UPSEE-2018-Paper-1-Set-AA

Physics

1. A very long solenoid is made out of a wire with n turns per unit length. The radius of the cylinder is a and is negligible compared to its length l. The interior of the cylinder is filled with materials such that the linear magnetic permeability varies with the distance r from axis according to

$$\mu(r) = \begin{cases} \mu_1 = \text{constant}; & \text{for } 0 < r < b \\ \mu_2 = \text{constant}; & \text{for } b < r < a \end{cases}$$

The self inductance of the solenoid is

(A) $\pi n^2 l [\mu_1 b^2 + \mu_2 a^2]$

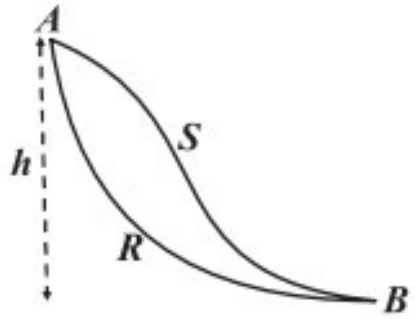
(B) $\pi n^2 l [\mu_1 + \mu_2] a^2$

(C) $\pi n^2 l [\mu_1 b^2 + \mu_2 (a^2 - b^2)]$

(D) $\pi n^2 l [\mu_1 b^2 + (\mu_1 + \mu_2) a^2]$

2. Two children Ramesh (on path ARB) and Sohan (on path ASB), travel down slides of identical height h but different shapes as shown. Assuming they start down the frictionless slides at the

same time with zero initial velocity, which of the following statements is true?



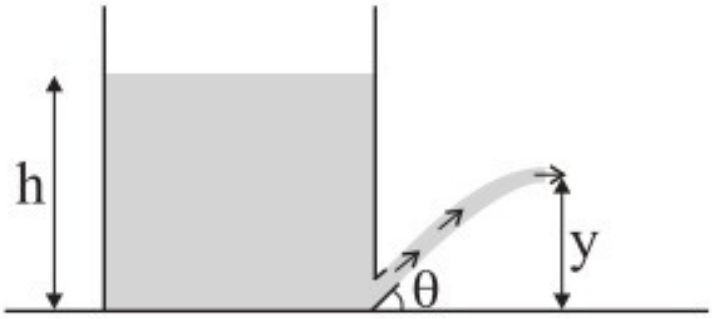
(A) Ramesh reaches the bottom first with the same average velocity as Sohan.

(B) Ramesh reaches the bottom first with a larger average acceleration than Sohan.

(C) Ramesh reaches the bottom first with the same average acceleration as Sohan.

(D) They reach the bottom at the same time with the same average acceleration.

3. A stream of non viscous liquid emerges from a very short outlet tube at the base of a large open tank, in which the depth of liquid is h. The tube is at a fixed angle θ to the ground as shown. The maximum height of the stream y is



(A) $h\sin 2\theta$

(B) $h\sin 2\theta$

(C) $\frac{1}{2}h\sin 2\theta$

(D) $h\tan 2\theta$

4. An eagle flies at constant velocity horizontally across the sky, carrying a mouse and releases the mouse while in flight. From the eagle's perspective, the mouse falls vertically with speed v1. From an observer on the ground's perspective, the mouse falls at an angle with speed v2. What is the speed of the eagle with respect to the observer on the ground?

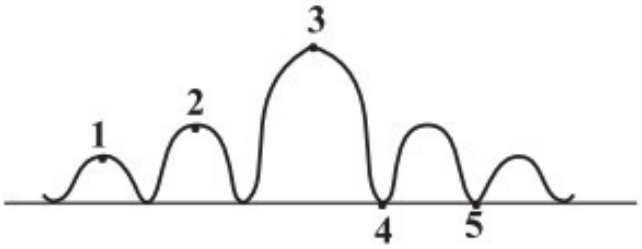
(A) $v1+v2$

(B) $v1-v2$

(C) $\sqrt{v21-v22}$

(D) $\sqrt{v22-v21}$

5. The diffraction pattern of a single slit is shown in figure. The point at which the path difference of the extreme rays is two wavelengths is



(A) Point 1

(B) Point 2

(C) Point 4

(D) Point 5

6. Which frequency produces a sound that can be heard by a person?

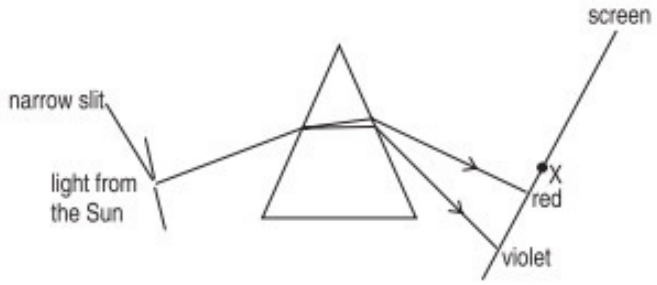
(A) 100kHz

(B) 40kHz

(C) 2kHz

(D) 30kHz

7. Light from the Sun passes through a prism and a spectrum is produced on a screen. A thermometer placed at point X shows a temperature increase. For the given diagram, which type of radiation causes this temperature increase? Select the most appropriate option.



(A) infra-red rays

(B) X-rays

(C) ultraviolet rays

(D) visible light

8. Light has wavelength 600nm in free space. It passes into glass, which has an index of refraction of 1.50, What is the frequency of the light inside the glass?

(A) 3.3×1014Hz

(B) 5.0×1014Hz

(C) 3.3×105Hz

(D) 5.0×105Hz

9. Two SHM are represented by the equations

$x_1 = 20\sin\left(5\pi t + \frac{\pi}{4}\right)$

$x_2 = 10(\sin 5\pi t + \sqrt{3}\cos 5\pi t)$

The ratio of the amplitudes of the two motions is

(A) 0.5

(B) 1

(C) 0.25

(D) $\frac{3}{2}$

10. The rms speed of hydrogen molecule at a certain temperature is v. If the temperature is doubled and hydrogen gas dissociates into atomic hydrogen, the rms speed will become

(A) v

(B) $\frac{v}{2}$

(C) 2v

(D) 2v

11. The activity of a radioactive element decreases in 10years to 1/5 of initial activity A0. After further next 10years its activity will be

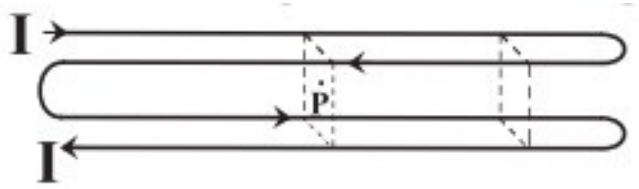
(A) $\frac{A0}{4}$

(B) $\frac{A0}{10}$

(C) $\frac{A0}{15}$

(D) $\frac{A0}{25}$

12. Four very long wires are arranged as shown, so that their cross-section forms a square, with connections at the ends so that current I flows through all four wires as shown. Length of each side of the formed such square is b. The magnetic field at the central point P (centre of the square) is



(A) $\frac{\mu 0 I}{\pi b}$

(B) $\frac{2\mu_0 I}{\pi b}$

(C) 0

(D) $\frac{\mu_0 I}{2\pi b}$

13. A nonconducting ring carries linear charge density λ. It is rotating with angular speed ω about its axis. The magnetic field at its centre is

(A) $\frac{3\mu_0 \lambda \omega}{2\pi}$

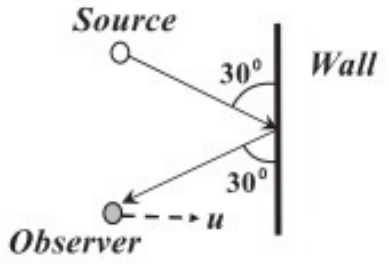
(B) $\frac{\mu_0 \lambda \omega}{2}$

(C) $\frac{\mu_0 \lambda \omega}{\pi}$

(D) $\mu_0 \lambda \omega$

14. A stationary source (see figure) emits sound waves of frequency f towards a stationary wall. If an observer moving with speed u in a direction perpendicular to the wall measures a frequency

$f' = \frac{11}{8} f$ at the instant shown, then u is related to the speed of sound VS as



(A) $\frac{3V}{4}_S$

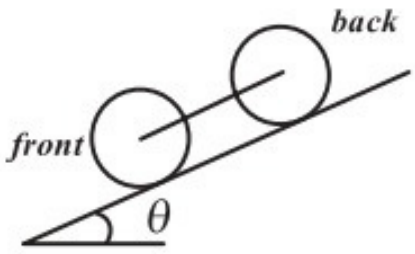
(B) $\frac{3V}{8}_S$

(C) $\frac{1V}{4}S$

(D) $\frac{8V}{3}_S$

15. The front solid cylinder has mass $M = \frac{w}{3}$ while the back one solid cylinder has mass $2M$. The centers of these cylinders are $\frac{}{3}$ connected by massless rod as shown. Both the cylinders have same radii R. The system is released from rest on the inclined

plane. The cylinders roll down. The speed of the rod after system descending a vertical distance h is



(A) $\sqrt{\frac{2gh}{3}}$

(B) $\sqrt{2gh}$

(C) $\sqrt{\frac{4gh}{3}}$

(D) $\sqrt{\frac{3gh}{7}}$

16. Suppose a particle of mass m moving with potential energy $U = \frac{kx2}{2}$ $+Ae-\alpha x2$ has velocity va when its position is x=a. Here k,A and α are constants. The particle will be able to pass the origin if

(A) $A \geq \frac{mv_a^2 + ka2}{2(1 - e-\alpha a2)}$

(B) $A \leq \frac{mv^2a + ka^2}{2(mv+ka^2)(1-e^{-\alpha a})}$

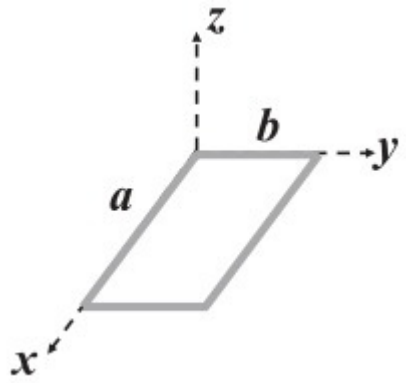
(C) $A \leq \frac{a^2}{(1-e^{-\alpha a})}$

(D) $A \geq \frac{mv^2+ka^2}{a(1-e^{-\alpha a^2})}$

17. A rectangular wire loop with length a and width b lies in the xy plane as shown. Within the loop there is a time dependent magnetic field given by

$$\vec{B} = c\hat{i}(x\cos\omega t)\hat{i}+(y\sin\omega t)\hat{k}\hat{i}\hat{i}\hat{i}$$

Here, c and ω are constants. The magnitude of emf induced in the loop as a function of time is



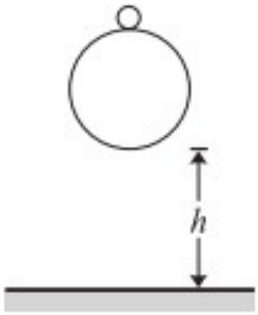
(A) $\left|\frac{ab^2c}{2}\omega\cos\omega t\right|$

(B) $\left|ab\,2\,c\omega\cos\omega t\right|$

(C) $\left|\frac{a^2bc}{2}\omega\sin\omega t\right|$

(D)None of the options

18. A Tennis ball with (small) mass m2 sits on the top of a basketball with (large) mass m1. The bottom of the basketball is at a height h above the ground and the bottom of the tennis ball is at a height (h+d) above the ground. The balls are dropp from rest. Here all collisions are elastic and m1>>m2. To what approximate height from the ground the tennis ball bounce?



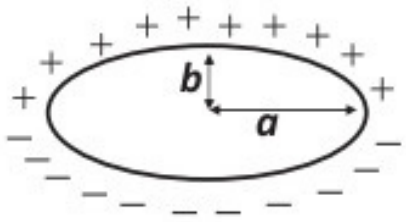
(A) $d+h$

(B) $d+2h$

(C) $d+3h$

(D) $d+9h$

19. An ellipse has uniform linear positive charge density in upper half (total upper half part charge +Q) and uniform linear negative charge density in lower half (total lower half part charge −Q) as shown in figure. Here semi minor axis b<a semi major axis. Select the correct statement about the magnitude of electric dipole moment *P* of the ellipse



(A) $P = \frac{Qb}{2}$

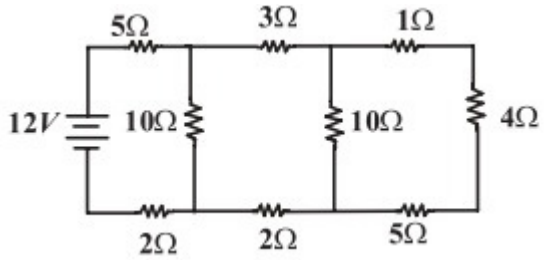
(B) $0<P < \frac{Qb}{2}$

(C) $\frac{Qb}{2}<P<2Qb$

(D) 2Qb

20. Consider the circuit shown below. The current in the resistor is

4 Ω



(A) 0.25A

(B) 0.50A

(C) 0.75A

(D) 1.00A

21. A thin layer of oil (index of refraction 1.5 and thickness 500nm) floats on the surface of the liquid (index of refraction 1.24). Now white light is normally incident on the thin film of oil. Of the following, the most reflected wavelength is

(A) 500nm

(B) 550nm

(C) 600nm

(D) 650nm

22. Point charges 30C, −20C and 10C are located at (−1,0,2), (0,0,0) and (1,5,−1) respectively. The total electric flux leaving cube of side 6m cantered at the origin is

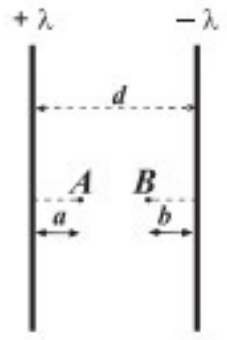
(A) $\frac{-20}{\varepsilon_0}$

(B) $\frac{10}{\varepsilon_0}$

(C) $\frac{20}{\varepsilon_0}$

(D) $\frac{30}{\varepsilon_0}$

23. Two infinitely long wires carry linear charge densities $+\lambda$ and $-\lambda$ respectively as shown. The potential difference between points A (at a distance a from the first wire) and B (at a distance b from the second wire) is



(A) $\frac{\lambda}{2\pi\varepsilon_0}\ln\left[\frac{(d-a)(d-b)}{ab}\right]$

(B) $\frac{\lambda}{2\pi\varepsilon_0}\ln\left[\frac{d^2}{}\right]$

(C) $\frac{\lambda}{4\pi\varepsilon_0}\ln\left[\frac{(d-a)(d-b)}{ab}\right]$

(D) $\frac{\lambda}{2\pi\varepsilon_0}\left[\frac{(d-a)(d-b)}{ab}\right]$

24. A charged particle of mass 2kg and charge 3C starts with initial velocity $4\hat{i}+3\hat{k}$ in an electric field $12\hat{i}+10\hat{j}$. Here all units are in SI. At time t=1 its velocity becomes

(A) $16\hat{i}+10\hat{j}+3\hat{k}$

(B) $40\hat{i}+30\hat{j}+3\hat{k}$

(C) $22\hat{i}+15\hat{j}+3\hat{k}$

(D) $22\hat{i}+18\hat{j}$

25. Which of these materials requires the least value of magnetic field strength to magnetize it?

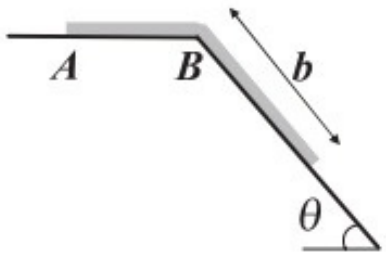
(A) Nickel

(B) Solver

(C) Tungsten

(D) Sodium Chloride

26. A chain of length L and of mass m is placed upon a smooth surface. The length of BA is L–b. Now the Chain is released and it slides down. Calculate the speed of the chain when its end reaches B



(A) $\sqrt{\frac{g\sin\theta(L^2 - b^2)}{L}}$

(B) $\sqrt{\frac{2g\sin\theta(L^2 - b^2)}{L}}$

(C) $\sqrt{2g\sin\theta(L-b)}$

(D) $\sqrt{g\sin\theta(L-b)}$

27. The basic idea of MASER was first given by

(A) Max Planck

(B) Einstein

(C) Townes

(D) Fresnel

28. The average value of rotational kinetic energy of one mole of oxygen gas at temperature *T* will be

(A) RT

(B) $\frac{3RT}{2}$

(C) $\frac{5RT}{2}$

(D) $\frac{1RT}{2}$

29. If the coefficient of static friction between shoes of a runner and the track is 0.85, the greatest acceleration that can be generated by the runner is (here g gravitational acceleration)

(A) 1.85g

(B) g

(C) 0.85g

(D) 0.15g

30. Two planets (each having mass m) revolve around a stationary star (of mass M) in a circle of radius r. The two planets are always on opposite side of the star (i.e. they are diametrically opposite and always having separation 2r). The orbital period T

of the planets is of the form $T=2\pi \sqrt{\frac{r^3}{GM'}}$, What is the value of M'?

(A) $M - \frac{m}{2}$

(B) $M - \frac{m}{4}$

(C) M

(D) $M + \frac{m}{4}$

31. An infinite number of capacitors 2.0μF, 4.0μF, 8.0μF, 16.0μF,..... are connected in series. The equivalent capacitance of the system is

(A) ∞

(B) 0.25μF

(C) 0.5μF

(D) 1.0μF

32. A motion is described by $y=4ex(e-5t)$ where

and *t* is in second.

(A) This represents progressive wave propagating along –x direction with 5m/s

(B) This represents progressive wave propagating along +x direction with 5m/s

(C) This does not represent progressive wave.

(D) This represents standing wave.

33. A ray of light is incident on the plane mirror at rest. The mirror starts turning at a uniform angular acceleration of $\frac{\pi}{4}$ rad · s-2. The reflected ray at the end of 1s must have turned through

(A) 90°

(B) 45°

(C) 22.5°

(D) 11.25°

34. In npn transistor circuit, the collector current is 20mA. If 90% of the electrons emitted reach the collector then the

(A) emitter current will be about 16mA

(B) emitter current will be 19mA

(C) base current will be about 2mA

(D) base current will be about 10mA

35. A wheel of radius 2m rolls on the ground with uniform velocity 4m/s.The relative acceleration of the topmost point of the wheel with respect to the bottommost point of the wheel is

(A) 8m/s2

(B) 16m/s2

(C) 4m/s2

(D) 32m/s2

36. A stone is released from an aeroplane which is rising with upward acceleration 5m/s2. Here g=10m/s2. Two seconds after the release, separation between stone and aeroplane will be

(A) 10m

(B) 20m

(C) 30m

(D) 25m

37. A solid body rotates an angle θ about a stationary axis according to the law θ=6t−2t3. What is the mean value of

angular velocity over the time interval between t=0 and the time when the body comes to rest?

(A) 1rad/s

(B) 2rad/s

(C) 3rad/s

(D) 4rad/s

38. For sodium light, the two yellow lines occur at $\lambda 1$ and $\lambda 2$ wavelengths. If the mean of these two is 6000A and $\lambda 2 - \lambda 1 = 6A$, then the approximate energy difference between the two levels corresponding to $\lambda 1$ and $\lambda 2$ is

(A) 2×10^{-3}eV

(B) 2eV

(C) 2000eV

(D) 2×10^{-6}eV

39. During the adiabatic expansion of 2 moles of an ideal gas, the increase in internal energy was found to be equal to (–200

The work done by the gas during the process will be equal to

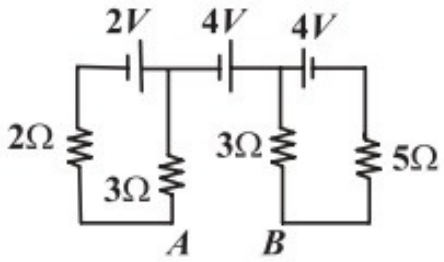
(A) 0

(B) 400J

(C) −200J

(D) 200J

40. In the given circuit, potential difference between Points A and B is



(A) 6.7V

(B) 3.7V

(C) 4V

(D) 10V

41. The angular momentum of an electron in hydrogen atom is $\frac{h}{\pi}$.

The kinetic energy of the electron is

(A) 13.6eV

(B) 3.4eV

(C) 1.51eV

(D) 0.85eV

42. Which of the following is not the unit of surface tension?

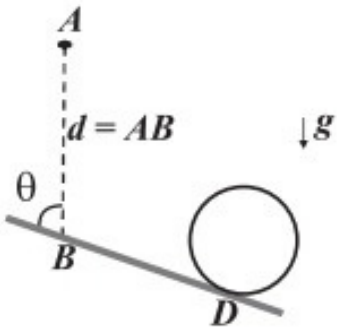
(A) $\frac{N}{m}$

(B) $\frac{J}{m^2}$

(C) $\frac{Kg}{s^2}$

(D) $\frac{watt}{m}$

43. A disk of radius *R* and mass *M* is at equilibrium at position D on the smooth inclined plane which makes an angle θ with the vertical as shown. The disk's centre is attracted to a point A located at a vertical distance d above the surface as shown. Assume that the force of attraction is proportional to the distance from the disk's center of mass to point A; i.e. assume that $F=-kr$ where r is the distance from the point A to the disk's centre of mass and *k* is constant. Then distance BD is



(A) $\left(\frac{Mg}{k} - d\right)\cos\theta$

(B) $\left(\frac{Mg}{k} - d\right)\sin\theta$

(C) $\left(\frac{Mg}{k} + d\right)\cos\theta$

(D) $\left(\frac{Mg}{k} - d\tan\theta\right)$

44. One milligram of matter converted into energy will give

(A) 90J

(B) 9×103J

(C) 9×1010J

(D) 9×105J

45. An object of mass 10kg falls from rest through a vertical distance of 10m and acquires a velocity of 10m/s.The work done by the push of air on the object is (g=10m/s

(A) 500J

(B) −500J

(C) 250J

(D) −250J

46. What type of waves are produced in a sitar wire

(A) Transverse progressive

(B) Longitudinal progressive

(C) Transverse stationary

(D) Longitudinal stationary

47. A long rigid wire lies along the x axis and carries a current of 10A in the positive x direction. Round the wire external magnetic field is B=□i+2x2□j with *x* in meters and B in Tesla. The magnetic force (in SI units) on the segment of the wire between x=1m and x=4m is

(A) 1260

(B) $\frac{1280}{3}$

(C) 1310

(D) 420

48. A train travels east towards Hubli at 80km/hr. A man on the train runs from the front of the train toward the rear of the train at 10km/hr with respect to train. As he runs, he carries a plate of fruit with him. He notices a giant spider on the plate and throws the plate away from him (toward the rear of the train) at 20km/hr with respect to him. Just after that instant, the startled spider jumps towards the man at 5km/hr with respect to plate. The instant after the spider jumps toward the man, how fast is the spider approaching Hubli?

(A) 45km/hr

(B) 115km/hr

(C) 55km/hr

(D) 95km/hr

49. The ratio of magnetic field at the centre of a current carrying circular coil to its magnetic moment is x. If the current and

radius each of them are made three times, the new ratio will become

(A) 3x

(B) 9x

(C) x/9

(D) x/27

50. If λ1 and λ2 denote the de Broglie wavelengths of two particles with same masses but charges in the ratio of 1:2 after they are accelerated from rest through the same potential difference then

(A) $\lambda_1=\lambda_2$

(B) $\lambda_1<\lambda_2$

(C) $\lambda_1>\lambda_2$

(D) none of the options

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Chemistry

51. If a mixture of FeO and Fe_3O_4 contains 75% Fe, what will be the percentage amount of each oxide in the mixture?

    (A) 64.10% FeO and 35.90% Fe_2O_3

    (B) 50% FeO and 50% Fe_2O_3

    (C) 75% FeO and 25% Fe_3O_4

    (D) 35.90% FeO and 64.10% Fe_2O_3

52. What will be the correct no. of total electrons in 1.6 g methane

    (A) 6.02×1024

    (B) 6.02×1023

    (C) 6.02×1022

    (D) 9.632×1023

53. Which of the following pair of salt produces Odourless gas with dil H_2SO_4

    (A) $HCO-3 and HSO-3$

    (B) $HCO-3 and CO-3$

(C) SO_2 −3andCH $3CO\bar{2}$

(D) CO2−3andCH $3CO\bar{2}$

54. One litre of an acidified solution of KMnO4 containing 15.8 g KMnO4 is decolorised by passing sufficient amount of SO2. If SO2is produced by roasting of iron pyrite (FeS2). The amo of pyrite required to produce the necessary amount of SO2 will be

(A) 15.8gFeS2

(B) 15.0gFeS2

(C) 7.5gFeS2

(D) 7.9gFeS2

55. If an e− is revolving in the first bohr orbit of a H atom with a velocity of 2.19×108 cms−1 , what will be the velocity of the e− in the third orbit of H atom

(A) 2.19×108cms−1

(B) 7.3×107cms−1

(C) 6.57×108cms−1

(D) 1.09×108cms−1

56. Which is the correct formula of Forstrite

(A) Mg2SiO4

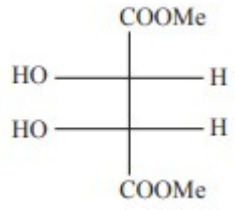
(B) $Al_2(OH)_4(Si_2O_5)$

(C) ZrSiO4

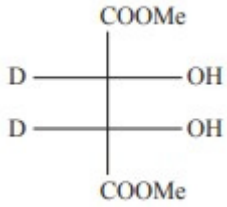
(D) Ca3Si3O9

57. Which of the following is optically active molecule

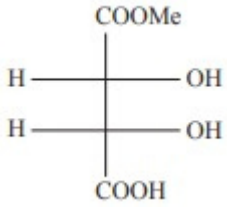
(A)



(B)



(C)



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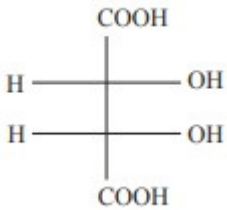


58. Which of the following does not show a resonance effect

(A) C_6H_5OH

(B) C_6H_5Cl

(C) $C_6H_5NH_2$

(D) $C_6H_5NH_3$

59. Petroleum refining involves

(A) Vaccum distillation

(B) Fractional distillation

(C) Steam distillation

(D) Simple distillation

60. D – Glucose units in cellulose are joint by

(A) α–1,4glycosidicbond

(B) β–1,6glycosidicbond

(C) β–1,4glycosidicbond

(D) Peptide bond

61. Most reactive alcohol towards esterification is

(A) Primary alcohol

(B) Secondary alcohol

(C) Tertiary alcohol

(D) All are same reactive

62. The Markonvikov's rule is best applicable to the reaction

(A) C2H4+HCl

(B) C3H6+Br2

(C) C3H6+HBr

(D) C3H8+Cl2

63. . The addition of Br2 to (E)–but–2–ene gives

(A) (R,R)2–3–dibromobutane

(B) (S,S)–2–3–dibromobutane

(C) (R,S)–2–3–dibromobutane

(D) a mixture of (R,R)and(S,S)2,3dibromobutane

64. Which among the following compounds will have meso form

(A) CH2OH–CHOH–CHOH–CHO

(B) CH2OH–CHOH–CHOH–COOH

(C) CH2OH–(CHOH)–CH2OH

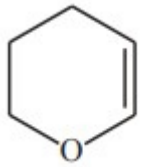
(D) C6H3–CHCl–CHOH–CH3

65. Which compound will be most reactive for electrophilic addition reaction

(A) CH3–CH=CH–CH3

(B) CH3–C≡C–CH3

(C) CH3–CH=CHCOOCH3

(D) 

66. At 298 K what will be the change in standard internal energy change for the given reaction

$$OF_2(g) + H_2O(g) \rightarrow O_2(g) + 2HF(g)$$

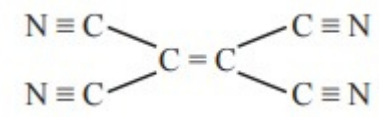
$$\Delta H = -310 \text{ kJ}$$

(A) −312.5kJ

(B) −125.03kJ

(C) −310kJ (D) −156kJ

67. How many σ bonds and π bonds are present in



(A) $5\sigma+8\pi$

(B) $9\sigma+7\pi$

(C) $9\sigma+9\pi$

(D) $5\sigma+9\pi$

68. Which of the following reactions is a redox reaction

(A) $CaCO_3+2HCl \rightarrow CaCl_2+H_2O+CO_2$

(B) $AgNO_3+KI \rightarrow AgI+KNO_3$

(C) $Cl_2+2Br^- \rightarrow Br_2+2Cl^-$

(D) $BaCl+SO_4^{2-} \rightarrow BaSO_4+2Cl^-$

69. The E°_{red} of Ag, Cu, Co and Zn are 0.799, 0.337, – 0.277 and – 0.762 V respectively, which of the following cells will have max cell e.m.f. ?

(A) $Zn|Zn^{2+}(1M)\|Cu^{2+}(1M)|Cu$

(B) $Zn|Zn^{2+}(1M)\|Ag^{+}(1M)|Ag$

(C) $Cu|Cu^{2+}(1M)\|Ag^{+}(1M)|Ag$

(D) $ZnZn2+(1M)Co2+(1M)Co$

70. What will be the value of ΔG and ΔGo for the reaction,

A+B⇌C+D at 27°C for which K=102

(A)ΔG=0;ΔGo=−11.48kJmol−1

(B) ΔG=0;ΔG=11.48kJmol−1

(C)ΔG=−11.48kJmol−1 ;ΔG=0

(D)ΔG=11.48kJmol−1 ;ΔG=0

71. In which of the following changes entropy decreases.

(A) Crystallization of sucrose from solution

(B) Dissolving sucrose in water

(C) Melting of ice

(D) Vaporization of camphor

72. Why is the Heat evolved in neutralization of HF is highest

(A) Due to low hydration energy of F ion

(B) Due to high hydration energy of F ion

(C) HF is a strong acid

(D) none of these

73. The reaction between p-methyl benzaldehyde and conc. NaOH is an example of

(E) Cannizzaro reaction

(A) Aldol condensation

(B) Hydrolysis

(C) Haloform reaction

74. How benzene is converted into n - propyl benzene

(A) Friedel - crafts Alkylation

(B) Friedel - crafts Acylation

(C) Friedel - crafts Alkylation followed by clemmensen reduction

(D) Friedal - crafts Acylation followed by clemmensen reduction

75. Which of the following does not depend on the attraction of the bonding pair towards the nucleus?

(A) The no. of protons in the nucleus

(B) The repulsion by the electrons in the same volence shell

(C) The amount of sheieding by inner shell electron

(D) The distance from the nucleus.

76. Which of the following oxide is of acidic nature?

(A) B_2O_3

(B) Al_2O_3

(C) Ga_2O_3

(D) In_2O_3

77. In activation energy for a simple Chemical reaction A→B is E_α in forward direction. The activation energy for reverse reaction

(A) can be less than or more than E_α

(B) is always double of E_α

(C) is negative of E_α

(D) is always less than E_α

78. The rate of first order reaction is $1.5 \times 10^{-2} mol L^{-1} min^{-1}$ at 0.5 M concentration of the reactant. The half life of the reaction is

(A) 0.383 min

(B) 23.1 min

(C) 8.73 min

(D) 7.53 min

79. 0.5 molal aqueous solution of a weak acid (HX) is 20% ionised. If K_f for water is $1.86 K kg mol^{-1}$, the lowering in freezing point of the solution is

(A) −1.12K

(B) 0.56K

(C) 1.12K

(D) −0.56K

80. Which of the following is not an example of addition polymer

(A) Polythene

(B) Polystyrene

(C) Neoprene

(D) Nylon – 6.6

81. The reactivity of the transition element usually decreases from Sc to Cu because of

(A) Lanthanide contraction

(B) Continious increase in ionization enthalpy

(C) Continuous decrease in ionization enthalpy

(D) Increase in no. of oxidation states

82. SO_2 is considered as airpollutant because

(A) its concentration increases with temperature increase of atmosphere.

(B) It is used as insecticide which is airpollutant

(C) It reacts with O_2 and H_2O to produce acid rain

(D) It is a strong oxidant and oxidizes other components of atmosphere

83. Ferric chloride is used to stop bleeding in cuts because

(A) Fe^{3+} coagulates blood which is positively charged sol

(B) Fe^{3+} coagulates blood which is negatively charged sol

(C) Cl^- coagulates blood which is positively charged sol

(D) Cl^- coagulates blood which is negatively charged sol

84. A method of removing excess solute from a colloidal solution is

(A) distillation

(B) crystallization

(C) dialysis

(D) gas chromatography

85. For a complex, MX3Y3 possessing trigonal prismatic geometry, the number of possible isomer is

(A) 2

(B) 4

(C) 3

(D) 6

86. On doping Ge metal with a little of In or Ga, we get

(A) p type semiconductor

(B) insulator

(C) n - type semi conductor

(D) rectifier

87. Zn converts from its melted state to its solid state, it has hcp structure, then the Number of nearest atoms will be

(A) 6

(B) 8

(C) 12

(D) 4

88. If the pKa of acetic acid and pKb of NH4OH are 4.76 and 4.75 respectively, what will be the pH of ammonium acetate solution

(A) 9.51

(B) 7.005

(C) 7.00

(D) 6.9

89. Which of the following has least oxidation state of Fe?

(A) $K_2[Fe(OH)_6]$

(B) $K_2[FeO_4]$

(C) $FeSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$

(D) $Fe(CN)_6^{3-}$

90. In electro chemical reaction of which set of reactants, the metal displacement will not take place

(A) Mg+Cu2+

(B)Pb+Ag+

(C) Zn+Cu2+

(D)Cu+Mg2+

91. The IUPAC name of the compound

CH3–CH(CH3)–CO–CH3 is

(A) 3–methyl–2–butanone

(B) 2–methyl–3–butanone

(C) isopropyl methyl ketone

(D) 2ethyl–2methylpentane

92. CH3MgI will give methane with

(A) C2H5OH

(B) CH3–CH2–NH2

(C) both of these (a and b)

(D) None of these

93. On long standing the bleaching powder undergoes auto-oxidation. The products formed are

(A) Calcium chloride only

(B) Calcium chlorate only

(C) Calcium chloride and calcium chlorate

(D) Calcium chloride and calcium chlorite

94. Colour of the bead in borax bead test is mainly due to the formation of

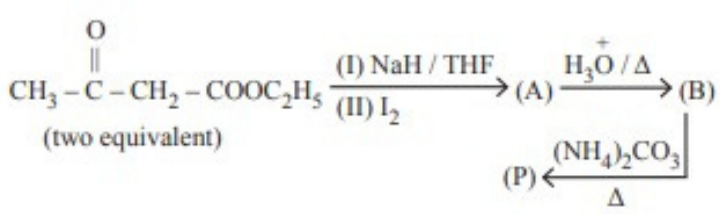
(A) metal oxides

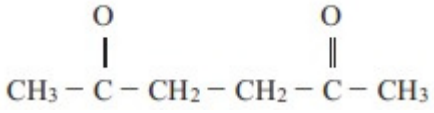
(B) boron oxides

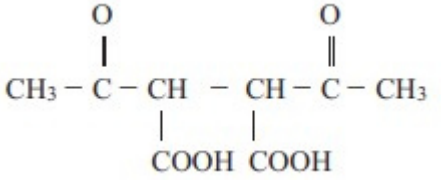
(C) metal metaborates

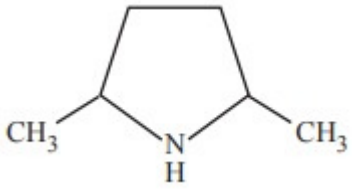
(D) elemental boron

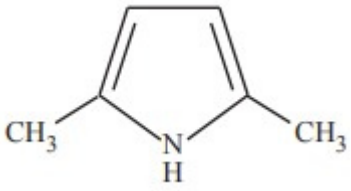
95. Product (P) of the given reaction is



(A) 

(B) 

(C) 

(D) 

96. Cordite is a mixture of

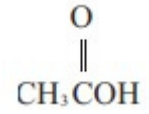
(A) nitroglycerine, guncotton and vaseline

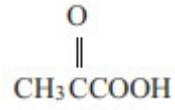
(B) borax, glycerine

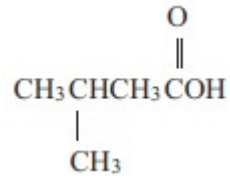
(C) carborundum and charcoal

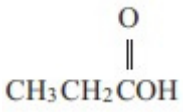
(D) glycerol and KMnO4

97. Which out of the following is the strongest acid?

(A) 

(B) 

(C) 

(D) 

98. Which element is not in first transition series

(A) Fe

(B) V

(C) Ag

(D) Cu

99. Which reagent is capable of giving test both of Aldehyde and ketones

(A) Tollen reagent

(B) Fehling solution

(C) 2, 4 dinitrophenylhydrazine

(D) Shift reagent

100. Which reaction will not occur out of the following

(A) $Fe+H_2SO_4 \rightarrow H_2+FeSO_4$

(B) $Cu+2AgNO_3 \rightarrow Cu(NO_3)_2+2Ag$

(C) $2KBr+I_2 \rightarrow 2KI+FeSO_4$

(D) $CuO+H_2 \rightarrow Cu+H_2O$

UPSEE-2018-Paper-1-Set-AA

Mathematics

101. The value of $\sin^4\frac{\pi}{8}+\sin^4\frac{3\pi}{8}+\sin^4\frac{5\pi}{8}+\sin^4\frac{7\pi}{8}$ is

(1) $\frac{3}{4}$

(2) $\frac{3}{4}$

(3) $\frac{3}{2}$

(4) $\frac{3}{2}$

102. For positive integer n, if $f(n)=\sin^n\theta+\cos^n\theta$ then $\frac{f(3)-f(5)}{f(5)-f(7)}$ is

(1) $\frac{f(1)}{f(3)}$

(2) $\frac{f(3)}{f(1)}$

(3) $f(3)$

$f(5)$

(4) $f(5)$

$f(7)$

103. If $f_n(x) = \frac{1}{n}(\cos nx + \sin nx)$, for $n = 1,2,3\ldots$, then $f_4(x) - f_6(x)$ is equal to

(1) 10

(2) $\frac{1}{12}$

(3) $\frac{1}{10}$

(4) 12

104. If $(1+\tan 1^\circ)(1+\tan 2^\circ)\ldots(1+\tan 45^\circ) = 2^n$, then n is

(1) 2

(2) 2

(3) $\frac{23}{2}$

(4) $\frac{12}{4}$

105. If $\cos^{-1}\frac{3}{5}+\cos^{-1}\frac{12}{13}=\cos^{-1}k$, then the value of k is,

(1) $\frac{16}{65}$

(2) $\frac{12}{65}$

(3) $\frac{11}{65}$

(4) $\frac{19}{65}$

106. If $\cos 3x\cos 2x\cos x=\frac{1}{4}$ and $0<x<\frac{\pi}{4}$, then the value of x is

(1) $\frac{\pi}{6}$

(2) $\frac{\pi}{5}$

(3) $\frac{\pi}{8}$

(4) $\frac{\pi}{7}$

107. The number of solutions of the equation $2^{x+2\sin x-\cos x}-1=0$ in the range $0\le x\le 2\pi$ is

(1) 3

(2) 4 (3) 2

(4) None of these

108. The number of distinct real roots of the equation

$$\begin{vmatrix} \sin x & \cos x & \cos x \\ \cos x & \sin x & \cos x \\ \cos x & \cos x & \sin x \end{vmatrix} = 0 \text{ in the interval } -\frac{\pi}{4} \le x \le \frac{\pi}{4}$$

(1) 4

(2) 3

(3) 1

(4) 2

109. In a triangle ABC the sides are of length 17, 25 and 28 units then the length of the largest altitude is

(1) 26.6

(2) 27

(3) 26

(4) $\frac{420}{17}$

110. If α, β and γ are the real roots of the equation

$x^3 - 3x^2 + 3x + 7 = 0$, ω is the cube root of the unity, the value of $\frac{\alpha - 1}{\beta - 1} + \frac{\beta - 1}{\gamma - 1} + \frac{\gamma - 1}{\alpha - 1}$ is equation to

(1) $3\omega 2$

(2) $\frac{3}{\omega}$

(3) $2\omega 2$

(4) None of these

111. The parameter of the locus represented by $\arg\left(\frac{z + i}{z - i}\right) = \frac{\pi}{4}$ is

equal to

(1) 4π

(2) $2\pi 2$

(3) $2\pi 3$

(4) $\frac{\pi 2}{3}$

112. In a right angle triangle ABC if $\cos A + \cos B + \cos C = \frac{3}{2}$, then

triangle is

(1) Right angled

(2) Right angled isoceles

(3) Equilateral

(4) None of these

113. In a right angle triangle ABC the minimum value of the sum of the squares of the sides is [Δ is the area of the triangle ABC]

(1) $3\ 3\Delta$

(2) $4\ 3\Delta$

(3) $2\ 3\Delta$

(4) $5\ 3\Delta$

114. A tower subtends angle $\theta, 2\theta$ and 3θ at three points A,B,C respectively lying on a horizontal line through the foot of the tower. Then the ratio of $\frac{AB}{BC}$ equals

(1) $\frac{\sin 3\theta}{\sin\theta}$

(2) $\frac{\sin\theta}{\sin 3\theta}$

(3) $\frac{\cos 3\theta}{\cos\theta}$

(4) $\frac{\tan\theta}{\tan 3\theta}$

115. From the top of a light house, the angle of depression of the two stations opposite of it at a distance d apart are α and β.

The height of the lighthouse is

(1) $\frac{d\tan\alpha}{\tan\alpha + \tan\beta}$

(2) $\frac{d}{\cot\alpha + \cot\beta}$

(3) $\frac{d\tan\beta}{\tan\alpha + \tan\beta}$

(4) $\frac{d\cot\alpha}{\cot\alpha + \cot\beta}$

116. If the vectors $\vec{a}, \vec{b}, \vec{c}$ are non three non-coplanar vectors, then $[\vec{a}\vec{b}\vec{c}]$ is equal to

(1) ±2

(2) ±3

(3) ±1

(4) 2

117. If the vectors $ai\hat{}+aj\hat{}+ck\hat{}$ and $ci\hat{}+cj\hat{}+bk\hat{}$ are coplanar, then

(1) $c2=ab$

(2) $b2=ac$

(3) $a+c=2b$

(4) $1 + \frac{1}{c} = \frac{2}{b}$
a

118. If the vectors a,b,c are non planar vectors, then $[a\times b, b\times c, c\times a]$ is equal to

(1) 0

(2) $[abc]^2$

(3) $[abc]$

(4) $2[abc]$

119. If vector a is collinear with $b=3i\hat{}+6j\hat{}+6k\hat{}$ and $a\cdot b=9$, then a is

(1) $3i\hat{}+j\hat{}+k\hat{}$

(2) $2i\hat{}+j\hat{}+k\hat{}$

(3) $i\hat{}+2j\hat{}+2k\hat{}$

(4) $2i\hat{}+3j\hat{}+3k\hat{}$

120. The value of $\lim_{x\to 0} \frac{(1+x)^{\frac{1}{2}}-1}{(1+x)^{\frac{1}{2}}}$ is equal to

(1) $\frac{3}{2}$

(2) $\frac{2}{3}$

(3) 0

(4) None of these

121. The value of $\lim_{x\to 0}\left(\frac{x}{\sqrt{x^2+4}-\sqrt{x^2+16}}\right)$ is equal to

(1) 4

(2) 8

(3) 2

(4) 16

122. $\lim_{x\to 0} \frac{a\tan x - a\sin x}{\tan x - \sin x}$ is equal to ($a > 0$)

(1) $\log_e a$

(2) 1

(3) 0

(4) e

123. The area of the triangle formed by coordinate axes and tangent to the curve $y=\log_e x$ at (0,1) is

(1) 1

(2) $\frac{1}{2}$

(3) 2

(4) $\frac{3}{2}$

124. The slope of the tangent at $\left(\pi, \frac{\pi}{4}\right)$ to the curve $1+16x^2y=\tan(x-2y)$ is

(1) $\frac{2}{\pi^2+4}$

(2) $\frac{1}{\pi^2+4}$

(3) $\frac{1}{\pi+4}$

(4) $\frac{2}{\pi 2+4}$

125. A man of height 2m walks at a uniform speed of 5kmhour away from the lamp post of 6m height. His shadow length increases at the rate of

(1) 12.5kmhour

(2) 2.5kmhour

(3) 3kmhour

(4) 3.5kmhour

126. If the function $f(x)=a\log x+bx2+x$ has its extreme values at $x=-1$ and $x=2$ then the values of a and b

(1) $a=2,\ b=\frac{1}{2}$

(2) $a=\frac{1}{2},\ b=2$

(3) $a=2,\ b=-\frac{1}{2_1}$

(4) $a=-2,\ b=-2$

127. If α, β, γ are roots of the equation $ax^3 + bx^2 + c = 0$ then the value of determinant $\begin{vmatrix} \alpha\beta & \beta\gamma & \alpha\gamma \\ \beta\gamma & \alpha\gamma & \alpha\beta \\ \alpha\gamma & \alpha\beta & \beta\gamma \end{vmatrix}$ is

(1) a

(2) b

(3) 0

(4) c

128. If a, b, c are p^{th}, q^{th} and r^{th} terms respectively of a geometric progression, the value of determinant $\begin{vmatrix} \log a & p & 1 \\ \log b & q & 1 \\ \log c & r & 1 \end{vmatrix}$ is equal to

(1) 0

(2) 1

(3) -1

(4) None of these

129. A matrix A is such that $A^2 = 2A - I$, where I is a unity matrix, then for $n \geq 2$, A^n is equal to

(1) $nA - (n-1)I$

(2) $nA-I$

(3) $2n-1A-(n-1)I$

(4) $2n-1A-nI$

130. The greatest coefficient in the expansion of $\left(x+\frac{1}{x}\right)^{2n}$ is

(1) $\frac{1.3.5\ldots(2n-1)}{n}2n$

(2) $\frac{2n!}{n!n!}$

(3) $\frac{2n!2}{\left(\frac{n}{2}\right)!}$

(4) None of these

131. The coefficient of x^5 in the expansion of $(1+x)^2(1+x)^4$ is

(1) 40

(2) 50

(3) 60

(4) −50

132. 10% bulbs manufactures by a company are found to be defective. The probability that out of sample of 5 bulbs none is defective is

(1) $\left(\frac{1}{2}\right)^5$

(2) $\left(\frac{1}{10}\right)^5$

(3) $\left(\frac{9}{10}\right)^4 \left(\frac{1}{10}\right)$

(4) $\left(\frac{9}{10}\right)^5$

133. Two dice of different colors are thrown simultaneously. The probability that the sum of the faces appeared is either 7 or 11 is

(1) $\frac{7}{36}$

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

(3) $\frac{2}{3}$

(4) $\frac{5}{9}$

134. Six students are to be selected for a quiz competition from 10 aspirants. The probability that two particular students are excluded is

(1) $\frac{2}{15}$

(2) $\frac{1}{3}$

(3) $\frac{1}{5}$

(4) $\frac{2}{3}$

135. If three distinct natural numbers are to be chosen randomly from the first natural numbers, then the probability that all th three of them are divisible by 2 or 3, is

(1) $\frac{4}{25}$

(2) $\frac{4}{35}$

(3) $\frac{4}{1161}$

(4) $\frac{4}{1155}$

136. If $y+\quad 1+y2=ex$ then the value of y is

(1) $ex-e-x$

(2) $ex+e-x$

(3) $\frac{ex+e-x}{2}$

(4) None of these

137. The number of points having position vector $ai\hat{}+bj\hat{}+ck\hat{}$ where $a,b,c\in\{1,2,3,4,5\}$ such that $2a+3b+5c$ is divisible by 4, is

(1) 140

(2) 70

(3) 100

(4) 150

138. There are four candidates for the post of professor in mathematics and one to be selected by the decision of 5 subject experts. The number of the ways in which expert opinion can be expressed is

(1) 1048

(2) 1072

(3) 1024

(4) 1020

139. If $g(x)=(x2+2x+3)f(x), f(0)=5$ and $\lim_{x\to\infty} \frac{f(x)-f(0)}{x-0}=4$, $g'(0)$ is equal to

(1) 30

(2) 18

(3) 20

(4) 22

140. The solution of the differential equation $y-x\frac{dy}{dx}=a\left(y2+\frac{dy}{dx}\right)$ is

(1) $y=k(1-ay)(x+a)$

(2) $y=k(1+ay)(x-a)$

(3) $y=k(1+ay)(x+a)$

(4) $y=k(1-ay)(x-a)$

141. The solution of the differential equation $\frac{dy}{dx} = \sin(10 + x + 6y)$ is

(1) $5\tan(5x-3y) = 4\tan(4x+k)+3$

(2) $5\tan(5x+3y) = 4\tan(4x+k)-3$

(3) $5\tan(5x-3y) = 4\tan(4x+k)-3$

(4) None of these

142. If $I = \int \tan x + \cot x\,dx$, then value of I is

(1) $\frac{\pi}{2}$

(2) $\frac{\pi}{2\sqrt{2}}$

(3) $\frac{\pi}{3}$

(4) $\frac{\pi}{2}$

143. The value of the integral $I = \int_0^{\pi} \frac{x\tan x}{\sec x + \tan x}\,dx$ is equal to

(1) $\frac{\pi}{2}\left(\frac{\pi}{\sqrt{2}} - 1\right)$

(2) $\frac{\pi}{2}(\pi - 1)$

(3) $\pi(\pi-1)$

(4) $\frac{\pi(\pi+1)}{2}$

144. If the sum of the distances of a moving point from two perpendicular lines in a plane is always 1 then, its locus is

(1) Parabola

(2) Ellipse

(3) Hyperbola

(4) None of these

145. The equation of the line with the focus at (1,–1), directrix $x-y-3=0$ and eccentricity $\frac{3}{2}$ is

(1) $7x2+2xy+7y2+7=0$

(2) $7x2+2xy+7y2-10x+10y+7=0$

(3) $7(x2+y2)+2xy+10x-10y+7=0$

(4) $7(x2+y2)+2xy-10x-10y+7=0$

146. The maximum and minimum of the resultant of two forces are F and G (the angle between these forces is 2α), then, the resultant of F and G is

(1) $(F2\cos2\alpha+G2\sin2\alpha)2_1$

(2) $(F2\sin2\alpha+G2\cos2\alpha^1)2$

(3) $(F2\sin\alpha+G2\cos\alpha^1)2$

(4) $(F2\sin2\alpha+G2\cos2\alpha^1)2$

147. The resultant of two forces 3P and 2P is R. if first force is doubled then the resultant is also doubled. The angle between the forces is

(1) 60°

(2) 30°

(3) 120°

(4) 150°

148. A particle at rest starts moving with uniform acceleration covers a distance of 114 meters in 8th second. The acceleration of the particle is

(1) 20msec2

(2) 15msec2

(3) 14.5msec2

(4) 15.4msec2

149. A helicopter is flying at a height of 500 m. if all of sudden its engine stops working, the helicopter will fall on the earth in

(1) 10second

(2) 12second

(3) 15second

(4) 20second

150. If $ax+by=1$ is a tangent to the hyperbola $\frac{x2}{a2} - \frac{y2}{b2} = 1$, then the value of $a2-b2$ is

(1) $b2e2$

(2) $\frac{1}{b2e2}$

(3) $a2e2$

(4) $\frac{1}{a^2e^2}$

UPSEE-2018-Paper-1-Set-AA

Answer key

1	C	31	D	61	A	91	A	121	C
2	B	32	B	62	C	92	C	122	A
3	A	33	D	63	C	93	C	123	B
4	D	34	C	64	C	94	C	124	D
5	D	35	B	65	D	95	D	125	B
6	C	36	C	66	A	96	A	126	C
7	A	37	D	67	C	97	B	127	C
8	B	38	A	68	C	98	C	128	C
9	B	39	D	69	B	99	C	129	A
10	C	40	B	70	A	100	C	130	B
11	D	41	B	71	A	101	D	131	C
12	B	42	D	72	B	102	A	132	D
13	B	43	A	73	A	103	B	133	*
14	A	44	C	74	D	104	C	134	A
15	C	45	B	75	B	105	A	135	D
16	B	46	C	76	A	106	C	136	D
17	A	47	D	77	A	107	A	137	C
18	D	48	C	78	B	108	C	138	C
19	C	49	D	79	C	109	D	139	D
20	A	50	C	80	D	110	A	140	A
21	C	51	A	81	B	111	B	141	B
22	B	52	B	82	C	112	A	142	D
23	A	53	B	83	B	113	B	143	A
24	C	54	B	84	C	114	A	144	D
25	A	55	B	85	C	115	B	145	B

26	A	56	A	86	A	116	B	146	A
27	C	57	C	87	C	117	B	147	C
28	A	58	D	88	B	118	B	148	D
29	C	59	B	89	C	119	C	149	A
30	D	60	C	90	D	120	D	150	D

UPSEE-2018-Paper-1-Set-AA

Solutions – Physics

1. The self inductance of a solenoid is given by the relation,

$L=\mu n^2 Al$

For the region $0<r<b$, the self inductance is,

$$L_1=\mu_1 n^2 l(\pi b^2)$$

For the region $b<r<a$, the self inductance is,

$$L_2 = \frac{\mu_2 n^2 l}{2\pi}(\pi a^2 - \pi b^2)$$

$$= \mu_2 n^2 l\pi(a^2 - b^2)$$

Therefore, the total self inductance of the solenoid is,

$$L = L_1 + L_2$$

$$= \mu_1 n^2 l(\pi b^2) + \mu_2 n^2 l\pi(a^2 - b^2)$$

$$= \pi n^2 l\{\mu_1 b^2 + \mu_2(a^2 - b^2)\}$$

2. Since the path ARB is steeper than the path ASB therefore, the acceleration of the person at the bottom that follows the path ARB is more than the person that follows the path ASB.

Hence, Ramesh reaches the bottom first with a larger average acceleration than Sohan.

3. The speed of the liquid leaving the hole is given by the relation,

   $v = \sqrt{2gh}$

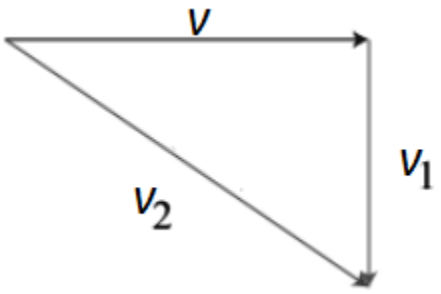
   The steam moves in a parabolic path. Therefore, the maximum height of the steam will be,

   $$y = \frac{v^2 \sin^2\theta}{2g}$$

   $$= \frac{(2gh)\sin^2\theta}{2g}$$

   $$= h\sin^2\theta$$

4. Let v be the velocity of the eagle with respect to the observer on the ground.



   Using the Pythagoras theorem, we get

$v_2^2 = v^2 + {}^2{}_2$

$v2 = v2_2 - v1$

$v = v2_2 - v1^2$

5. The condition of the minima for the single slit diffraction is,

   pathdifference=mλ (m=1,2,3,...)

   So, two wavelengths is the second minima that is point 5.

   Hence, the path difference of the extreme rays is two wavelengths at point 5.

6. The audible range of frequency for the human beings is 20Hz to 20kHz.

   Hence, the frequency produces a sound that can be heard by a person is 2kHz.

7. In the spectrum of white light, the wavelength increases from violet to red colour. The point X lies above the red colour so, the wavelength of radiation reaches at point X has wavelength more than the red colour. It means it is infra-red radiation.

Hence, infra-red rays cause the temperature increase.

8. Given: Wavelength in free space, $\lambda=600\text{nm}$ and index of refraction of glass, $n=1.50$

The frequency of light remains constant when it passes through the glass.

The frequency of light inside the glass is,

$$f = \frac{c}{\lambda} = \frac{3.0\times10^{8}\ \text{m/s}}{600\times10^{-9}\ \text{m}} = 5.0\times10^{14}\ \text{Hz}$$

Hence, the frequency of light inside the glass is $5.0\times10^{14}\ \text{Hz}$.

9. Two simple harmonic waves are,

$$x_1 = 20\sin\left(5\pi t + \frac{\pi}{4}\right) \qquad (1)$$

$$x_2 = 10(\sin 5\pi t + \sqrt{3}\cos 5\pi t)$$

$$= 20\left(\frac{1}{2}\sin 5\pi t + \frac{\sqrt{3}}{2}\cos 5\pi t\right)$$

$$= 20\left(\cos\frac{\pi}{3}\sin 5\pi t + \sin\frac{\pi}{3}\cos 5\pi t\right)$$

$$= 20\sin\left(5\pi t + \frac{\pi}{3}\right) \qquad (2)$$

From equation (1) and (2), the amplitudes of two waves are equal.

Hence, the ratio of the amplitude of two motions is 1.

10. The rms speed of gas is given by the relation,

$$v = \sqrt{\frac{3RT}{M}}$$

Where, R is the universal gas constant, T is the temperature and M is the molecular weight.

When the temperature doubled and hydrogen gas is dissociates into atomic hydrogen, the rms speed will be

$$v' = \sqrt{\frac{3R(2T)}{M/2}}$$

$$= \sqrt{4\left(\frac{3RT}{M}\right)}$$

$$= 2v$$

11. The radioactivity is given by the relation,

$$A = A_0 e^{-\lambda t}$$

As the radioactivity after the first 10years is A0, therefore,

$$\frac{A_0}{5} = A_0 e^{-\lambda t}$$

$$e^{-\lambda t} = \frac{1}{5}$$

Now, after further 10 years, the activity will be,

$$A' = Ae^{-\lambda}$$

$$= \left(\frac{A_0}{2}\right)\left(\frac{1}{5}\right)$$

$$= \frac{A_0}{25}$$

12. The diagonal of the square formed is,

$$d = \sqrt{2}b$$

Since the same current is flowing through all the four wires therefore, the magnitude of magnetic field due to each wire is equal. The magnetic field due to wire 1 and 2 will be in the same direction (say x) and the magnetic field due to wire 3 and 4 will be in the same direction (say y).

The magnetic field due to wire 1 and 2 is,

$$B'' = 2\left(\frac{\mu_0 I}{2\pi(2b/\sqrt{2})}\right)\left(\frac{x}{\sqrt{2}}\right)$$

$$= \frac{2\mu_0 I x}{\pi b}$$

The magnetic field due to wire 3 and 4 is,

$$B''' = 2\left(\frac{\mu_0 I}{2\pi(2b/\sqrt{2})}\right)\left(\frac{y}{\sqrt{2}}\right)$$

$$= \frac{2\mu_0 I y}{\pi b}$$

The net magnetic field at the central point P is,

$$B = \left(\frac{2\mu_0 I}{\pi b}\right)\left(\frac{x}{\sqrt{2}}\right)^2 + \left(\frac{2\mu_0 I}{\pi b}\right)\left(\frac{y}{\sqrt{2}}\right)^2$$

$$= \frac{2\mu_0 I}{\pi b}$$

13. The charge on the ring is,

$Q = 2\pi r\lambda$

When the ring is rotated about the axis, it acts as a current carrying loop.

The current in the circular loop is,

$$I = \frac{Q}{T}$$

$$= \frac{Q}{(2\pi/\omega)}$$

The magnetic field at the centre of current carrying loop is given by the relation,

$$B = \frac{\mu_0 I}{2r}$$

$$= \frac{\mu_0}{2r} \times \frac{Q}{2\pi/\omega}$$

$$= \frac{\mu_0}{2r} \times \frac{2\pi r\lambda}{2\pi/\omega}$$

$$= \frac{\mu_0 \lambda \omega}{2}$$

14. The velocity of observer towards the sound is,

$$v_o = u \cos 60°$$

$$= \frac{u}{2}$$

The apparent frequency of the sound is given by the relation,

$$f' = f\left(\frac{v_s + v_o}{v_s}\right)$$

$$\frac{11}{8} f = f\left(1 + \frac{u}{2v_s}\right)$$

$$\frac{u}{2v_s} = \frac{11}{8} - 1$$

$$u = \frac{3}{4} v_s$$

15. Total mass of the system is,

$$\frac{M}{3} + \frac{2M}{3} = M$$

When the system descend a vertical distance h, the change in its potential energy will be equation to the sum of its translational kinetic energy and rotational energy of the cylinders.

$$Mgh = \frac{1}{2}Mv^2 + \frac{1}{2}I\omega^2$$

$$Mgh = \frac{1}{2}Mv^2 + \frac{1}{2}\cdot\frac{1}{2}MR^2\left(\frac{v}{R}\right)^2$$

$$Mgh = \frac{1}{2}Mv^2 + \frac{1}{4}Mv^2$$

$$gh = \frac{3}{4}v^2$$

$$v = \frac{4gh}{3}$$

16. The potential energy of particle at x=a,

$$U(a) = \frac{1}{2}ka^2 + Ae^{-\alpha a^2}$$

The kinetic energy of particle at x=a,

$$K(a) = \frac{1}{2}mv_a^2$$

Total energy of the particle at x=a,

$$E(a) = K(a) + U(a)$$

$$= \frac{1}{2}mv_a^2 + \frac{1}{2}ka^2 + Ae^{-\alpha a^2}$$

If the particle just reaches the origin, then minimum energy it have will be,

$$E(0) = 0 + 0 \quad Ae - 0$$

$$= A \quad +$$

Thus, the particle will be able to pass the origin only when,

$$A \; 1 \leq mv2 \quad 1 \quad +Ae^{-\alpha a^2}$$

$$2 \quad 2$$

$$A(1 - e^{-\alpha a^2}) \leq \frac{m \; v}{2} + ka$$

$$A \quad \frac{mv + ka^2}{2(1 - e^{-\alpha a^2})}$$

17. The flux and the magnetic field can be related as,

$$d\varphi m = B \cdot dA$$

$$= c(x\cos\omega t)i + (y\sin\omega t)k \; dxdyk$$

$$= cy\sin(\omega t)\, dxdy$$

Integrating both the sides, we get

$$\varphi m = \int_0^a \int_0^b cy \sin(\omega t)\, dxdy$$

$$= c\sin(\omega t) \int_0^a \int_0^b y \, dxdy$$

$$= \frac{ab2c}{2} \sin(\omega t)$$

According to Faraday's law, the induced emf is,

$$\varepsilon = \frac{d\varphi_m}{dt}$$

$$= \frac{d}{dt}\left[\frac{ab2c}{2}\sin(\omega t)\right]$$

$$= \frac{ab2c}{2}\omega\cos(\omega t)$$

18. Let v be the velocity of both the balls just before they hit the ground.

From the conservation of energy,

$$mgh = \frac{1}{2}mv2$$

$$v = \sqrt{2gh}$$

The velocity of the basketball just after it bounces off the ground is v but the tennis ball still moving downward with velocity v. The relative speed of the tennis ball with basketball is 2v. The upward speed of the tennis ball just after it bounces off the basket ball is,

$$v' = 2v + v$$

$$= 3v$$

Again from the conservation of energy,

$$mgH = mgd\left(1+\frac{9}{2}\right) + \frac{1}{2}m(3v_2)$$

$$H = d + \frac{9}{2g}(2gh)$$

$$= d + 9h$$

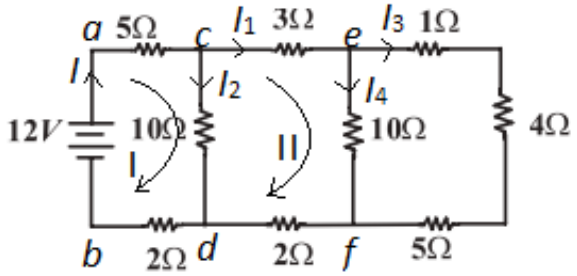
19. The whole charge on one half of the ellipse can be concentrated at a distance b from the semi-major axis and the two types of charges not combined upto the distance $\frac{b}{4}$ from the semi-major axis. Therefore,

Maximum electric dipole moment is, $P_{max} = 2Qb$

Minimum electric dipole moment is, $P_{min} = Q\left(2b - \frac{b}{4}\right) = \frac{Qb}{2}$

Hence, the electric dipole moment of ellipse lies between $\frac{Qb}{2} < P < 2Qb$.

20. Consider the circuit below.



The equivalent resistance between points ef is,

$$\frac{1}{R_{ef}} = \frac{1}{10} + \frac{1}{1+4+5}$$

$$R_{ef} = 5\,\Omega$$

The equivalent resistance between points cd is,

$$\frac{1}{R_{cd}} = \frac{1}{10} + \frac{1}{3+5+2}$$

$$R_{cd} = 5\,\Omega$$

The equivalent resistance between points ab is,

$$R_{ab} = 5\Omega + 5\Omega + 2\Omega$$

$$= 12\,\Omega$$

The net current in the circuit is,

$$I = \frac{V}{R_{ab}} = \frac{12V}{12\Omega}$$

$$= 1\,A$$

Applying the Kirchhoff's voltage law for loop I,

$$5I + 10I2 + 2I = 12$$

$$10I2 = 12 - 7(1)$$

$$I2 = 0.5\ A$$

Applying the Kirchhoff's current law at point c,

$I - I1 - I2 = 0$

$I1 = I - I2$

$= 1\,A - 0.5\,A$

$= 0.5\ A$

Applying the Kirchhoff's voltage law for loop II,

$3I1 + 10I_4 + 2I1 - 10I_2 = 0$

$10I_4 = 10(0.5) - (3 + 2)(0.5)$

$10I_4 = 2.5$

$I_4 = 0.25A$

Applying the Kirchhoff's current law at point e,

$I1 - I3 - I4 = 0$

$I3 = I1 - I4$

$= 0.5\ A - 0.25\ A$

$= 0.25\ A$

Hence, the current in 4Ω resistance is 0.25A.

21. For reflective coating, the condition for the constructive interference is given as,

$$2tn = \left(m + \frac{1}{2}\right)\lambda \qquad (m = 0,1,2,\ldots)$$

Where, t is the thickness of film, n is the refractive index of film and λ is the wavelength.

For m=0,

$$\lambda = \frac{2(500nm)(1.5)}{0+1/2}$$

$$=3000nm$$

This is far beyond the visible range.

For m=2,

$$\lambda = \frac{2(500nm)(1.5)}{2+1/2}$$

$$= 600\ nm$$

Hence, the most reflected wavelength is 600 nm.

22. Only two charges q1=30C and $q_2 = -20C$ are located inside the cube.

According to the Gauss's law,

$$\phi E = \frac{q_{enc}}{\varepsilon_0}$$

$$= \frac{q1+q_2}{\varepsilon_0}$$

$$= \frac{30+(-20)}{\varepsilon_0}$$

$$= \frac{10}{\varepsilon_0}$$

Hence, the total electric flux leaving the cube is $\frac{10}{\varepsilon_0}$.

23. The potential at point A is,

$$V_A = \frac{\lambda}{2\pi\varepsilon_0}\ln\left(\frac{r+a}{r-a}\right)$$

$$= \frac{\lambda}{2\pi\varepsilon_0}\ln\left(\frac{d-a}{a}\right)$$

The potential at point B is,

$$V_B = \frac{\lambda}{2\pi\varepsilon_0}\ln\left(\frac{r+b}{r-b}\right)$$

$$= \frac{\lambda}{2\pi\varepsilon_0}\ln\left(\frac{b}{d-b}\right)$$

The potential difference between points A and B is,

$$V_A - V_B = \frac{\lambda}{2\pi\varepsilon_0}\left[\ln\left(\frac{d-a}{a}\right) - \ln\left(\frac{b}{d-b}\right)\right]$$

$$= \frac{\lambda}{2\pi\varepsilon_0}\left[\ln\left(\frac{d-a}{a}\right) + \ln\left(\frac{d-b}{b}\right)\right]$$

$$= \frac{\lambda}{2\pi\varepsilon_0}\ln\left[\frac{(d-a)(d-b)}{ab}\right]$$

24. Given: Mass of charged particle, m=2kg and charge,

$q = 3\ C$

The force on the particle in the electric field will be,

$F = qE$ qE

$ma = 3(12\hat{i}$

$2a = +10\hat{j})$

$a = 18\hat{i}+15\hat{j}$

The velocity of the particle at 1s will be,

$v = u+at$

$= (4\hat{i}+3(18\hat{i}+15\hat{j})(1)$

$= 22\hat{i}+15\hat{j}+3k\hat{}$

25. Nickel requires the least value of magnetic field strength to magnetize as it is ferromagnetic material.

26. Let the potential energy at the horizontal level be zero.

The initial potential energy of the string is,

$U_i = -\frac{m}{L}b(g\sin\theta)\frac{b}{2}$

$= -\frac{mgsin\theta b2}{2L}$

The potential energy when its end reaches B is,

$$U_f = -mg\sin\frac{L\theta}{2}$$

The kinetic energy when its end reaches B is,

$$K = \frac{1}{2}mv^2$$

From the conservation of energy,

$$\frac{1}{2}mv^2 - mg\sin\theta\frac{L}{2} = -\frac{mg\sin\theta b^2}{2L}$$

$$v^2 - g\sin\theta L = -\frac{g\sin\theta b^2}{L}$$

$$v = \frac{g\sin\theta(L^2 - b^2)}{L}$$

27. MASER is a device that operates on the same basic principle as LASER and produces coherent electromagnetic waves. It was first introduce by Charles H. Townes.

28. The rotational degrees of freedom for one mole of oxygen gas are 2.

The rotational kinetic energy is,

$$K_{rot} = \frac{f}{2} RT$$

$$= \frac{2}{2} RT$$

$$= RT$$

29. The maximum force of static friction is,

$F_{max} = \mu mg$

$ma_{max} = \mu mg$

$a_{max} = \mu g$

$= 0.85g$

30. The gravitational force between the star and either of the planets is,

$$F_1 = \frac{GMm}{r^2}$$

The gravitational force between two planets is,

$$F_2 = \frac{Gm^2}{(2r)^2}$$

The net force provides the necessary centripetal force for the planets to move in circular path.

$$F_{cent} = F_1 + F_2$$

$$\frac{mv^2}{r} = \frac{GMm}{r^2} + \frac{Gm^2}{4r^2}$$

$$v = \sqrt{\frac{G\left(M + \frac{m}{4}\right)}{r}}$$

The time period of the planet is,

$$T = \frac{2\pi r}{v}$$

$$= \frac{2\pi r}{\sqrt{\frac{G\left(M + \frac{m}{4}\right)}{r}}}$$

$$= 2\pi \sqrt{\frac{r^3}{G\left(M + \frac{m}{4}\right)}}$$

Thus, the value of M′ is,

$$M' = M + \frac{m}{4}$$

31. The equivalent capacitance in series is,

$$\frac{1}{C_{eq}} = \frac{1}{C1} + \frac{1}{C2} + \frac{1}{C3} + \ldots\ldots + \infty$$

$$\frac{1}{C_{eq}} = \frac{1}{24} + \frac{1}{8} + \ldots\ldots + \infty$$

$$= 1/2$$

$$= 1 - 1/2$$

$$= 1$$

$$C_{eq} = 1.0\,\mu F$$

Hence, the equivalent capacitance of the system is 1.0μF.

32. The motion is described by,

$$y = 4ex(e - 5t)$$

Taking the derivative with respect to time,

$$\frac{dy}{dt} = -5 \square 4ex \square (e - 5t) \square$$

Hence, the given wave represents a progressive wave propagating along +x direction with velocity 5m/s.

33. The angle turned by the reflected ray will be twice the angular displacement.

The angular displacement is,

$$\Delta\theta = \omega_0 t + \frac{1}{2}\alpha t^2$$

$$= 0 + \frac{1}{2}(180)\left(\frac{1}{4}\right)^2$$

$$= 5.625°$$

Hence, the angle turned by the ray is 2×5.625°=11.25°.

34. Since 90% of electrons emitted reach the collector, then

0.9IE=IC

Now,

IE=IC+IB

IB = IE − 0.9IE

= $0.1I_E$

=0.1×20mA

= 2.0 mA

Hence, the base current will be about 2mA.

35. The relative acceleration of topmost point with respect to bottommost point is given by the relation,