FIITJEE

Solutions to JEE(Main) -2023

Test Date: 1st February 2023 (Second Shift)

PHYSICS, CHEMISTRY & MATHEMATICS

Paper - 1

Time Allotted: 3 Hours | **Maximum Marks: 300**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.

Important Instructions:

1. The test is of 3 hours duration.
2. This test paper consists of 90 questions. Each subject (PCM) has 30 questions. The maximum marks are 300.
3. This question paper contains **Three Parts. Part-A** is Physics, **Part-B** is Chemistry and **Part-C** is Mathematics. Each part has only two sections: **Section-A and Section-B**.
4. **Section – A** : Attempt all questions.
5. **Section – B :** Do any 5 questions out of 10 Questions.
6. **Section-A (01 – 20)** *contains 20 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*
7. ***Section-B (1 – 10)*** *contains 10 Numerical based questions. The answer to each question is rounded off to the nearest integer value. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

PART – A (PHYSICS)

SECTION - A

(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

Q1. Given below are two statements : One is labelled as **Assertion A** and the other is labelled as **Reason R.**

Assertion A : For measuring the potential difference across a resistance of $600\,\Omega$, the voltmeter with resistance $1000\,\Omega$ will be preferred over voltmeter with resistance $4000\,\Omega$.

Reason R : Voltmeter with higher resistance will draw smaller current than voltmeter with lower resistance.

In the light of the above statements, choose the most appropriate answer from the options given below.

(A) Both **A** and **R** are correct and **R** is the correct explanation of **A**
(B) **A** is not correct but **R** is correct
(C) Both **A** and **R** are correct but R is not the correct explanation of **A**
(D) **A** is correct but **R** is not correct

Q2. Two objects A and B are placed at 15cm and 25cm from the pole in front of a concave mirror having radius of curvature 40cm. The distance between images formed by the mirror is _________.

(A) 60cm
(B) 40cm
(C) 160cm
(D) 100cm

Q3. A coil is placed in magnetic field such that plane of coil is perpendicular to the direction of magnetic field. The magnetic flux through a coil can be changed :

A. By changing the magnitude of the magnetic field within the coil.
B. By changing the area of coil within the magnetic field.
C. By changing the angle between the direction of magnetic field and the plane of the coil.
D. By reversing the magnetic field direction abruptly without changing its magnitude.

Choose the most appropriate answer from the options given below :

(A) A, B and D only
(B) A and B only
(C) A, B and C only
(D) A and C only

Q4. The escape velocities of two planets A and B are in the ratio 1 : 2. If the ratio of their radii respectively is 1 : 3, then the ratio of acceleration due to gravity of planet A to the acceleration of gravity of planet B will be :

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

Q5. If the velocity of light c, universal gravitational constant G and Planck's constant h are chosen as fundamental quantities. The dimensions of mass in the new system is :

(A) $\left[h^{1/2}c^{1/2}G^{-1/2}\right]$
(B) $\left[h^{-1/2}c^{1/2}G^{1/2}\right]$
(C) $\left[h^{1}c^{1}G^{-1}\right]$
(D) $\left[h^{1/2}c^{-1/2}G^{1}\right]$

Q6. The Young's modulus of a steel wire of length 6m and cross-sectional area 3 mm^2, is 2×10^{11} N/m^2. The wire is suspended from its support on a given planet. A block of mass 4kg is attached to the free end of the wire. The acceleration due to gravity on the planet is $\frac{1}{4}$ of its value on the earth. The elongation of wire is (Take g on the earth = $10m/s^2$) :
(A) 1 cm
(B) 0.1 cm
(C) 1 mm
(D) 0.1 mm

Q7. Choose the correct statement about Zener diode :
(A) It work as a voltage regulator in forward bias behaves like simple pn junction diode in reverse bias.
(B) It works as a voltage regulation in both forward and reverse bais.
(C) It works as a voltage regulator in reverse bias behaves like simple pn junction diode in forward bias.
(D) It works as a voltage regulator only in forwards bias.

Q8. Given below are statements : One is labelled as **Assertion A** and the other is labelled as **Reason R.**
Assertion A : Two metallic spheres are charged to the same potential. One of them is hollow and another is solid, and both have the same radii. Solid sphere will have charge than the hollow one.

Reason R : Capacitance of metallic sphere depend on the radii of sphere.

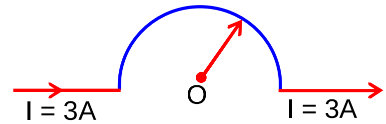
In the light of the above statements, choose the correct answer from the options given below.
(A) **A** is false but **R** is true
(B) **A** is true but R is false
(C) Both **A** and **R** are true but **R** is **not** the correct explanation of **A**
(D) Both **A** and **R** are true and **R** is the correct explanation of **A**

Q9. In an amplitude modulation, a modulating signal having amplitude of X V is superimposed with a carrier signal of amplitude Y V in first case. Then, in second case, the same modulating signal is superimposed with different carrier signal of amplitude 2Y V. The ratio of modulation index in the two cases respectively will be :
(A) 1 : 1
(B) 2 : 1
(C) 4 : 1
(D) 1 : 2

Q10. Equivalent resistance between the adjacent corners of a regular n-sided polygon of uniform wire of resistance R would be :
(A) $\frac{(n-1)R}{n^2}$
(B) $\frac{(n-1)R}{n}$
(C) $\frac{n^2 R}{n-1}$
(D) $\frac{(n-1)R}{(2n-1)}$

Q11. An electron of a hydrogen like atom, having Z = 4, jumps from 4^{th} energy state to 2^{nd} energy state. The energy released in this process, will be :
(Given Rch = 13.6 eV)
Where R = Rydberg constant
c = Speed of light on vacuum
h = Planck's constant
(A) 3.4 eV
(B) 40.8 eV
(C) 10.5 eV
(D) 13.6 eV

Q12. As shown in the figure, a long straight conductor with semicircular arc of radius $\frac{\pi}{10}$m is carrying current I = 3A. The magnitude of the magnetic field. at the centre O of the arc is :
(The permeability of the vacuum = $4\pi \times 10^{-7} NA^{-2}$)

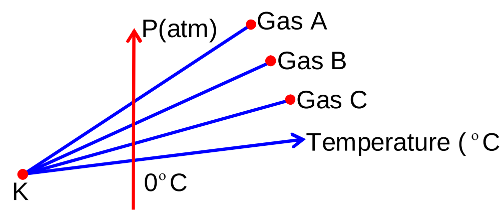


(A) $3\mu T$
(B) $6\mu T$
(C) $4\mu T$
(D) $1\mu T$

Q13. The ratio of average electric energy density and total average energy density of electromagnetic wave is :

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

Q14. For three low density gases A, B, C pressure versus temperature graphs are plotted while keeping them at constant volume, as shown in the figure. The temperature corresponding to the point 'K' is :

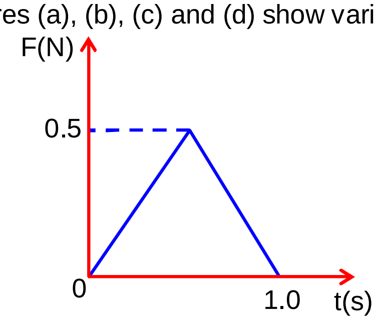


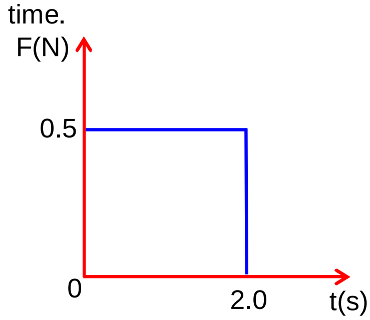
(A) $-273^\circ C$
(B) $-100^\circ C$
(C) $-373^\circ C$
(D) $-40^\circ C$

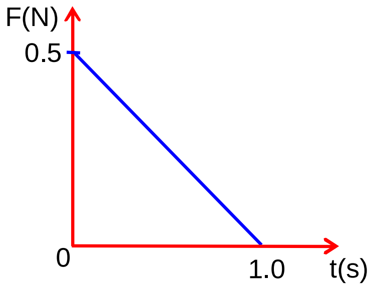
Q15. The threshold frequency of a metal of f_0. When the light of frequency $2f_0$ is incident on the metal plate, the maximum velocity of photoelectrons is υ_1. When the frequency of incident radiation is increased to $5f_0$, the maximum velocity of photoelectrons emitted is υ_2. The ratio of υ_1 to υ_2 is :

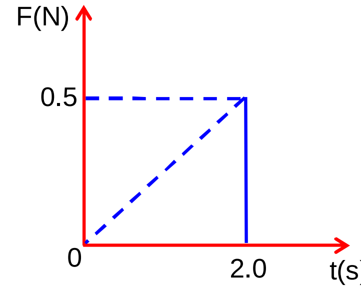
(A) $\frac{\upsilon_1}{\upsilon_2} = \frac{1}{2}$
(B) $\frac{\upsilon_1}{\upsilon_2} = \frac{1}{4}$
(C) $\frac{\upsilon_1}{\upsilon_2} = \frac{1}{16}$
(D) $\frac{\upsilon_1}{\upsilon_2} = \frac{1}{8}$

Q16. Figures (a), (b), (c) and (d) show variation of force with time.

(a)


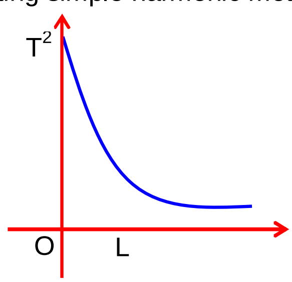
(b)


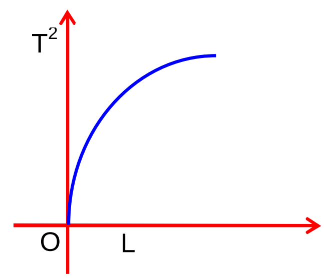
(c) 

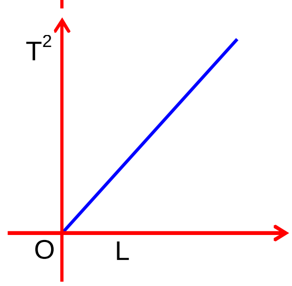
(d) 

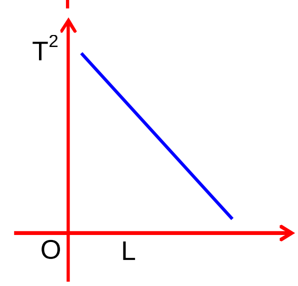
The impulse is highest in figure.
(A) Fig (b)
(B) Fig (d)
(C) Fig (a)
(D) Fig (c)

Q17. Choose the correct length (L) versus square of time period (T^2) graph for a simple pendulum executing simple harmonic motion.

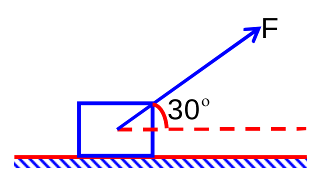
(A) 

(B) 

(C) 

(D) 

Q18. As shown in the figure a bock of mass 10kg lying on a horizontal surface is pulled by a force F acting at an angle 30°, with horizontal. For $\mu_s = 0.25$, the block will just start to move for the value of F : [Given g = 10 ms^{-2}]



(A) 33.3 N
(B) 25.2 N
(C) 35.7 N
(D) 20 N

Q19. A Carnot engine operating between two reservoirs has efficiency $\frac{1}{3}$. When the temperature of cold reservoir raised by x, its efficiency decreases to $\frac{1}{6}$. The value of x. if the temperature hot reservoir is 99°C, will be :
(A) 66 K
(B) 16.5 K
(C) 33 K
(D) 62 K

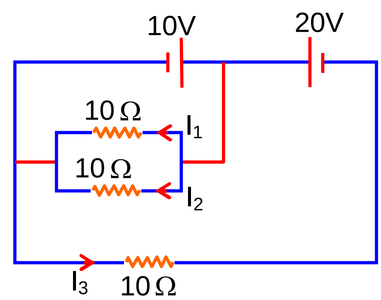
Q20. For a body projected at an angle with the horizontal from the ground, choose the correct statement.
(A) Gravitational potential energy is maximum at the highest point.
(B) The Kinetic Energy (K.E.) is zero at the highest point of projectile motion.
(C) The vertical component of momentum is maximum at the highest point.
(D) The horizontal component of velocity is zero at the highest point.

SECTION - B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

Q1. In the given circuit, the value of $\left|\frac{I_1 + I_3}{I_2}\right|$ is ________



Q2. Moment of inertia of a disc of mass M and radius 'R' about any of its diameter is $\frac{MR^2}{4}$. The moment of inertia of this disc about an axis normal to the disc and passing through a point on its edge will be, $\frac{x}{2}MR^2$. The value of x is _________.

Q3. A square shaped coil of area 70 cm^2 having 600 turns rotates in a magnetic field of 0.4 wbm^{-2}, about an axis which is parallel to one of the side of the coil and perpendicular to the direction of field. If the coil completes 500revolution in a minute, the instantaneous emf when the plane of the coil is inclined at 60° with the field, will be _______V. (Take $\pi = \frac{22}{7}$)

Q4. The surface of water in a water tank of cross section area 750cm^2 on the top of a house is h m above the tap level. The speed of water coming out through the tap of cross section area 500 mm^2 is 30cm/s. At that instant, $\frac{dh}{dt}$ is $x \times 10^{-3}$ m/s. The value of x will be _______.

Q5. A block is fastened to a horizontal spring. The block is pulled to a distance x = 10 cm from its equilibrium position (at x = 0) on a frictionless surface from rest. The energy of the block at x = 5cm is 0.25 J. The spring constant of the spring is ________Nm^{-1}.

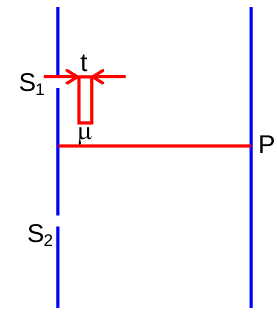
Q6. Nucleus A having Z = 17 and equal number of protons and neutrons has 1.2 MeV binding energy per nucleon.
Another nucleus B of Z = 12 has total 26 nucleons and 1.8 MeV binding energy per nucleons. The difference of binding energy of B and A will be _______ MeV.

Q7. A cubical volume is bounded by the surfaces x = 0, x = a, y = 0, y = a, z = 0, z = a. The electric field in the region is given by $\vec{E} = E_0 x \hat{i}$. Where $E_0 = 4 \times 10^4 NC^{-1}m^{-1}$. If a = 2cm, the charge contained in the cubical volume is $Q \times 10^{-14}$ C. The value of Q is ________.
(Take $\epsilon_0 = 9 \times 10^{-12} C^2/Nm^2$)

Q8. For a train engine moving with speed of 20 ms^{-1}, the driver must apply brakes at a distance of 500m before the station for the train to come to rest at the station. If the breaks were applied at half of this distance, the train engine would cross the station with speed $\sqrt{x}\ ms^{-1}$. The value of x is _______.
(Assuming same retardation is produced by brakes)

Q9. A force $F = (5 + 3y^2)$ acts on a particle in the y-direction, where F is in newton and y is in meter. The work done by the force during a displacement form y = 2m to y = 5m is ______J.

Q10. As shown in the figure, in Young's double slit experiment, a thin plate of thickness t = 10 μ m and refractive index $\mu = 1.2$ is inserted infront of slit S_1. The experiment is conducted in air $(\mu = 1)$ and uses a monochromatic light of wavelength $\lambda = 500$ nm. Due to the insertion of the plate, central maxima is shifted by a distance of $x\beta_0$. β_0 is the fringe – width before the insertion of the plate. The value of the x is ________.



PART – B (CHEMISTRY)

SECTION - A

(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

Q1. Given below are two statements: one is labelled as **Assertion (A)** and the other is labelled as **Reason (R)**

Assertion (A): Cu^{2+} in water is more stable than Cu^{+}

Reason (R): Enthalpy of hydration for Cu^{2+} is much less than that of Cu^{+}

In the light of the above statements, choose the correct answer from the options given below:

(A) Both **(A)** and **(R)** are correct but **(R)** is **not** the correct explanation of **(A)**
(B) **(A)** is correct but **(R)** is not correct
(C) Both **(A)** and **(R)** are correct and (R) is the correct explanation of **(A)**
(D) **(A)** is not correct but **(R)** is correct

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

Assertion (A): α-halocarboxylic acid on reaction with dil NH_3 gives good yield of α-amino carboxylic acid whereas the yield of amine is very low when prepared from alkyl halides.

Reason (R): Amino acids exist in zwitter ion form in aqueous medium.

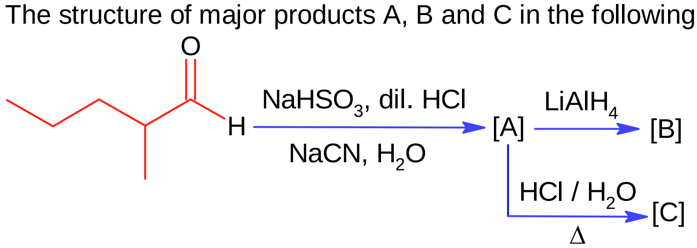
In the light of the above statements, choose the correct answer from the options given below:

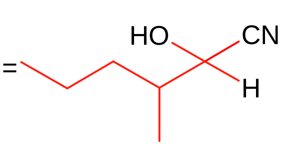
(A) **(A)** is not correct but **(R)** is correct
(B) Both **(A)** and **(R)** are correct but **(R)** is **not** the correct explanation of **(A)**
(C) **(A)** is correct but **(R)** is not correct
(D) Both **(A)** and **(R)** are correct and (R) is the correct explanation of **(A)**

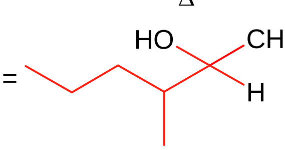
Q3. The correct order of bond enthalpy ($kJ\ mol^{-1}$) is:

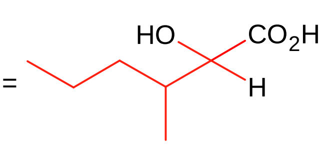
(A) Si –Si > C – C > Ge – Ge > Sn – Sn
(B) C – C > Si – Si > Ge – Ge > Sn – Sn
(C) C – C > Si – Si> Sn – Sn > Ge – Ge
(D) Si – Si > C – C > Sn – Sn > Ge – Ge

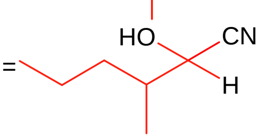
Q4. The structure of major products A, B and C in the following reaction sequence are.

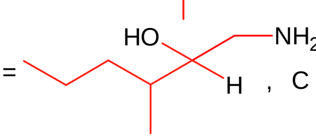


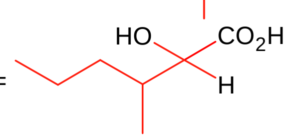
(A) A = 

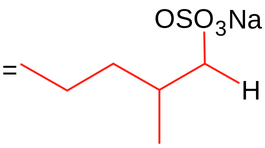
, B = 

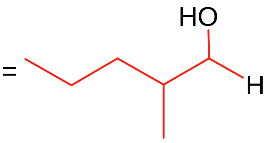
, C = 

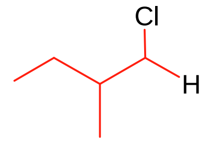
(B) A = 

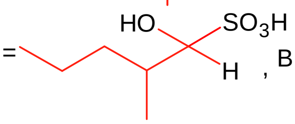
, B = 

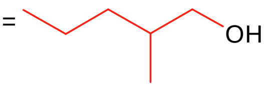
, C = 

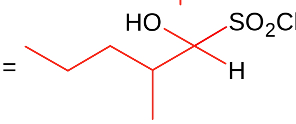
(C) A = 

, B = 

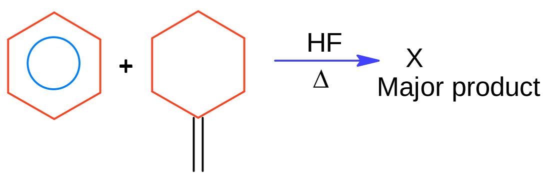
, C = 

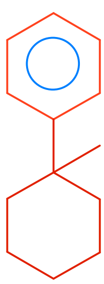
(D) A = 

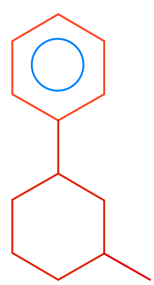
, B = 

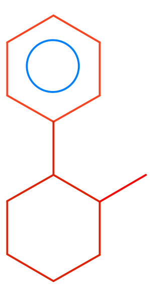
, C = 

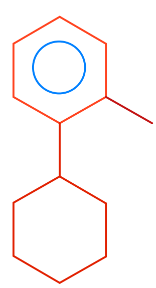
Q5. Given below are two statements: one is labelled as **Assertion (A)** and other is labelled as **Reason (R)**
Assertion (A): Gypsum is used for making fireproof wall boards
Reason (R): Gypsum is unstable at high temperature
In the light of the above statements, choose the correct answer from the options given below:
(A) **(A)** is not correct but **(R)** is correct
(B) Both **(A)** and **(R)** are correct but **(R)** is **not** the correct explanation of **(A)**
(C) **(A)** is correct but **(R)** is not correct
(D) Both **(A)** and **(R)** are correct and (R) is the correct explanation of **(A)**

Q6. 'X' is 

(A) 

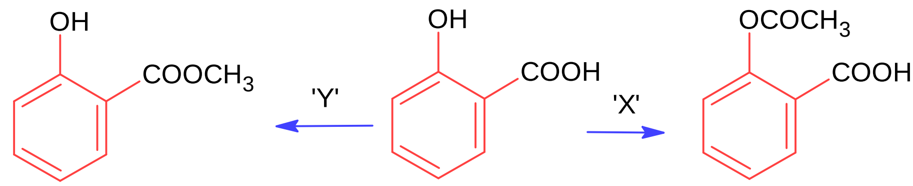
(B) 

(C) 

(D) 

Q7. Given below are two statements:
Statement I: Sulphanilic acid gives esterification test for carboxyl group.
Statement II: Sulphanilic acid gives red colour in Lassigne's test for extra element detection.
In the light of the above statements, choose the most appropriate answer from the options given below:
(A) Both **Statement I** and **Statement II** are correct
(B) Both **Statement I** and **Statement II** are incorrect
(C) **Statement I** is correct but **Statement II** is incorrect
(D) **Statement I** is incorrect but **Statement II** is correct

Q8. In a reaction



Reagents 'X' and 'Y' respectively are:
(A) $(CH_3CO)_2O/H^+$ and $CH_3OH/H^+,\Delta$
(B) $CH_3OH/H^+, \Delta$ and $(CH_3CO)_2O/H^+$
(C) $CH_3OH/H^+,\Delta$ and $CH_3OH/H^+,\Delta$
(D) $(CH_3CO)_2O/H^+$ and $(CH_3CO)_2O/H^+$

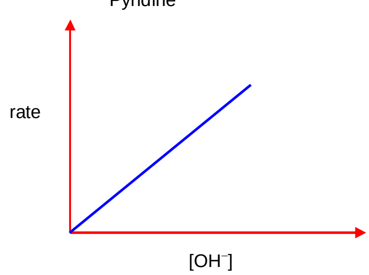
Q9. Which one of the following sets of ions represents a collection of isoelectronic species?
(Given: Atomic Number: F: 9, Cl: 17, Na = 11, Mg = 12, Al = 13, K = 19, Ca = 20, Sc= 21)
(A) $Ba^{2+}, Sr^{2+}, K^+, Ca^{2+}$
(B) $Li^+, Na^+, Mg^{2+}, Ca^{2+}$
(C) $K^+, Cl^-, Ca^{2+}, Sc^{3+}$
(D) $N^{3-}, O^{2-}, F^-, S^{2-}$

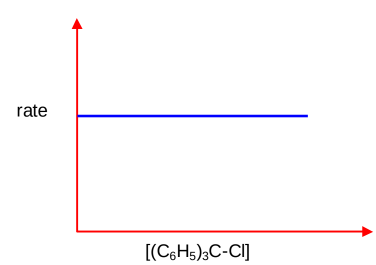
Q10. Which element is not present in Nessler's reagent?
(A) Oxygen
(B) Mercury
(C) Iodine
(D) Potassium

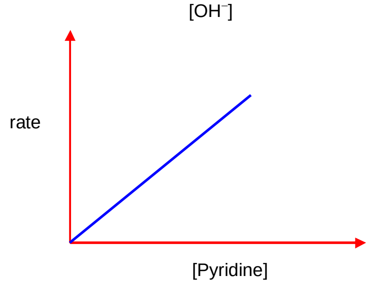
Q11. For electron gain enthalpies of the elements denoted as $\Delta_{eg}H$, the incorrect option is:
(A) $\Delta_{eg}H(I) < \Delta_{eg}H(At)$
(B) $\Delta_{eg}H(Te) < \Delta_{eg}H(Po)$
(C) $\Delta_{eg}H(Cl) < \Delta_{eg}H(F)$
(D) $\Delta_{eg}H(Se) < \Delta_{eg}H(S)$

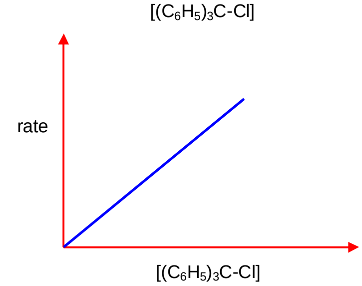
Q12. The graph which represents the following reaction is:

$$(C_6H_5)_3C-Cl \xrightarrow[\text{Pyridine}]{OH^-} (C_6H_5)_3C-OH$$

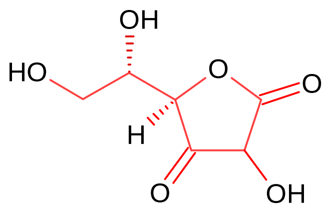
(A)


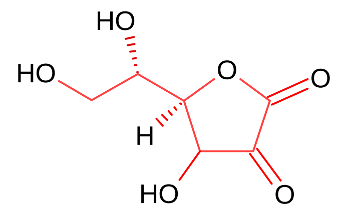
(B)


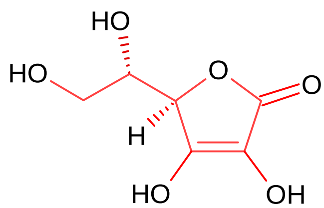
(C)


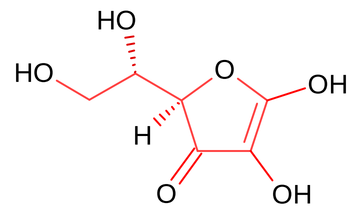
(D)


Q13. All structure given below are of vitamin C. Most stable of them is:

(A) 

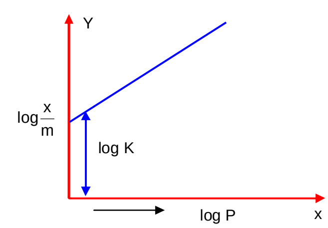
(B) 

(C) 

(D) 

Q14. The Industrial activity held least responsible for global warming is:
(A) Electricity generation in thermal power plants
(B) Steel manufacturing
(C) Industrial production of urea
(D) manufacturing of cement

Q15. In figure, a straight line is given for Freundrich Adsorption (y = 3x +2.505). The vale of $\frac{1}{n}$ and log K are respectively.



(A) 0.3 and 0.7033
(B) 3 and 2.505
(C) 0.3 and log 2.505
(D) 3 and 0.7033

Q16. The complex cation which has two isomers is :
(A) $[Co(NH_3)_5Cl]^{2+}$
(B) $[Co(NH_3)_5Cl]^{+}$
(C) $[Co(NH_3)_5NO_2]^{2+}$
(D) $[Co(H_2O)_6]^{3+}$

Q17. The starting material for convenient preparation of deuterated hydrogen peroxide(D_2O_2) in laboratory is :
(A) $K_2S_2O_8$
(B) BaO_2
(C) 2- ethylanthraquinol
(D) BaO

Q18. The effect of addition of helium gas to the following reaction in equilibrium state, is
$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$
(A) The equilibrium will shift in the forward direction and more of Cl_2 and PCl_3 gases will be produced.
(B) The equilibrium will go backward due to suppression of dissociation of PCl_5.
(C) Helium will deactivate PCl_5 and reaction will stop.
(D) Addition of helium will not effect the equilibrium.

Q19. Given below are two statements: one is labelled as **Assertion (A)** and other is labelled as **Reason (R)**
Assertion (A): An aqueous solution of KOH when used for volumetric analysis, its concentration should be checked before the use.
Reason (R): On aging, KOH solution absorbs atmospheric CO_2.
In the light of the above statements, choose the correct answer from the options given below:
(A) Both **(A)** and **(R)** are correct but **(R)** is **not** the correct explanation of **(A)**
(B) **(A)** is not correct but **(R)** is correct
(C) Both **(A)** and **(R)** are correct and (R) is the correct explanation of **(A)**
(D) **(A)** is correct but **(R)** is not correct

Q20. O-O bond length in H_2O_2 is X than the O-O bond length in F_2O_2. The O-H bond length in H_2O_2 is Y than that of the O-F bond in F_2O_2.
Choose the correct option for X and Y from those given below:

(A) X – shorter, Y = longer
(B) X- longer, Y – shorter
(C) X- shorter, Y- shorter
(D) X- longer, Y- longer

SECTION - B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

Q1. The molality of a 10%(v/v) solution of di-bromine solution in CCl_4 (Carbon tetrachloride) is 'x'
x= ______________ $\times 10^{-2}$ m. (Nearest integer)
[Given: molar mass of Br_2 = 160 g mol^{-1}
Atomic mass of C = 12 g mol^{-1}, Atomic mass of Cl = 35.5 g mol^{-1}
Density of dibromine = 3.2g cm^{-3}
Density of CCl_4 = 1.6 g cm^{-3}]

Q2. 0.3 g of ethane undergoes combustion at 27°C in a bomb calorimeter. The temperature of calorimeter system (including the water) is found to rise by 0.5°C. The heat evolved during combustion of ethane at constant pressure is_______ kJ mol^{-1}.(Nearest integer)
[Given: The heat capacity of the calorimeter system is 20 kJ K^{-1}, R = 8.3 JK^{-1} mol^{-1}.
Assume ideal gas behaviour.
Atomic mass of C and H are 12 and 1g mol^{-1} respectively]

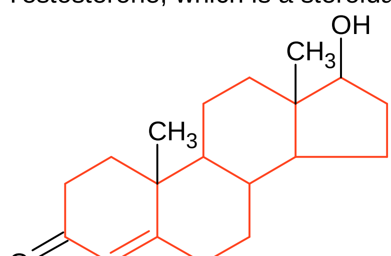
Q3. $A \rightarrow B$
The above reaction is of zero order. Half life of this reaction is 50 min. the time taken for the concentration of A to reduced to one- fourth of its initial value is___________ min. (Nearest integer)

Q4. 20% of acetic acid is dissociated when its 5 g is added to 500mL of water.
The depression in freezing point of such water is___________ $\times 10^{-3}$ °C.
Atomic mass of C, H and O are 12,1 and 16 a.m.u respectively.
[Given: Molal depression constant and density of water are 1.86 K kg $mol^{-1}$and 1g cm^{-3} respectively].

Q5. Among following compounds, the number of those present in copper matte is______.
(A) $CuCO_3$ (B) Cu_2S
(C) Cu_2O (D) FeO

Q6. Among the following, the number of tranquilizer is / are____________.
(A) Chloroliazepoxide (B) Veronal
(C) Valium (D) Salvarsan

Q7. Testosterone, which is a steroidal hormone, has the following structure.



Testosterone

The total number of asymmetric carbon atom/s in testosterone is___________.

Q8. 1×10^{-5} M $AgNO_3$ is added to 1 L of saturated solution of AgBr. The conductivity of this solution at 298 K is__________$\times10^{-8}$ Sm^{-1}.
[Given : $K_{sp}(AgBr) = 4.9\times10^{-13}$ at 298 K
$\lambda^0_{Ag^+} = 6\times10^{-3} Sm^2 mol^{-1}$
$\lambda^0_{Br^-} = 8\times10^{-3} Sm^2 mol^{-1}$
$\lambda^0_{NO_3^-} = 7\times10^{-3} Sm^2 mol^{-1}$]

Q9. The spin only magnetic moment of $[Mn(H_2O)_6]^{2+}$ complexes is_______B.M
(Nearest integer)
(Given: Atomic no. of Mn is 25)

Q10. A metal M crystallizes into two lattices:- face centred cubic (fcc) and body centred cubic (bcc) with unit cell edge length of 2.0 and 2.5 $\overset{o}{A}$ respectively. The ratio of densities of lattices fcc to bcc for the metal M is___________.
(Nearest integer)

PART – C (MATHEMATICS)

SECTION - A

(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

Q1. The sum of the absolute maximum and minimum values of the function $f(x)=\left|x^2-5x+6\right|-3x+2$ in the interval $[-1,3]$ is equal to :

(A) 10 (B) 12
(C) 13 (D) 24

Q2. The area of the region given by $\{(x,y): xy \le 8, 1 \le y \le x^2\}$ is :

(A) $8\log_e 2+\frac{7}{6}$ (B) $8\log_e 2-\frac{13}{3}$
(C) $16\log_e 2-\frac{14}{3}$ (D) $16\log_e 2+\frac{7}{3}$

Q3. Let $f: R-\{0,1\} \to R$ be a function such that $f(x)+f\left(\frac{1}{1-x}\right)=1+x$ .Then $f(2)$ is equal to

(A) $\frac{7}{4}$ (B) $\frac{7}{3}$
(C) $\frac{9}{4}$ (D) $\frac{9}{2}$

Q4. The number of integral values of k, for which one root of the equation $2x^2-8x+k=0$ lies in the interval $(1,2)$ and its other root lies in the interval $(2,3)$, is :

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

Q5. If $y(x)=x^x, x>0$, then $y''(2)-2y'(2)$ is equal to :

(A) $8\log_e 2-2$ (B) $4\log_e 2+2$
(C) $4(\log_e 2)^2+2$ (D) $4(\log_e 2)^2-2$

Q6. Let $\vec{a}=2\hat{i}-7\hat{j}+5\hat{k}, \vec{b}=\hat{i}+\hat{k}$ and $\vec{c}=\hat{i}+2\hat{j}-3\hat{k}$ be three given vectors. If $\vec{r}$ is vector such that $\vec{r}\times\vec{a}=\vec{c}\times\vec{a}$ and $\vec{r}\cdot\vec{b}=0$, then $|\vec{r}|$ is equal to :

(A) $\frac{\sqrt{914}}{7}$ (B) $\frac{11}{7}$
(C) $\frac{11}{5}\sqrt{2}$ (D) $\frac{11}{7}\sqrt{2}$

Q7. Let $S=\left\{x\in R:0<x<1 \text{ and } 2\tan^{-1}\left(\frac{1-x}{1+x}\right)=\cos^{-1}\left(\frac{1-x^2}{1+x^2}\right)\right\}$.

If $n(S)$ denotes the number of elements in S then :

(A) $n(S)=1$ and the element in S is less than $\frac{1}{2}$.

(B) $n(S)=1$ and the elements in S is more than $\frac{1}{2}$.

(C) $n(S)=0$

(D) $n(S)=2$ and only one element in S is less than $\frac{1}{2}$.

Q8. Let $P(S)$ denote the power set of $S=\{1,2,3,....,10\}$. Define the relations R_1 and R_2 on $P(S)$ as AR_1B if $(A\cap B^C)\cup(B\cap A^C)=\phi$ and AR_2B if $A\cup B^C=B\cup A^C, \forall A,B\in P(S)$. Then :

(A) both R_1 and R_2 are not equivalence relations
(B) only R_1 is an equivalence relation
(C) both R_1 and R_2 are equivalence relations
(D) only R_2 is an equivalence relation

Q9. Let $9=x_1<x_2<....<x_7$ be in an A.P. with common difference d. If the standard deviation of $x_1,x_2,....,x_7$ is 4 and the mean is $\overline{x}$, then $\overline{x}+x_6$ is equal to :

(A) $2\left(9+\frac{8}{\sqrt{7}}\right)$ (B) $18\left(1+\frac{1}{\sqrt{3}}\right)$
(C) 25 (D) 34

Q10. Let $P(x_0,y_0)$ be the point on the hyperbola $3x^2-4y^2=36$, which is nearest to the line $3x+2y=1$. Then $\sqrt{2}(y_0-x_0)$ is equal to :

(A) 9 (B) –3
(C) 3 (D) –9

Q11. If $A=\frac{1}{2}\begin{bmatrix}1 & \sqrt{3}\\ -\sqrt{3} & 1\end{bmatrix}$, then :

(A) $A^{30}+A^{25}-A=I$ (B) $A^{30}-A^{25}=2I$
(C) $A^{30}=A^{25}$ (D) $A^{30}+A^{25}+A=I$

Q12. The sum $\sum_{n=1}^{\infty}\frac{2n^2+3n+4}{(2n)!}$ is equal to :

(A) $\frac{11e}{2}+\frac{7}{2e}$ (B) $\frac{11e}{2}+\frac{7}{2e}-4$
(C) $\frac{13e}{4}+\frac{5}{4e}$ (D) $\frac{13e}{4}+\frac{5}{4e}-4$

Q13. Which of the following statements is a tautology?

(A) $(p\wedge(p\to q))\to \sim q$ (B) $p\vee(p\wedge q)$
(C) $(p\wedge q)\to(\sim(p)\to q)$ (D) $p\to(p\wedge(p\to q))$

Q14. Two dice are thrown independently. Let A be the event that the number appeared on the 1st die is less than the number appeared on the 2nd die, B be the even that the number appeared on the 1st die is even and that on the second die is odd, and C be the event that the number appeared on the 1st die is odd and that on the 2nd is even. Then :
(A) the number of favourable cases of the events A, B and C are 15, 6 and 6 respectively
(B) the number of favourable cases of the event $(A \cup B) \cap C$ is 6
(C) A and B are mutually exclusive
(D) B and C are independent

Q15. Let a, b, be two real numbers such that $ab < 0$. If the complex number $\frac{1+ai}{b+i}$ is of unit modulus and $a+ib$ lies on the circle $|z-1| = |2z|$, then a possible value of $\frac{1+[a]}{4b}$, where $[t]$ is greatest integer function, is :
(A) $\frac{1}{2}$
(B) -1
(C) $-\frac{1}{2}$
(D) 1

Q16. The value of the integral $\int_{-\frac{\pi}{4}}^{\frac{\pi}{4}} \frac{x+\frac{\pi}{4}}{2-\cos 2x}dx$ is :
(A) $\frac{\pi^2}{6\sqrt{3}}$
(B) $\frac{\pi^2}{3\sqrt{3}}$
(C) $\frac{\pi^2}{6}$
(D) $\frac{\pi^2}{12\sqrt{3}}$

Q17. Let $\alpha x = \exp\left(x^{\beta} y^{\gamma}\right)$ be the solution of the differential equation
$2x^2y\,dy - \left(1-xy^2\right)dx = 0,\ x > 0,\ y(2) = \sqrt{\log_e 2}$. Then $\alpha + \beta - \gamma$ equals :
(A) -1
(B) 3
(C) 1
(D) 0

Q18. For the system of linear equations $\alpha x + y + z = 1,\ x + \alpha y + z = 1,\ x + y + \alpha z = \beta$, which one of the following statements is NOT correct?
(A) It has infinitely many solutions if $\alpha = 2$ and $\beta = -1$
(B) It has no solution if $\alpha = -2$ and $\beta = 1$
(C) $x + y + z = \frac{3}{4}$ if $\alpha = 2$ and $\beta = 1$
(D) It has infinitely many solutions if $\alpha = 1$ and $\beta = 1$

Q19. Let $\vec{a} = 5\hat{i} - \hat{j} - 3\hat{k}$ and $\vec{b} = \hat{i} + 3\hat{j} + 5\hat{k}$ be two vectors. Then which one of the following statements is TRUE?
(A) Projection of $\vec{a}$ on $\vec{b}$ is $\frac{17}{\sqrt{35}}$ and the direction of the projection vector is opposite to the direction of $\vec{b}$.

(B) Projection of $\vec{a}$ on $\vec{b}$ is $\frac{-17}{\sqrt{35}}$ and the direction of the projection vector is same as of $\vec{b}$.

(C) Projection of $\vec{a}$ on $\vec{b}$ is $\frac{-17}{\sqrt{35}}$ and the direction of the projection vector is opposite to the direction of $\vec{b}$.

(D) Projection of $\vec{a}$ on $\vec{b}$ is $\frac{17}{\sqrt{35}}$ and the direction of the projection vector is same as of $\vec{b}$.

Q20. Let the plane P pass through the intersection of the planes $2x+3y-z=2$ and $x+2y+3z=6$, and be perpendicular to the plane $2x+y-z+1=0$. If d is the distance of P from the point $(-7,1,1)$, then d^2 is equal to :

(A) $\frac{250}{83}$

(B) $\frac{15}{53}$

(C) $\frac{25}{83}$

(D) $\frac{250}{82}$

SECTION - B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

Q1. If $\int_0^{\pi} \frac{5^{\cos x}\left(1+\cos x \cos 3x+\cos^2 x+\cos^3 x \cos 3x\right)dx}{1+5^{\cos x}}=\frac{k\pi}{16}$, then k is equal to………

Q2. Let $\alpha x+\beta y+yz=1$ be the equation of a plane passing through the point $(3,-2,5)$ and perpendicular to the line joining the points $(1,2,3)$ and $(-2,3,5)$. Then the value of $\alpha\beta\gamma$ is equal to………..

Q3. Number of integral solutions to the equation $x+y+z=21$, where $x\ge 1, y\ge 3, z\ge 4$, is equal to……….

Q4. The total number of six digit numbers, formed using the digits 4, 5, 9 only and divisible by 6, is…………

Q5. The point of intersection C of the plane $8x+y+2z=0$ and the line joining the points $A(-3,-6,1)$ and $B(2,4,-3)$ divides the line segment AB internally in the ratio $k:1$. If $a,b,c,(|a|,|b|,|c| \text{ are coprime})$ are the directions ratios of the perpendicular from the point C on the line $\frac{1-x}{1}=\frac{y+4}{2}=\frac{z+2}{3}$, then $|a+b+c|$ is equal to………

Q6. The sum of the common terms of the following three arithmetic progressions
$3,7,11,15,......,399$,
$2,5,8,11,.....,359$ and
$2,7,12,17,.....,197$, is equal to…………

Q7. If the x-intercept of a focal chord of the parabola $y^2=8x+4y+4$ is 3, then the length of this chord is equal to…….

Q8. Let the sixth term in the binomial expansion of $\left(\sqrt{2^{\log_2\left(10-3^x\right)}}+\sqrt[5]{2^{(x-2)\log_2 3}}\right)^m$, in the increasing powers of $2^{(x-2)\log_2 3}$, be 21. If the binomial coefficients of the second, third and fourth terms in the expansion are respectively the first, third and fifth terms of A.P., then the sum of the squares of all possible values of x is………..

Q9. The line x = 8 is the directrix of the ellipse is $E:\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ with the corresponding focus $(2,0)$. If the tangent to E at the point P in the first quadrant passes through the point $\left(0,4\sqrt{3}\right)$ and intersects the x-axis at Q, then $(3PQ)^2$ is equal to………..

Q10. If the term without x in the expansion of $\left(x^{\frac{2}{3}}+\frac{\alpha}{x^3}\right)^{22}$ is 7315, then $|\alpha|$ is equal to……….

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KEYS to JEE (Main)-2023

PART – A (PHYSICS)

SECTION - A

1.	B	2.	C	3.	C	4.	C
5.	A	6.	D	7.	C	8.	A
9.	B	10.	A	11.	B	12.	A
13.	B	14.	A	15.	A	16.	A
17.	C	18.	B	19.	D	20.	A

SECTION – B

1.	2	2.	3	3.	44	4.	2
5.	50	6.	6	7.	288	8.	200
9.	132	10.	4				

PART – B (CHEMISTRY)

SECTION - A

1.	C	2.	D	3.	B	4.	B
5.	B	6.	A	7.	D	8.	A
9.	C	10.	A	11.	D	12.	D
13.	C	14.	C	15.	B	16.	C
17.	A	18	A OR D	19.	C	20.	B

SECTION - B

1.	139	2.	1006	3.	75	4.	372
5.	1	6.	3	7.	6	8.	14
9.	6	10.	4				

PART – C (MATHEMATICS)

SECTION - A

1.	A	2.	C	3.	C	4.	B
5.	D	6.	D	7.	A	8.	C
9.	D	10.	D	11.	A	12.	D
13.	C	14.	B	15.	DROP	16.	A
17.	C	18	A	19.	DROP	20.	A

SECTION - B

1.	13	2.	6	3.	105	4.	81
5.	10	6.	321	7.	16	8.	4
9.	39	10.	1				

FIITJEE
Solutions to JEE (Main)-2023

PART – A (PHYSICS)

SECTION – A

Sol1. To measure the potential difference between two points, voltmeter is used. But this voltmeter should be with higher resistance so that it cannot draw any current. Now to measure the potential difference across 600Ω, voltmeter of 4000 Ω is much better than 1000 Ω voltmeter.

Sol2. Using mirror formula

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

$$\Rightarrow v=\frac{uf}{u-f}$$

For object O_1, u_1 = - 15cm, f = - 20 cm, v_1 = ?

$$v_1=\frac{u_1 f}{u_1-f}=\frac{(-15)(-20)}{(-15)-(-20)}=\frac{300}{5}\text{cm}=60\text{cm}$$

For object O_2, u_2 = - 25cm, f = - 20 cm, v_2 = ?

$$v_2=\frac{u_2 f}{u_2-f}=\frac{(-25)(-20)}{(-25)-(-20)}=\frac{500}{-5}\text{cm}=-100\text{cm}$$

Hence, the distance between images formed by the mirror is $d=160\text{cm}$

Sol3. $\phi=BA\cos\theta$

From above expression, we can say that, the flux can be changed by
- changing the magnitude of field,
- changing the area of coil
- changing the angle between the direction of field and the plane of the coil.

Sol4. Given: $\frac{v_A}{v_B}=\frac{1}{2}$ & $\frac{r_A}{r_B}=\frac{1}{3}$

$$\frac{g_A}{g_B}=?$$

As we know that $v_{escape}=\sqrt{\frac{2GM}{R}}$

Hence,

$$\frac{v_A}{v_B}=\frac{\sqrt{\frac{2GM_A}{R_A}}}{\sqrt{\frac{2GM}{R_B}}}=\sqrt{\frac{M_A R_B}{M_B R_A}}=\frac{1}{2}\text{..........(1)}$$

Also, $\frac{r_A}{r_B} = \frac{1}{3}$ …………..(2)

On solving (1) & (2), we get

$\therefore \frac{g_A}{g_B} = \frac{M_A R_A^2}{M_B R_B^2} = \frac{1}{4} \times \frac{1}{3} \times 9 = \frac{3}{4}$

Sol5. Let the mass is represented as

$M = G^x h^y c^z$

$[M] = [G]^x [h]^y [c]^z$

$[M] = \left[M^{-1}L^3T^{-2}\right]^x \left[ML^2T^{-1}\right]^y \left[LT^{-1}\right]^z$

$\left[M^1L^0T^0\right] = \left[M^{-x+y}\right]\left[L^{3x+2y+z}\right]\left[T^{-2x-y-z}\right]$

So, on comparing we get

$-x + y = 1$……………………(1)

$3x + 2y + z = 0$……………… (2)

$-2x - y - z = 0$………………..(3)

On solving (1), (2) & (3), we get

$x = -\frac{1}{2},\ y = \frac{1}{2},\ z = \frac{1}{2}$

$m = \sqrt{\frac{hc}{G}}$ So,

Sol6. As we know that,

Young's modulus, $Y = \frac{\text{stress}}{\text{strain}} \Rightarrow Y = \frac{FL}{A\Delta L}$

Given: $Y = 2 \times 10^{11}, N/m^2 L = 6m g_P = \frac{g}{4}, A = 3mm^2$

Hence, $M = 4kg F = mg_P = 4 \times \frac{10}{4} = 10N$

$2 \times 10^{11} = \frac{10 \times 6}{3 \times 10^{-6} \times \Delta L}$

$\Rightarrow \Delta L = 0.1mm$

Sol7. Zener diode act as a voltage regulator & it is used in reverse bias.
Similarly it behaves as a p-n junction diode in forward bias.

Sol8. As we know, capacitance of spherical conductor is $C = 4\pi\varepsilon_0 R$

So, capacitance does not depend on its charge, it depends only on the radius of the conductor (R).

Therefore, assertion is false, R is true.

Sol9. $\mu =$ ratio of modulation index

$A_m = x, A_c = y$

$A_m = x, A_c = 2y$ ------------------------ (i)

$$\mu_1 = \frac{A_m}{A_c} = \frac{x}{y} \;\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(ii)}$$

$$\mu_2 = \frac{A_m}{A_c} = \frac{x}{2y}$$

On solving both eq^n, we get

$$\frac{\mu_1}{\mu_2} = \frac{2}{1}$$

Sol10. When, a uniform wire of resistance R is shaped into a regular n-sided polygon, the resistance of each side will be

$$R_1 = \frac{R}{n}$$

Let R_1 & R_2 be the resistance between adjacent corners of a regular polygon.

Thus, the resistance of (n-1) side,

$$R_2 = \frac{(n-1)R}{n}$$

As the two parts are in parallel, So,

$$R_{eq} = \frac{R_1 \times R_2}{R_1 + R_2} = \frac{\left(\frac{R}{n}\right)\left(\frac{n-1}{n}\right)R}{\left(\frac{R}{n}\right)+\left(\frac{n-1}{n}\right)R}$$

$$R_{eq} = \frac{(n-1)R^2}{n^2} \times \frac{n}{R + nR - R}$$

So, $R_{eq} = \frac{(n-1)R}{n^2}$

Sol11. $\Delta E = 13.6 \times Z^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

$Z = 4$, $n_1 = 2$, $n_2 = 4$

$$\Delta E = 13.6 \times 4^2\left(\frac{1}{4} - \frac{1}{16}\right)$$

$$\Delta E = 13.6 \times (4)^2\left(\frac{16-4}{16}\right)$$

$$\Delta E = 40.8 \text{ eV}$$

Sol12. Given: $R = \frac{\pi}{10}$m, $I = 3A$, $\mu_0 = 4\mu \times 10^{-7}$ N/A^2

Magnetic field due to semi-circular arc is

$$B = \frac{\mu_0 I}{4R} = \frac{4\mu \times 10^{-7} \times 3}{4 \times \frac{\mu}{10}} = 3\mu T$$

Sol13. Average electric energy density $= \frac{1}{4}\varepsilon_0 E_0^2$

Total average energy density $= \frac{1}{2}\varepsilon_0 E_0^2$

So,

The ratio of average electric energy density and total average energy density is

$$\Rightarrow \frac{\frac{1}{4}\varepsilon_0 E_0^2}{\frac{1}{2}\varepsilon_0 E_0^2} = \frac{1}{2}$$

Sol14. From ideal gas equation

$PV = nRT$

$\because$ volume is constant

$P \propto T$

It is clear from graph that for all the gases lines of grpahs meet at the same value.

At x-axis i.e, temperature axis, P is zero but temperature is negative and it will be equal to 0 K or -273°C.

Sol15. Using photoelectric equation

$hf - hf_0 = eV_0$

According to the question,

$h(2f_0) - h(f_0) = eV_1$

$h(2f_0 - f_0) = eV_1$ ……………………….(i)

Again,

$hf_0 = eV_1$

$h(5f_0) - hf_0 = eV_2$ ……………………..(ii)

Using eq (i) & eq (ii), we get

$h(5f_0 - f_0) = eV_2$

$4hf_0 = eV_2$

$$\frac{4hf_0}{hf_0} = \frac{eV_2}{eV_1}$$

$$\frac{V_2}{V_1} = 4$$

Or,

As we know that

$KE_{max} = eV = \frac{1}{2}mv_{max}^2$

$\therefore V_{max} \propto \sqrt{V}$

Thus, $\frac{v_2}{v_1} = \sqrt{\frac{V_2}{V_1}} = \sqrt{4} = 2$

$$\frac{v_1}{v_2} = \frac{1}{2}$$

Sol16. As we know that impulse is given by

$$J = \Delta P = F \times \Delta t$$

or, $J =$ Area of f-t graph

For fig (a) $\rightarrow J = \frac{1}{2} \times \text{base} \times \text{height}$

$$= \frac{1}{2} \times 0.5 \times 1 = 0.25 \text{ N-sec}$$

For fig (b) $\rightarrow J = \text{length} \times \text{height}$

$$= 2 \times 0.5 = 1 \text{ N-sec}$$

For fig (c) $\rightarrow J = \frac{1}{2} \times \text{base} \times \text{height}$

$$= \frac{1}{2} \times 1 \times 0.75 = 0.375 \text{ N-sec}$$

For fig (d) $\rightarrow J = \frac{1}{2} \times \text{base} \times \text{height}$

$$= \frac{1}{2} \times 2 \times 0.5 = 0.5 \text{ N-sec}$$

So, impulse is highest for fig (b) whose area under F-t curve is maximum.

Sol17. As we know, time period of simple pendulum is

$$T = 2\pi\sqrt{\frac{L}{g}}$$

or, $T^2 = \frac{4\pi^2}{g}L$

or, $T^2 \propto L$

Thus, the graph between T^2 & L is a straight line.

Sol18. Given: $m = 10$ kg, $\mu_s = 0.25$, $\theta = 30^\circ$, $g = 10$ ms^{-2}

Free Body Diagram of the block is shown below:

Along horizontal direction

$F\cos 30^\circ = f$ …………………..(i)

Along horizontal direction

$F\sin 30^\circ + N = mg$

$\Rightarrow N = mg - F\sin 30^\circ$ ………..(ii)

So, from eq (i),

$F\cos 30^\circ = \mu_s\left(mg - F\sin 30^\circ\right)$

$$F = \frac{\mu_s mg}{\cos 30^\circ + \mu_s \sin 30^\circ} = \frac{0.25 \times 10 \times 10}{\frac{\sqrt{3}}{2} \times 0.25 \times \frac{1}{2}} = 25.2 \text{ N}$$

Sol19. Given: $\eta = \frac{1}{3}$

When $T_2 \to (T_2 + x)$ i.e, temperature of the cold reservoir

$\eta^{'} = \frac{1}{6}$

Temperature of hot reservoir $(T_1) = 99\ ^{\circ}C$

$= 99 + 273 = 372\ \mathrm{K}$

As we know,

$\eta = 1 - \frac{T_2}{T_1} = \frac{1}{3}$ …………………(i)

$\eta^{'} = 1 - \frac{(T_2 - x)}{T_1} = \frac{1}{6}$ …………..(ii)

From eq (i), we get

$\frac{1}{3} = 1 - \frac{T_2}{372}$

$\Rightarrow T_2 = 248\ \mathrm{K}$

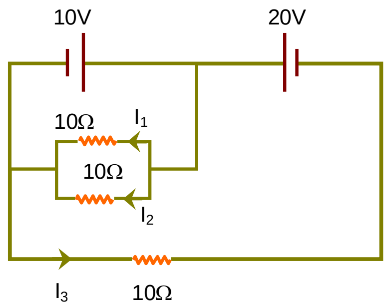
Using value of T_2 in eq (ii), we get

$x = 62\ \mathrm{K}$

Sol20. At the highest point vertical component of velocity is zero. So the momentum of the particle is zero. At highest point horizontal component of velocity is not zero but vertical component of velocity is equal to zero and because of this K.E. will not be equal to zero.

SECTION - B

Sol1. Applying KVL in loop – 1



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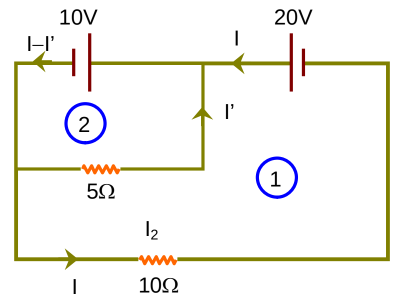
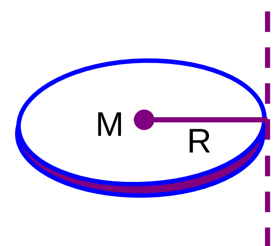


Sol2. By using parallel axis theorem



$I = I_0 + MR^2$

$I = \frac{MR^2}{2} + MR^2$

$I = \frac{3}{2}MR^2$

But $I = \frac{x}{2}MR^2$

So, $x = 3$

Sol3. Area $(A) = 70cm^2 = 70 \times 10^{-4} m^2$, $B = 0.4T$

$f = 500 \frac{\text{rev}}{\text{min}} = \frac{500}{60} \frac{\text{rev}}{\text{sec}}$

As we know that,
Induced emf in a coil is given by

$e = N\omega BA\sin\theta$

$= 600 \times 2 \times \frac{22}{7} \times \frac{500}{60} \times 0.4 \times 70 \times 10^{-4} \sin 30^\circ$

$= 44$ volt

Sol4. Using equation of continuity

$A_1 v_1 = A_2 v_2$

$750 \times 10^{-4} \times v_1 = 500 \times 10^{-6} \times 30 \times 10^{-2}$

$v_1 = 20 \times 10^{-4}$ m/sec

$v_1 = 2 \times 10^{-3}$ m/sec

Given: $\frac{dh}{dt} = v = x \times 10^{-3}$ m/sec

$\therefore x = 2$

Sol5. As we know that the total energy for free oscillation remains constant.

So, Total energy is equal to $\frac{1}{2}m\omega^2 A^2 = \frac{1}{2}kA^2$

$\Rightarrow \frac{1}{2}kA^2 = 0.25$ J

$$\Rightarrow k = \frac{0.25 \times 2}{A^2} = \frac{0.25 \times 2}{\left(10 \times 10^{-2}\right)^2} = 50 \text{ N/m}$$

PART – B (CHEMISTRY)

SECTION – A

Sol1. Cu^{2+} in water is more stable than Cu^{+} due to more negative hydration enthalpy of Cu^{2+} which is due to high charge density.

Sol2.

$$R-\underset{\displaystyle X}{\underset{|}{CH}}-COOH + \text{dil.}NH_3 \longrightarrow R-\underset{\displaystyle NH_2}{\underset{|}{CH}}-COOH + HX$$

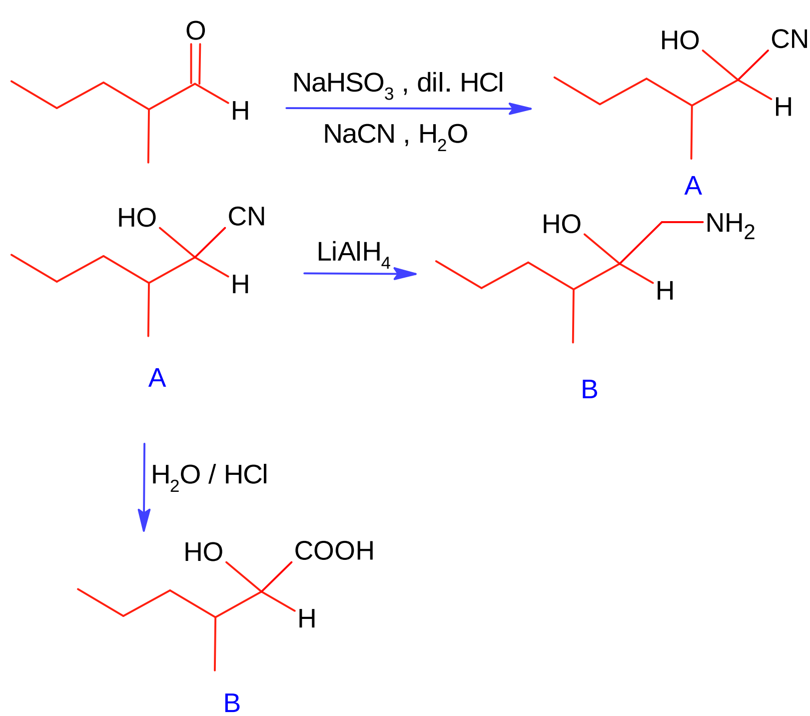
$\alpha-$Amino acid

α- amino acids exists as zwitter ion in aqueous solution as,

$$R-\underset{\displaystyle NH_2}{\underset{|}{CH}}-COOH \rightleftharpoons R-\underset{\displaystyle \overset{+}{N}H_3}{\underset{|}{CH}}-COO^{-}$$

Sol3. Down the group as atomic size increases, bond length increases & bond enthalpy decreases.

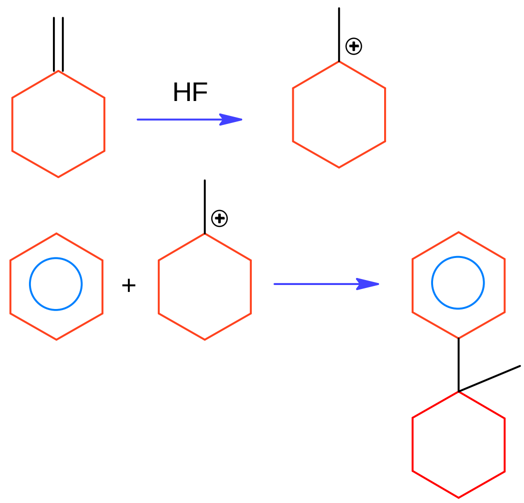
Sol4.



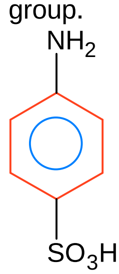
Sol5. Gypsum ($CaSO_4.2H_2O$) is used to make fireproof wall boards.
Gypsum is unstable at high temperature as;

$$CaSO_4.2H_2O \xrightarrow{\Delta} CaSO_4.\frac{1}{2}H_2O + \frac{3}{2}H_2O$$

Sol6.

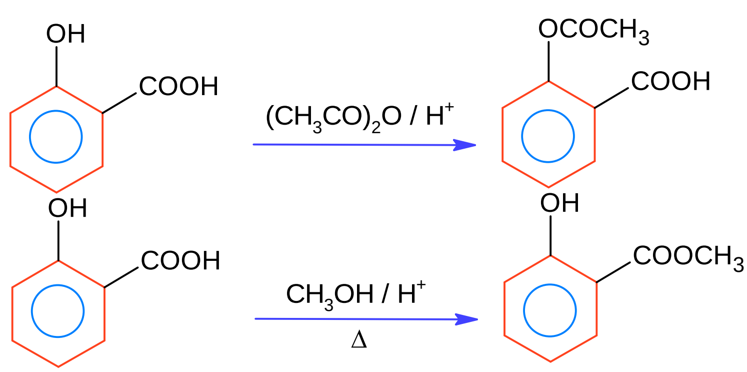


Sol7. Sulphanilic acid does not have –COOH group so it does not gives esterification for carboxyl group.



Sulphanilic acid
Here, both N & S are present so gives red colour in Lassigne's test for extra element detection.

Sol8.



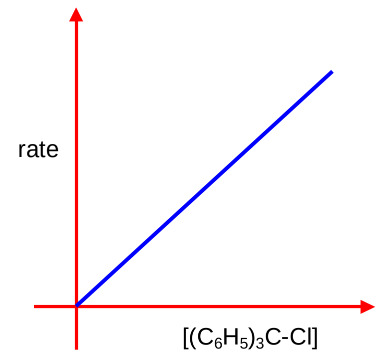
X is $(CH_3CO)_2O$ / H^+ & Y is CH_3OH / H^+, Δ

Sol9. K^+, Cl^-, Ca^{2+}, Sc^{3+} all are isoelectronic species with 18 electrons.

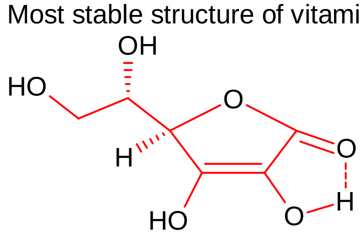
Sol10. Nessler's reagent is $K_2[HgI_4]$.

Sol11. $\Delta_{eg}H$ of S is more negative than $\Delta_{eg}H$ of Se.

Sol12. Here, rate of reaction $\propto$ $[(C_6H_5)_3C\text{-}Cl]$; so correct graph is.



Sol13. Most stable structure of vitamin C is



Due to intramolecular H- bond

Sol14. In manufacturing of urea, NH_3 and CO_2 are used. CO_2 is green house gas which is used in manufacturing of urea. So manufacturing of urea is least responsible for global warming.

Sol15. $\log\frac{x}{m} = \frac{1}{n}\log p + \log k$ ------------------------ (i)

$y = 3x + 2.505$ -------------------------------- (ii)

Comparing (i) & (ii);

$\frac{1}{n} = 3$

$\log k = 2.505$

Sol16. $\left[Co(NH_3)_5NO_2\right]^{2+}$ and $\left[Co(NH_3)_5ONO\right]^{2+}$ are linkage isomers.

Sol17. $K_2S_2O_8(s) + 2D_2O(\ell) \longrightarrow 2KDSO_4(aq) + D_2O_2(aq)$

Sol18. For given equilibrium, addition of He gas at constant volume will not affect equilibrium while at constant pressure, equilibrium shifts in forward direction & more Cl_2 & PCl_3 will from.

Sol19. KOH solution being basic in nature absorbs atmospheric CO_2 so its concentration get changed, therefore concentration should be checked before use in titration.

Sol20. O–O bond length $\Rightarrow$ $H_2O_2 > O_2F_2$

O–H bond in H_2O_2 < O–F bond in O_2F_2.

SECTION - B

Sol1. 10% by volume means 10mL Br_2 in 100 mL solution
Volume of Br_2 = 10 mL
Volume of CCl_4 = 90 mL
Mass of Br_2 = 10×3.2 g
= 32 g
Mass of CCl_4 = 90×1.6g
= 144g

Moles of $Br_2 = \frac{32}{160}$ mol.

Molality = $\frac{32}{160\times144}\times1000\,m$
= 1.389 m
= 138.9×10^{-2} m

Sol2. Heat released in bomb calorimeter = 20×0.5 KJ = 10 KJ

Moles of ethane = $\frac{0.3}{30}=0.01$ mol

$$\Delta U=-\frac{10}{0.01}KJ=-1000KJ$$

$$C_2H_6(g)+\frac{7}{2}O_2(g)\longrightarrow 2CO_2(g)+3H_2O(\ell)$$

$$\Delta n_g=-2.5$$

$$\Delta H=\Delta U+\Delta n_gRT$$

$$=-1000+(-2.5)\times8.3\times10^{-3}\times300$$

$$=-1006.225KJ$$

Sol3. Half life, $t_{1/2}=50\,min$;

$$t_{3/4}=\frac{3}{2}\times t_{1/2}$$

$$=\frac{3}{2}\times50\,min$$

$$t_{3/4}=75\,min$$

Sol4. $\alpha=\frac{i-1}{n-1}$

$$0.2=\frac{i-1}{2-1}$$

$$i=1.2$$

$$\Delta T_f=ik_f.m$$

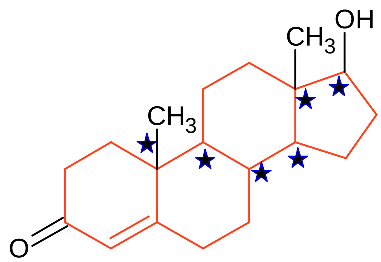
$$\Delta T_f=1.2\times1.86\times\frac{5}{60\times500}\times1000^oC$$

$$=0.372^oC=372\times10^{-3o}C$$

Sol5. Copper matte is $Cu_2S.FeS$.

Sol6. Chloroliazepoxide, veronal and valium are tranquilizers while salvarsan is antibiotic.

Sol7.



* marks are chiral carbons.

Sol8. $\left[Ag^{+}\right] = 10^{-5}M$

$\left[NO_3^{-}\right] = 10^{-5}M$

$\left[Br^{-}\right] = \frac{K_{sp}}{\left[Ag^{+}\right]} = \frac{4.9\times10^{-13}}{10^{-5}} = 4.9\times10^{-8}M$

Using; $\lambda_m = \frac{\kappa}{1000\times M}$

For Ag^{+};

$$6\times10^{-3} = \frac{\kappa}{1000\times10^{-5}}$$

$$\kappa = 6\times10^{-5}\,Sm^{-1}$$

For NO_3^{-};

$$7\times10^{-3} = \frac{\kappa}{1000\times10^{-5}}$$

$$\kappa = 7\times10^{-5}\,Sm^{-1}$$

For Br^{-}

$$8\times10^{-3} = \frac{\kappa}{1000\times4.9\times10^{-8}}$$

$$\kappa = 39.2\times10^{-8}\,Sm^{-1}$$

Conductivity of solution $= \left(6000+7000+39.2\right)\times10^{-8}$

$= 13039.2\times10^{-8}\,Sm^{-1}$

Sol9. $Mn^{2+} = 4s^0 3d^5$

$n = 5$

$\mu = \sqrt{n\left(n+2\right)}$ B.M

$= \sqrt{5\times7}$ B.M

$= \sqrt{35}$ B.M

$= 5.91$B.M

Sol10. Using ; $d = \frac{Z\times A}{N_A\times a^3}$

$$d_{fcc} = \frac{4\times A}{N_A\times\left(2\right)^3}$$

$$d_{bcc} = \frac{2\times A}{N_A\times\left(2.5\right)^3}$$

$$\frac{d_{fcc}}{d_{bcc}} = \frac{4}{(2)^3} \times \frac{(2.5)^3}{2}$$
$= 3.9$

PART – C (MATHEMATICS)

SECTION – A

Sol1. $f(x) = |x^2 - 5x + 6| - 3x + 2\ [-1, 3]$

$$f(x) = \begin{cases} x^2 - 8x + 8 & x \in [-1, 2] \\ -x^2 + 2x - 4 & x \in (2, 3] \end{cases}$$

f^n is continuous at everywhere.

$$f'(x) = \begin{cases} 2x - 8 & x \in (-1, 2) \\ -2x + 2 & x \in (2, 3) \end{cases}$$

$f'(x) = 0,\ x = 4,\ x = 1$

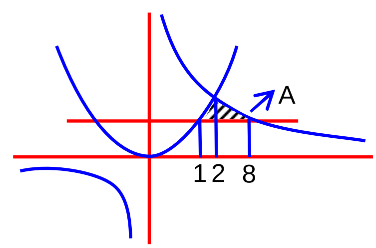
Vertex not lies in interval. So maximum and minimum found in boundary point.

$f(-1) = 17,\ f(2) = -4,\ f(3) = -7$

Maximum = 17, minimum = -7
max + min = 17 – 7 = 10

Sol2. $xy \le 8, \quad 1 \le y \le x^2$

Required area = $\int_1^2 (x^2 - 1)dx + \int_2^8 \left(\frac{8}{x} - 1\right)dx$



Simplify

$A = 16\log_e 2 - \frac{14}{3}$

Sol3. $f(x) + f\left(\frac{1}{1-x}\right) = 1 + x,\ f(2) = ?$

Put $x = 2$

$f(2) + f(-1) = 3$ ………(i)

Put $x = -1$

$f(-1) + f\left(\frac{1}{2}\right) = 0$ ……..(ii)

(i) – (ii)

$f(2) - f\left(\frac{1}{2}\right) = 3$ ………..(iii)

Put $x = \frac{1}{2}$

$f\left(\frac{1}{2}\right) + f(2) = \frac{3}{2}$ ………..(iv)

(iii) + (iv)

$f(2) = \frac{9}{4}$

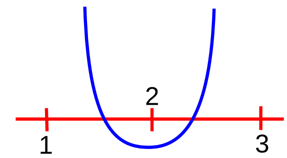
Sol4. $f(1)f(2) < 0$

$f(2)f(3) < 0$

After simplification

$k \in (6,8)$

$k = 7$



Sol5. $y(x) = x^x \quad x > 0, \quad y''(2) - 2y'(2)$

$y'(x) = x^x(1 + \log_e x)$

$y''(x) = x^x\left(\frac{1}{x}\right) + x^x(1 + \log_e x)^2$

$y''(2) - 2y'(2)$

$2 + 9(1 + \log_e 2)^2 - [8(1 + \log_e 2)]$

$= 4(\log_e 2)^2 - 2$

Sol6. $\vec{a} = (2, -7, 5), \vec{b} = (1, 0, 1), \vec{c} = (1, 2, -3)$

$= \vec{r} \times \vec{a} = \vec{c} \times \vec{a}, \vec{r} \cdot \vec{b} = 0$

$= (\vec{r} \cdot \vec{c}) \times \vec{a}$

$\Rightarrow \vec{r} = \vec{c} + \alpha\vec{a}$

$\vec{r} \cdot \vec{b} = 0$ (given)

$(\vec{c} + \alpha\vec{a}) \cdot \vec{b} = 0$

$[(1, 2, -3) + \alpha(2, -7, 5)] \cdot (1, 0, 1) = 0$

$[1 + 2\alpha, 2 - 7\alpha, -3 + 5\alpha] \quad [1, 0, 1] = 0$

$1 + 2\alpha + 0 - 3 + 5\alpha = 0$

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

$\vec{r} = (1, 2, -3) + \frac{2}{7}(2, -7, 5)$

$\vec{r} = \left(\frac{11}{7}, 0, \frac{-11}{7}\right), |\vec{r}| = \sqrt{\left(\frac{11}{7}\right)^2 + \left(\frac{-11}{7}\right)^2} = \frac{11}{7}\sqrt{2}$

Sol7. $2\tan^{-1}\left(\frac{1-x}{1+x}\right) = \cos^{-1}\left(\frac{1-x^2}{1+x^2}\right)$

$\cos^{-1}\frac{2x}{1+x^2} = \cos^{-1}\frac{1-x^2}{1+x^2}$

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

$x = \sqrt{2} - 1, \ x = -\sqrt{2} - 1$

$0 < x < 1$

$x = \sqrt{2} - 1$

Sol8. AR_1B **if** $(A \cap B^C) \cup (B \cap A^C) = \phi$

$\Rightarrow A \cap B^C = \phi$ and $B \cap A^C = \phi$

$\Rightarrow A = B$

$\therefore R_1$ is reflexive and symmetric.

Again $\left.\begin{array}{l} AR_1B \Rightarrow A = B \\ BR_1C \Rightarrow B = C \end{array}\right\} \Rightarrow A = C$

$\therefore R_1$ is transitive

Hence R_1 is equivalence relation.

AR_2B if $A \cup B^C = B \cup A^C$

$\Rightarrow V - B = V - A$

$\Rightarrow B = A$

$\therefore R_2$ is also reflexive, symmetric and transitive

R_2 is equivalence relation.

Sol9. $x_1 = 9$

$x_1 = 9, x_2 = 9 + d, x_3 = 9 + 2d, x_4 = 9 + 3d, x_5 = 9 + 4d$

$x_6 = 9 + 5d, x_7 = 9 + 6d$

$$\vec{x} = \frac{d + 2d + 3d + 4d + 5d + 6d}{7} = 3d$$

$$16 = \frac{1}{7}\left(0^2 + 1^2 .... + 6^2\right) - 9d^2$$

$16 = 4d^2$

$d = \pm 2, d > 0$

$d = 2$

$\overline{x} + x_6 = 15 + 19 = 34$

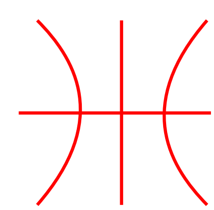
S.D = 4

$\vec{x} = 6$

$$\sqrt{\frac{\left(0^2 + 1^2 ....6^2\right)}{7}} = 4$$

$\overline{x} + x_6 = 15 + 19 = 34$

Sol10. $3x^2 - 4y^2 = 36$



$$\frac{dy}{dx} = \frac{3x}{4y} = \frac{3x_0}{4y_0}$$

Point (x_0, y_0) on curve.

$$\frac{3x_0}{4y_0} = \frac{-3}{2}$$

$x_0 = -2y_0$

$3x_0^2 - 4y_0^2 = 36$

$y_0 = \pm 3/\sqrt{2}$ $\qquad$ $x_0 = -2y_0$

$$\left(\frac{-6}{\sqrt{2}}, \frac{3}{\sqrt{2}}\right), \left(\frac{6}{\sqrt{2}}, \frac{-3}{\sqrt{2}}\right)$$

Calculating $\perp$ distance from both co-ordinate

$\left(\frac{6}{\sqrt{2}}, \frac{-3}{\sqrt{2}}\right)$ is nearest to line.

$\sqrt{2}\left(y_0 - x_0\right) = -9$

Sol11. $A = \frac{1}{2}\begin{bmatrix} 1 & \sqrt{3} \\ -\sqrt{3} & 1 \end{bmatrix}$

$|A - xI| = 0$

$x^2 - x + 1 = 0$

$A^2 - A + I = 0$

$A^2 = A - I$

$A^4 = -A$

$\left(A^4\right)^6 = \left(-A\right)^6$

$A^{24} = I$

$A^{30} = I$

$A^{25} = A$

Put in equation

$A^{30} + A^{25} - A$

$I + A - A = I$

Sol12. $\sum_{n=1}^{\infty} \frac{2n^2 + 3n + 4}{\underline{|2n}}$

$\sum_{n=1}^{\infty} \frac{2n\left(n+1\right) + \left(n+4\right)}{\underline{|2n}}$

$\frac{1}{2}\sum_{n=1}^{\infty}\left(\frac{1}{\underline{|2n-2}} + \frac{3}{\underline{|2n-1}}\right) + \frac{1}{2}\left(\sum_{n=1}^{\infty}\frac{1}{\underline{|2n-1}} + \frac{8}{\underline{|2n}}\right)$

$\frac{1}{2}\left[\frac{e + e^{-1}}{2} + \frac{3\left(e - e^{-1}\right)}{2}\right] + \frac{1}{2}\left[\frac{e - e^{-1}}{2} + 8\left(\frac{e + e^{-1}}{2}\right) - i\right]$

Using $e^x = 1 + \frac{x}{\underline{|1}} + \frac{x^2}{\underline{|2}}$............

Simplify $= \frac{13 - e}{4} + \frac{5}{4e} - 4$

Sol13. $\left(p \wedge \left(p \to q\right)\right) \to nq$

$n\left(p \wedge \left(np \vee q\right)\right) \vee nq$

$n\left(p \,\overline{\wedge}\, q\right) \vee q$

$= np \vee nq$

Sol14. $A = (1,2)(1,3)(1,4)(2,3)(2,4)....(2,1)(3,4)(3,0)(3,6)(4,5)(4,6),(5,6)$

$n\left(A\right) = 15$

$n\left(B\right) = 9$

$n\left(C\right) = 9$

$n\left(\left(A \cup B\right) \cap C\right)$

$n\left(\left(A \cap C\right) \cup \left(B \cap C\right)\right) = 6$

Sol15. $ab < 0$ $\left|\frac{1+ai}{b+i}\right| = 1, |1+ai| = |b+i|$

$a = \pm b$

$a = -b$

$a+ib$ lies $|z-1| = |2z|$

$|a+ib| = |2a+2ib|$

$|(a-1)+ib| = |2a+2ib|$ put b = -a

$6a^2 + 2a - 1 = 0$

$a = \frac{\sqrt{7}-1}{6}, a = \frac{-\sqrt{7}-1}{6}$

$a = \frac{\sqrt{7}-1}{6}, b = \frac{1-\sqrt{7}}{6}(a=-b)$

$\frac{1+[a]}{4b} = \frac{1+0}{4\left(\frac{1-\sqrt{7}}{6}\right)} = \frac{-1}{4}(\sqrt{7}+1)$

$a = \frac{-\sqrt{7}-1}{6}, b = \frac{\sqrt{7}+1}{6}$

Not match with any option.

Sol16. $= \int_{-\pi/4}^{\pi/4} \frac{x+\pi/4}{2-\cos 2x}dx$

$= \int_{-\pi/4}^{\pi/4} \frac{xdx}{2-\cos 2x} + \frac{\pi}{4}\int_{-\pi/4}^{\pi/4} \frac{dx}{1+2\sin^2 x}$

$\frac{\pi}{4} \times 2\int_0^{\pi/4} \frac{dx}{1+2\sin^2 x}$

$\frac{\pi}{2}\int_0^{\pi/4} \frac{\sec^2 x\, dx}{1+\left(\sqrt{3}\tan x\right)^2}$

$\frac{\pi}{2}\int_0^1 \frac{d_2}{1+\left(\sqrt{3}z\right)^2} = \frac{\pi}{2\sqrt{3}}\left[\tan^{-1}\frac{\sqrt{3}z}{1}\right]_0^1$

$\frac{\pi}{2\sqrt{3}}\left[\frac{\pi}{3}\right] = \frac{\pi^2}{6\sqrt{3}}$

Sol17. $2x^2y = \left(1-xy^2\right)dx$

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

Let $p = y^2$

$\frac{dp}{dx} = \frac{1-px}{x^2}$

$\frac{dp}{dx} + \frac{p}{x} = \frac{1}{x}$

$I.f = x$

$$p \times x = \int \left(\frac{1}{x^2} \times x \right) dx + c$$
$$y^2 \cdot x = \log_e x + \log_e 2$$
$$2x = e^{x^1 y^2}$$
$$\alpha = 2, \beta = 1, \gamma = 2$$
$$\alpha + B - \gamma = 1$$

Sol18. For $\alpha = 2, \Delta \neq 0$

Sol19. Not match with anyone

$$\vec{a} = (5, -1, -3), \vec{b} = (1, 3, 5)$$

Projection of $\vec{a}$ on $\vec{b} = \frac{\vec{a} \cdot \vec{b}}{|\vec{b}|}$

$$= \frac{(5, -1, -3) \cdot (1, 3, 5)}{|1, 3, 5|}$$
$$= \frac{5 - 3 - 15}{\sqrt{1 + 9 + 25}} = \frac{-13}{\sqrt{35}}$$

Sol20. $(2x + 3y - z - 2) + \lambda(x + 2y + 3z - 6) = 0$

$x(2 + \lambda) + y(3 + 2\lambda) + z(-1 + 3\lambda) - 6\lambda - 2 = 0$ ………..(i)

$x(2 + \lambda) + y(3 + 2\lambda) + z(-1 + 3\lambda) - 6\lambda - 2 = 0$

$\perp$ to $2x + y - z + 1 = 0$

$2(2 + \lambda) + 1(3 + 2\lambda) - 1(-1 + 3\lambda) = 0$

$\lambda = -8$

Put in (i)

$6x + 13y + 252 - 46 = 0$

$\perp$ distance $(-7, 1, 1)$

$$d = \left| \frac{6 \times -7 + 13 \times 1 + 25(1) - 46}{\sqrt{6^2 + 13^2 + 25^2}} \right| = \frac{50}{\sqrt{830}}$$
$$d^2 = \frac{250}{83}$$

SECTION – B

Sol1. $I = \int_0^{\pi} \frac{5^{\cos x} \left(1 + \cos x \cos 3x + \cos^2 x + \cos^3 x \cos 3x\right)}{1 + 5^{\cos x}} dx$

$\int_a^b f(x) dx = \int_a^b f(a + b - x) dx$ & Add.

$$2I = \int_0^{\pi} \left(1 + \cos x \cos 3x + \cos^2 x + \cos^3 x \cos 3x\right) dx$$

$$2I=\int_0^{\pi}dx+\int_0^{\pi}\cos x\cos 3x+2\cdot\int_0^{\pi/2}\cos^2 x dx+\int_2^{\pi}\cos^3 x\cos 3x\, dx$$

$$2I=\pi+0+2\int_0^{\pi/2}\cos^2 x\, dx+\int_0^{\pi}\left(4\cos^6 x-3\cos^4 x\right)dx$$

$$2I=\pi+2\left(\frac{2-1}{2}\times\frac{\pi}{2}\right)+4\int_0^{\pi}\cos^6 x dx-3\int_0^{\pi}\cos^4 x dx$$

$$2I=\pi+\frac{\pi}{2}+4\times 2\int_6^{\pi/2}\cos^6 x dx-3\times 2\int_0^{\pi/2}\cos^4 x dx$$

$$2I=\frac{3\pi}{2}+8\left(\frac{6-1}{6}\times\frac{6-3}{4}\times\frac{1}{2}\times\frac{\pi}{2}\right)-6\left(\frac{4-1}{4}\times\frac{4-3}{4-2}\right)$$

$$2I=\frac{3\pi}{2}+\frac{5\pi}{4}-\frac{9\pi}{8}$$

$$I=\frac{13\pi}{16}$$

$$k=13$$

Sol2. $\alpha\beta\gamma=6$

$$\left[\vec{r}-(3,-2,5)\right]\cdot\left[3,-1,-2\right]=0$$

$$3x-y-2z=1$$

$$\alpha=3,\ \beta=-1,\ \gamma=-2$$

Sol3. $x+y+z=21$ $\quad$ $x\ge 1,\ y\ge 3,\ z\ge 4$

$x-1+y-3+z-4=13$ $\quad$ $x-1\ge 0,\ y-3\ge 0,\ z-4\ge 0$

$\alpha+\beta+\gamma=13$ $\quad$ $\alpha\ge 0,\beta\ge 0,\gamma\ge 0$

$\Rightarrow\ {}^{13+3-1}C_3={}^{15}C_2=105$

Sol4. (i) Using single digit…………4 = $\frac{\underline{|5}}{\underline{|5}}=1$

(ii) Using 4,5 ……………4 = $\frac{\underline{|5}}{\underline{|3}\,\underline{|2}}=10$

(iii) Using (4, 9) = 444499………..4 = $\frac{\underline{|5}}{\underline{|2}\,\underline{|3}}=10$

(iv) Using 3 digit 4,5,9 (4 5 9 444) =………..4 = $\frac{\underline{|5}}{\underline{|3}}=20$

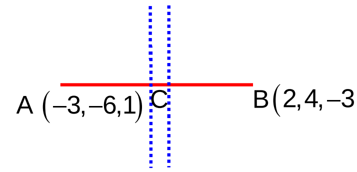
(v) 4 5 9 5 5 5=………..4 = $\frac{\underline{|5}}{\underline{|4}}=5$

4,5,9999…………4 = $\frac{\underline{|5}}{\underline{|4}}=5$

4,5,9,4,5,9................4 = $\frac{\underline{|5}}{\underline{|2}\,\underline{|2}}=\frac{5\times 4\times 3\times 23}{\underline{|2}\cdot 2}=30$

Total digit = 81

Sol5. $C \equiv \left(\frac{2k-3}{k+1}, \frac{4k-6}{k+1}, \frac{-3k+1}{k+1}\right)$

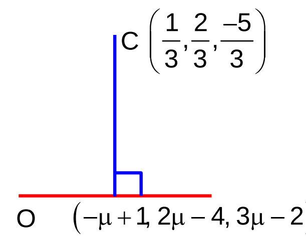


$8x + y + 2z = 8$

$8\left(\frac{2k-3}{k+1}\right) + \left(\frac{4k-6}{k+1}\right) + 2\left(\frac{-3k+1}{k+1}\right) = 8$

$k = 2$

$C \equiv \left(\frac{1}{3}, \frac{2}{3}, \frac{-5}{3}\right)$



$\ell_1 \equiv \frac{x-1}{-1} = \frac{y+4}{2} = \frac{z-(-2)}{3} = \mu$

d.r $CD = \left(-\mu+1-\frac{1}{3}\right), \left(2\mu-4-\frac{2}{3}\right), \left(3\mu-2+\frac{5}{3}\right)$

d.r of $\ell_1 = -1, 2, 3$

$-1\left(-\mu+1-\frac{1}{3}\right) + 2\left(2\mu-\frac{14}{3}\right) + 3\left(\frac{3\mu-1}{3}\right) = 6$

$\mu = \frac{11}{14}$

$\left(\frac{-5}{42}, \frac{-130}{42}, \frac{85}{42}\right) = (-1, -2\,6, 17)$

$= |a+b-c| = |-1-26+17| = 10$

Sol6. $S_1 = 3, 7, 11, 15, 19, 23, 27, 31, 35, 39, 43, 47, 51, 55, 59$

$S_2 = 2, 5, 8, 11, 14, 17, 20, 23, 26, 29, 32, 35, 38, 41, 44, 47, 50$

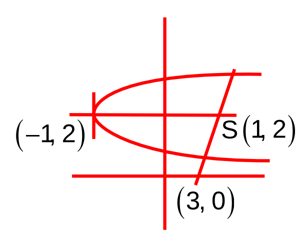
$S_3 = 2, 7, 12, 17, 22, 27, 32, 37, 42, 47$

$\left| \begin{array}{l} d_1 = 4 \\ d_2 = 3 \\ d_3 = 5 \end{array} \right.$

$d_4 = 60$

$S_4 = 47, 107, 167 = 47 + 107 + 167 = 321$

Sol7. $(y-2)^2 = 8[x+1)$



$L_f = 4a\,\text{cosec}^2\theta$

$m = -1, \cot\theta = -1$

$8(2) = 16$

Sol8. $\left[\sqrt{10-3^x} + 3^{\frac{x-2}{5}}\right]^m$

$T_6 = 21 \Rightarrow {}^mC_5 \left(10-3^x\right)^{\frac{m-5}{2}} 3^{x-2} = 21$

$T_{1+1} = {}^mC_1, T_{2+1} = {}^mC_2, T_{3+1} = {}^mC_3$ (Binomial) in A.P

$T_1^1 = {}^mC_1, T_3^1 = {}^mC_2, T_5^1 = {}^mC_3$

${}^{2m}C_2 = {}^mC_1 + {}^mC_3$

$m = 7$

$^{7}C_5\left(10-3^x\right)^{\frac{2}{2}}3^{x-2} = 21$

$\left(10-3^x\right)\cdot 3^x = 9$

$(10-t)\cdot t = 9$

$10t - t^2 = 9$

$t^2 - 10t + 9 = 0$

$t^2 - 9t - t + 9 = 0$

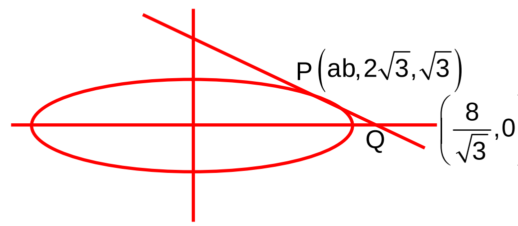
$t(t-9) - 1(t-9) = 0$

$(t-1)(t-9) = 0$

$t = 1, t = 9$

$3^x = 1, 3^x = 9 \Rightarrow x = 0, x = 2 \Rightarrow (0+2)^2 = 4$

Sol9. $\dfrac{x^2}{a^2}+\dfrac{y^2}{b^2}=1$



$\dfrac{a}{e} = 8, ab = 2$

$e = \dfrac{1}{2}$

$a = 4, b^2 = 12$

equation of tangent at $(a\cos\theta, b\sin\theta)$

$\dfrac{x\cos\theta}{4}+\dfrac{y\sin\theta}{\sqrt{12}}=1$

passing $Q\left(0, 4\sqrt{3}\right)$

$\sin\theta = \dfrac{1}{2}$

$\theta = 30^0$

$PQ = \sqrt{\left(\sqrt{3}-0\right)^2+\left(2\sqrt{3}-\dfrac{8}{\sqrt{3}}\right)^2} = \sqrt{\dfrac{13}{3}}$

$(3PQ)^2 = 9(PQ)^2 = 9\times\dfrac{13}{3} = 39$

Sol10. $|\alpha| = 1 = 9\times\dfrac{13}{3} = 39$

$\left[x^{2/3}+\dfrac{\alpha}{x^3}\right)^{22}$

$T_{r+1} = {}^{22}C_r\ x^{\frac{44-2r}{3}-3r}$

$\dfrac{44-2r}{3} - 3r = 0$

$r = 4$

$T_{4+1} = T_5 = {}^{22}C_4\ \alpha^4 = 7315$

$\alpha^4 = 1$

$\alpha = \pm 1 \qquad |\alpha| = 1$