right]$

Q13. A bomb is dropped by a fighter plane flying horizontally. To an observer sitting in the plane, the trajectory of the bomb is a:

(A) hyperbola
(B) parabola in the direction of motion of plane
(C) straight line vertically down the plane
(D) parabola in a direction opposite of the motion of plane

Q14. The solid cylinder of length 80 cm and mass M has a radius of 20 cm. Calculate the density of the material used if the moment of inertia of the cylinder about an axis CD parallel to AB as shown in figure is 2.7 kg m^2.

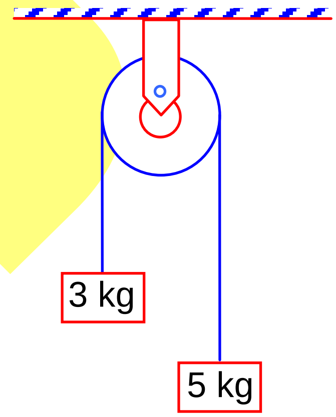


(A) 7.5×10^1 kg/m^3
(B) 1.49×10^2 kg/m^3
(C) 14.9 kg/m^3
(D) 7.5×10^2 kg/m^3

Q15. A light beam is described by $E = 800 \sin \omega \left(t - \frac{x}{c}\right)$. An electron is allowed to move normal to the propagation of light beam with a speed of 3×10^7 ms^{-1}. What is the maximum magnetic force exerted on the electron?
(A) 1.28×10^{-21} N (B) 1.28×10^{-18} N
(C) 12.8×10^{-17} N (D) 12.8×10^{-18} N

Q16. If the length of the pendulum in pendulum clock increases by 0.1%, then the error in time per day is
(A) 8.64 s (B) 43.2 s
(C) 86.4 s (D) 4.32 s

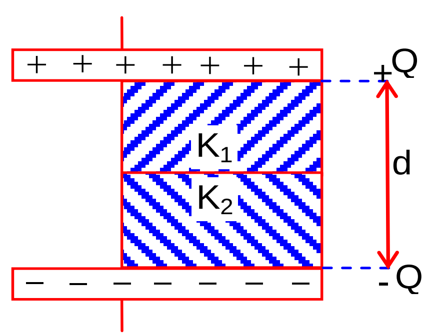
Q17. Two blocks of masses 3 kg and 5 kg are connected by a metal wire going over a smooth pulley. The breaking stress of the metal is $\frac{24}{\pi} \times 10^2\ Nm^{-2}$. What is the minimum radius of the wire? (take g = 10 ms^{-2})



(A) 1250 cm
(B) 125 cm
(C) 12.5 cm
(D) 1.25 cm

Q18. A transmitting antenna at top of a tower has a height of 50 m and the height of receiving antenna is 80 m. What is the range of communication for Line of Sight (LoS) mode? [use radius of earth = 6400 km]
(A) 144.1 km (B) 57.28 km
(C) 45.5 km (D) 80.2 km

Q19. A parallel-plate capacitor with plate area A has separation d between the plates. Two dielectric slabs of dielectric constant K_1 and K_2 of same area A/2 and thickness d/2 are inserted in the space between the plates. The capacitance of the capacitor will be given by:



(A) $\frac{\varepsilon_0 A}{d}\left(\frac{1}{2}+\frac{K_1+K_2}{K_1K_2}\right)$ (B) $\frac{\varepsilon_0 A}{d}\left(\frac{1}{2}+\frac{2(K_1+K_2)}{K_1K_2}\right)$

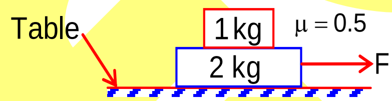
(C) $\frac{\varepsilon_0 A}{d}\left(\frac{1}{2}+\frac{K_1K_2}{K_1+K_2}\right)$ (D) $\frac{\varepsilon_0 A}{d}\left(\frac{1}{2}+\frac{K_1K_2}{2(K_1+K_2)}\right)$

Q20. The temperature of equal masses of three different liquids x, y and z are 10°C, 20°C and 30°C respectively. The temperature of mixture when x is mixed with y is 16°C and that when y is mixed with z is 26°C. The temperature of mixture when x and z are mixed will be:

(A) 28.32°C (B) 23.84°C
(C) 25.62°C (D) 20.28°C

Section-B

Q1. The coefficient of static friction between two blocks is 0.5 and the table is smooth. The maximum horizontal force that can be applied to move the blocks together is __________ N.(take $g = 10\,ms^{-2}$)

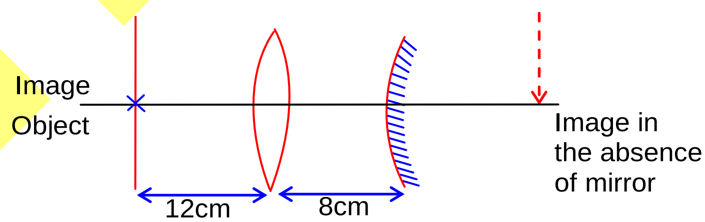


Q2. A source of light is placed in front of a screen. Intensity of light on the screen is I. Two Polaroids P_1 and P_2 are so placed in between the source of light and screen that the intensity of light on screen is $I/2$. P_2 should be rotated by an angle of __________ (degrees) so that the intensity of light on the screen becomes $\frac{3I}{8}$.

Q3. If the maximum value of accelerating potential provided by a radio frequency oscillator is 12 kV. The number of revolution made by proton in a cyclotron to achieve one sixth of the speed of light is __________.
[$m_p = 1.67 \times 10^{-27}$ kg, $e = 1.6 \times 10^{-19}$ C, Speed of light = 3×10^8 m/s]

Q4. The acceleration due to gravity is found upto an accuracy of 4% on a planet. The energy supplied to a simple pendulum of known mass 'm' to undertake oscillations of time period T is being estimated. If time period is measured to an accuracy of 3%, the accuracy to which E is known as ________%.

Q5. An object is placed at a distance of 12 cm from a convex lens. A convex mirror of focal length 15 cm is placed on other side of lens at 8 cm as shown in the figure. Image of object coincides with the object. When the convex mirror is removed, a real and inverted image is formed at a position. The distance of the image from the object will be ______ (cm).



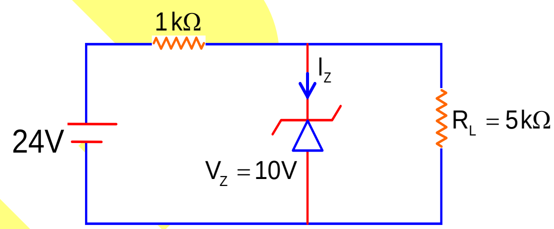
Q6. Two simple harmonic motions are represented by the equations $x_1 = 5\sin\left(2\pi t + \frac{\pi}{4}\right)$ and $x_2 = 5\sqrt{2}(\sin 2\pi t + \cos 2\pi t)$. The amplitude of second motion is ________ times the amplitude in first motion.

Q7. A circular coil of radius 8.0 cm and 20 turns is rotated about its vertical diameter with an angular speed of 50 rad s^{-1} in a uniform horizontal magnetic field of 3.0×10^{-2} T. The maximum emf induced in the coil will be ________ $\times 10^{-2}$ volt (rounded off to the nearest integer).

Q8. A coil in the shape of an equilateral triangle of side 10 cm lies in a vertical plane between the pole pieces of permanent magnet producing a horizontal magnetic field 20 mT. The torque acting on the coil when a current of 0.2 A is passed through it and its plane becomes parallel to the magnetic field will be $\sqrt{x} \times 10^{-5}$ Nm. The value of x is ________.

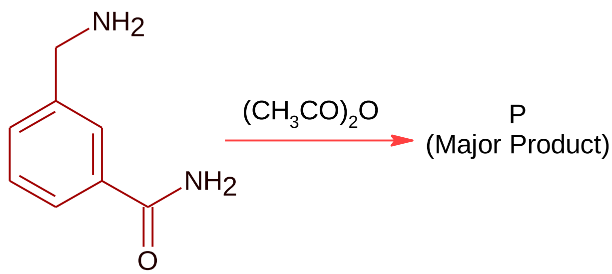
Q9. Two waves are simultaneously passing through a string and their equations are:
$y_1 = A_1 \sin k(x - vt)$, $y_2 = A_2 \sin k(x - vt + x_0)$. Given amplitudes A_1 = 12 mm and A_2 = 5 mm, x_0 = 3.5 cm and wave number k = 6.28 cm^{-1}. The amplitude of resulting wave will be ________ mm.

Q10. For the given circuit, the power across zener diode is ________ mW.



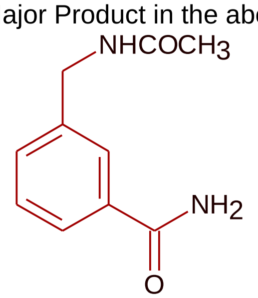
CHEMISTRY
Section-A

Q1.

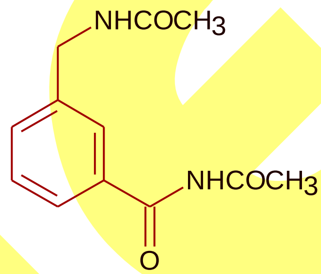


The Major Product in the above reaction is:

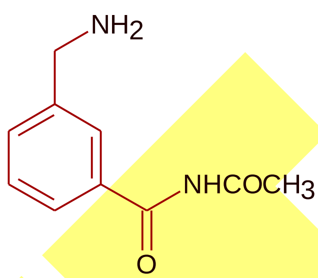
(A)



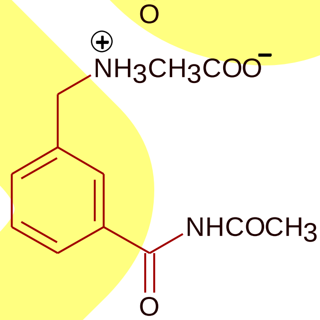
(B)



(C)



(D)



Q2. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).

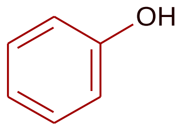
Assertion (A): Barium carbonate is insoluble in water and is highly stable.

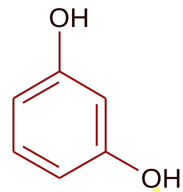
Reason (R): The thermal stability of the carbonates increases with increasing cationic size.

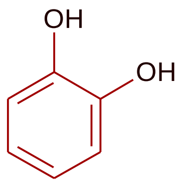
Choose the most appropriate answer from the options given below:
(A) (A) is false but (R) is true.
(B) (A) is true but (R) is false.
(C) Both (A) and (R) are true but (R) is not the true explanation of (A).
(D) Both (A) and (R) are true and (R) is the true explanation of (A).

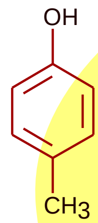
Q3. The interaction energy of London forces between two particles is proportional to r^x, where r is the distance between the particles. The value of x is:
(A) –3 (B) –6
(C) 6 (D) 3

Q4. Which one for the following phenols does not give colour when condensed with phthalic anhydride in presence of conc. H_2SO_4?

(A) 

(B) 

(C) 

(D) 

Q5. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A): Sucrose is a disaccharide and a non-reducing sugar.

Reason (R): Sucrose involves glycosidic linkage between C_1 of β-glucose and C_2 of α-fructose.

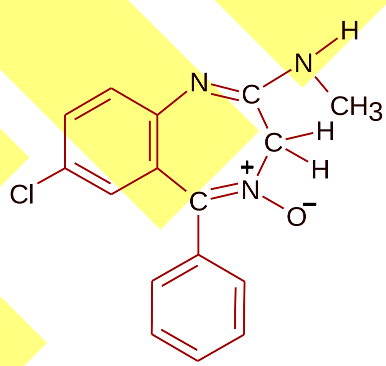
Choose the most appropriate answer from the options given below:
(A) Both (A) and (R) are true but (R) is the true explanation of (A).
(B) (A) is true but (R) is false.
(C) (A) is false but (R) is true.
(D) Both (A) and (R) are true but (R) is not the true explanation of (A).

Q6. Arrange the following Cobalt complexes in the order of increasing Crystal Field Stabilization Energy (CFSE) value.

Complexes: $[CoF_6]^{3-}$, $[Co(H_2O)_6]^{2+}$, $[Co(NH_3)_6]^{3+}$ and $[Co(en)_3]^{3+}$
A B C D

Choose the correct option:
(A) B < A < C < D
(B) A < B < C < D
(C) B < C < D < A
(D) C < D < B < A

Q7.

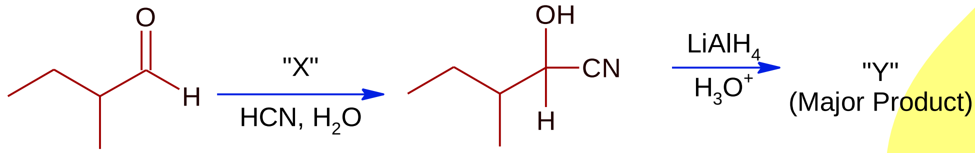


Chlorodiazepoxide

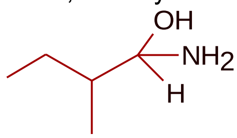
The class of drug to which chlordiazepoxide with above structure belongs is:
(A) Analgesic
(B) Tranquilizer

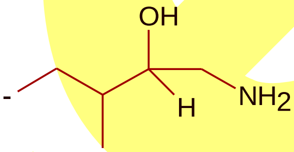
(C) Antacid (D) Antibiotic

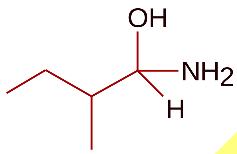
Q8.

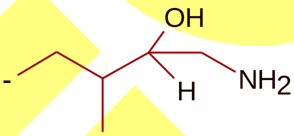


Consider the given reaction, Identify 'X' and 'Y'

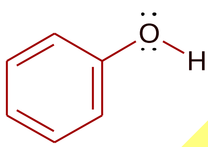
(A) X - HNO_3 Y - 

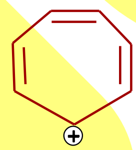
(B) X - HNO_3 Y - 

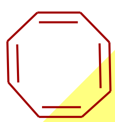
(C) X - NaOH Y - 

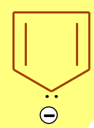
(D) X - NaOH Y - 

Q9. Which one of the following compounds is not aromatic?

(A) 

(B) 

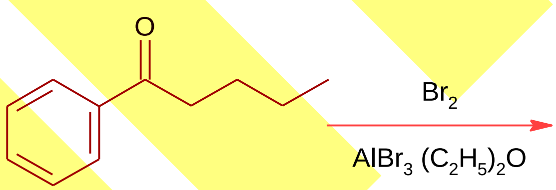
(C) 

(D) 

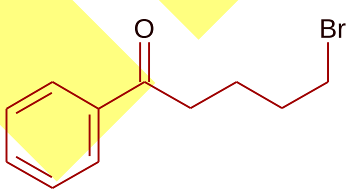
Q10. The number of stereoisomers possible for 1,2-dimethyl cyclopropane is

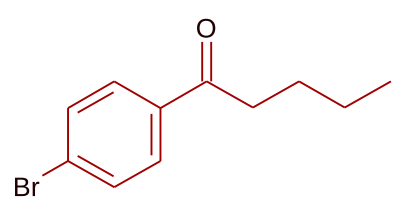
(A) Three (B) Two
(C) One (D) Four

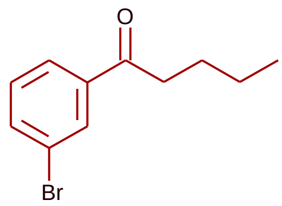
Q11.

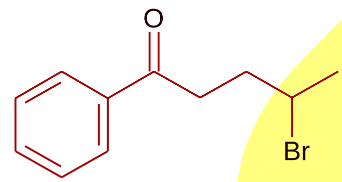


Consider the given reaction, the Product A is:

(A) 

(B) 

(C) 

(D) 

Q12. Match List – I with List – II.

List – I (Chemical Reaction)	List – II (Reagent used)
(a) $CH_3COOCH_2CH_3 \rightarrow CH_3CH_2OH$	(i) CH_3MgBr / H_3O^+ (1.equivalent)
(b) $CH_3COOCH_3 \rightarrow CH_3CHO$	(ii) H_2SO_4 / H_2O
(c) $CH_3C\equiv N \rightarrow CH_3CHO$	(iii) DIBAL-H/H_2O
(d) $CH_3C\equiv N \longrightarrow H_3C-C(=O)-CH_3$	(iv) $SnCl_2$,HCl / H_2O

Choose the most appropriate match.

(A) (a) – (ii), (b) – (iv), (c) – (iii), (d) – (i)
(B) (a) – (ii), (b) – (iii), (c) – (iv), (d) – (i)
(C) (a) – (iii), (b) – (ii), (c) – (i), (d) – (iv)
(D) (a) – (iv), (b) – (ii), (c) – (iii), (d) – (i)

Q13. The number of non-ionisable hydrogen atoms present in the final product obtained from the hydrolysis of PCl_5 is:

(A) 2
(B) 1
(C) 3
(D) 0

Q14. The sol given below with negatively charged colloidal particles is:

(A) $FeCl_3$ added to hot water
(B) KI added to $AgNO_3$ solution
(C) $Al_2O_3 \cdot xH_2O$ in water
(D) $AgNO_3$ added to KI solution

Q15. Indicate the complex / complex ion which did not show any geometrical isomerism:

(A) $[Co(NH_3)_3(NO_2)_3]$
(B) $[CoCl_2(en)_2]$
(C) $[Co(NH_3)_4Cl_2]^+$
(D) $[Co(CN)_5(NC)]^{3-}$

Q16. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A): Heavy water is used for the study of reaction mechanism.

Reason (R): The rate of reaction for the cleavage of O–H bond is slower than that of O–D bond.

Choose the most appropriate answer from the options given below:

(A) (A) is true but (R) is false.
(A) (A) is false but (R) is true.
(C) Both (A) and (R) are true but (R) is the true explanation of (A).
(D) Both (A) and (R) are true and (R) is not the true explanation of (A).

Q17. The bond order and magnetic behaviour of O_2^- ion are, respectively:
(A) 2 and diamagnetic.
(B) 1 and paramagnetic.
(C) 1.5 and diamagnetic.
(D) 1.5 and paramagnetic

Q18. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A): Photochemical smog causes cracking of rubber.

Reason (R): Presence of ozone, nitric oxide, acrolein, formaldehyde and peroxyacetyl nitrate in photochemical smog makes it oxidizing.

Choose the most appropriate answer from the options given below:
(A) (A) is false but (R) is true.
(B) Both (A) and (R) are true but (R) is the true explanation of (A).
(C) (A) is true but (R) is false.
(D) Both (A) and (R) are true and (R) is not the true explanation of (A).

Q19. Chalcogen group elements are:
(A) Se, Tb and Pu
(B) O, Ti and Po
(C) S, Te and Pm
(D) Se, Te and Po

Q20. Given below are two statements:

Statement I: Sphalerite is a sulphide ore of zinc and copper glance is a sulphide ore of copper.

Statement II: It is possible to separate two sulphide ores by adjusting proportion of oil to water or by using 'depressants' in a froth flotation method.

Choose the most appropriate answer from the options given below:
(A) Both Statement I and Statement II are false.
(B) Both Statement I and Statement II are true.
(C) Statement I is true but Statement II is false.
(D) Statement I is false but Statement II is true.

Section-B

Q1. For water $\Delta_{vap} H = 41$ kJ mol^{-1} at 373 K and 1 bar pressure. Assuming that water vapour is an ideal gas that occupies a much larger volume than liquid water, the internal energy change during evaporation of water is ________ kJ mol^{-1}. [Use: R = 8.3 J mol^{-1} K^{-1}]

Q2. 83 g of ethylene glycol dissolved in 625 g of water. The freezing point of the solution is _______ K. (Nearest integer).

[Use: Molal Freezing point depression constant of water = 1.86 K kg mol^{-1}

Freezing point of water = 273 K

Atomic masses: C : 12.0 u, O : 16.0 u, H : 1.0 u]

Q3. In the sulphur estimation, 0.471 g of an organic compound gave 1.44 g of barium sulphate. The percentage of sulphur in the compound is __________%. (Nearest integer)

(Atomic mass of Ba = 137u).

Q4. A metal surface is exposed to 500 nm radiation. The threshold frequency of the metal for photoelectric current is 4.3×10^{14} Hz. The velocity of ejected electron is _______ $\times 10^{5}$ ms^{-1}. (Nearest integer)

[Use: $h = 6.63 \times 10^{-34}$ Js, $m_e = 9.0 \times 10^{-31}$ kg]

Q5. The equilibrium constant K_c at 298 K for the reaction

$A + B \rightleftharpoons C + D$

is 100. Starting with an equimolar solution with concentrations of A, B, C and D all equal to 1 M, the equilibrium concentration of D is ________ $\times 10^{-2}$ M. (Nearest integer)

Q6. The reaction rate for the reaction

$$[PtCl_4]^{2-} + H_2O \rightleftharpoons [Pt(H_2O)Cl_3]^{-} + Cl^{-}$$

was measured as a function of concentrations of different species. It was observed that

$$\frac{-d\left[[PtCl_4]^{2-}\right]}{dt} = 4.8 \times 10^{-5}\left[[PtCl_4]^{2-}\right] - 2.4 \times 10^{-3}\left[[Pt(H_2O)Cl_3]^{-}\right]\left[Cl^{-}\right]$$

where square brackets are used to denote molar concentrations. The equilibrium constant K_C = __________. (Nearest integer)

Q7. For the galvanic cell,

$$Zn(s) + Cu^{2+}(0.02M) \rightarrow Zn^{2+}(0.04M) + Cu(s),$$

E_{cell} = ________ $\times 10^{-2}$ V.

(Nearest integer)

[Use: $E^{0}_{Cu/Cu^{2+}} = -0.34V$, $E^{0}_{Zn/Zn^{2+}} = +0.76V$, $\frac{2.303RT}{F} = 0.059V$]

Q8. A chloro compound "A"

(i) forms aldehydes on ozonolysis followed by the hydrolysis.

(ii) when vaporized completely 1.53 g of A, gives 448 mL of vapour at STP.

The number of carbon atoms in a molecule of compound A is ________.

Q9. The overall stability constant of the complex ion $[Cu(NH_3)_4]^{2+}$ is 2.1×10^{13}. The overall dissociation constant is $y \times 10^{-14}$. Then y is ________. (Nearest integer)

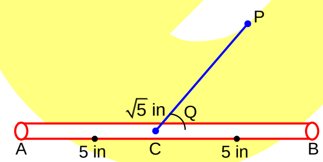
Q10. 100 mL of Na_3PO_4 solution contains 3.45 g of sodium. The molarity of the solution is ________ $\times 10^{-2}$ mol L^{-1}, (Nearest integer)
[Atomic Masses – Na : 23.0 u, O : 16.0 u, P : 31.0 u]

MATHEMATICS
Section-A

Q1. Let P be the plane passing through the point (1, 2, 3) and the line of intersection of the planes $\vec{r}\cdot(\hat{i}+\hat{j}+4\hat{k})=16$ and $\vec{r}\cdot(-\hat{i}+\hat{j}+\hat{k})=6$.
Then which of the following points does NOT lie on P?
(A) (3, 3, 2)
(B) (6, –6, 2)
(C) (–8, 8, 6)
(D) (4, 2, 2)

Q2. A fair die is tossed until six is obtained on it. Let X be the number of required tosses, then the conditional probability $P(X \ge 5 \mid X > 2)$ is:
(A) $\frac{5}{6}$
(B) $\frac{25}{36}$
(C) $\frac{125}{216}$
(D) $\frac{11}{36}$

Q3. A 10 inches long pencil AB with mid point C and a small eraser P are placed on the horizontal top of a table such that $PC=\sqrt{5}$ inches and $\angle PCB = \tan^{-1}(2)$. The acute angle through which the pencil must be rotated about C so that the perpendicular distance between eraser and pencil becomes exactly 1 inch is:



(A) $\tan^{-1}\left(\frac{1}{2}\right)$
(B) $\tan^{-1}\left(\frac{4}{3}\right)$
(C) $\tan^{-1}(1)$
(D) $\tan^{-1}\left(\frac{3}{4}\right)$

Q4. Two fair dice are thrown. The numbers on them are taken as λ and μ, and a system of linear equations
$x + y + z = 5$
$x + 2y + 3z = \mu$
$x + 3y + \lambda z = 1$
is constructed. If ρ is the probability that the system has a unique solution q is the probability that the system has no solution, then
(A) $p=\frac{5}{6}$ and $q=\frac{5}{36}$
(B) $p=\frac{1}{6}$ and $q=\frac{1}{36}$
(C) $p=\frac{1}{6}$ and $q=\frac{5}{36}$
(D) $p=\frac{5}{6}$ and $q=\frac{1}{36}$

Q5. The locus of the mid points of the chords of the hyperbola $x^2 - y^2 = 4$, which touch the parabola $y^2 = 8x$, is:
(A) $y^3(x-2)=x^2$
(B) $y^2(x-2)=x^3$
(C) $x^3(x-2)=y^2$
(D) $x^2(x-2)=y^3$

Q6. The local maximum value of the function
$$f(x)=\left(\frac{2}{x}\right)^{x^2},\ x>0, \text{ is:}$$
(A) $\left(2\sqrt{e}\right)^{\frac{1}{e}}$
(B) $(e)^{\frac{2}{e}}$

(C) $\left(\frac{4}{\sqrt{e}}\right)^{\frac{e}{4}}$ (D) 1

Q7. Let [t] denote the greatest integer less than or equal to t.
Let $f(x) = x - [x]$, $g(x) = 1 - x + [x]$, and $h(x) = \min\{f(x), g(x)\}$, $x \in [-2, 2]$
Then h is:
(A) not continuous at exactly three points in [–2, 2]
(B) not continuous at exactly four points in [–2, 2]
(C) Continuous in [–2, 2] but not differentiable at exactly three points in (–2, 2)
(D) Continuous in [–2, 2] but not differentiable at more than four points in (–2, 2)

Q8. The domain of the function $\operatorname{cosec}^{-1}\left(\frac{1+x}{x}\right)$ is:
(A) $\left(-1, -\frac{1}{2}\right] \cup (0, \infty)$
(B) $\left[-\frac{1}{2}, \infty\right) - \{0\}$
(C) $\left[-\frac{1}{2}, 0\right) \cup [1, \infty)$
(D) $\left(-\frac{1}{2}, \infty\right) - \{0\}$

Q9. If the value of the integral $\int_0^5 \frac{x+[x]}{e^{x-[x]}}dx = \alpha e^{-1} + \beta$, where α, β ε R, $5\alpha + 6\beta = 0$, and [x] denotes the greatest integer less than or equal to x; then the value of $(\alpha+\beta)^2$ is equal to
(A) 16
(B) 100
(C) 25
(D) 36

Q10. The value of
$2\sin\left(\frac{\pi}{8}\right)\sin\left(\frac{2\pi}{8}\right)\sin\left(\frac{3\pi}{8}\right)\sin\left(\frac{5\pi}{8}\right)\sin\left(\frac{6\pi}{8}\right)\sin\left(\frac{7\pi}{8}\right)$ is :
(A) $\frac{1}{8\sqrt{2}}$
(B) $\frac{1}{4\sqrt{2}}$
(C) $\frac{1}{4}$
(D) $\frac{1}{8}$

Q11. Consider the two statements:
(S1): $(p \to q) \vee (\sim q \to p)$ is a tautology.
(S2): $(p \wedge \sim q) \wedge (\sim p \vee q)$ is a fallacy.
Then:
(A) only (S1) is true.
(B) only (S2) is true.
(C) both (S1) and (S2) are false.
(D) both (S1) and (S2) are true.

Q12. A circle C touches the line x = 2y at the point (2, 1) and intersects the circle $C_1 : x^2 + y^2 + 2y - 5 = 0$ at two points P and Q such that PQ is a diameter of C_1. Then the diameter of C is
(A) $7\sqrt{5}$
(B) $4\sqrt{15}$
(C) 15
(D) $\sqrt{285}$

Q13. Let $A = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 1 \\ 1 & 0 & 0 \end{pmatrix}$. Then $A^{2025} - A^{2020}$ is equal to:

(A) A^5
(B) A^6
(C) $A^5 - A$
(D) $A^6 - A$

Q14. The value of $\int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} \left(\frac{1+\sin^2 x}{1+\pi^{\sin x}} \right) dx$ is:

(A) $\frac{3\pi}{4}$
(B) $\frac{5\pi}{4}$
(C) $\frac{3\pi}{2}$
(D) $\frac{\pi}{2}$

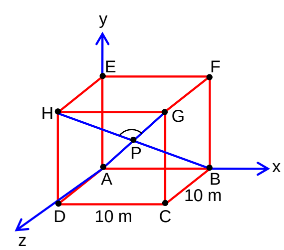
Q15. If $\left(\sqrt{3}+i\right)^{100} = 2^{99}(p+iq)$. then p and q are roots of the equation:

(A) $x^2 + \left(\sqrt{3}+1\right)x + \sqrt{3} = 0$
(B) $x^2 - \left(\sqrt{3}+1\right)x + \sqrt{3} = 0$
(C) $x^2 + \left(\sqrt{3}-1\right)x - \sqrt{3} = 0$
(D) $x^2 - \left(\sqrt{3}-1\right)x - \sqrt{3} = 0$

Q16. $\lim_{x\to 2} \left(\sum_{n=1}^{9} \frac{x}{n(n+1)x^2 + 2(2n+1)x + 4} \right)$ is equal to:

(A) $\frac{9}{44}$
(B) $\frac{5}{24}$
(C) $\frac{7}{36}$
(D) $\frac{1}{5}$

Q17. A hall has a square floor of dimension 10 m × 10 m (see the figure) and vertical walls. If the angle GPH between diagonals AG and BH is $\cos^{-1}\frac{1}{5}$, then the height of the hall (in meters) is:



(A) 5
(B) $2\sqrt{10}$
(C) $5\sqrt{3}$
(D) $5\sqrt{2}$

Q18. The point $P(-2\sqrt{6}, \sqrt{3})$ lies on the hyperbola $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ having eccentricity $\frac{\sqrt{5}}{2}$. If the tangent and normal at P to the hyperbola intersect its conjugate axis at the points Q and R respectively, then QR is equal to:

(A) $4\sqrt{3}$
(B) 6
(C) $3\sqrt{6}$
(D) $6\sqrt{3}$

Q19. Let y(x) be the solution of the differential equation $2x^2dy + (e^y - 2x)dx = 0$, $x > 0$. If y(e) = 1, then y(1) is equal to:

(A) 2
(B) 0
(C) $\log_e(2e)$
(D) $\log_e 2$

Q20. If $\sum_{r=1}^{50} \tan^{-1}\frac{1}{2r^2} = p$, then the value of tan p is:

(A) 100
(B) $\frac{101}{102}$
(C) $\frac{51}{50}$
(D) $\frac{50}{51}$

Section-B

Q1. Let $\binom{n}{k}$ denote ^nC_k and $\begin{bmatrix} n \\ k \end{bmatrix} = \begin{cases} \binom{n}{k}, \text{ if } 0 \le k \le n \\ 0 \text{ , otherwise} \end{cases}$

If $A_k = \sum_{i=0}^{9} \binom{9}{i} \begin{bmatrix} 12 \\ 12-k+i \end{bmatrix} + \sum_{i=0}^{8} \binom{8}{i} \begin{bmatrix} 13 \\ 13-k+i \end{bmatrix}$ and $A_4 - A_3 = 190$ p, then p is equal to _________.

Q2. Let a and b respectively be the points of local maximum and local minimum of the function $F(x) = 2x^3 - 3x^2 - 12x$. If A is the total area of the region bounded by y = f(x), the x-axis and the lines x = a and x = b, then 4 A is equal to _________.

Q3. Let $\lambda \neq 0$ be in R. If α and β are the roots of the equation $x^2 - x + 2\lambda = 0$, and α and γ are the roots of the equation $3x^2 - 10x + 27\lambda = 0$, then $\frac{\beta\gamma}{\lambda}$ is equal to _________.

Q4. Let A be a 3 × 3 real matrix. If det(2 adj(2 Adj(adj (2A))) = 2^{41}, then the value of det (A^2) equals _________.

Q5. The sum of all 3-digit numbers less then or equal to 500, that are formed without using the digit "1" and they all are multiple of 11, is _________.

Q6. If the projection of the vector $\hat{i} + 2\hat{j} + \hat{k}$ on the sum of the two vectors $2\hat{i} + 4\hat{j} - 5\hat{k}$ and $-\lambda\hat{i} + 2\hat{j} + 3\hat{k}$ is 1, then λ is equal to _________.

Q7. The least positive integer n such that $\frac{(2i)^n}{(1-i)^{n-2}}, i = \sqrt{-1}$, is a positive integer, is _________.

Q8. Let the mean and variance of four numbers 3, 7, x and y(x > y) be 5 and 10 respectively. Then the mean of four numbers 3 + 2x, 7 + 2y, x + y and x – y is _________.

Q9. Let Q be the foot of the perpendicular from the point P(7, –2, 13) on the plane containing the lines $\frac{x+1}{6} = \frac{y-1}{7} = \frac{z-3}{8}$ and $\frac{x-1}{3} = \frac{y-2}{5} = \frac{z-3}{7}$. Then $(PQ)^2$, is equal to ________.

Q10. Let $a_1, a_2, \ldots, a_{10}$ be an AP with common difference –3 and $b_1, b_2, \ldots, b_{10}$ be a GP with common ratio 2. Let $c_k = a_k + b_k$, k = 1, 2, …, 10. If $c_2 = 12$ and $c_3 = 13$, then $\sum_{k=1}^{10} c_k$ is equal to_________

ANSWER- KEY

ANSWER: JEE Main- 26-08-2021-Evening

PHYSICS	CHEMISTRY	MATHEMATICS
Section-A	**Section-A**	**Section-A**
Ans1. D	**Ans1.** A	**Ans1.** D
Ans2. A	**Ans2.** D	**Ans2.** B
Ans3. A	**Ans3.** B	**Ans3.** D
Asn4. A	**Ans4.** D	**Ans4.** A
Ans5. C	**Ans5.** B	**Ans5.** B
Ans6. D	**Ans6.** A	**Ans6.** B
Ans7. D	**Ans7.** B	**Ans7.** D
Ans8. C	**Ans8.** D	**Ans8.** B
Ans9. B	**Ans9.** C	**Ans9.** C
Ans10. A	**Ans10.** A	**Ans10.** D
Ans11. A	**Ans11.** C	**Ans11.** D
Ans12. A	**Ans12.** B	**Ans12.** A
Ans13. C	**Ans13.** D	**Ans13.** D
Ans14. B	**Ans14.** D	**Ans14.** A
Ans15. D	**Ans15.** D	**Ans15.** D
Ans16. B	**Ans16.** A	**Ans16.** A
Ans17. C	**Ans17.** D	**Ans17.** D
Ans18. B	**Ans18.** B	**Ans18.** D
Ans19. C	**Ans19.** D	**Ans19.** D
Ans20. B	**Ans20.** B	**Ans20.** D
Section-B	**Section-B**	**Section-B**
Ans1. 15	**Ans1.** 38	**Ans1.** 49
Ans2. 30	**Ans2.** 269	**Ans2.** 114
Ans3. 543	**Ans3.** 42	**Ans3.** 18
Ans4. 14	**Ans4.** 5	**Ans4.** 4
Ans5. 50	**Ans5.** 182	**Ans5.** 7744
Ans6. 2	**Ans6.** 0.02 (But NTA answer is 50)	**Ans6.** 5
Ans7. 60	**Ans7.** 109	**Ans7.** 6
Ans8. 3	**Ans8.** 3	**Ans8.** 12
Ans9. 7	**Ans9.** 5	**Ans9.** 96
Ans10. 120	**Ans10.** 50	**Ans10.** 2021

SOLUTION: JEE Main- 26-08-2021-Evening
PHYSICS
Section-A

Sol1. $\frac{Q_H}{Q_L} = \frac{T_H}{T_L}$

$\Rightarrow Q_L = \frac{T_L}{T_H - T_L} \times (Q_H - Q_L)$

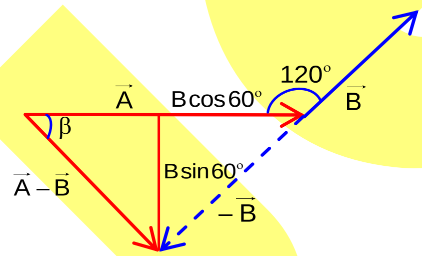
$\Rightarrow \frac{dQ_L}{dt} = \frac{T_L}{T_H - T_L} \cdot \frac{d(Q_H - Q_L)}{dt}$

$= \frac{273 - 10}{25 - (-10)} \times 35$

$= 263\,Js^{-1}$

Sol2. $\tan\beta = \frac{B\sin 60^o}{A - B\cos 60^o}$

$\Rightarrow \beta = \tan^{-1}\left(\frac{\sqrt{3}B}{2A - B}\right)$

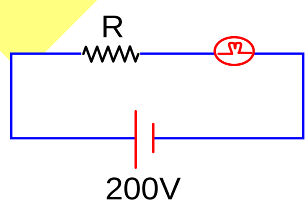


Sol3. $Y = \overline{\left(\overline{\overline{A+B}+A}\right) + \left(\overline{\overline{A+B}+B}\right)} = \left(\overline{A+B}+A\right).\left(\overline{A+B}+B\right)$

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

Sol4. As power delivered by the bulb is 500 W, potential difference across it should be 100 V. Thus,

$R = R_{bulb} = \frac{100^2}{500} = 20\Omega$



Sol5. $R_{eq} = \frac{2 \times 4}{2+4} + 6 + 8 = \frac{46}{3}\Omega$

Sol6. $\lambda' = \lambda \times \frac{75}{100} = \frac{3}{4}\lambda$

$\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mE}}$

$\Rightarrow \frac{E'}{E} = \left(\frac{\lambda}{\lambda'}\right)^2 = \left(\frac{4}{3}\right)^2$

$\Rightarrow E' = \frac{16}{9}E$

Extra energy required,

$$\Delta E = E' - E = \frac{7}{9}E$$

Sol7. $[B] = MT^{-2}A^{-1}$

$[\phi] = ML^2T^{-2}A^{-1}$

$[\mu] = MLT^{-2}A^{-2}$

$[M] = M^0L^{-1}A$

Sol8. $P = \frac{nRT}{V} = \frac{(1+2)\times 8.3\times 400}{4.0\times 10^{-3}} = 24.9\times 10^5 \text{Pa}$

Sol9. Let, current throngh inductor,

$i_L = I_L \sin(\omega t + \phi_1)$

$$I_L = \frac{200\sqrt{2}}{\sqrt{50^2 + (100\times 0.50)^2}} = 4\,A$$

$$\phi_1 = \tan^{-1}\left(\frac{-100\times 0.50}{50}\right) = -\frac{\pi}{4}$$

Let, current through capacitor,

$i_C = I_C \sin(\omega t + \phi_2)$

$$i_C = \frac{200\sqrt{2}}{\sqrt{100^2 + \left(\frac{1}{100\times 100\times 10^{-6}}\right)^2}} = 2\,A$$

$$\phi_2 = \tan^{-1}\left(\frac{\frac{1}{100\times 100\times 10^{-6}}}{100}\right) = \frac{\pi}{4}$$

As $\phi_2 - \phi_1 = \frac{\pi}{2}$,

$$I = \sqrt{(I_L)^2 + (I_C)^2}$$

$$= \sqrt{4^2 + 2^2} = 4.47\,A$$

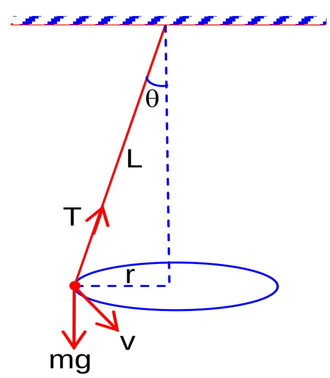
Sol10. $\sin\theta = \frac{r}{L} = \frac{1}{\sqrt{2}} \Rightarrow \theta = 45^\circ$

$$T\sin\theta = \frac{mv^2}{r}$$

$$T\cos\theta = mg$$

$$\tan\theta = \frac{v^2}{rg}$$

$$\Rightarrow v = \sqrt{rg}$$



Sol11. $\frac{dN_B}{dt} = \lambda N_A - \lambda N_B = 2\lambda N_B(0).e^{-\lambda t} - \lambda N_B$

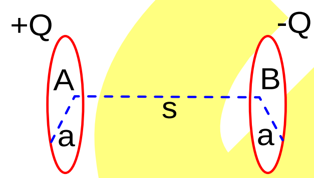
$\Rightarrow \frac{dN_B}{dt} + \lambda N_B = 2\lambda N_B(0)e^{-\lambda t}$

Solving it, $N_B(t) = N_B(0)(1+2\lambda t)e^{-\lambda t}$

$N_B(t)$ is maximum when,

$\frac{dN_B}{dt} = 0 \Rightarrow t = \frac{1}{2\lambda}$

Sol12. $V_A = \frac{1}{4\pi\varepsilon_0}\left[\frac{1}{a} - \frac{1}{\sqrt{a^2+s^2}}\right]$



$V_B = \frac{-1}{4\pi\varepsilon_0}\left[\frac{1}{a} - \frac{1}{\sqrt{a^2+s^2}}\right]$

$V_A - V_B = \frac{1}{2\pi\varepsilon_0}\left[\frac{1}{a} - \frac{1}{\sqrt{a^2+s^2}}\right]$

Sol13. Horizontal component of velocity of bomb equals to the velocity of plane. So, bomb and plane are in same vertical line always.

Sol14. $I_{CD} = \frac{1}{2}Mr^2 + M\left(\frac{L}{2}\right)^2$

$\Rightarrow 2.7 = M\left(\frac{0.2^2}{2} + \frac{0.8^2}{4}\right)$

$\Rightarrow M = 15\,kg$

Density, $\rho = \frac{M}{\pi r^2 L} = \frac{15}{3.14 \times 0.2^2 \times 0.8} = 1.49 \times 10^2\,kg/m^3$

Sol15. $B_0 = \frac{E_0}{c} = \frac{800}{3\times10^8}T$

$F_{max} = evB_0 = 1.6\times10^{-19} \times 3\times10^7 \times \frac{800}{3\times10^8} = 12.8\times10^{-18}N$

Sol16. $\frac{\Delta T}{T} = \frac{1}{2}\frac{\Delta \ell}{\ell}$

$\Rightarrow \Delta T = \frac{1}{2} \times \frac{0.1}{100} \times 24 \times 60 \times 60 = 43.2\,s$

Sol17. Tension in wire, $T = \frac{2\times3\times5\times10}{3+5} = \frac{75}{2}N$

$\frac{T}{\pi r_{min}^2} = \frac{24}{\pi} \times 10^2$

$\Rightarrow r_{min}^2 = \frac{75}{2\times24} \times 10^{-2} = \frac{25}{16} \times 10^{-2}$

$\Rightarrow r_{min} = \frac{5}{4} \times 10^{-1}m = 12.5\,cm.$

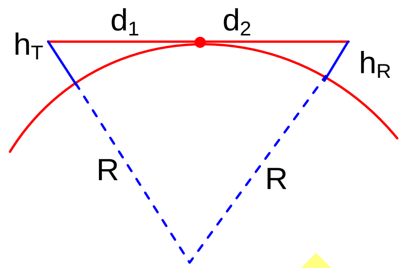
Sol18. Range of communication

$= d_1 + d_2$

$= \sqrt{2Rh_T} + \sqrt{2Rh_R}$

$= \sqrt{2 \times 6400}\left(\sqrt{0.05} + \sqrt{0.08}\right)$

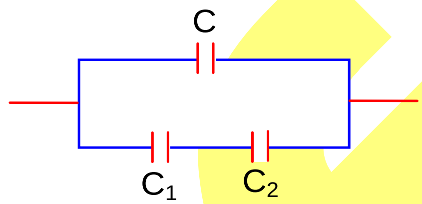
$= 57.28\,\text{km}$



Sol19. $C_{eq} = C + \dfrac{C_1.C_2}{C_1 + C_2}$

$$= \frac{\varepsilon_0 A/2}{d} + \frac{\dfrac{k_1\varepsilon_0 A/2}{d/2} \cdot \dfrac{k_2\varepsilon_0 A/2}{d/2}}{\dfrac{k_1\varepsilon_0 A/2}{d/2} + \dfrac{k_2\varepsilon_0 A/2}{d/2}}$$

$$= \frac{\varepsilon_0 A}{d}\left(\frac{1}{2} + \frac{k_1 k_2}{k_1 + k_2}\right)$$



Sol20. $ms_x(16-10) = ms_y(20-16)$

$\Rightarrow \dfrac{s_x}{s_y} = \dfrac{2}{3}$

$ms_y(26-20) = ms_z(30-26)$

$\Rightarrow \dfrac{s_y}{s_z} = \dfrac{2}{3}$

$\dfrac{s_x}{s_z} = \dfrac{s_x}{s_y} \times \dfrac{s_y}{s_z} = \dfrac{2}{3} \times \dfrac{2}{3} = \dfrac{4}{9}$

$ms_x(T-10) = ms_z(30-T)$

$\Rightarrow 4(T-10) = 9(30-T)$

$\Rightarrow T = 23.84^\circ C$

Section-B

Sol1. $\dfrac{F_{max}}{1+2} = 0.5 \times 10 \Rightarrow F_{max} = 15\text{N}$

Sol2. $\dfrac{I}{2}\cos^2\theta = \dfrac{3I}{8}$

$\Rightarrow \cos\theta = \dfrac{\sqrt{3}}{2}$

$\Rightarrow \theta = 30^\circ$

Sol3. $2nqV = \dfrac{1}{2}mv^2$

$$n = \frac{mv^2}{4qV}$$

$$= \frac{1.67 \times 10^{-27} \times (0.5 \times 10^8)^2}{4 \times 1.6 \times 10^{-19} \times 12 \times 10^3} = 543$$

Sol4. Let, $E \propto m^a g^b T^c$

So, $[E] = [m]^a [g]^b [T]^c$

$\Rightarrow ML^2T^{-2} = M^a (LT^{-2})^b T^c$

$\Rightarrow a = 1, b = 2 \text{ and } c = 2$

Thus, $E = k m g^2 T^2$

$$\frac{\Delta E}{E} = 2.\frac{\Delta g}{g} + 2.\frac{\Delta T}{T}$$

Percentage error in $E = 2 \times 4 + 2 \times 3 = 14\%$

Sol5. As image coincides with the object, image formed by convex lens should be at the centre of curvature of the convex mirror. If the convex mirror is removed, then, also, image formed the convex lens is at the same location.
Distance of image from object $= 12 + 8 + 2 \times 15 = 50\,cm$

Sol6. $x_1 = 5\sin\left(2\pi t + \frac{\pi}{4}\right)$

$x_2 = 5\sqrt{2}(\sin 2\pi t + \cos 2\pi t)$

$= 10\sin\left(2\pi t + \frac{\pi}{4}\right)$

$x_{2,max} = 2.x_{1,max}$

Sol7. $\varepsilon_{max} = nBA\omega$

$= 20 \times 3.0 \times 10^{-2} \times 3.14 \times (0.08)^2 \times 50$

$= 60.3 \times 10^{-2}\,V$

Sol8. $\tau = MB\sin\theta$

$= 0.2 \times \frac{\sqrt{3}}{4} \times (0.1)^2 \times 20 \times 10^{-3} \times \sin 90^o$

$= \sqrt{3} \times 10^{-5}\,Nm$

Sol9. Phase difference between the two waves,
$\phi = kx_0 = 6.28 \times 3.5 = 7\pi$ rad
Amplitude of resulting wave,

$A = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\phi}$

$= \sqrt{12^2 + 5^2 + 2 \times 12 \times 5 \times \cos(7\pi)}$

Sol10. Current through zener diode,

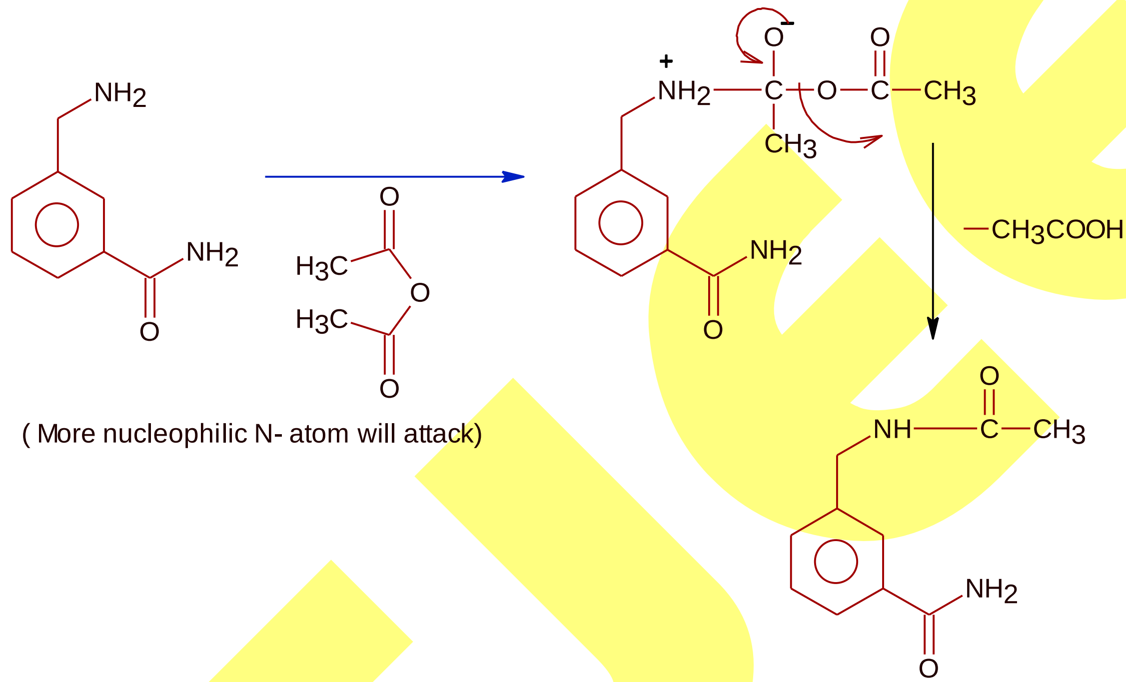
$$I_z = \frac{24-10}{1} - \frac{10}{5} mA = 12 mA$$

Power across zener diode,

$$P_z = V_z . I_z = 10 \times 12 = 120 mW$$

CHEMISTRY
Section-A

Sol1.



(More nucleophilic N- atom will attack)

Sol2. In alkaline earth metals cationic size increases down the groups, hence thermal stability of carbonates increases down the group. Therefore both assertion and reason are correct and reason is correct explanation of assertion.

Sol3. The interaction energy of London forces ; $E \propto \frac{1}{r^6}$ or $E \propto r^{-6}$. Hence x = -6.

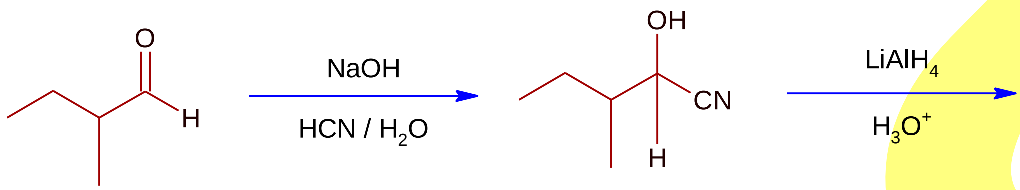
Sol4. In given following phenol and its derivaties only para- methyl phenol does not produce any colour with phthalic anhydride in the presence of conc. H_2SO_4.

Sol5. Sucrose is the disaccharides which is a non- reducing sugar, but if forms glycosidic linkage between C_1 of α- glucose and C_2 of β- fructose. Hence Assertion is correct, but Reason is incorrect.

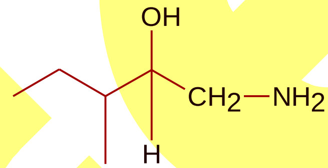
Sol6. CFSE $\propto$ strength of ligand
And order of strength of ligand is
en > NH_3 > H_2O > F^-

Sol7. Chlordiazepoxide is an example of tranquilizer.

Sol8.

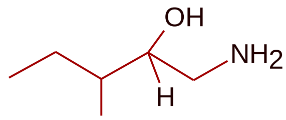


Cyanohydrine

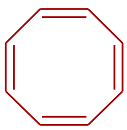
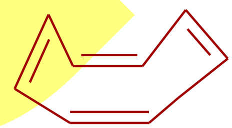


(Reduced product)

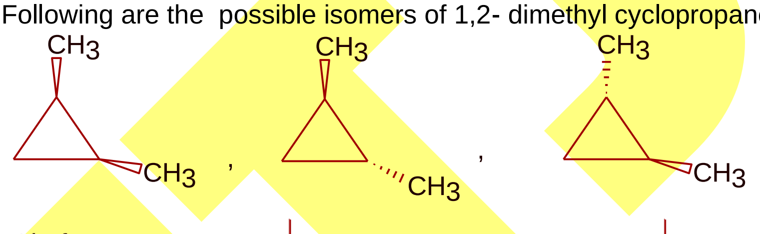
Hence, X= NaOH and

Y = 

Sol9.

 is a non- aromatic due to non- planar shape and it exist in tub- form  .

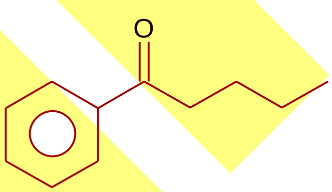
Sol10. Following are the possible isomers of 1,2- dimethyl cyclopropane

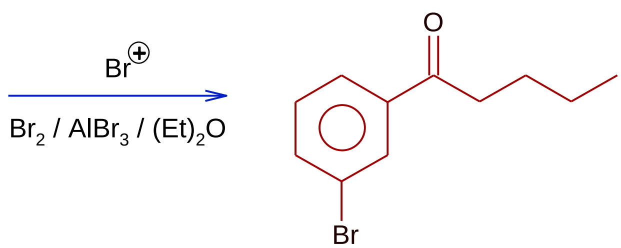


Cis form
(optically inactive)

trans form
(optically active)

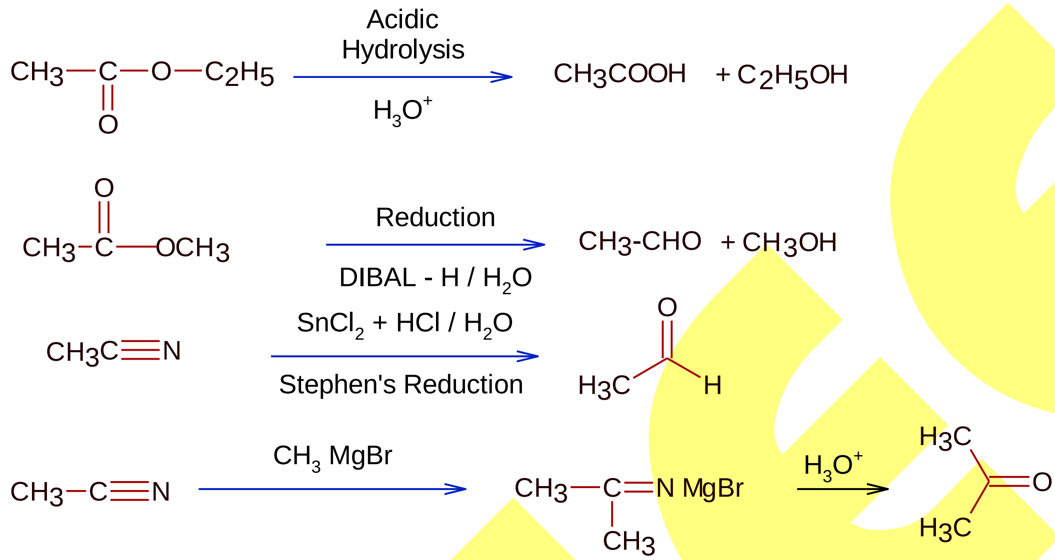
Sol11.



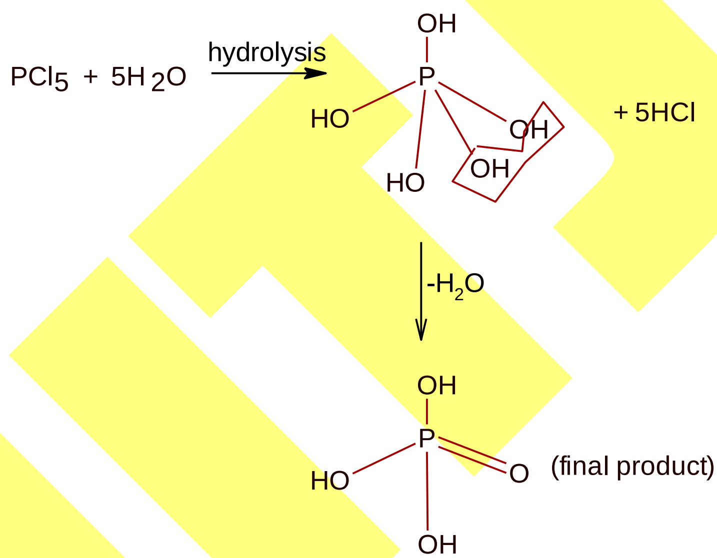


(Presence of meta directing group)

Sol12.



Sol13.



All hydrogens are attached to oxygen are ionisable.

Sol14. When $AgNO_3$ added to KI solution, it form precipitate of AgI(s) which absorb I^- ions from KI and colloidal particles become negatively charged.

Sol15. $\left[Co(NH_3)_3(NO_2)_3\right]$ shows Facial and Meridional geometrical isomerism.

$\left[CoCl_2(en)_2\right]$ shows cis and trans geometrical isomerism.

$\left[Co(NH_3)_4Cl_2\right]^+$ shows cis and trans geometrical isomerism.

$\left[Co(CN)_5(NC)\right]^{3-}$ can not show geometrical isomerism.

Sol16. Heavy water (D_2O) is used to study reaction mechanism. O-H bond energy is less than O-D, hence it will produce fast reaction than O-D. Here assertion is true but Reason is false.

Sol17. Electronic configuration of O_2^- anion is;

$$(\sigma 1s)^2(\sigma_{1s}^*)^2(\sigma_{2s})^2(\sigma_{2s}^*)^2(\sigma 2pz)^2(\pi 2px)^2=(\pi 2py)^2(\pi * 2px)^2=(\pi * 2py)^1$$

In O_2^- anion total $10\,e^-$ resides in Bonding Molecular Orbitals and $7e^-$ resides in anti-Bonding Molecular orbitals. Hence bond order

$$=\frac{10-7}{2}=\frac{3}{2}=1.5.$$

It is paramagnetic due to one unpaired electron.

Sol18 Photo-chemical smog is the mixture of various component like, O_3, NO, acrolein formaldehyde and peroxyacetyl nitrate and other oxidizing agents, which causes the cracking of rubber.

Sol19. Elements of oxygen family are called chalcogens, so Se, Te and Po are chalcogens.

Sol20. Sphalerite is the sulphide ore of zinc (ZnS) and copper glance Cu_2S is the sulphide ores of copper. Two sulphide ores can be separated by adjusting proportion of oil to water or by using depressant in froth flotation method.

Section-B

Sol1. $\Delta H_{vap}=41KJmol^{-1}$

$\Delta H=\Delta E+\Delta nRT$

$H_2O_{(\ell)}\longrightarrow H_2O_{(vap)}$

$\Delta n=1$

$R=8.3\,JK^{-1}mol^{-1}$

$T=373K$

ΔE (Change of internal energy) = $\Delta H - \Delta nRT$

$$\because \Delta E=41-\frac{1\times 8.3\times 373}{1000}kJmol^{-1}=41-3.09kJmol^{-1}=37.91kJmol^{-1}$$

Nearest integer = 38.

Sol2. $\Delta T_f=i\times K_f\times m$

{for ethylene glycol i = 1, due to non- ionisable}

$$=1\times 1.86\times\frac{83\times 1000}{62\times 625}K$$

$=3.984K\approx 4K$ (nearest integer)

Hence, freezing point of solution = 273 K – 4K = 269 K.

Sol3. Molar weight of $BaSO_4$ = 233 gram

233 gm of $BaSO_4$ has 32 gm of S content

Hence 1.44 gm of $BaSO_4$ has $\left(\frac{32\times 1.44}{233}\right)$ g of S content = 0.1977 gm of 'S'

Weight of sulphur = 0.2 gram (nearest)

Weight of organic sample = 0.471 gram

$$\%\text{ of Sulphur} = \frac{0.2\times 100}{0.471}=42.46\%$$

Nearest = 42%

Sol4. In photo- electric effect;

$$\frac{hc}{\lambda} = hv_0 + \frac{1}{2}mv^2$$

$$\frac{6.63\times10^{-34}\times3\times10^{8}}{500\times10^{-9}} = \left(6.63\times10^{-34}\times4.3\times10^{14}\right)+\frac{1}{2}\times9.0\times10^{-31}\times v^2$$

$$3.978\times10^{-19} = 2.85\times10^{-19}+4.5\times10^{-31}\times v^2$$

$$v = \sqrt{\frac{\left(3.978\times10^{-19}-2.85\times10^{-19}\right)}{4.5\times10^{-31}}} = \sqrt{25\times10^{10}} = 5\times10^{5}\,m/s$$

Ans. = 5

Sol5. For equation $A+B \rightleftharpoons C+D$

$$K_C = \frac{[C][D]}{[A][B]} = 100 \text{ at } 298K$$

Here;	A +	B $\rightleftharpoons$	C +	D
t = 0	1M	1M	1M	1M
eq.	(1-x)	(1-x)	(1+x)	(1+x)

$$Kc = \frac{(1+x)\times(1+x)}{(1-x)\times(1-x)}$$

$$\therefore 100 = \frac{(1+x)^2}{(1-x)^2}$$

$$\therefore \frac{1+x}{1-x} = 10$$

$$1+x = 10-10x$$

$$\therefore x = \frac{9}{11}$$

At equilibrium, concentration of D is = $1+\frac{9}{11} = \frac{11+9}{11} = \frac{20}{11}$

$$= 1.818 = 181.8\times10^{-2}M$$

Ans. = 182 (Nearest integer)

Sol6. $[PtCl_4]^{2-} + H_2O \rightleftharpoons [Pt(H_2O)Cl_3]^{-} + Cl^{-}$

At equilibrium $\frac{dx}{dt} = 0$, hence

$$0 = \frac{-d\left[[PtCl_4]^{2-}\right]}{dt} = 4.8\times10^{-5}\left[[PtCl_4]^{2-}\right] - 2.4\times10^{-3}\left[[Pt(H_2O)Cl_3]^{-}\right]\left[Cl^{-}\right]$$

$$K_c = \frac{K_f}{K_b} = \frac{4.8\times10^{-5}}{2.4\times10^{-3}}$$

$$= 2\times10^{-2}$$

$$= 0.02$$

Sol7. $E_{cell} = \left(E^o_{RHS} - E^o_{LHS}\right)_{RP} - \frac{0.0591}{n}\log_{10} Q$

$Q = \frac{\left[Zn^{++}\right]}{\left[Cu^{++}\right]} = \frac{0.04}{0.02}$ and $n = 2$

$\therefore E_{cell} = (0.34 + 0.76) - \frac{0.0591}{2}\log_{10}\frac{0.04}{0.02}$

$= 1.1 - \frac{0.0591}{2} \times 0.3010 = 1.091V = 109 \times 10^{-2} V$

Sol8.

A (Chloro compound) $\xrightarrow[(2)\ H_2O]{(1)\ O_3}$ Formaldehyde

↓

Weight = 1.53 gm

V = 448 ml(STP)

Mole = $\frac{448}{22400} = \frac{\text{weight}}{\text{molecular weight}}$

$\therefore \frac{1.53}{\text{molecular weight}} = \frac{1}{50}$

$\therefore$ Molecular weight of compound A = $50 \times 1.53 = 76.5$ gram

Molecular weight = 76.5 = $C_nH_{2n-1}Cl$

$\therefore C_nH_{2n-1} = 41$

or $12n + 2n - 1 = 41$

$\therefore n = \frac{42}{14} = 3$

Molecular formula = C_3H_5Cl

Number of C- atoms = 3

Sol9. Stability constant of complex = $\frac{1}{\text{dissocation constant}}$

$\therefore$ Dissociation constant $= \frac{1}{2.1 \times 10^{13}} = 4.76 \times 10^{-14}$

Nearest value of dissociation constant = $= 5 \times 10^{-14}$

Ans. = 5

Sol10. 23×3 gm of Na contained by 164 gm of Na_3PO_4

So, 3.45gm of Na contained by $\left(\frac{164 \times 3.45}{69}\right)$ gm of Na_3PO_4

Therefore mole of $Na_3PO_4 = \frac{164 \times 3.45}{69 \times 164} = 0.05$ mol

$$\text{Molarity} = \frac{0.05\times1000}{100}\text{M} = 0.5\text{M}$$
$$= 50.0\times10^{-2}\text{M}$$

MATHEMATICS
Section-A

Sol1. Equation of required plane

$(x+y+4z-16)+\lambda(-x+y+z-6)=0$ it passes $(1,2,3)$

$\Rightarrow -1+\lambda(-2)=0$

$\Rightarrow \lambda=-\frac{1}{2}$

$\therefore$ Equation of plane

$(1-\lambda)x+(1+\lambda)y+(4+\lambda)z-16-6\lambda=0$

$\frac{3}{2}x+\frac{1}{2}y+\frac{7}{2}z-13=0$

$\Rightarrow 3x+y+7z=26$

$(4,2,2)$ not satisfying the plane

Sol2. $P\left(\frac{x\ge 5}{x>2}\right)=\frac{P(x\ge 5\cap x>2)}{P(x>2)}=\frac{P(x\ge 5)}{P(x>2)}$

$=\frac{1-P(x\le 4)}{1-P(x\le 2)}$

$=\frac{1-\left[\left(\frac{5}{6}\right)^3\times\frac{1}{6}+\left(\frac{5}{6}\right)^2\times\frac{1}{6}+\left(\frac{5}{6}\right)\frac{1}{6}+\frac{1}{6}\right]}{1-\left[\frac{5}{6}\times\frac{1}{6}+\frac{1}{6}\right]}$

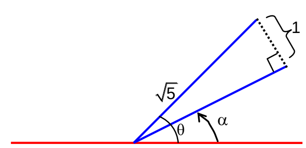
$=\frac{1-\frac{1}{6}\times\frac{1-\left(\frac{5}{6}\right)^4}{1-\frac{5}{6}}}{1-\frac{1}{6}\times\frac{11}{6}}=\frac{1-\left(1-\left(\frac{5}{6}\right)^4\right)}{\frac{25}{36}}$

$=\left(\frac{5}{6}\right)^4\times\left(\frac{6}{5}\right)^2=\left(\frac{5}{6}\right)^2=\frac{25}{36}$

Sol3. $\tan^{-1}2=\theta$

$\Rightarrow \tan\theta=2$

$\sin(\theta-\alpha)=\frac{1}{\sqrt{5}}$



$\tan(\theta-\alpha)=\frac{\frac{1}{\sqrt{5}}}{\frac{2}{\sqrt{5}}}=\frac{1}{2}$

$\frac{\tan\theta-\tan\alpha}{1+\tan\theta\tan\alpha}=\frac{1}{2}$

$\frac{2-\tan\alpha}{1+2\tan\alpha}=\frac{1}{2}$

$$\Rightarrow 4-2\tan\alpha = 1+2\tan\alpha = \tan\alpha = \frac{3}{4}$$

$$\alpha = \tan^{-1}\frac{3}{4}$$

Sol4. System of equations can be written as

$$\begin{pmatrix}1 & 1 & 1\\ 1 & 2 & 3\\ 1 & 3 & \lambda\end{pmatrix}\begin{pmatrix}x\\ y\\ z\end{pmatrix} = \begin{pmatrix}5\\ \mu\\ 1\end{pmatrix}$$

$R_3 - R_2, \quad R_2 - R_1$

$$\begin{pmatrix}1 & 1 & 1\\ 0 & 1 & 2\\ 0 & 1 & \lambda-3\end{pmatrix}\begin{pmatrix}x\\ y\\ z\end{pmatrix} = \begin{pmatrix}5\\ \mu-5\\ 1-\mu\end{pmatrix}$$

$R_3 - R_2, \quad R_2 - R_1$

$$\begin{pmatrix}1 & 1 & 1\\ -1 & 0 & 1\\ 0 & 0 & \lambda-5\end{pmatrix}\begin{pmatrix}x\\ y\\ z\end{pmatrix} = \begin{pmatrix}5\\ \mu-10\\ 6-2\mu\end{pmatrix}$$

For unique solution $\lambda \neq 5, \mu \in R$. $\quad P = \frac{5}{6}$

For no solution $\lambda = 5, \mu \neq 3 \qquad q = \frac{1}{6}\times\frac{5}{6} = \frac{5}{36}$

Sol5. Let $P(h,k)$ be the mid point of the chord $x^2 - y^2 = 4$

$\therefore$ its equation is $xh - yk = h^2 - k^2$

Or, $y = \left(\frac{h}{k}\right)x + \frac{k^2-h^2}{k}$ if this line is tangent to $y^2 = 8x$ then $\frac{k^2-h^2}{k} = \frac{2}{h/k} = \frac{2k}{h}$

$h\left(k^2 - h^2\right) = 2k^2$

$\therefore$ Required locus is $2y^2 = x\left(y^2 - x^2\right)$

$\Rightarrow x^3 = y^2(x-2)$

Sol6. $f(x) = e^{x^2 \ln\left(\frac{2}{x}\right)} = e^{x^2(\ln 2 - \ln x)}$

$f'(x) = e^{x^2(\ln 2-\ln x)}\left[2x(\ln 2 - \ln x) - x\right]$

$= \left(\frac{2}{x}\right)^{x^2} x\left[2(\ln 2 - \ln x) - 1\right]$

$f'(x) = 0 \Rightarrow 2(\ln 2 - \ln x) - 1 = 0$

$2\ln x = \ln\frac{4}{e} \Rightarrow x^2 = \frac{4}{e}$

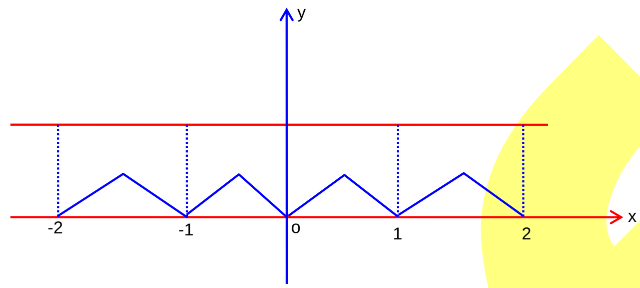
$x > \frac{2}{\sqrt{e}}, \; f'(x) < 0$

$x < \frac{2}{\sqrt{e}}, \; f'(x) > 0$

$f(x)$ is maximum at $x = \frac{2}{\sqrt{e}}$

$f(x)_{max} = \left(\frac{2}{2/\sqrt{e}}\right)^{4e} = e^{2/e}$

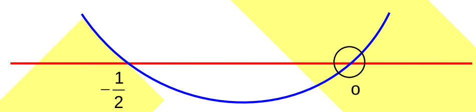
Sol7. $f(x) = \{x\}, g(x) = 1 - \{x\}$



Sol8. $\Rightarrow \frac{1+x}{x} \geq 1$ and $\frac{1+x}{x} \leq -1$

$\Rightarrow \frac{1}{x} \geq 0$ $\quad \frac{1+2x}{x} \leq 0$

$\Rightarrow x > 0$



Domain $\left[-\frac{1}{2}, 0\right) \cup (0, \infty)$

$= \left[-\frac{1}{2}, \infty\right) - \{0\}$

Sol9. $\int_0^5 \frac{x + [x]}{e^{x-[x]}} dx$

x	r − 1	r
t	0	1

$= \sum_{r=1}^{5} \int_{r-1}^{r} \frac{(x+1-r)}{e^{x+1-r}} dx$

Put $x + 1 - r = t \Rightarrow dx = dt$

$= \sum_{r=1}^{5} \int_0^1 \frac{t}{e^t} dt = \int_0^1 te^{-t} dt$

$= 5\left[-te^{-t} - e^{-t}\right]_0^1$

$= 5\left[-1e^{-1} - e^{-1} + e^0\right] = 5\left(1 - \frac{2}{e}\right)$

$\Rightarrow \alpha = -10 \quad \beta = 5 \quad \Rightarrow (\alpha + \beta)^2 = 25$

Sol10. $2\sin\frac{\pi}{8}\sin\frac{2\pi}{8}\tan\frac{3\pi}{8}\ \sin\left(\pi-\frac{5\pi}{8}\right)\sin\left(\pi-\frac{6\pi}{8}\right)\sin\left(\pi-\frac{7\pi}{8}\right)$

$= 2\sin^2\frac{\pi}{8}\sin^2\frac{2\pi}{8}\sin^2\frac{3\pi}{8}$

$= \left(\frac{1}{\sqrt{2}}\right)^2 . 2\sin^2\frac{\pi}{8}\sin^2\frac{3\pi}{8}$

$= \frac{1}{4}.\left(2\sin\frac{\pi}{8}\sin\frac{3\pi}{8}\right)^2$

$= \frac{1}{4}\left[\cos\frac{\pi}{4}-\cos\frac{\pi}{2}\right]^2 = \frac{1}{4}\times\left(\frac{1}{\sqrt{2}}\right)^2 = \frac{1}{8}$

Sol11.

p	q	~p	~q	$p\to q$	$\sim q\to p$	$(p\to q)\vee(\sim q\to p)$
T	T	F	F	T	T	T
T	F	F	T	F	T	T
F	T	T	F	T	T	T
F	F	T	T	T	F	T
						(Tautology)

p	q	~p	~q	$p\wedge\sim q$	$\sim p\vee q$	$(p\wedge\sim q)\wedge(\sim p\vee q)$
T	T	F	F	F	T	F
T	F	F	T	T	F	F
F	T	T	F	F	T	F
F	F	T	T	F	T	F
						(Fallacy)

Sol12. Equation of required circle

$C:(x-2)^2+(y-1)^2+\lambda(2y-x)=0$ ....(i)

Intersect $C_1\ x^2+y^2+2y-5=0$ ....(ii)

$\therefore$ Equation of radical axis

$-4x-4y+10+\lambda(2y-x)=0$ ....(ii)

Centre of $C_1(0,-1)$ lies on ....(ii)

$\Rightarrow 4+10-2\lambda=0\Rightarrow\lambda=7$

Equation of circle C is

$x^2+y^2-11x+12y+5=0$

Diameter = $\sqrt{245}=7\sqrt{5}$

Sol13. $A^2=\begin{pmatrix}1&0&0\\0&1&1\\1&0&0\end{pmatrix}\begin{pmatrix}1&0&0\\0&1&1\\1&0&0\end{pmatrix}=\begin{pmatrix}1&0&0\\1&1&1\\1&0&0\end{pmatrix}$

$A^3=\begin{pmatrix}1&0&0\\1&1&1\\1&0&0\end{pmatrix}\begin{pmatrix}1&0&0\\0&1&1\\1&0&0\end{pmatrix}=\begin{pmatrix}1&0&0\\2&1&1\\1&0&0\end{pmatrix}$

$A^{2025}-A^{2020}$

$$=\begin{pmatrix}1&0&0\\2024&1&1\\1&0&0\end{pmatrix}-\begin{pmatrix}1&0&0\\2019&1&1\\1&0&0\end{pmatrix}=\begin{pmatrix}1&0&0\\5&0&0\\1&0&0\end{pmatrix}=A^6-A$$

Sol14. $=\int_0^{\frac{\pi}{2}}\left[\frac{1+\sin^2 x}{1+\pi^{\sin x}}+\frac{1+\sin^2 x}{1+\pi^{-\sin x}}\right]dx$

$$=\int_0^{\frac{\pi}{2}}(1+\sin^2 x)dx=\frac{\pi}{2}+\frac{1}{2}\int_0^{\frac{\pi}{2}}(1-\cos 2x)dx$$

$$=\frac{\pi}{2}+\frac{1}{2}\left[x-\frac{\sin 2x}{2}\right]_0^{\frac{\pi}{2}}$$

$$=\frac{\pi}{2}+\frac{\pi}{4}=\frac{3\pi}{4}$$

Sol15. $(\sqrt{3}+i)^{100}=2^{100}\left(\frac{\sqrt{3}}{2}+i\frac{1}{2}\right)^{100}$

$$=2^{100}\left(\cos\frac{\pi}{6}+i\sin\frac{\pi}{6}\right)^{100}$$

$$=2^{100}\left(\cos\frac{100\pi}{6}+i\sin\frac{100\pi}{6}\right)$$

$$=2^{100}\left(-\frac{1}{2}+i\frac{\sqrt{3}}{2}\right)$$

$$=2^{99}\left(-1+i\sqrt{3}\right)=2^{99}(p+iq)$$

$\therefore p=-1\ \&\ q=\sqrt{3}$

$\therefore$ Required equation $x^2-\left(\sqrt{3}-1\right)x-\sqrt{3}=0$

Sol16. $n(n+1)x^2+2(2n+1)x+4$

$$=n(n+1)x^2+\{(2n+2)+2n\}x+4$$

$$=(n+1)x(nx+2)+2(nx+2)$$

$$=(nx+2)((n+1)x+2)$$

$$\sum_{n=1}^{9}\frac{x}{(nx+2)((n+1)x+2)}$$

$$=\sum_{n=1}^{9}\left[\frac{1}{nx+2}-\frac{1}{(n+1)x+2}\right]$$

$$\left[\left(\frac{1}{x+2}-\frac{1}{2x+2}\right)+\left(\frac{1}{2x+2}-\frac{1}{3x+2}\right)+.....+\left(\frac{1}{9x+2}-\frac{1}{10x+2}\right)\right]$$

$$=\frac{1}{x+2}-\frac{1}{10x+2}=\frac{9x}{(10x+2)(x+2)}$$

$$\therefore \underset{x\to 2}{\text{Lt}} \frac{9x}{(10x+2)(x+2)} = \frac{9}{44}$$

Sol17. Let height of the wall = h than $A(0,0,0)\ G(10,10,h)$

$\overrightarrow{AG} = 10\hat{i} + 10\hat{j} + h\hat{k}$

$B(10,0,0)\ A(0,10,h)$

$\overrightarrow{BH} = -10\hat{i} + 10\hat{j} + h\hat{k}$

$$\cos\theta = \frac{1}{5} = \frac{\overrightarrow{BH}.\overrightarrow{AG}}{|\overrightarrow{BH}||\overrightarrow{AG}|}$$

$$= \frac{-100+100+h^2}{(200+h^2)}$$

$5h^2 = 200 + h^2 \Rightarrow h^2 = 50$

$h = 5\sqrt{2}$

Sol18. $P(-2\sqrt{6}, \sqrt{3})$ lies on $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$

$$\Rightarrow \frac{24}{a^2} - \frac{3}{b^2} = 1 \text{.........(i)}$$

$$\frac{5}{4} = 1 + \frac{b^2}{a^2} \Rightarrow \frac{b^2}{a^2} = \frac{1}{4}$$

$$b^2 = \frac{a^2}{4} \text{ ....(ii)}$$

Solving (i) & (ii) $a^2 = 12 \Rightarrow b^2 = 3$ hyperbola $\frac{x^2}{12} - \frac{y^2}{3} = 1$

$P(-2\sqrt{6}, \sqrt{3})$

Equation of tangent $\frac{x(-2\sqrt{6})}{12} - \frac{y\sqrt{3}}{3} = 1$ cuts conjugate axis at $Q(0, -\sqrt{3})$

Equation of normal at P

$$\frac{12x}{-2\sqrt{6}} + \frac{3y}{\sqrt{3}} = a^2e^2 = 15$$

Cuts conjugate axis at $R(0, 5\sqrt{3})$

$\therefore QR = 6\sqrt{3}$

Sol19. $\frac{dy}{dx} + \frac{e^y - 2x}{2x^2} = 0$

$$\frac{dy}{dx} + \frac{e^y}{2x^2} - \frac{1}{x} = 0$$

$$e^{-y}\frac{dy}{dx} - \frac{e^{-y}}{x} = -\frac{-1}{2x^2}$$

Put $e^{-y} = t \Rightarrow -e^{-y}\frac{dy}{dx} = \frac{dt}{dx}$

$$\frac{dt}{dx}+\frac{t}{x}=\frac{1}{2x^2}$$

$$\text{I.F.}=e^{\int\frac{dx}{x}}=e^{\ln x}=x$$

$$\text{Soln. } tx=\int\frac{x}{2x^2}dx=\frac{1}{2}\ln x+c$$

$$xe^{-y}=\frac{1}{2}\ln x+c$$

$$x=e,\ y=1\Rightarrow e\times e^{-1}=\frac{1}{2}+c\Rightarrow c=\frac{1}{2}$$

$$\Rightarrow xe^{-y}=\frac{1}{2}\ln x+\frac{1}{2}$$

$$x=1\Rightarrow e^{-y}=\frac{1}{2}\Rightarrow y=\ln 2$$

Sol20. $\tan^{-1}\frac{1}{2r^2}=\tan^{-1}\frac{2}{1+\left(4r^2-1\right)}$

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

$$=\tan^{-1}(2r+1)-\tan^{-1}(2r-1)$$

$$\sum_{r=1}^{50}\left[\tan^{-1}(2r+1)-\tan^{-1}(2r-1)\right]$$

$$\therefore P=\sum_{r=1}^{50}\tan^{-1}\frac{1}{2r^2}=\left(\tan^{-1}3-\tan^{-1}1\right)+\left(\tan^{-1}5-\tan^{-1}3\right)+....+\left(\tan^{-1}101-\tan^{-1}99\right)$$

$$=\tan^{-1}101-\tan^{-1}1=\tan^{-1}\frac{100}{102}$$

$$\Rightarrow \tan P=\frac{100}{102}=\frac{50}{51}$$

Section-B

Sol1. $A_k=\sum_{i=0}^{9}{}^{9}C_i\times{}^{12}C_{k-i}+\sum_{i=0}^{8}{}^{8}C_i\times{}^{13}C_{k-i}$

$$A_4=\sum_{i=0}^{9}{}^{9}C_i\times{}^{12}C_{4-i}+\sum_{i=0}^{8}{}^{8}C_i\times{}^{13}C_{4-i}$$

= coefficient of x^4 in $(1+x)^{21}$ + coefficient of x^4 in $(1+x)^{21}$

$$={}^{21}C_4+{}^{21}C_4=2.{}^{21}C_4$$

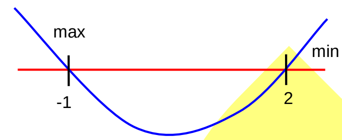
A_3 = coefficient of x^3 in $(1+x)^{21}$ + coefficient of x^3 in $(1+x)^{21}$

$$={}^{21}C_3+{}^{21}C_3=2.\left({}^{21}C_3\right)$$

$$A_4-A_3=2\left[{}^{21}C_4-{}^{21}C_3\right]=190P$$

$$P=49$$

Sol2. $f(x) = 2x^3 - 3x^2 - 12x$



$f'(x) = 6x^2 - 6x - 12$

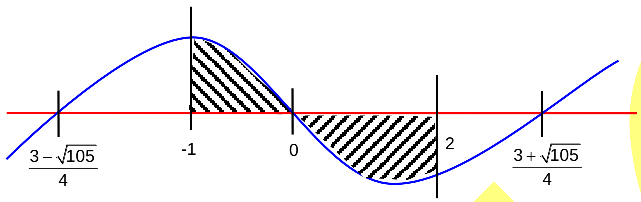
$= 6(x-2)(x+1)$

$a = -1, b = 2$

$A = \int_{-1}^{2} \left|2x^3 - 3x^2 - 12x\right| dx$

$f(x) = 2x^3 - 3x^2 - 12x$

$= x(2x^2 - 3x - 12)$



$A = \int_{-1}^{0} (2x^3 - 3x^2 - 12x) dx - \int_{0}^{2} (2x^3 - 3x^2 - 12x) dx = \frac{57}{2}$

$\Rightarrow 4A = 114$

Sol3. $\alpha + \beta = 1$

$\alpha\beta = 2\lambda$

$\frac{\beta}{\gamma} = \frac{2}{9}$,

$\Rightarrow \beta = \frac{2}{3}$

$\alpha = \frac{1}{3}, \quad \lambda = \frac{1}{9}$

$\therefore \frac{\beta\gamma}{\lambda} = 18$

$\alpha + \gamma = \frac{10}{3}$

$\alpha\gamma = 9\lambda$

$\beta - \gamma = 1 - \frac{10}{3} = -\frac{7}{3}$

$\gamma = 3$

Sol4. $|2A| = 2^3 |A|$

replace A by adj 2A

$|2 \text{ adj } 2A| = 2^3 |\text{adj } 2A|$

$= 2^3 |2A|^2 = 2^3 \left(2^3 |A|\right)^2$

$= 2^9 |A|^2$

Again replace A by (adj A)

$|2 \text{ adj} 2(\text{adj} A)| = 2^9 |\text{adj } A|^2$

$= 2^9 . |A|^4$

Replace A by (adj 2A)

$|2 \text{ adj } 2(\text{adj } (\text{adj } 2A))| = 2^9 \ |\text{adj } 2A|^4$

$= 2^9 \left(|2A|^2\right)^4$

$= 2^9\left(2^3|A|\right)^8$

$= 2^{9+24}|A|^8 = 2^{41}$

$\Rightarrow 2^{33}|A|^8 = 2^{41}$

$\Rightarrow |A|^8 = 2^8$

$\Rightarrow |A| = 2$

$\Rightarrow |A^2| = 4$

Sol5. The 1st such digit is 11 x 19 = 209

Sum = $[209+220+231+.....+495]-[231+319+341+418+451] = 7744$

Sol6. $\vec{a} = \hat{i}+2\hat{j}+\hat{k}$

$\vec{b} = 2\hat{i}+4\hat{j}-5\hat{k}$ $\quad\quad$ $\vec{c} = -\lambda\hat{i}+2\hat{j}+3\hat{k}$

$\vec{b}+\vec{c} = (2-\lambda)\hat{i}+6\hat{j}-2\hat{k}$

$1 = \dfrac{\vec{a}.(\vec{b}+\vec{c})}{|\vec{b}+\vec{c}|}$

$= \dfrac{2-\lambda+12-2}{\sqrt{(2-\lambda)^2+36+4}}$

$\Rightarrow (12-\lambda)^2 = (2-\lambda)^2+40$

$\Rightarrow \lambda = 5$

Sol7. $\dfrac{(2i)^n}{(1-i)^{n-2}}$

$= \dfrac{(2i)^n(1+i)^{n-2}}{(1+1)^{n-2}}$

$= \dfrac{2^n.i^2\left(i+i^2\right)^{n-2}}{2^{n-2}}$

$= -4(-1+i)^{n-2}$

now $(-1+i)^2 = -2i$

$(-1+i)^4 = (-2i)^2 = -4$

$\therefore -4(-1+i)^{n-2} \in (+)$ve integer for n – 2 = 4

$\Rightarrow n = 6$

Sol8. $\dfrac{3+7+x+y}{4} = 5$

$\Rightarrow x+y = 10$ ……….(i)

$\dfrac{1}{4}\left(9+49+x^2+y^2\right)-25 = 10$

$x^2+y^2 = 82$ ……….(ii)

$$\therefore \bar{x} = \frac{(3+2x)+(7+2y)+(x+y)+(x-y)}{4}$$

$$= \frac{10+4x+2y}{4}$$

Solving (i) & (ii), x = 9, y = 1

$$\therefore \bar{x} = \frac{48}{4} = 12$$

Sol9. $\vec{n}_1 = 6\hat{i}+7\hat{j}+8\hat{k}$ $\quad\quad$ $\vec{n}_2 = 3\hat{i}+5\hat{j}+7\hat{k}$

$$\vec{n}_1 \times \vec{n}_2 = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 6 & 7 & 8 \\ 3 & 5 & 7 \end{vmatrix} = 9\hat{i} - 18\hat{j} + 9k$$

$\therefore$ the normal to required plane is $\hat{i} - 2\hat{j} + \hat{k}$

Equation of plane $1(x+1) - 2(y-1) + (z-3) = 0$

$x - 2y + z = 0$

$P(7, -2, 13)$

$$\therefore PQ = \left|\frac{7+4+13}{\sqrt{1+4+1}}\right| = \frac{24}{\sqrt{6}}$$

$$(PQ)^2 = \frac{24 \times 24}{6} = 96$$

Sol10. $C_2 = a_2 + b_2 = (a_1 - 3) + 2b_1 = 12$

$a_1 + 2b_1 = 15$ ....(i)

$C_3 = a_3 + b_3 = (a_1 - 6) + 4b_1 = 13$

$a_1 + 4b_1 = 19$ ....(ii)

Solving (i) & (ii), $b_1 = 2, a_1 = 11$

$$\sum_{k=1}^{10} C_k = \sum_{k=1}^{10} a_k + \sum_{k=1}^{10} b_k$$

$$= 5[22 + 9(-3)] + 2\left(\frac{2^{10}-1}{2-1}\right)$$

$$= 5[-5] + 2(2^{10} - 1)$$

$$= 2^{11} - 27 = 2^6 \times 2^5 - 27 = 2021$$