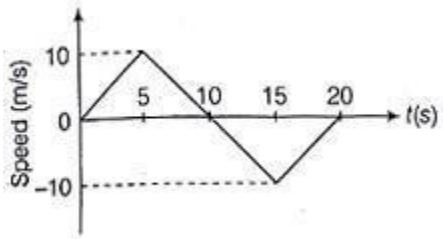
Physics

Single correct answer type:

1. The one-dimensional motion of a point particle is shown in the figure. Select the correct statement.



(A) The total distance travelled by the particle is zero
(B) The total displacement of the particle is zero
(C) The maximum acceleration of the particle is –
(D) The total distance travelled by the particle at the end of s is
(E) At the fifth second, the acceleration of the particle is
Solution: (B)
Given, figure shows the relation between speed and time. So, area of the figure will be displacement.
Therefore,
area of first triangular ( ) –, area of second triangular

( ) ( ) –

Therefore, total area ( ) total displacement of particle

2. The period of oscillation of a simple pendulum is given by √ , where is the

length of the pendulum and is the acceleration due to gravity. The length is measured using a meter scale which has divisions. If the measured value is , the accuracy in the determination of is and the time taken for oscillations is seconds, what should be the resolution of the clock (in milliseconds)?
(A) (B) (C) (D) (E)
Solution: (C)
Given,

√ –

or –

— — — …(i)

Now,

— —

Put these values in Equation. (i), then we get

— – [— —]

or

In s, resolution of clock is .

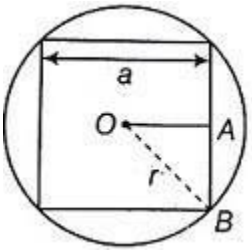
In s resolution of clock is

3. From a circular card board of uniform thickness and mass , a square disc of maximum possible area is cut. If the moment of inertia of the square with the axis of rotation at the centre and perpendicular to the plane of the disc is the radius of the circular card board is

(A) √ (B) (C) (D) — (E) √

Solution: (B)

According to the question,



In the triangular

( ) ( ) ( )

Or - / - /

√ √

4. The length is measured using a vernier system whose main scale is cm long with divisions. If divisions of the main scale coincide with divisions of the vernier scale, then its least count is

(A) (B)
(C) (D)
(E)

Solution: (D)

Least count

-

and

Least count ( )

5. A particle of mass is moving along the under the potential ( )

where and are positive constants of appropriate dimensions. The particle is slightly displaced from its equilibrium position. The particle oscillates with the angular frequency ( ) given by

(A) (B) (C) √ (D) √ (E) √

Solution: (C)

Given, ( )

In electrical analogy,

√

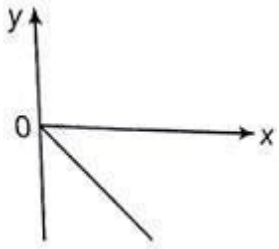
but in mechanical analogy and
will be transformed into and

Here, is mass of particle.

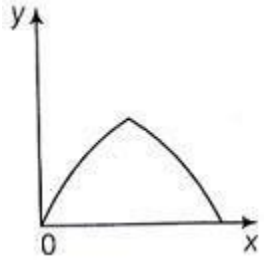
Hence, angular frequency, or √

6. Two particles of mass and have their position vectors as a function of time as ( ) ^ ^ ^ and ( ) ^ ^ ^ respectively (where t is the time). Which one of the following graphs represents the path of the centre of mass?

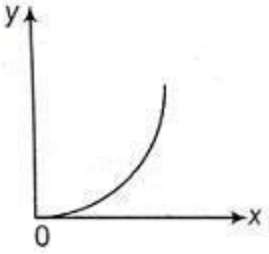
(A)



(B)

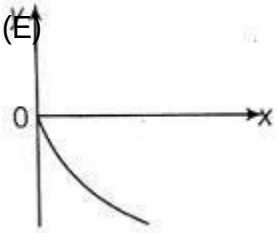


(C)



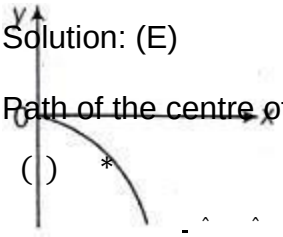
(D)

(E)



Solution: (E)

Path of the centre of mass in a two particle system,



( ) ( )

( ) * ———+

- ˆ ˆ ˆ (ˆ ˆ ˆ)/

or ( ) * ————————————————+

( ) ————————

7. Two planets and have the same average density. Their radii and are such that . If and are the acceleration due to gravity at the surfaces of the planets, the equals

(A) (B) (C) (D) (E) √

Solution: (A)

Given,

–– – …..(i)

and .....(ii)

Average density, ——

From Equation (ii),

——— ——— — —

From Equation (i),

— –

8. The magnetic induction field has the dimensions of
(A) Force
(B) Force constant
(C) Surface tension
(D) ————
(E) Force constant current

Solution: (D)

— ——— — –

———————

9. Einstein was awarded the Nobel Prize for his work on
(A) Photoelectric effect
(B) Special theory of relativity
(C) Brownian motion
(D) General theory of relativity
(E) Quantum theory

Solution: (A)
Einstein was awarded the Nobel Prize for his work in Photoelectric effect.

10. A thin circular ring of mass and radius is rotating about its axis perpendicular to the plane of the ring with a constant angular velocity . Two point particles each of mass are attached gently to the opposite ends of a diameter of the ring. The ring now rotates, with an angular velocity . Then, the ratio is

(A)
(B)
(C)
(D) √
(E) √

Solution: (B)

Momentum before particle is attached to the ring,

Momentum after two particle is attached to the ring, ( )

Here, and

So, ( ) 0 ( )1

,

According law of conservation of momentum, (momentum before) = (momentum after)

( )

So

11. A body of mass is moving in a medium and experiences a fractions force , where is the speed of the body. The initial speed is and after s, its energy becomes half of initial energy. Then, the value of is

(A) √
(B) √
(C)
(D)
(E)

Solution: (C)

According to the question,

( )

or

or

Given,

or

12. The position vector of the particle is ( ) ˆ ˆ, where and are real constants of suitable dimensions. The acceleration is
(A) Perpendicular to the velocity
(B) Parallel to the velocity
(C) Directed away from the origin
(D) Perpendicular to the position vector
(E) Always along with the direction of ˆ

Solution: (A)
Given that, ( )
( )
ˆ
ˆ
(ˆ ˆ)
(ˆ ˆ)

, | || | -
Above result implies that acceleration is perpendicular to velocity.

13. Some of the following equations are kinetic equations, where the symbols have their usual meaning. The theorem is represented by
(A)
(B)
(C) –
(D) —
(E)

Solution: (E)
According work-energy theorem, net work = change in kinetic energy = final KE-initial KE

So

14. If and denote the displacement, the velocity and the acceleration of a particle executing simple harmonic motion of time period , then which of the following do not change with time?

(A)

(B)

(C)

(D)

(E)

Solution: (A)

In option ( )

So, according to the result above relation does not depend on time.

15. A rubber cord of density Young's modulus and length is suspended vertically. If the cord extends by a length under its own weight, then is

(A)

(B)

(C)

(D)

(E)

Solution: (B)

Young's modulus

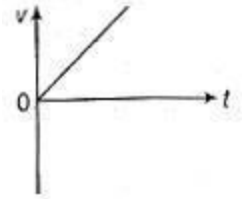
……(i)

Force exerted due to its own weight

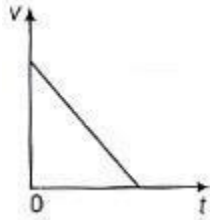
So

16. Which of the following graphs represents the speed of a projectile as a function of time ?

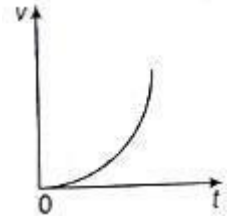
(A)



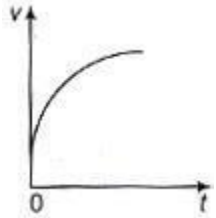
(B)



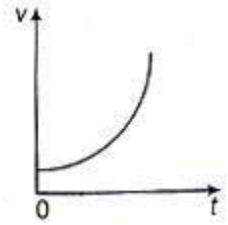
(C)



(D)



(E)



Solution: (B)
In a projectile motion, speed ( ) of a projectile decreases with time ( ).
Hence, graph in option ( ) is correct.

17. A body floats in water with half its volume immersed. Another body floats in a liquid of density ~~o~~f the density of water with two-third of the volume immersed. The ratio of density of to that of is
(A)
(B)
(C)

(D)
(E)

Solution: (B)
Let, for body , volume
Given, Immersed volume —

For body volume

Immersed volume –

According to Archimedes principle,
Weight of body weight of fluid displaced
For body

(*

So, — – …..(i)

For body ,

(— * (–*

(* –

So, — – …..(ii)

From Equations (i) and (ii),

— or

18. A pipe of length is closed at one end. Taking the speed of sound in air as the air column in the pipe cannot resonate for the frequency ( )

(A) 80
(B) 160
(C) 240
(D) 560
(E) 720

Solution: (B)
Given,
For an organ pipe whose one end is closed, only odd harmonics containing odd multiples of fundamental frequency are present.
Resonate frequency of first mode, —

Second mode,
Third mode,
Fourth mode,
Fifth mode,

So, —

So according result, option ( ) as multiple of cannot a resonating frequency of the pipe.

19. A wave pulse in a string is described by the equation ———— and another wave pulse in the same string is described by _____. The values of and are in metres and in seconds.
Which of the following statement is correct?

(A) travels along -direction and along -direction
(B) Both and travel along -direction
(C) Both and travel along -direction
(D) At and always cancel
(E) At time and exactly cancel everywhere

Solution: (D)
Given,

———— ————

According option ( ), at

————

————

————

Both wave pulse equation are existing in same string therefore resultant equation of wave pulse.

Hence, option At and always cancel is correct.

20. The maximum transverse velocity and maximum transverse acceleration of a harmonic wave in a string are and respectively. The phase velocity if the wave is ..... The waveform is
(A) ( )
(B) ( )
(C) ( )
(D) -- /
(E) - / –

Solution: (A)
Wave equation, ( ) ....(i)

where, angular wave number —

amplitude

. / — —

(given)

From Equation (i),

( )

21. Two particles and of same mass have their de-Broglie wavelengths in the ratio Their potential energies The ratio of their total energies is

(A)
(B)
(C)
(D)
(E)

Solution: (B)

According to question, — – …(i)

— —

So, and

According to de-Broglie wavelength,

_____ …..(ii)
√

Here, is kinetic energy.

So, from Equations (i) and (ii),

(_____) ——
√
————— – √—— –
(_____)
√

——

So, and

Total energy,

So,

and

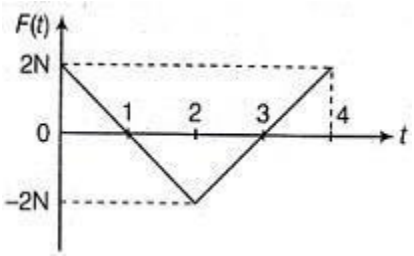
or –– –—–– ———

So, — — ( )

22. A particle is moving along with -axis such that its acceleration is proportional to the displacement from the equilibrium position and they are in the same direction. The displacement ( ) is given by
(A)
(B)
(C)
(D)
(E) and

Solution: (C)
Given, ( ) …..(i)
According option ( )
( )
( ) ( ) and
( )
— ( )
or ( ) ….(ii)
According option ( )
( )
( )
( )
and ( )
or ( ) ( ) …..(iii)
According option ( )
( )
( )
( )
And ( )
or ( ) …..(iv)
According option ( ),
( )
( )
( )
and ( )
or ( ) …..(v)
According option ( )
( ) and > 0
( )
( )
And ( )
Or ..... (vi)
Hence by comparing Equations. (ii), (iii), (iv), (v) and (vi) with Equation (i), option ( ) is correct.

23. A block of mass is free to move along the -axis. It is at rest and from time onwards it is subjected to a time-dependent force ( ) in the -direction. The force ( ) varies with as shown in figure. The kinetic energy of the block at s is



(A)
(B)
(C)
(D)
(E)

Solution: (D)
Total momentum of block Area of given graph

Or – – –

Or or or

Hence, kinetic energy at ( ) –

24. Consider a wire with density ( ) and stress ( ) For the same density, if the stress increases 2 times, the speed of the transverse waves along the wire changes by

(A) √‾
(B) ‾/√‾
(C)
(D) –
(E)

Solution: (A)
Speed of transverse wave

√———— or √‾–

According to question, if increases 2 times

then √— √ √‾√‾ – ‾

Hence, speed of transverse waves along with wire changes by √‾ times.

25. Two soap bubbles of radii and confined in vacuum coalesce isothermally to form a new bubble. The radius of the bubble formed ( ) is

(A)

(B)
(C)
(D)
(E)

Solution: (D)
Surface area new bubble surface area of first bubble surface area of second bubble

Surface area of a bubble,

( )

( ) ( )

26. An oscillator circuit contains an inductor and a capacitor of capacity . When the maximum voltage across the capacitor is , the maximum current (in amperes) in the circuit is
(A)
(B)
(C)
(D)
(E)

Solution: (C)
Given

Voltage equation ( )
Current (i) — —

—

√

Maximum current ( ) √√ —

27. The displacement of a particle, if given by ( ) This expression may be considered to be a result of the superposition of how many simple harmonic motions?
(A)
(B)
(C)

(D)
(E)

Solution: (B)
Equation of displacement of particle is

( ) .....(i)

Or .....

(*

Or
Or
, ( ) ( )-
Hence, equation (i) is the result of the superposition of three simple harmonic motion.

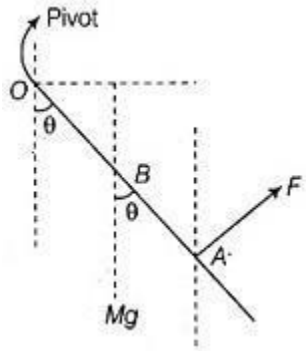
28. A cylindrical tube, open at both the ends has fundamental frequency..... If one of the ends is closed, the fundamental frequency will become
(A)
(B)
(C)
(D)
(E)

Solution: (A)
For a cylindrical tube
If both the ends is closed then
Fundamental frequency,.....(i)

If one of the ends is closed then fundamental frequency, ….(ii)
from equation (i) and (ii)

29. A uniform bar of mass is supported by a pivot at its top about which the bar can swing like a pendulum. If a force is applied perpendicular to the lower end of the bar as shown in figure, what is the value of in order to hold the bar in equilibrium at an angle ( ) from the vertical
(A)
(B)
(C)
(D)
(E)

Solution: (D)
Let the length of bar is , then according to the problem.



For equilibrium of the bar,

and

taking torque about pivot

(clockwise) (anti-clockwise)

–

_____

30. A particle of rest mass is travelling, so that its total energy is twice its rest mass energy. It collides with another stationary particle of rest mass to form a new particle. What is the rest mass of the new particle?

(A) √‾

(B)

(C) √‾

(D) √‾

(E)

Solution: (E)

Total energy of particle rest mass energy of particle according question,

Or

When a particle collides with another particle then net mass of new particle will be

31. The dimensions of (permittivity in free space) is

(A)

(B) (C)

(D) (E)

Solution: (E)

Electrical force between two charge

——— ———

dimension of [ ]
———————
, -, -

, -

32. The displacement of a wave is represented by ( ) where all the quantities are in their proper units. The maximum particle velocity ( ) of the medium is

(A)
(B)
(C)
(D)
(E)

Solution: (E)

The displacement of wave

( )

— ( )

( )

For maximum particle velocity,

( )

Hence,

33. The electric field of certain radiation is given by the equation * ( ) ( ) + falls in a metal surface having work function The maximum kinetic energy ( ) of the photoelectrons is [use Planck's constant ( ) and electron charge ( )]

(A)
(B)
(C)
(D)
(E)

Solution: (D)

According photoelectric equation,

– …..(i)

Here, is work function and is frequency of photon.

According question equation, electric field representing given as, is

* ( ) ( ) +

Here, fundamental frequency of above equation will be of both component frequency.

Hence, the fundamental frequencies

rad

or ———

Put the value of and in Equation (i)

( )

Hence

34. The de-Broglie wavelength of the electron in the orbit of hydrogen atom is
(A) Inversely proportional to
(B) Proportional to
(C) Proportional to
(D) Inversely proportional to
(E) Inversely proportional to radius of the orbit in the state

Solution: (A)

de-Broglie wavelength of the electron in the orbit of hydrogen atom

—

——

– ——

— — —

[ ]

–

Hence, is inversely proportional to

35. In a thermodynamic system, represents the energy transferred to or from a system by heat and represents the energy transferred to or from a system by work
(I) and
(II) and
(III) and
(IV) and
Which of the above will lead to an increase in the internal energy of the system?
(A) I only
(B) II only
(C) I and IV only
(D) II and III only
(E) II and IV only

Solution: (C)

According first law of thermodynamics,

Or

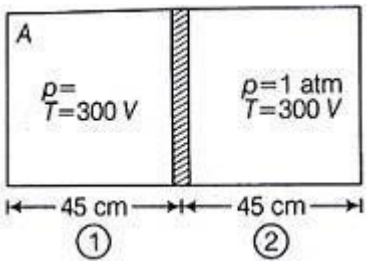
According given conditions

I. and

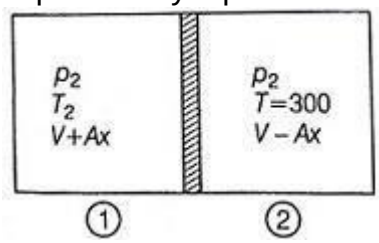
or
Here , therefore will be increase.
II. and
or
Here , therefore will be decrease.
III. and
or
Here , therefore will be decrease.
IV. and
or
Here , therefore will be increase.
Hence, condition I and IV will lead to an increase in the internal energy of the system.
Therefore, option I and IV only is correct.

36. A cylinder closed at both ends is separated into two equal parts (45 cm each) by a piston impermeable to heat. Both the parts contain the same masses of gas at a temperature of and a pressure of . How much the gas should be heated in one part of the cylinder to shift the piston by and the pressure of the gas after shifting the piston?
(A) and
(B) and
(C) and
(D) and
(E) and

Solution: (E)
Let the crossectional area of the cylinder is . Initially



Representing a closed cylinder
separated by a piston



Piston is shifted by in the cylinder
For 1, —–—– —–— ___ ( ) _____ …..(i)
For 2, ( )

….(ii)

From Equations (i) and (ii),

Putting in Equation (i),

37. Five moles of an ideal monoatomic gas with an initial temperature of expand and in the process absorb of heat and does of work. The final temperature of the gas in is (ideal gas constant,).

(A)
(B)
(C)
(D)
(E)

Solution: (A)
According to thermodynamics first law,
Given, that

….(i)

For monoatomic gas,

From Equation (i),

Or

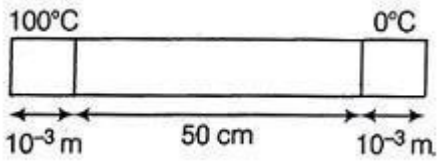
38. The temperature of an ideal gas is increased from to . If the speed of the gas molecule is at , then at it becomes

(A)
(B) (C)
(D)
(E)

Solution: (A)
speed of molecule √ –
for
( ) √ For
( ) √
therefore, ()√ —
()
or _____ –
()
or ( )

39. A uniform copper rod of length is insulated on the sides and has its ends exposed to ice and steam respectively. If there is a layer of water thick at each end, the temperature gradient ( ) in the bar is (assume that the thermal conductivity of copper is and water is)
(A)
(B)
(C)
(D)
(E)

Solution: (B)
Given,



In steady state, flow of heat will be same throughout the whole system
() ( )
- /
Or ( ) ()

() ( )
( ) ( ) ( )
Or ( )

Hence, temperature gradient along the bar

40. A Carnot engine whose low temperature reservoir is at has an efficiency of . It is desired to increase this to . If the temperature of the low temperature reservoir remains constant, then the temperature of high temperature reservoir must be increased by how many degrees?

(A)
(B)
(C)
(D)
(E)

Solution: (B)
Efficiency of Carnot engine,

When
then

or
When
then

or
Hence, the temperature of high reservoir is increased by

41. Two identical systems, with heat capacity at constant volume that varies as (where is a constant) are thermally isolated. Initially, one system is at a temperature and the other is at . The systems are then brought to thermal contact and the combined system is allowed to reach thermal equilibrium. The final temperature (in) of the combined system will be

(A)
(B)
(C)
(D)
(E)

Solution: (A)
Energy given by a system = Energy taken by another system

$$\int \int$$

$$\int \qquad \int ( ) ( )$$

( )

42. Water flows steadily through a horizontal pipe of a variable cross-section. If the pressure of the water is at a point, where the speed of the flow is , what is the pressure at another point, where the speed of the flow is ? Let the density of water be

(A) ÷ /

(B)

(C)

(D)

(E) . / –

Solution: (E)

Two point are situated in a pipe and their height from ground is zero ( )

According Bernoulli's theorem,

– constant

At a point pressure of water is and speed of flow is

therefore, – .....(i)

At another point speed of flow is therefore,

– ( ).....(ii)

To find pressure at another point, equating the equation (i) and (ii)

– – ( )

–

43. A soap bubble of radius is blown upto form a bubble of radius under isothermal conditions. If is the surface tension of soap solution, the energy spent in doing so is

(A)

(B)

(C) (D)

(E)

Solution: (C)

Energy spent Work done

Here, is total surface area

for soap bubble

Hence, energy spent , ( ) -

( )

44. The mean momentum of a nucleon in a nucleus with mass number varies as

(A)
(B)
(C) $^{-}$
(D) $^{-}$
(E) $^{-}$

Solution: (E)

Mean momentum of a nucleon in a nucleus is proportional to . $^{-}$

45. A decay chain of the nucleus involves eight -decays and six -decays. The final nucleus at the end of the process will be
(A)
(B)
(C)
(D)
(E)

Solution: (D)
(i) When -particle is emitted from a radioactive nucleus then atomic number decreases by and atomic mass decreases by .
(ii) When -particle emitted from a radioactive nucleus then atomic number is increased by and atomic mass unaffected.
Here, atomic number ( )
After emitting -particles and -particles,

and atomic mass,

46. A flat mirror revolves at a constant angular velocity making revolutions per second. With what velocity ( ) will a light spot move along a spherical screen with a radius of metres, if the mirror is at the centre of curvature of the screen?
(A)
(B)
(C)
(D)
(E)

Solution: (D)
Angular velocity of mirror /
/
Angular velocity of reflected ray
/
Hence, velocity of light spot over the screen
/

47. A parallel beam of light of wavelength passes through a slit of width
The angular spread of the central maxima in the diffraction pattern is
(A) rad
(B) rad (C)
rad (D)
rad (E)
rad

Solution: (B)
Angular spread of the central maxima in the diffraction pattern (=width of the slit)

Here,
Hence,..... /

rad
or rad

48. A wire made of aluminium having resistivity with a circular cross-section and has a radius of A current of flows through the wire. If the voltage difference between the ends is , what is the length of the wire in meters?
(A)
(B)
(C)
(D)
(E)

Solution: (C)
Given, resistivity ( ) , Radius
( )
Current
Voltage difference ( )
Resistivity ( )

( )

( )

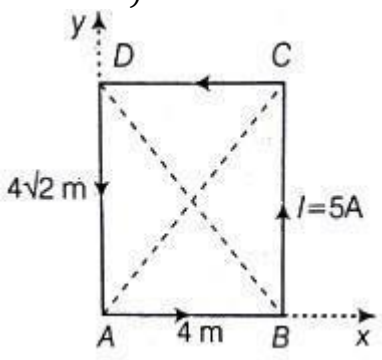
( )

49. When two capacities are connected in parallel the resulting combination has capacitance The same capacitors when connected in series results in a capacitance The respective values of individual capacitors are

(A) and
(B) (√) and (√)
(C) (√) and (√)
(D) and
(E) and

Solution: (C)
When capacitors are connected in parallel then..... (i)
When capacitors are connected in series
then ——
or ( )
or ( ) ..... (ii)
( )
( ) ..... (iii)
( ) ..... (iv)
Put the value from Equations (i) and (ii) in the equation (iii)
Hence, ( )
Put the above value in Equation (iv)
( )
√ ..... (v)
Now from Equations (i) and (v),
√
—— (√)
√
—— (√)

50. A rectangular conducting loop of length √ and breadth carrying a current of in the anti-clockwise direction is placed in the -plane. The magnitude of the magnetic induction field vector at the intersection of the diagonal is (
)



(A) (B)
(C) (D)

(E)

Solution: (A)
Magnetic field due to a straight current carrying conductor of finite length

——– ( )

(i) Magnetic field due to conductor
Here, –

√ –
(—)

and (given)
From Equation (i),

— – ( )

Similarly, magnetic field due to conductor

(ii) Magnetic field due to conductor .
Here, √√ –

(——*
√

and (given)
From Equation (i),

— ——( )
√

Similarly magnetic field due to conductor

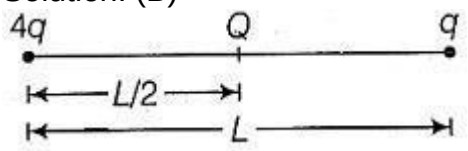
Hence, magnitude of induction field vector at the intersection of the diagonals

( )

Or

51. Three point charges and are placed in a straight line of length at points –
and respectively. The net force on charge is zero. The value of is
(A)
(B)
(C)
(D)
(E)

Solution: (B)



Net force on charge,

…..(i)

Here, is the force on charge due to charge is the force on charge due to charge

From equation (i)

( )

52. A particle of charge moves with a velocity ˆ in a magnetic field ˆ where and are constants. The magnitude of the force experienced by the particle is

(A) ( )

(B) Zero

(C) √( ) ( )

(D) √( )

(E) ( )

Solution: (C)

Lorentz force, ( ) ….(i)

Here ˆ ˆ ˆ

From Equation (i)

(ˆ ˆ ˆ)

(ˆ ˆ)

(According cross production),

(ˆ ˆ ˆ ˆ ˆ ˆ)

Magnitude of the force,

| | √( ) ( )

or √( )

53. A point charge is held at rest at a point Another point charge , whose mass is , moves at a constant velocity in a circular orbit of radius , around . The work required to increase the radius of revolution of from , to another orbit is ( )

(A) 01 — —

(B) 01 —

(C) 0 — —1

(D) 0— —1

(E) 0— —1

Solution: (D)
The force due to point charge on charge is ()

Therefore work required to increase the radius of revolution of from to is

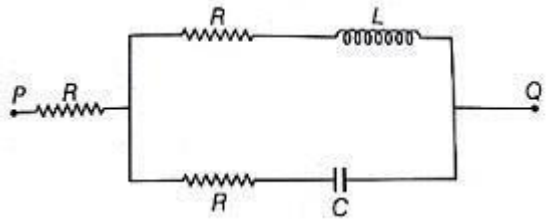
$$\int$$

$$\int [\ ] —\quad —$$

$$[— \quad —]$$

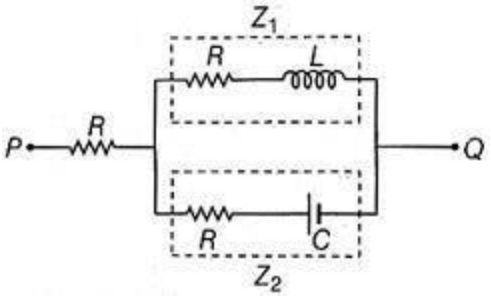
54. A voltage (where, is a real amplitude) is applied between the points and in the network shown in the figure. The values of capacitance and inductance are and √

Then, the total impedance between and is



(A)
(B)
(C)
(D)
(E)

Solution: (C)
Given that, √



In the above figure,

Impedance and are in parallel,

So,

So, total impedance between and is

55. Two particles and of same mass have their total energies and in the ratio . Their potential energies and are in the ratio . If and are their de-Broglie wavelengths, then is

(A)

(B)

(C)

(D)

(E)

Solution: (D)

Given,

So

And

And
here and are kinetic energy of particles and
So ( ) …..(i)

( ) ….(ii)

de-Broglie wavelength,

$$\lambda = \frac{h}{\sqrt{2mK}}$$

So $\lambda_1 = \frac{h}{\sqrt{2mK_1}}$ $\lambda_2 = \frac{h}{\sqrt{2mK_2}}$

$\frac{\lambda_1}{\lambda_2} = \sqrt{\frac{K_2}{K_1}}$ …..(iii)

From Equation (i), (ii) and (iii),

$\frac{\lambda_1}{\lambda_2} = \sqrt{\frac{(\quad)\sqrt{\quad}}{(\quad)}}$ —

56. The electrical conductivity of a metal is
(A) Directly proportional to the mean free path
(B) Directly proportional to the mass of electron
(C) Inversely proportional to the relaxation time
(D) Inversely proportional to the mean free path
(E) Directly proportional to the average speed of free electrons

Solution: (A)
Electrical conductivity,
Here, is mean free path.

57. A neutron is emitted in a fission reactor. If it looses half of its kinetic energy in each collision with a moderator atom, how many collisions must it undergo to achieve thermal energy of ?
(A)
(B)
(C)
(D)
(E)

Solution: (B)
neutron looses half of its kinetic energy in each collision. So, making geometric progression of each collision
In this geometric progression,

th term,

(±

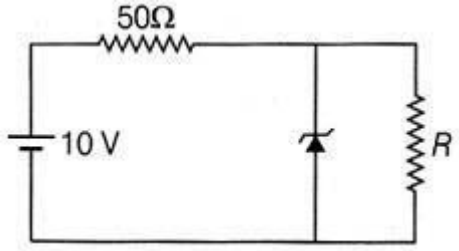
(–*

Taking log both sides,

( ) (* ( ) –

Number of collision ( ) collision

58. The Zener diode is shown in figure has negligible resistance and a knee current of . The minimum value of ( ) so that the voltage across it does not fall below is



(A)
(B)
(C)
(D)
(E)

Solution: (D)
In Zener diode,

_____

_____

and

59. An electron is moving with a velocity / along positive -direction in the uniform electric field of / applied along positive -direction. The magnitude and direction of a uniform magnetic field (in tesla) that will cause the electrons to move undeviated along its original path is

(A) direction
(B) direction
(C) direction
(D) direction
(E) direction

Solution: (A)
For electrons to move undeviated along its original path,
Electric force = Magnetic force
Or

Or

Direction of magnetic field will be -------- direction because of negative charge.

60. What is minimum thickness (in nm) of a soap film ( ) that results in constructive interference in reflected light if the film is illuminated with light whose wavelength in free space is
(A)
(B)
(C)
(D)
(E)

Solution: (B)
For constructive interference,

61. Three variable Boolean expression
can be written as
(A)
(B)
(C) (D)

(E)

Solution: (C)
Given, boolean expression is

62. A prism is made up of material of refractive index √ The angle of the prism is . If the angle of minimum deviation is equal to the angle of the prism, the value of is
(A)
(B)
(C)
(D)

(E)

Solution: (E)

Here, is refractive index is minimum deviation angle, is angle of prism.

Hence,

63. Consider a cylindrical conductor of length and area of cross-section . The specific conductivity varies as ( ) where is the distance along the axis of the cylinder from one of its ends. The resistance of the system along the cylindrical axis is

(A)

(B)

(C)

(D)

(E)

Solution: (A)

Given, ( )

Resistance of the system along the cylindrical axis,

64. If the emission rate of blackbody at is , then the rate of emission at is

(A)
(B)
(C)
(D)
(E)

Solution: (D)
According Stefan's law, emission rate of a ideal blackbody

For
( ) …(i)
For
( ).....(ii)
From Equations (i) and (ii),

(* (* ( )

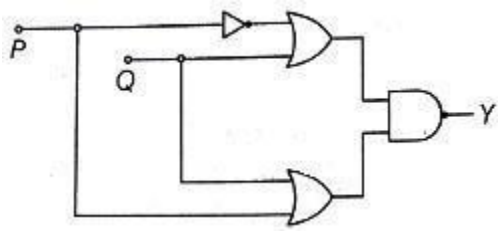
Hence,

65. For any material, if and represent the reflection coefficient, transparent coefficient and absorption coefficient respectively, then for a blackbody which one of the following is true
(A)
(B)
(C)
(D)
(E)

Solution: (D)
Relation between and is
…(i)
For ideal blackbody,

According Equation (i),
and

66. In the given circuit and form the inputs. The output is



(A)
(B)
(C)

(D)
(E)

Solution: (D)
From the given circuit, the output is

67. A radio transmitter sends out of radiation. Assuming that the radiation is uniform on a sphere with the transmitter at its centre, the intensity (/) of the wave at a distance is
(A) (B)
(C)
(D) (E)

Solution: (E)

Power of transmitted radiation,
Intensity of wave,

68. Consider a system of gas of a diatomic molecule in which the speed of sound at is . Then, the molecular weight of the gas is (given, the gas constant is /)
(A)
(B)
(C)
(D)
(E)

Solution: (A)
Speed of sound,

For diatomic gas,

( )

69. A satellite is orbiting the Earth in a circular orbit of radius . Which one of the following statements is true?

(A) Angular momentum varies as

(B) Linear momentum varies as

(C) Frequency of revolution varies as

(D) Kinetic energy varies as

(E) Potential energy varies as

Solution: (D)

Kinetic energy of satellite,

Option Kinetic energy varies as is correct.

70. The magnitude of a magnetic field at the centre of a circular coil of radius , having turns and carrying a current can be doubled by changing

(A) to and to keeping unchanged

(B) to and keeping and unchanged

(C) to and to keeping/unchanged

(D) to and to keeping unchanged

(E) to and keeping and unchanged

Solution: (E)

Magnetic field due to circular current carrying coil,

can be doubled by changing to and Keeping and unchanged.

Options to and keeping and unchanged is correct.

71. An alternating voltage is applied across a circuit and as a result, a current . / − flows in it. The power consumed per cycle is

(A)

(B)

(C)

(D)

(E)

Solution: (E)

Given that,

( )

Power consumed per cycle

Here –

–

72. An electromagnetic wave of intensity is incident on a non-reflecting surface. If is the speed of light in free space, then the ratio / is same as

(A) Momentum
(B) Force
(C) Pressure
(D) Pressure per unit area
(E) Force -area

Solution: (C)

Intensity, – ——

Speed of light, —

– ————
—

-⁻/
————— ————
(————*

Hence, pressure.

Chemistry

Single correct answer type:

1. Which element has the highest first ionization potential?
(A)
(B)
(C)
(D)
(E)

Solution: (C)
Due to small size ( ) and fully filled inert gas configuration. show highest .

2. Which statement (s) is (are) false for the periodic classification of elements?
(A) The properties of the elements are the periodic functions of their atomic numbers
(B) Non-metallic elements are lesser in number than the metallic elements
(C) The first ionization energies of the elements along a period do not vary in a regular manner with increase in atomic number
(D) For transition elements, the -electrons are filled monotonically with increase in atomic number
(E) Both The first ionization energies of the elements along a period do not vary in a regular manner with increase in atomic number and For transition elements, the -electrons are filled monotonically with increase in atomic number

Solution: (D)
The option (For transition elements, the -electrons are filled monotonically with increase in atomic number) is false as -electrons do not filled monotonically with the increase in atomic number.

3. The electronegativities of and are in the order
(A)
(B)
(C)
(D)
(E) Difficult to predict

Solution: (C)
Electronegativity increases on moving left to right in a period and decreases for the period below it ( )
( ) and ( ) respectively belongs to ( ) and ( )
Electronegativity of electronegativity of and electronegativity of electronegativity of

Hence, correct order is:

4. ( ) has_____unpaired electrons with sum of spin___.
(A)
(B)
(C)
(D)
(E)

Solution: (D)
The element ( ) show electronic configuration [ ] Thus, it has unpaired electrons ( ) and its sum of spin is .

5. When gas is passed into aqueous the product (s) formed is (are) (A)
(B)
(C)
(D) and
(E) and

Solution: (C)
On passing the ( ) in the aqueous solution of we get as product.
( )

6. Portland cement does not contain
(A)
(B) (C)
(D) ( )
(E) Both and ()

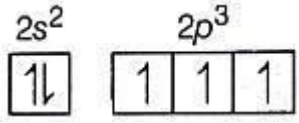
Solution: (D)
Main components of Portland cement are
( ) ( ) ( )
and some other substance but it does not contain ( ) .

7. ( ) is used in the following but not
(A) As a coagulant in treating drinking water and sewage
(B) In plastics industry
(C) As a mordant in dyeing
(D) In paper industry
(E) Both As a mordant in dyeing and In paper industry

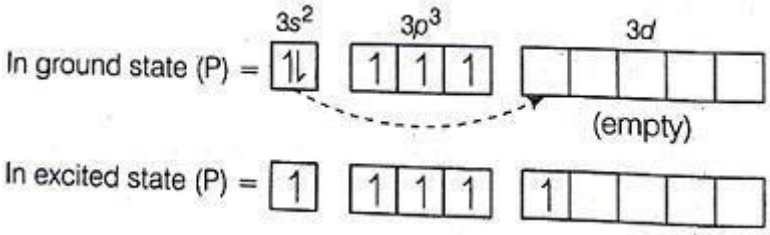
Solution: (B)
( ) is not used in plastic industry.

8. Maximum number of covalent bonds formed by and are
(A)
(B)
(C)
(D)
(E) None of these

Solution: (E)
The outermost orbital of -atom contain unpaired electrons and has



Thus, it is not able to expand its octet and can only form covalent bonds.
It can also form one coordinate bond with the help of one lone pair of electrons over atom ( )
On the other hand, the outer most orbital for is
Which contain empty orbitals.



(has 5 unpaired electrons)
Thus, none of the given are correct.
Correct choice is None of these.

9. Consider the following statements concerning
(i) It is an exothermic compound.
(ii) It burns in air with the evolution of heat.
(iii) It has kinetic stability.
(iv) In reduces to in acidic medium. Which of the following combination is correct?
(A) (ii) and (iii) are correct
(B) (i) and (ii) are correct
(C) All are correct
(D) (iii) and (iv) are correct
(E) (ii), (iii) and (iv) are correct

Solution: (B)
Only the following statements are correct for .
(i) It is an exothermic compound.
(ii) It burns with evolution of heat.
(i) and (ii) are correct is the correct choice.

10. Consider the following species:
(i) [ ]
(ii) [ ]
(iii) [ ]
Among these sigma bond alone is present in
(A) (i) alone
(B) (ii) alone
(C) (iii) alone
(D) (i) and (ii)
(E) (i), (ii) and (iii)

Solution: (A)
Among the given species, all are di atomic species. Only [ ] contain one bond between two bonded atoms.
(i) alone is the correct option

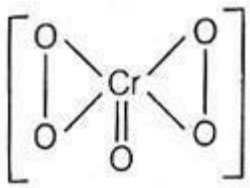
11. Select the correct option (s) for the following statements:
and are used as bleaching agents.
salts are used as detergents.
disproportionates in alkaline medium.
is oxidized in acidic medium.
(A) correct
(B) correct
(C) correct
(D) correct
(E) All are correct

Solution: (A)
Among the given statements:
and give nascen oxygen, thus behave as bleaching agent.
Salts of are used as detergents.
Oxidation state of in is ( ), thus it shows disproportionation reaction in acidic medium:
( ) ( )
[ ]
[ ]
does not oxidise in acidic medium.
Thus correct is the correct answer.

12. When is added to an acidified solution
(A) A green colour solution is obtained
(B) A yellow solution is obtained
(C) A blue-violet solution is obtained
(D) A green precipitate is formed

(E) A yellow precipitate is formed

Solution: (C)
On adding in acidic solution of oxidise it to (chromic penta oxide/chromic per oxide) and gives the blue-violet solution.



(CrO_5)

on decomposition gives oxygen
( )

13. Consider the following compounds:
( )

Which compound (s) yield nitrogen gas upon heating?
(A) and
(B) and
(C) and
(D) and
(E) All

Solution: (A)
Only ( ) and give on heating.

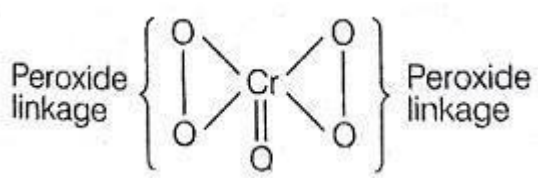
(i) ( )

(ii) →

and is the correct option.

14. How many peroxy linkages are present in ?
(A)
(B)
(C)
(D)
(E)

Solution: (B)
The structure of is as follows:



It has two per-oxide linkage.

15. More than four bonds are made by how many elements in carbon family?
(A)
(B)
(C)
(D)
(E)

Solution: (E)
The elements belong to carbon family are:
Carbon ( )
Silicon ( )
Germanium ( )
Tin ( )
Lead ( )
Flerovium ( )
Except carbon all other elements contain empty d-orbitals in their outermost shell, thus can form more than four bonds.
is the correct answer.

16. The effective nuclear charge of an element with three valence electrons is .
What is the atomic number of the element?
(A)
(B)
(C)
(D)
(E)

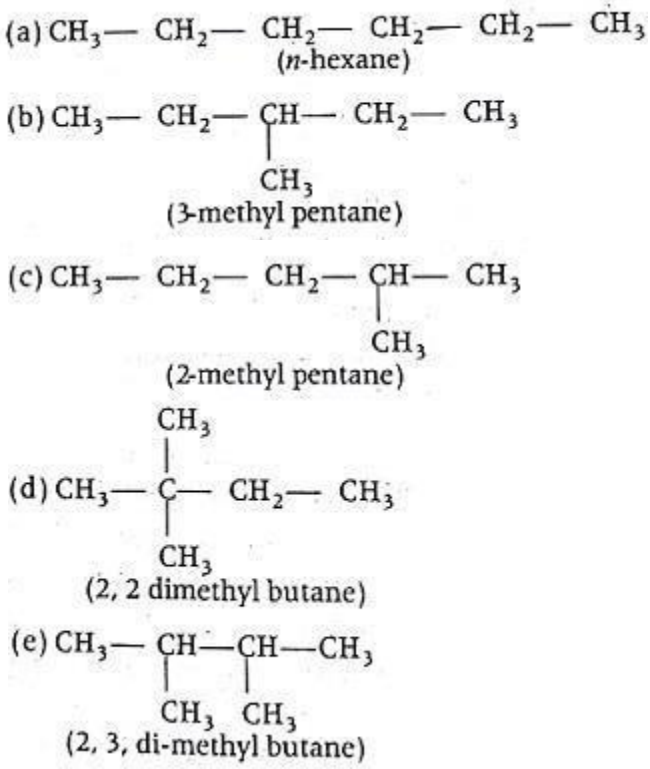
Solution: (E)
Effective nuclear charge and valency shell contain 3 electrons. Thus, minimum number of main shells for the given element are two i.e. ( ) and its configuration will be .
Thus, the given element has electrons in all.
Also, for a neutral atom.
No. of electrons = Atomic number
Thus, atomic number of the element is .

17. The elution sequence of a mixture of compounds containing chlorobenzene, anthracene and -cresol developed of an alumina column using a solvent system of progressively increasing polarity is
(A) Anthracene chlorobenzene -cresol
(B) Anthracene -cresol chlorobenzene
(C) Chlorobenzene -cresol anthracene
(D) Chlorobenzene anthracene -cresol
(E) -cresol anthracene chlorobenzene

Solution: (A)
Alumina column having suitable solvent elutes the species based on their nature of polarity. Less polar species absorb first and more polar thereafter. Thus the correct order is:
Anthracene chlorobenzene -cresol

18. Number of constitutional isomers of alkane with formula is
(A)
(B)
(C)
(D)
(E)

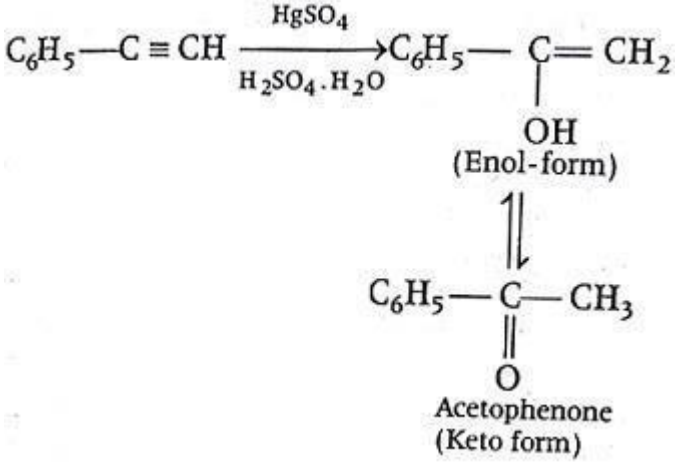
Solution: (C)
The formula of alkane gives the following structural isomers-



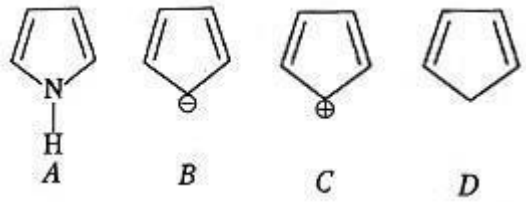
Total isomers

19. Phenylacetylene on treatment with / produces
(A) Acetophenone
(B) Phenylacetaldehyde
(C) Phenylacetic acid
(D) 1-Phenylethanol
(E) 2-phenyletharol

Solution: (A)
On reaction with / phenyl acetylene gives acetophenone as a product:

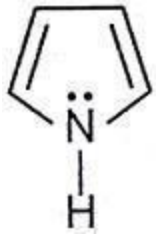


20. Which of the following compounds are aromatic?



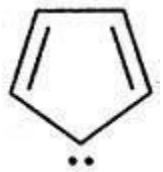
(A)
(B)
(C)
(D)
(E)

Solution: (A)
(i) Structure ( ) has two -bonds and one lone pair of electrons over -atom and has planer structure.
Thus, is an aromatic compound.

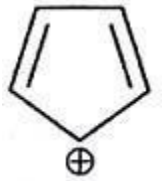


(ii) The structure ( ) also contain two -bonds and one lone pair of electrons. Thus, follow Huckel's rule. The structure is cyclic and planer.

( ) is also an aromatic compound.



(iii) The structure ( ) has only 2 -bonds and do not follow Huckel's rule. So, it not an aromatic compound.



(iv) Structure ( ) also contain only two bonds, thus do not follow Huckel's rule and is not an aromatic compound.

21. Aromatic electrophilic substitution reaction that is reversible is
(A) Nitration
(B) Chlorination
(C) Sulphonation
(D) Alkylation
(E) Acylation

Solution: (C)
Among the aromatic electrophilic substitution reactions. Sulphonation is an example of reversible reaction.

22. Which one of the following statements is false?
(A) and configurations correspond to the enantiomers of an optically active compound
(B) The process of converting an optically active compound into a racemate is called racemization
(C) A molecule containing a plane of symmetry can be optically active
(D) Optical isomers that are not enantiomers are called diastereoisomers
(E) All chiral objects are asymmetric

Solution: (C)
configuration is related to the enantiomers, which are optically active. ( )

(ii) The mixing of two optically-active compounds ( ) in equimolar quantity is called racemization ( )
(iii) A molecule containing plane of symmetry does not show optical activity.
Hence, the given statement is false.
(iv) Optical isomers that are not enantiomers are called diastereoisomers (is true).
(v) All chiral objects are asymmetric (true)
A molecule containing a plane of symmetry can be optically active is the correct answer.

23. Neopentyl bromide, undergoes dehydrohalogenation to give alkenes even though it has no hydrogen. This is due to
(A) mechanism
(B) mechanism
(C) Rearrangement of carbocations by mechanism
(D) mechanism
(E) mechanism

Solution: (C)
Neopentyl bromide give a carbocation as intermediate which undergo for rearrangement and show mechanism (even has no atom).
Thus Rearrangement of carbocations by mechanism is the correct option.

24. The compound which does not lead to nitrile by substitution with / is
(A) Benzyl chloride
(B) Ethyl chloride
(C) Isopropyl chloride
(D) Chlorobenzene
(E) Isobutyl chloride

Solution: (D)
Chlorobenzene does not lead to nitrile by substitution with / due to resonance and double bond character between and carbon [ ] of the benzene ring.

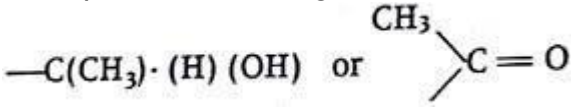
25. Oxidation of alcohols to aldehydes is very successful for the alcohols like
(A) Pent-2-yn-1-ol
(B) 1-hexanol
(C) n-propyl alcohol
(D) 1-pentanol
(E) 1-octanol

Solution: (C)
The oxidation of n-propyl alcohol (among the alcohols) is very successful because of least steric hindrance in the given molecule.

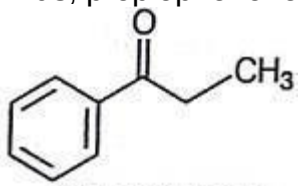
Bio-waste give the most efficient and clean fuel thus known as Green-fuel.

26. The compound that does not undergo halo form reaction is
(A) Acetaldehyde
(B) Ethanol
(C) Acetone
(D) Acetophenone
(E) Propiophenone

Solution: (E)
The species containing



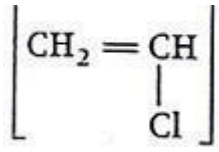
will show haloform reaction.
Thus, propiophenone does not show haloform reaction.



(Propiophenone)

27. The halogen compound which will not react with phenol to give ethers is
(A) Ethyl chloride
(B) Methyl chloride
(C) Benzyl chloride
(D) Vinyl chloride
(E) Allyl chloride

Solution: (D)

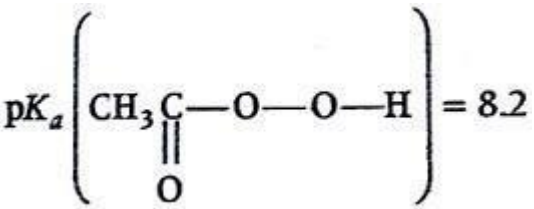
Due to resonance structure 

(vinyl chloride) will not react with phenol to give ethers.

28. The weakest among the following acids is
(A) Peroxyacetic acid
(B) Acetic acid
(C) Chloroacetic acid
(D) Trichloroacetic acid
(E) Propanoic acid

Solution: (A)
As value of
( )

( )
( )



and more be the value of , weaker be the acid. Hence, peroxyacetic acid is the weakest acid.

29. The nitrosation of -------dimethylaniline takes place through the attack of electrophile
(A) Nitronium ion
(B) Protonated nitrous acid
(C) Nitrous acid
(D) Nitrite ion
(E) Nitrosonium ion

Solution: (E)
On attacking at

dimethyl aniline by , electrophilic nitration takes place and the process is

called Nitrosation. Here act as an attacking electrophilic agent. It is produced as follows:

30. The nitrogeneous base present only in is
(A) Guanine
(B) Adenine
(C) Cytosine
(D) Uracil
(E) Thymine

Solution: (D)
In *RNA*, nitrogen-base uracil is present in place of thymine (which is present in).
Uracil is the correct answer.

31. Green fuel is the fuel obtained from
(A) Bio-waste
(B) Metal waste
(C) Plastic waste
(D) Chemical waste
(E) Electronic waste

Solution: (A)

104. Barbiturates are potent
(A) Hypnotics
(B) Antimicrobials
(C) Antacids
(D) Antiseptics
(E) Antiallergics

Solution: (A)
Barbiturates are derivatives of barbituric acids. These are potent hypnotics.

105. of ( ) is oxidized to ( ) .
Calculate the equivalent weight of ferrousion
(A)
(B)
(C)
(D)
(E)

Solution: (A)
Atomic mass of
Equivalent mass ——————————

For the charge, i.e. ( )
the equivalent mass ——

106. Mass % of carbon in ethanol is
(A) 52
(B) 13
(C) 34
(D) 90
(E) 80

Solution: (A)
Molecular mass of

[ ]

Also,
of contain,
of contain, ———
( )

107. One mole of ethanol is produced reacting graphite, and together. The standard enthalpy of formation is Calculate the standard enthalpy of the reaction when moles of graphite is involved
(A)

(B)
(C)
(D)
(E)

Solution: (B)
The related equation for the formation of ethanol is.

( ) ( ) ( ) ( ) / –

When moles of graphite is involved the standard enthalpy of reaction is /

When moles of graphite is involved, standard enthalpy of reaction is (/)

( ) /

108. Which of the following process best describes atomization of ()
(A) Exothermic
(B) Endothermic
(C) Non-spontaneous
(D) Spontaneous
(E) Both Endothermic and Non-spontaneous

Solution: (E)
The energy required to separate one mole molecule into its gaseous atoms is known as heat of atomization.
In this process, heat is absorbed i.e. (endothermic) and the said reaction is non-spontaneous.
Both Endothermic and Non-spontaneous is the correct answer.

109. Consider the equilibrium . Find the stoichiometric coefficient of the using the data given in the following table:

/	/	/

(A)
(B)
(C)
(D)
(E)

Solution: (B)
Given,

Let the coefficient of be
Now, we know that

$$\frac{[\ ]}{[\ ][\ ]}$$

According to the data given in question,

$$\frac{(\qquad)}{(\ )(\ )}$$

Also, $\frac{(\qquad)}{(\ )(\ )}$

Now, substitute the values of given in option one by one.

$$(\ )_{(\ )(\ )} \frac{(\ )}{}$$

$$\frac{(\ )}{(\ )(\ )}$$

, thus option 1 is incorrect.

$$(\ )_{(\ )(\ )} \frac{(\ )}{}$$

$$\frac{(\ )}{(\ )(\ )}$$

Option 2 is correct

110. Which of the following can help predict the rate of a reaction if the standard Gibbs free energy of reaction ( ) is known?
(A) Equilibrium constant
(B)
(C)
(D) Heat liberated during the course of reaction in calorimeter
(E) Both (Equilibrium constant) and ( )

Solution: (A)
(Gibbs free energy) is related to (equilibrium constant) as follows:

where, Gas constant
Temperature in Kelvin
By knowing the value of we can find out rate of a reaction.
Equilibrium constant is the correct answer.

111. Calculate the molarity of a solution containing of dissolved in the product of a fuel cell operated at current for hours.
(Assume / of electrons and molecular weight of as)
(A)
(B)
(C)
(D)
(E)

Solution: (B)
Total charge produced by cell
( )

_____

of
Now, in fuel cell following reaction occurs,
At mode ( ) ( ) ( )
At cathode ( ) ( ) ( )
Overall reaction ( ) ( ) ( )
Thus, from above reaction it is clear that
of of
of of
( ) of
[_____]

or of
Now, number of mol of —
We know that,

_____( )___

____

112. If of solute is dissolved into the of water, at what temperature will water boil at bar?
( )
(A)
(B)
(C)
(D)
(E)

Solution: (B)

—

Given,

_____

Boiling point of pure water at bar (i.e.) is
Boiling point of the solution

113. Consider the electrochemical reaction between ( ) and ( ) electrodesin of aqueous solution. Solubility product of is and
/ . At current, calculate the time required to start observing the precipitation in the galvanic cell
(A)
(B)
(C)
(D) (E)

Solution: (A)
The electrochemical reaction between ( ) and ( ) is as follows:

Given, [ ]
[ ][ ]
[ ]

[ ] ————————

of solution contains moles of .
Quantity of electricity required

Time required ( ) ————

114. The voltage of the cell consisting of ( ) and ( ) electrodes is at standard condition at . What is the voltage if the electrolyte consists of .
( )
(A)
(B)
(C)
(D)
(E)

Solution: (A)
Now, the cell reaction is

( ) – ( )

We know that,

— ————

———— [ ][ ]

———————— ( )

115. Consider the galvanic cell. ( )| ( )| ( )( )| ( )| ( ). After running the cell for sometime, the concentration of the electrolyte is automatically raised to . Molar conductivity of the is about and limiting molar conductivity of is about . If of water is , calculate the boiling point of the electrolyte at the end of the experiment
(A)
(B)
(C)
(D)
(E)

Solution: (A)
Given,

Degree of ionization,

Van't Hoff factor
( ) [for ionization]
( ) [ ]

Elevation in boiling,
( )

Since, water boils at at bar pressure, therefore the boiling point of solution will be

116. The data given below are for the reaction of and to form product at .
Find the correct rate expression for this reaction

(A) [ ] [ ]
(B) [ ] [ ]

(C) [ ] [ ]
(D) [ ] [ ]
(E) [ ] [ ]

Solution: (A)
From the data ( ) and ( )

[ ] [ ]
[ ] [ ]

i.e [ ]
[ ]

( ) [ ]
Rate ( ) [ ] , where order
( ) [ ]
Order of [ ]

Similarly, from data ( ) and ( )

( ) [ ]
( ) [ ]

rate ( ) [ ]
[ ]

or order for [ ]
Hence, rate expression [ ] [ ]
[ ] [ ] is the correct answer.

117. Find the unit of the rate constant of a reaction represented with a rate equation,
rate [ ] [ ]
(A)
(B)
(C) (D)
(E)

Solution: (A)
Rate ( ) [ ]

[ ]

or, [ ]
[ ] [ ]

[ ]
[ ]

is the correct answer.

118. Under what condition the order of the reaction,
( ) ( ) is zero
(A) At high temperature
(B) At high partial pressure of
(C) At low partial pressure of
(D) At high partial pressure of
(E) At high partial pressure of

Solution: (B)
The reaction,

→ ( ) ( )

is of zero-order in which is present at high partial pressure.

119. Which of the following statement is true about the adsorption?
(A) and
(B) and
(C) and
(D) and
(E) and

Solution: (A)
In adsorption the adsorbed particles show strong force of attraction with the surface on which they adsorb and therefore their randomness also decreases.
and
Hence, and is the correct answer.

120. In synthesis by Haber's process, what is the effect on the rate of the reaction with the addition of and , respectively?
(A) Increases and decreases
(B) Decreases and decreases
(C) Decreases and increases
(D) Both and increases the rate
(E) Both and does not affect the rate

Solution: (A)
In formation of by Haber's process.

( ) ( ) → ( )

(i) When is used as catalyst, it increase the rate of formation of because it behaves as promoter.
(**i**) But, when is used as catalyst it decreases the formation of because it behaves as poisoning agent.
Increases and decreases is the correct answer.