WAVE OPTICS

1. The intensity of light emerging from one of the slits in a Young's double slit experiment is found to be 1.5 times the intensity of light emerging from the other slit. What will be the approximate ratio of intensity of an interference maximum to that of an interference minimum?
(A) 2.25 (B) 98 (C) 5 (D) 9.9

2. In a Fraunhofer diffraction experiment, a single slit of width 0.5 mm is illuminated by a monochromatic light of wavelength 600 nm. The diffraction pattern is observed on a screen at a distance of 50 cm from the slit. What will be the linear separation of the first order minima?
(A) 1.0 mm (B) 1.1 mm (C) 0.6 mm (D) 1.2 mm

3. In Young's experimenter for the interference of light, the separation between the slits is d and the distance of the screen from the slits is D. If D is increased by 0.5% and d is decreased by 0.3% then for the light of a given wavelength, which one of the following is true ?
"The fringe width………..
(A) increases by 0.8% (B) decreases by 0.8%
(C) increases by 0.2% (D) decreases by 0.2%

4. When the frequency of the light used is changed from $4 \times 10^{14}\ s^{-1}$ to $5 \times 14\ s^{-1}$, the angular width of the principal (central) maximum in a single slit Fraunhoffer diffraction pattern changes by 0.6 radian. What is the width of the slit (assume that the experiment is performed in vacuum) ?
(A) 1.5×10^{-7} m (B) 3×10^{-7} m (C) 5×10^{-7} m (D) 6×10^{-7} m

5. The intensity of a sound appears to an observer to be periodic. Which of the following can be the cause of it?
(A) The intensity of the source is periodic
(B) The source is moving towards the observer
(C) The observer is moving away from the source
(D) The source is producing a sound composed of two nearby frequencies

6. Two monochromatic coherent light beam A and B have intensities L and $\frac{L}{4}$, respectively. If these beams are superposed, the maximum and minimum, intensities will be

(A) $\frac{9L}{4}, \frac{L}{4}$ (B) $\frac{5L}{4}, 0$ (C) $\frac{5L}{2}, 0$ (D) $2L, \frac{L}{2}$

7. For Fraunhoffer diffraction to occur

(A) Light source should be at infinity
(B) Both source and screen should be at infinity
(C) Only the source should be at finite distance
(D) Both source and screen should be at finite distance

8. Find the right condition(s) for Fraunhoffer diffraction due to a single slit.

(A) Source is at infinite distance and the incident beam has converged at the slit
(B) Source is near to the slit and the incident beam is parallel
(C) Source is at infinity and the incident beam is parallel
(D) Source is near to the slit and the incident beam has converged at the slit

9. Two coherent monochromatic beams of intensities I and $4I$ respectively are superposed. The maximum and minimum intensities in the resulting pattern are

(A) $5I$ and $3I$ (B) $9I$ and $3I$ (C) $4I$ and I (D) $9I$ and I

10. If young's double slit experiment is done with white light, which of the following statements will be true?

(A) All the bright fringes will be coloured.
(B) All the bright fringes will be white.
(C) The central fringe will be white.
(D) No stable interference pattern will be visible.

MODERN PHYSICS

11. If R is the Rydberg constant in cm^{-1}, then hydrogen atom does not emit any radiation of wavelength in the range of

(A) $\frac{1}{R}$ to $\frac{4}{3R}$ cm (B) $\frac{7}{5R}$ to $\frac{19}{5R}$ cm (C) $\frac{4}{R}$ to $\frac{36}{5R}$ cm (D) $\frac{9}{R}$ to $\frac{144}{7R}$ cm

12. A nucleus X emits a β-particle to produce a nucleus Y. If their atomic masses are M_x and M_y respectively, then the maximum energy of the β-particle emitted is (where m_e is the mass of an electron and c is the velocity of light)

(A) $(M_x - M_y - m_e)\,c^2$ (B) $(M_x - M_y + m_e)\,c^2$ (C) $(M_x - M_y)\,c^2$ (D) $(M_x - M_y - 2m_e)\,c^2$

13. For nuclei with mass number close to 119 and 238 the binding energies per nucleon are approximately 7.6 MeV and 8.6 MeV respectively. If a nucleus mass number 238 breaks into two nuclei of nearly equal masses, what will be the approximate amount of energy released in the process of fission?

(A) 214 MeV (B) 119 MeV (C) 2047 MeV (D) 1142 MeV

14. A point source of light is used in an experiment of photoelectric effects. If the distance between the source and the photoelectric surface is doubled, which of the following may result.

(A) Stopping potential will be halved

(B) Photoelectric current will decreases

(C) Maximum kinetic energy of photoelectrons will decrease

(D) Stopping potential will increase slightly

15. A parent nucleus X undergoes α-decay with a half-life of 75000 yrs. The daughter nucleus Y undergoes β-decay with a half-life of 9 months. In a particular sample, it is found that the rate of β-particles is nearly constant (over several months) at 10^7/h. What will be the number of α-particles emitted in an hour ?

(A) 10^2 (B) 10^7 (C) 10^{12} (D) 10^{14}

16. A proton and an electron initially at rest are accelerated by the same potential difference. Assuming that a proton is 2000 times heavier than an electron, what will be the relation between the de Broglie wavelength of the proton (λ_p) and that of electron (λ_e) ?

(A) $\lambda_p = 2000\,\lambda_e$ (B) $\lambda_p = \frac{\lambda_e}{2000}$ (C) $\lambda_p = 20\sqrt{5}\,\lambda_e$ (D) $\lambda_p = \frac{\lambda_e}{20\sqrt{5}}$

17. To which of the following the angular velocity of the electron in the n-th Bohr orbit is proportional?

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

18. Electrons are emitted with kinetic energy T from a metal plate by an irradiation of light of intensity J and frequency v. Then, which of the following will be true?

(A) $T \propto J$ (B) T linearly increasing with v

(C) $T \propto$ time of irradiation (D) Number of electrons emitted $\propto J$

19. How the linear velocity v of an electron in the Bohr orbit is related to its quantum number n?

(A) $v \propto \frac{1}{n}$ (B) $v \propto \frac{1}{n^2}$ (C) $v \propto \frac{1}{\sqrt{n}}$ (D) $v \propto n$

20. If the half-life of a radioactive nucleus is 3 days, nearly what fraction of the initial number of nuclei will decay on the third day? $\left(\text{Given} \sqrt[3]{0.25} \approx 0.63\right)$

(A) 0.63 (B) 0.5 (C) 0.37 (D) 0.13

21. An electron accelerated through a potential of 10000 V from rest has a de – Broglie wave length λ. What should be the accelerating potential, so that the wavelength is doubled?
(A) 20000 V (B) 40000 V (C) 5000 V (D) 2500 V

22. The de-Broglie wavelength of an electron is 0.4×10^{-10} m when its kinetic energy is 1.0 kev. Its wavelength will be 1.0×10^{-10} m, when its kinetic energy is
(A) 0.2 keV (B) 0.8 keV (C) 0.63 keV (D) 0.16 keV

23. When light of frequency ν_1 is incident on a metal with work function W (where $h\nu_1 > W$), then photocurrent falls to zero at a stopping potential of V_1. If the frequency of light is increased to V_2. Therefore, the charge of an electron is given by
(A) $\frac{W(\nu_2+\nu_1)}{\nu_1 V_2+\nu_2 V_1}$ (B) $\frac{W(\nu_2+\nu_1)}{\nu_1 V_1+\nu_2 V_2}$ (C) $\frac{W(\nu_2-\nu_1)}{\nu_1 V_2+\nu_2 V_1}$ (D) $\frac{W(\nu_2-\nu_1)}{\nu_2 V_2-\nu_1 V_1}$

24. Radon-222 has a half-life of 3.8 days. if one starts with 0.064 kg of radon-222, the quantity of radon-222 left after 19 days will be
(A) 0.022 kg (B) 0.062 kg (C) 0.032 kg (D) 0.024 kg

25. Let v_n and E_n be the respective speed and energy of an electron in the nth orbit of radius r_n, in a hydrogen atom, as predicted by Bohr's model. Then.
(A) plot of $\frac{E_n r_n}{E_1 r_1}$ as a function of n is a straight line of slope 0
(B) plot of $\frac{r_n v_n}{r_1 v_1}$ as a function of n is a straight line of slope 1
(C) plot of In $\left(\frac{r_n}{r_1}\right)$ as a function of In (n) is a straight line of slope 2
(D) plot of In $\left(\frac{r_n E_1}{E_n r_1}\right)$ as a function of In (n) is a straight line of slope 4

26. The potential difference V required for accelerating an electron to have the de-Broglie wavelength of 1Å is
(A) 100V (B) 125V (C) 150V (D) 200V

27. The work function of Cesium is 2.27eV. The cut-off voltage which stops the emission of electrons from a cesium cathode irradiated with light of 600 nm wavelength is
(A) 0.5V (B) –0.2V (C) –0.5V (D) 0.2V

28. The number of de-Broglie wavelengths contained in the second Bohr orbit of hydrogen atom is
(A) 1 (B) 2 (C) 3 (D) 4

29. The wavelength of second Balmer line in hydrogen spectrum is 600 nm. The wavelength for its third line in Lyman series is

(A) 800nm (B) 600nm (C) 40nm (D) 200nm

30. The distance between a light source and photoelectric cell is d. If the distance is decreased to $\frac{d}{2}$ then

(A) The emission of electron per second will be four times

(B) Maximum kinetic energy of photoelectrons will be four times

(C) Stopping potential will remain same

(D) The emission of electrons per second will be doubled.

31. A photon of wavelength 300 nm interacts with a stationary hydrogen atom in ground state. During the interaction whole energy of the photon is transferred to the electron of the atom. State which possible is correct. (Consider, Plank constant = 4×10^{-15} eVs, velocity of light = 3×10^{8} m/s, ionisation energy of hydrogen = 13.6 eV)

(A) Electrons will be knocked out of the atom

(B) Electron will go to any excited state of the atom

(C) Electron will go only to first excited state of the atom

(D) Electron will keep orbiting in the ground state of the atom

32. The work function of metals is in the range of 2eV to 5eV. Find which of the following wavelength of light cannot be used for photoelectric effect? (Consider, Plank constant = 4×10^{-15} eVs, velocity of light = 3×108 m/s)

(A) 510mm (B) 650mm (C) 400mm (D) 570mm

33. Consider two particles of difference masses. In which of the following situations the heavier of the two particles will have smaller de-Broglie wavelength?

(A) Both have a free fall through the same height

(B) Both move with the same kinetic energy

(C) Both move with the same linear momentum

(D) Both move with the same speed

34. The ionization energy of hydrogen is 13.6 eV. The energy of the photon released when an electron jumps from the first excited state (n = 2) to the ground state of a hydrogen atom is

(A) 3.4 eV (B) 4.53 eV (C) 10.2 eV (D) 13.6 eV

35. For the radioactive nuclei that undergo either α or β decay, which one of the following cannot occur?

(A) Isobar of original nucleus is produced

(B) Isotope of the original nucleus is produced

(C) Nuclei with higher atomic number than that of the original nucleus is produced

(D) nuclei with lower atomic number than that of the original nucleus is produced

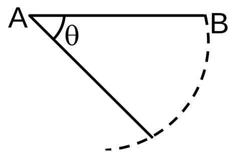
36. The energy of gamma (γ) ray photon is E_γ and that of an X-ray photon is E_X. If the visible light photon has an energy of E_v, then we can say that

(A) $E_X > E_\gamma > E_V$ (B) $E_\gamma > E_V > E_X$ (C) $E_\gamma > E_X > E_V$ (D) $E_X > E_V > E_\gamma$

37. The de-Broglie wavelength of an electron is the same as that of a 50 ke V X-ray photon. The ratio of the energy of the photon to the kinetic energy of the electron is (the energy equivalent of electron mass is 0.5 MeV)

(A) 1 : 50 (B) 1 : 20 (C) 20 : 1 (D) 50 : 1

38. Find the correct statement(s) about photoelectric effect.



(A) There is no significant time delay between the absorption of a suitable radiation and the emission of electrons

(B) Einstein analysis gives a threshold frequency above which no electron can be emitted

(C) The maximum kinetic energy of the emitted photoelectrons is proportional to the frequency of incident radiation

(D) The maximum kinetic energy of electrons does not depend on the intensity of radiation

POC

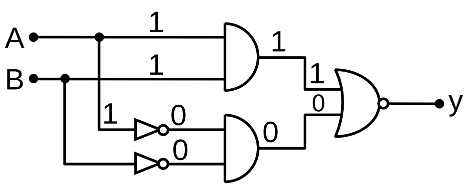
39. A common emitter transistor amplifier is connected with a load resistance of 6kΩ. When a small AC signal of 15 mV is added to the base-emitter voltage, the alternating base current is 20 μA and the alternative collector current is 1.8 mA. What is the voltage gain of the amplifier?

(A) 90 (B) 640 (C) 900 (D) 720

40. Each of the two inputs A and B can assume values either 0 or 1. Them which of the following will be equal to $\overline{A}\cdot\overline{B}$?

(A) A + B (B) $\overline{A+B}$ (C) $\overline{A\cdot B}$ (D) $\overline{A}+\overline{B}$

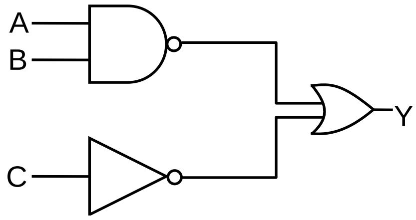
41.



In the given circuit, the binary inputs at A and B are both 1 in one case and both 0 in the next case. The respective outputs at Y in these two cases will be

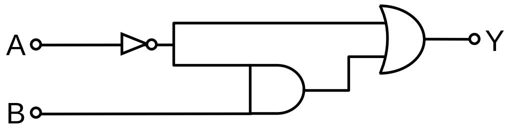
(A) 1, 1 (B) 0, 0 (C) 0, 1 (D) 1, 0

42. The inputs to the digital circuit are as shown below. The output Y is



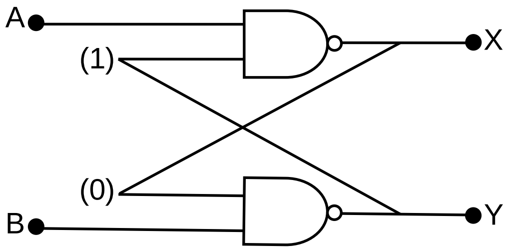
(A) $A + B + \overline{C}$ (B) $(A + B)\overline{C}$ (C) $\overline{A} + \overline{B} + \overline{C}$ (D) $\overline{A} + \overline{B} + C$

43. The output Y of the logic circuit given below is



(A) $\overline{A} + B$ (B) $\overline{A}$ (C) $\overline{(\overline{A} + B)} \cdot \overline{A}$ (D) $\overline{(\overline{A} + B)} \cdot A$

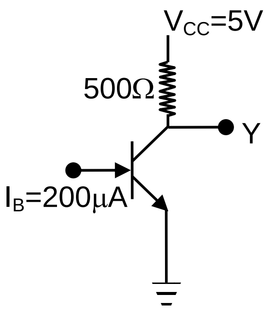
44. In the circuit shown, inputs A and B are in states 1 and 0 respectively. What is the only possible stable state of the outputs X and Y?



(A) X = 1, y = 1 (B) X = 1, y = 0 (C) X = 0, y = 1 (D) X = 0, y = 0

SEMICONDUCTOR

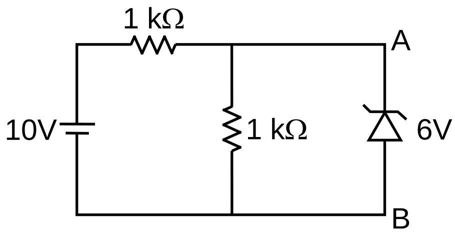
45.



In the circuit shown the value of β of the transistor is 48. If the supplied base current is 200 μA, what is the voltage at the terminal Y?

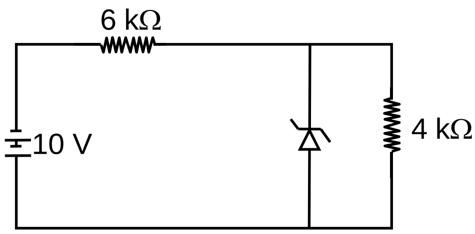
(A) 0.2V (B) 0.5V (C) 4V (D) 4.8V

46. In the circuit shown, what will be the current through the 6V zener ?



(A) 6 mA, from A to B
(B) 2 mA, from A to B
(C) 2 mA, from B to A
(D) Zero

47. What will be the current flowing through the 6 kΩ resistor in the circuit shown, where the breakdown voltage of the Zener is 6 V?



(A) $\frac{2}{3}$mA
(B) 1mA
(C) 10mA
(D) $\frac{3}{2}$mA

48. When a semiconducting device is connected in series with a battery and a resistance, a current is found to flow in the circuit. If however, the polarity of the battery is reversed, practically no current flows in the circuit. The device may be

(A) a p-type semiconductor
(B) a n-type semiconductor
(C) an intrinsic semiconductor
(D) a p-n junction

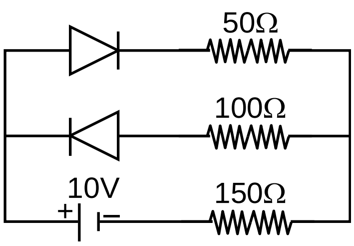
49. A Zener diode having break-down voltage 5.6V is connected in reverse bias with a battery of emf 10V and a resistance of 100Ω in series. The current flowing through the Zener diode is

(A) 88mA
(B) 0.88mA
(C) 4.4mA
(D) 44mA

50. In case of a bipolar transistor $\beta = 45$. The potential drop across the collector resistance of 1kΩ is 5V. The base current is approximately

(A) 222 μA
(B) 55 μA
(C) 111 μA
(D) 45 μA

51. Assume that each diode as shown in the figure has a forward bias resistance of 50W and an infinite reverse bias resistance. The current through the resistance 150Ω is

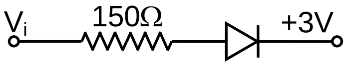


(A) 0.66A
(B) 0.05A
(C) zero
(D) 0.04A

52. In the bandgap between valence band and conduction band in a material is 5.0 eV, then the material is

(A) semiconductor (B) good conductor
(C) superconductor (D) insulator

53. In the circuit shown assume the diode to be ideal. When V_i increases from 2 V to 6 V, the change in the current is (in mA)



(A) zero (B) 20 (C) 80/3 (D) 40

54. In a transistor output characteristics commonly used in common emitter configuration, the base current I_B, the collector current I_C and the collector-emitter voltage V_{CE} have values of the following orders of magnitude in the active region

(A) I_B and I_C both are in m_A and V_{CE} in volt (B) I_B is in m_A and I_C is in m_A and V_{CE} in volt
(C) I_B is in m_A and I_C is in μA and V_{CE} in mV (D) I_B is in mA and I_C is in mA and V_{CE} in mV

UNIT & DIMENSIONS

55. The frequency ν of the radiation emitted by an atom when an electron jumps from one orbit to another is given by $\nu = k\delta E$, where k is a constant δE is the change in energy level due to the transition. Then dimension of k is

(A) $[ML^2T^{-2}]$ (B) the same dimension of angular momentum
(C) $[ML^2T^{-1}]$ (D) $[M^{-1}L^{-2}T]$

56. The correct dimensional formula for impulse is given by

(A) ML^2T^{-2} (B) MLT^{-1} (C) ML^2T^{-1} (D) MLT^{-2}

57. The dimension of the universal constant of gravitation, G is

(A) $[ML^2T^{-1}]$ (B) $[M^{-1}L^3T^{-2}]$ (C) $[M^{-1}L^2T^{-2}]$ (D) $[ML^3T^{-2}]$

58. In which of the following pairs, the two physical quantities have different dimensions?

(A) Planck's constant and angular momentum
(B) Impulse and linear momentum
(C) Moment of inertia and moment of a force
(D) Energy and torque

59. If n denotes a positive integer, h the Planck's constant, q the charge and B the magnetic field, then the quantity $\left[\frac{nh}{2\pi qB}\right]$ has the dimension of

(A) area (B) length (C) speed (D) acceleration

VECTOR

60. Consider the vectors A = $\hat{i}+\hat{j}-\hat{k}$, B = $2\hat{i}-\hat{j}+\hat{k}$ and C = $\frac{1}{\sqrt{5}}\left(\hat{i}-2\hat{j}+2\hat{k}\right)$. What is the value of C. (A ×B)?

(A) 1 (B) 0 (C) $3\sqrt{2}$ (D) $18\sqrt{5}$

61. In a triangle ABC, the sides AB and AC are represented by the vectors $3\hat{i}+\hat{j}+\hat{k}$ and $\hat{i}+2\hat{j}+\hat{k}$, respectively. Calculate the angle $\angle$ABC.

(A) $\cos^{-1}\sqrt{\frac{5}{11}}$ (B) $\cos^{-1}\sqrt{\frac{6}{11}}$

(C) $\left(90^o-\cos^{-1}\sqrt{\frac{5}{11}}\right)$ (D) $\left(180^o-\cos^{-1}\sqrt{\frac{5}{11}}\right)$

62. Three vectors A = ai + j + k; B = i + bj + k and C = i + j + ck are mutually perpendicular (i, j and k are unit vectors along X, Y and Z-axes respectively). The respective values of a, b and c are

(A) 0, 0, 0 (B) $-\frac{1}{2},-\frac{1}{2},-\frac{1}{2}$ (C) 1, –1, 1 (D) $\frac{1}{2},\frac{1}{2},\frac{1}{2}$

63. If x = at + bt^2 where x is in metre (m) and t is in hour (h) then unit of b will be

(A) $\frac{m^2}{h}$ (B) m (C) $\frac{m}{h}$ (D) $\frac{m}{h^2}$

64. The vectors A and B are such that |A + B| = |A – B|. The angle between the two vectors will be

(A) 0º (B) 60º (C) 90º (D) 45º

65. Consider three vectors $A=\hat{i}+\hat{j}-2\hat{k}$, $B=\hat{i}+\hat{j}-\hat{k}$ and $C=2\hat{i}+3\hat{j}-4\hat{k}$. A vector X of the form αA + βB (α and β are numbers) is perpendicular to C. The ratio of α and β is

(A) 1 : 1 (B) 2 : 1 (C) –1 : 1 (D) 3 : 1

KINEMATICS

66. A fighter plane, flying horizontally with a speed 360 km/h at an altitude of 500 m drops a bomb for a target straight ahead of it on the ground. The bomb should be dropped at what approximate distance ahead of the target? Assume that acceleration due to gravity (g) is 10 ms^{-1}. Also neglect air drag.

(A) 1000 m (B) $50\sqrt{5}$ m (C) $500\sqrt{3}$ m (D) 866m

67. A block of mass 1 kg starts from rest at x = 0 and moves along the X-axis under the action of a force F = kt, where t is time and $k = 1\ Ns^{-1}$. The distance the block will travel in 6 seconds is

(A) 36 m (B) 72 m (C) 108 m (D) 18 m

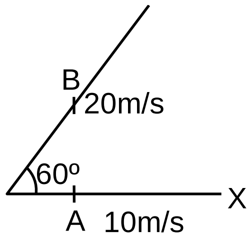
68. At a particular height the velocity of an ascending body is u. The velocity at the same height while the body falls freely is

(A) 2u (B) –u (C) u (D) –2u

69. A train moves from rest with acceleration a and in time t_1 covers a distance x. It then decelerates to rest at constant retardation β for distance y in time t_2. Then

(A) $\frac{x}{y}=\frac{\beta}{\alpha}$ (B) $\frac{\beta}{\alpha}=\frac{t_1}{t_2}$ (C) x = y (D) $\frac{x}{y}=\frac{\beta t_1}{\alpha t_2}$

70. Particle A moves along X-axis with a uniform velocity of magnitude 10m/s. Particle B moves with uniform velocity 20m/s along a direction making an angle of 60º with the positive direction of X-axis as shown in the figure. The relative velocity of B with respect to that of A is



(A) 10m/s along X-axis

(B) $10\sqrt{3}$ m/s along Y-axis (perpendicular to x-axis)

(C) $10\sqrt{5}$ m/s along the bisection of the velocities of A and B

(D) 30 m/s along negative X-axis

71. Two particles A and B having different masses are projected from a lower with same speed. A is projected vertically upward and B vertically downward. On reaching the ground

(A) Velocity of A is greater than that of B

(B) Velocity of B is greater than that of A

(C) Both A and B attain the same velocity

(D) The particle with the larger mass attains higher velocity

Ans. (C)

72. A cricket ball thrown across a field is at heights h_1 and h_2 from the point of projection at times t_1 and t_2 respectively after the throw. The ball is caught by a fielder at the same height as that of projection. The time of flight of the ball in this journey is

(A) $\frac{h_1t_2^2-h_2t_1^2}{h_1t_2-h_2t_1}$ (B) $\frac{h_1t_1^2+h_2t_2^2}{h_2t_1+h_1t_2}$ (C) $\frac{h_1t_2^2+h_2t_1^2}{h_1t_2+h_2t_1}$ (D) $\frac{h_1t_1^2-h_2t_2^2}{h_1t_1+h_2t_2}$

73. A particle moves with constant acceleration along a straight line starting from rest. The percentage increase in its displacement during the 4th second compared to that in the 3rd second is

(A) 33% (B) 40% (C) 66% (D) 77%

74. A block of mass m rests on a horizontal table with a coefficient of static friction μ. What minimum force must be applied one the block to drag it on the table?

(A) $\frac{\mu}{\sqrt{1+\mu^2}}mg$ (B) $\frac{\mu-1}{\mu+1}mg$ (C) $\frac{\mu}{\sqrt{1+\mu^2}}mg$ (D) μ mg

75. Two weights of the mass m_1 and m_2 (> m_1) are joined by an inextensible string of negligible mass passing over a fixed frictionless pulley. The magnitude of the acceleration of the loads is

(A) g (B) $\frac{m_2-m_1}{m_2}g$ (C) $\frac{m_1}{m_2+m_1}g$ (D) $\frac{m_2-m_1}{m_2+m_1}g$

76. A block of mass m_2 is placed on a horizontal table and another block of mass m_1 is placed on top of it. An increasing horizontal force F = αt is exerted on the upper block but the lower block never moves as a result. If the coefficient of friction between the blocks is μ_1 and that between the lower block and the table is μ_2, then what is the maximum possible value of μ_1/μ_2 ?

(A) $\frac{m_2}{m_1}$ (B) $1+\frac{m_2}{m_1}$ (C) $\frac{m_1}{m_2}$ (D) $1+\frac{m_1}{m_2}$

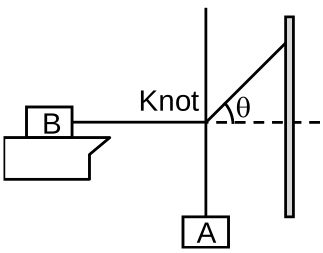
77. The velocity (v) of a particle (under a force F) depends on its distance (x) from the origin (with x > 0) $v \propto \frac{1}{\sqrt{x}}$. Find how the magnitude of the force (F) on the particle depends on x?

(A) $F \propto \frac{1}{x^{3/2}}$ (B) $F \propto \frac{1}{x}$ (C) $F \propto \frac{1}{x^2}$ (D) $F \propto x$

78. A mass of 1kg is suspended by means of a thread. The system is (i) lifted up with an acceleration of 4.9 ms^{-2}. (ii) Lowered with an acceleration of 4.9 ms^{-2}. The ratio of tension in the first and second case is

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

79. Block B lying on a table weights W. The coefficient of static friction between the block and the table is μ. Assume that the cord between B and the knot is horizontal. The maximum weight of the block A for which the system will be stationary is



(A) $\frac{W\tan\theta}{\mu}$ (B) μW tan θ (C) $\mu W\sqrt{1+\tan^2\theta}$ (D) μW sin θ

80. A smooth mass-less string passes over a smooth fixed pulley. Two masses m_1 and m_2, ($m_1 > m_2$) are tied at the two ends of the string. The masses are allowed to move under gravity starting from rest. The total external force acting on the two masses is

(A) $(m_1 + m_2)g$
(B) $\frac{(m_1 - m_2)^2}{m_1 + m_2}g$
(C) $(m_1 - m_2)g$
(D) $\frac{(m_1 + m_2)^2}{m_1 - m_2}g$

81. To determine the coefficient of friction between a rough surface and a block, the surface is kept inclined at 45º and the block is released from rest. The block takes a time t in moving a distance d. The rough surface is then replaced by a smooth surface and the same experiment is repeated. The block now takes a time t/2 in moving down the same distance d. The coefficient of friction is

(A) 3/4
(B) 5/4
(C) 1/2
(D) $1/\sqrt{2}$

CENTER OF MASS & COLLISION

82. A tennis ball hits the floor with a speed v at an angle θ with the normal to the floor. If the collision is inelastic and the coefficient of restitution is ε, what will be the angle of reflection?

(A) $\tan^{-1}\left(\frac{\tan\theta}{\varepsilon}\right)$
(B) $\sin^{-1}\left(\frac{\sin\theta}{\varepsilon}\right)$
(C) $\theta\varepsilon$
(D) $\theta\frac{2\varepsilon}{\varepsilon+1}$

83. Two particles A and B (both initially at rest) start moving towards each other under a mutual force of attraction. At the instant, when the speed of A is v and the speed of B is 2v, the speed of the centre of mass is

(A) zero
(B) v
(C) $\frac{3v}{2}$
(D) $-\frac{3v}{2}$

84. A small steel ball bounces on a steel plate held horizontally. On each bounce the speed of the ball arriving at the plate is reduced by a factor e (coefficient of restitution) in the rebound, so that $V_{upward} = eV_{downward}$

If the ball is initially dropped from a height of 0.4 m above the plate and if 10 seconds later the bouncing ceases, the value of e is

(A) $\sqrt{\frac{2}{7}}$
(B) $\frac{3}{4}$
(C) $\frac{13}{18}$
(D) $\frac{17}{18}$

85. Two bodies of masses m_1 and m_2 are separated by a distance R. The distance of the centre of mass of the bodies from the mass m_1 is

(A) $\frac{m_2R}{m_1+m_2}$
(B) $\frac{m_1R}{m_1+m_2}$
(C) $\frac{m_1m_2}{m_1+m_2}R$
(D) $\frac{m_1+m_2}{m_1}R$

86. A large number of particles are placed around the origin each at a distance R from the origin. The distance of the centre of mass of the system from the origin is

(A) Equal to R
(B) Less than equal to R
(C) Greater than R
(D) Greater than equal to R

87. The bob of a swinging second pendulum (one whose time period is 2s) has a small speed v_0 at its lowest point. Its height from this lowest point 2.25s after passing through it is given by

(A) $\frac{v_0^2}{2g}$ (B) $\frac{v_0^2}{g}$ (C) $\frac{v_0^2}{4g}$ (D) $\frac{9v_0^2}{4g}$

88. Two metallic spheres of equal outer radii are found to have same moment of inertia about their respective diameters. Then which of the following statement(s) is/are true?

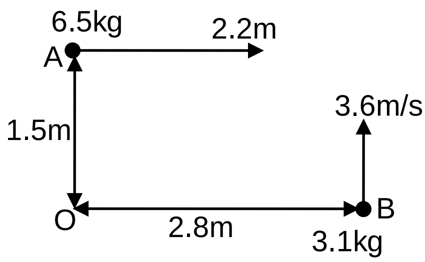
(A) The two spheres have equal masses

(B) The ratio of their masses is nearly 1.67 : 1.

(C) The spheres are made of different materials

(D) Their rotational kinetic energies will be equal when rotated with equal uniform angular speed about their respective diameters.

89. Two particles A and B are moving as shown in the figure.



Their total angular momentum about the point O is

(A) 9.8 kg m^2/s (B) zero (C) 52.7 kg m^2/s (D) 37.9 kg m^2/s

90. A circular disc rolls on a horizontal floor without slipping and the centre of the disc moves with a uniform velocity v. Which of the following values of the velocity at a point on the rim of the disc can have?

(A) v (B) –v (C) 2v (D) zero

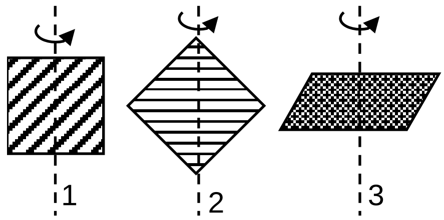
91. A uniform solid spherical ball is rolling down a smooth inclined plane from a height h. The velocity attained by the ball when it reaches the bottom of the inclined plane is v. If the ball is now thrown vertically upwards with the same velocity v, the maximum height to which the ball will rise is

(A) $\frac{5h}{8}$ (B) $\frac{3h}{5}$ (C) $\frac{5h}{7}$ (D) $\frac{7h}{9}$

92. A solid uniform sphere resting on a rough horizontal plane is given a horizontal impulse directed through its centre so that it starts sliding with an initial velocity v_0. When it finally starts rolling without slipping the speed of its centre is

(A) $\frac{2}{7}v_0$ (B) $\frac{3}{7}v_0$ (C) $\frac{5}{7}v_0$ (D) $\frac{6}{7}v_0$

93. There identical square plates rotate about the axes shown in the figure in such a way that their kinetic energies are equal. Each of the rotation axes passes through the centre of the square. Then the ratio of angular speeds $\omega_1 : \omega_2 : \omega_3$ is



(A) 1 : 1 : 1 (B) $\sqrt{2} : \sqrt{2} : 1$ (C) $1 : \sqrt{2} : 1$ (D) $1 : 2 : \sqrt{2}$

94. A thin rod AB is held horizontally so that it can freely rotate in a vertical plane about the end A as shown in the figure. The potential energy of the rod when it hangs vertically is taken to be zero. The end B of the rod is released from rest from a horizontal position. At the instant the rod makes an angle θ with the horizontal

(A) the speed of end B is proportional to $\sqrt{\sin\theta}$

(B) the potential energy is proportional energy is proportional to $(1 - \cos\theta)$

(C) the angular acceleration is proportional to $\cos\theta$

(D) the torque about A remains the same as its initial value

PROPERTIES OF MATTER

95. A steel a brass wire, each of length 50cm and cross-sectional area 0.005cm^2 hang from a ceiling and are 15cm apart. Lower ends of the wires are attached to a light horizontal bar. A suitable downward load is applied to the bar, so that each of the wires extends in length by 0.1 cm. At what distance from the steel wire, the load must be applied? [Young's modulus of steel = 2×10^{12} dyne/cm^2]

(A) 7.5 cm (B) 5 cm (C) 10 cm (D) 3 cm

96. When 100g of boiling water at 100ºC is added into a calorimeter containing 300g of cold water at 10ºC temperature of the mixture becomes 20ºC. Then, a metallic block of mass 1kg at 10ºC is dipped into the mixture in the calorimeter. After reaching thermal equilibrium the final temperature becomes 19ºC. What is the specific heat of the metal in CGS unit?

(A) 0.01 (B) 0.3 (C) 0.09 (D) 0.1

97. A metallic block of mass 20kg is dragged with a uniform velocity of 0.5ms^{-1} on a horizontal table for 2.1 s. The coefficient of static friction between the block and the table is 0.10. What will be the maximum possible rise in temperature of the metal block if the specific heat of the block is 0.1 CGS unit? Assume g = 10ms^{-2} and uniform rise in temperature throughout the whole block. [Ignore absorption of heat by the table]

(A) 0.0025ºC (B) 0.025ºC (C) 0.001ºC (D) 0.05ºC

98. Consider an engine that absorbs 130 cal of heat from a hot reservoir and delivers 30cal heat to a cold reservoir in each cycle. The engine also consumes 2J energy in the engine works at 90 cycle per minute what will be the maximum power delivered to the load? [Assume the thermal equivalent of heat is 4.2 J/cal]

(A) 816 W (B) 819 W (C) 627 W (D) 630 W

99. A compressive force is applied to a uniform rod of rectangular cross-section so that its length decreases by 1%. If the Poisson's ration for the material of the rod be 0.2, which of the following statements is correct ?

"The volume approximately ……… "

(A) decreases by 1% (B) decreases by 0.8%

(C) decreases by 0.5% (D) increases by 0.2%

100. Two black bodies A and B have equal surface areas and are maintained at temperatures 27ºC and 177ºC respectively. What will be the ratio of the thermal energy radiated per second by A to that by B?

(A) 4 : 9 (B) 2 : 3 (C) 16 : 81 (D) 27 : 177

101. A horizontal fire hose with a nozzle of cross-sectional area $\frac{5}{\sqrt{21}} \times 10^{-3}\,m^2$ delivers a cubic metre of water in 10s. What will be the maximum possible increase in the temperature of water while it hits a rigid wall (neglecting the effect of gravity)?

(A) 1ºC (B) 0.1ºC (C) 10ºC (D) 0.01ºC

102. Two identical blocks of ice move in opposite directions with equal speed and collide with each other. What will be the minimum speed required to make both the blocks melt completely, if the initial temperatures of the blocks were –8ºC each ?

Specific heat of ice is 2100 $Jkg^{-1}\,K^{-1}$ and latent heat of fusion of ice is 3.36×10^5 Jkg^{-1})

(A) 840 ms^{-1} (B) 420 ms^{-1} (C) 8.4 ms^{-1} (D) 84 ms^{-1}

103. The stress along the length of a rod (with rectangular cross-section) is 1 % of the Young's modulus of its material. What is the approximate percentage of change of its volume? (Poisson's ratio of the material of the rod is 0.3.)

(A) 3 % (B) 1 % (C) 0.7 % (D) 0.4 %

104. The water equivalent of a calorimeter is 10 g and it contains 50 g of water at 15ºC. Some amount of ice, initially at – 10 ºC is dropped in it and half of the ice melts till equilibrium is reached. What was the initial amount of ice that was dropped (when specific heat of ice = 80 cal gm^{-1})?

(A) 10 g (B) 18 g (C) 20 g (D) 30 g

105. A bullet of mass 4.2×10^{-2} kg, moving at a speed of 300 ms^{-1}, gets stuck into a block with a mass 9 times that of the bullet. If the block is free to move without any kind of friction, the heat generated in the process will be

(A) 45 cal (B) 405 cal (C) 450 cal (D) 1701 cal

106. The temperature of the water of a pond is 0ºC while that of the surrounding atmosphere is –20ºC. If the density of ice is ρ, coefficient of thermal conductivity is k and latent heat of melting is L, then the thickness Z of ice layer formed increases as a function of time t is

(A) $Z^2 = \frac{60k}{\rho L}$ (B) $Z = \sqrt{\frac{40k}{\rho L}}$ (C) $Z^2 = \frac{40k}{\rho L}\sqrt{t}$ (D) $Z^2 = \frac{40k}{\rho L}t$

107. The length of a metal wire is L_1 when ten tension is T_1 and L_2 when the tension is T_2. The unscratched length of wire is

(A) $\frac{L_1 + L_2}{2}$ (B) $\sqrt{L_1 L_2}$ (C) $\frac{T_3 L_1 - T_1 L_2}{T_2 - T_1}$ (D) $\frac{T_2 L_1 + T_1 L_2}{T_2 + T_1}$

108. A 20cm long capillary tube is dipped vertically in water and the liquid rises up to 10cm. If the entire system is kept is a freely falling platform, the length of the water column in the tube will be

(A) 5cm (B) 10cm (C) 15cm (D) 20cm

109. A solid maintained at $t^o{}_1$C is kept in an evacuated chamber at temperature $t^o{}_2$C ($t_2 >> t_1$). The rate of heat absorbed by the body is proportional to

(A) $t_2^4 - t_1^4$ (B) $\left(t_2^4 + 273\right) - \left(t_1^4 + 273\right)$

(C) $t_2 - t_1$ (D) $t_2^2 - t_1^2$

110. A scientist proposes a new temperature scale in which the ice point is 25 X (X is the new unit of temperature) and the steam point is 305 X. The specific heat capacity of water in this new scale is (in J kg^{-1} X^{-1})

(A) 4.2×10^3 (B) 3.0×10^3 (C) 1.2×10^3 (D) 1.5×10^3

111. A metal rod is fixed rigidly at two ends so as to prevent its thermal expansion. If L, a and Y respectively denote the length of the rod, coefficient of linear thermal expansion and Young's modulus of its material, then for an increase in temperature of the rod by ΔT, the longitudinal stress developed in the rod is

(A) Inversely proportional to a (B) Inversely proportional to Y

(C) Directly proportional to $\Delta T/Y$ (D) independent of L

112. In which of the following phenomena, the heat waves travel along straight lines with the speed of light?

(A) Thermal conduction (B) Forced convection

(C) Natural convection (D) Thermal radiation

113. Consider a black body radiation in a cubical box at absolute temperature T. If the length of each side of the box is doubled and the temperature of the walls of the box and that of the radiation is halved, then the total energy

(A) halves (B) doubles (C) quadruples (D) remains the same

114. Same quantity of ice is filled in each of the two metal containers P and Q having the same size, shape and wall thickness but made of different materials. The containers are kept in identical surroundings. The ice in P melts completely in time t_1 whereas in Q takes a time t_2. The ratio of thermal conductivities of the materials of P and Q is

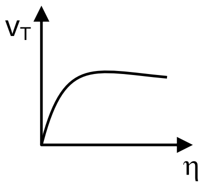
(A) $t_2 : t_1$ (B) $t_1 : t_2$ (C) $t_1^2 : t_2^2$ (D) $t_2^2 : t_1^2$

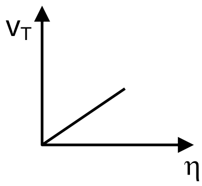
115. A 10 W electric heater is used to heat a container filled with 0.5 kg of water. It is found that the temperature of water and the container rises by 3ºK in 15 min. The container is then emptied, dried and filled with 2 kg of oil. The same heater now raises the temperature of container-oil system by 2º K in 20 min. Assuming that there is no heat loss in the process and the specific heat of water is 4200 J kg^{-1} K^{-1}, the specific heat of oil in the same unit is equal to

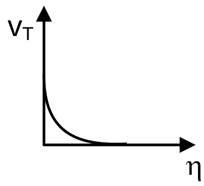
(A) 1.50×10^3 (B) 2.55×10^3 (C) 3.00×10^3 (D) 5.10×10^3

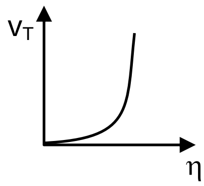
FLUID MECHANICS

116. Which of the following diagrams correctly shows the relation between the terminal velocity nT of a spherical body falling in a liquid and viscosity η of the liquid?

(A) 

(B) 

(C) 

(D) 

117. Uniform capillary tube of length l and inner radius r with its upper end sealed is submerged vertically into water. The outside pressure is p_0 and surface tension of water is γ. When a length a length x of the capillary is submerged into water, it is found that water levels inside and outside the capillary coincide. The value of x is

(A) $\dfrac{l}{\left(1+\dfrac{p_0 r}{4\gamma}\right)}$ (B) $l\left(1-\dfrac{p_0 r}{4\gamma}\right)$ (C) $l\left(1-\dfrac{p_0 r}{2\gamma}\right)$ (D) $\dfrac{l}{\left(1+\dfrac{p_0 r}{2\gamma}\right)}$

118. A small spherical body f radius r and density ρ moves with the terminal velocity v in a fluid of coefficient of viscosity η and density σ. What will be the net force on the body ?

(A) $\dfrac{4\pi}{3} r^3(\rho-\rho)g$ (B) $6\pi\eta rv$ (C) Zero (D) infinity

119. A spherical liquid drop is placed on a horizontal plane. A small disturbance causes the volume of the drop to oscillate. The time period of oscillation (T) of the liquid drop depends on radius (r) of the drop, density (ρ) and surface tension (S) of the liquid. Which among the following will be a possible expression for T (where, k is a dimensionless constant)?

(A) $k\sqrt{\dfrac{\rho r}{S}}$ (B) $k\sqrt{\dfrac{\rho^2 r}{S}}$ (C) $k\sqrt{\dfrac{\rho r^3}{S}}$ (D) $k\sqrt{\dfrac{\rho r^3}{S^2}}$

120. What will be the approximate terminal velocity of a rain drop of diameter 1.8×10^{-3} m, when density of rain water $\approx 10^3$ kgm^{-3} and the coefficient of viscosity of air $\approx 1.8 \times 10^{-5}$ N-sm^{-2} ? (Neglect buoyancy of air)

(A) 49 ms^{-1} (B) 98 ms^{-1} (C) 392 ms^{-1} (D) 980 ms^{-1}

121. 1000 droplets of water having 2mm diameter each coalesce to form a single drop. Given the surface tension of water is 0.072 Nm^{-1}. The energy loss in the process is

(A) 8.146×10^{-4}J (B) 4.4×10^{-4} J (C) 2.108×10^{-5}J (D) 4.7×10^{-1}J

122. A drop of water detaches itself from the exit of tap when (σ = surface tension of water, ρ = density of water, R = radius of the tap exit, r = radius of the drop)

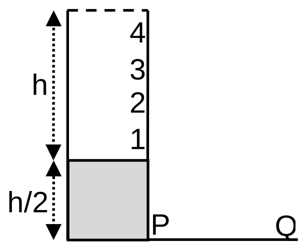
(A) $r > \left(\frac{2}{3}\frac{R\sigma}{\rho g}\right)^{1/3}$ (B) $r = \frac{2}{3}\frac{s}{\rho g}$

(C) $\frac{2\sigma}{r}$ > atmospheric pressure (D) $r > \left(\frac{2}{3}\frac{R\sigma}{\rho g}\right)^{2/3}$

123. A hollow sphere of external radius R and thickness t(<<R) is made of a metal of density ρ. The sphere will float in water, if

(A) $t \le \frac{R}{\rho}$ (B) $t \le \frac{R}{3\rho}$ (C) $t \le \frac{R}{2\rho}$ (D) $t \ge \frac{R}{3\rho}$

124. A cylinder of height 'h' is filled with water and kept on a block of height h/2. The level of water in the cylinder is kept constant. Four holes numbered 1, 2, 3 and and 4 are at the side of the cylinder and at heights 0, h/4, h/2 and 3h/4, respectively. When all four holes are opened together, the hole from which water will reach farthest distance on the plane PQ is the hole number.



(A) 1 (B) 2 (C) 3 (D) 4

125. A small metal sphere of radius of a is falling with a velocity v through a vertically column of a viscous liquid. If the coefficient of viscosity of the liquid is η, then the sphere encounters an opposing force of

(A) $6\pi\eta a^2 v$ (B) $\frac{6\eta v}{\pi a}$ (C) $6\pi\eta a v$ (D) $\frac{\pi\eta v}{6a^3}$

126. A wooden block is floating on water kept in a beaker. 40% of the block is above the water surface. Now the beaker is kept inside a lift that starts going upward with acceleration equal to g/2. the block will then

(A) sin k (B) Float with 10% above the water surface

(C) Float with 40% above the water surface (D) Float with 70% above the water surface

127. A uniform rod is suspended horizontally from its mid-point. A piece of metal whose weight is w is suspended at a distance l from the mid-point. Another weight W_1 is suspended on the other side at a distance l_1 from the mid-point to bring the rod to a horizontal position. When ω is completely immersed in water, w_1 needs to be kept at a distance l_2 from the mid-point to get the rod back into horizontal position. The specific gravity of the metal piece is

(A) $\frac{w}{w_1}$ (B) $\frac{wl_1}{wl - w_1 l_2}$ (C) $\frac{l_1}{l_1 - l_2}$ (D) $\frac{l_1}{l_2}$

128. A drop of some liquid of volume 0.04 cm^3 is placed on the surface of a glass slide. then another glass slide is placed on it in such a way that the liquid forms a thin layer of area 20 cm^2 between the surfaces of the two slides. To separate the slides a force of 16×10^5 dyne has to be applied normal to the surfaces. The surface tension of the liquid is (in dyne-cm^{-1})

(A) 60 (B) 70 (C) 80 (D) 90

129. To determine the composition of a bimetallic alloy, a sample is first weighed in air and then in water. These weights are found to be ω_1 and ω_2 respectively. If the densities of the two constituent's metals are ρ_1 and ρ_2 respectively, then the weight of the first metal in the sample is (where ρ_ω is the density of water)

(A) $\frac{\rho_1}{\rho_w(\rho_2 - \rho_1)}\left[w_1(\rho_2 - \rho_w) - w_2\rho_2\right]$

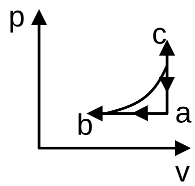
(B) $\frac{\rho_1}{\rho_w(\rho_2 + \rho_1)}\left[w_1(\rho_2 - \rho_w) + w_2\rho_2\right]$

(C) $\frac{\rho_1}{\rho_w(\rho_2 - \rho_1)}\left[w_1(\rho_2 + \rho_w) - w_2\rho_1\right]$

(D) $\frac{\rho_1}{\rho_w(\rho_2 - \rho_1)}\left[w_1(\rho_1 - \rho_w) - w_2\rho_1\right]$

KTG & THERMODYNAMICS

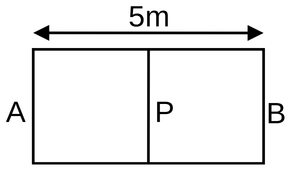
130. An ideal gas undergoes the cyclic process abca as shown in the given p-V diagram.



It rejects 50J of heat during ab and absorbs 80J of heat during ca. During bc, there is no transfer of heat and 40 J of of work is done by the gas. What should be the area of the closed curve abca?

(A) 30J (B) 40J (C) 10J (D) 90J

131. A container AB in the shape of rectangular parallelepiped of length 5m is divided internally by a movable partition P as shown in the figure.



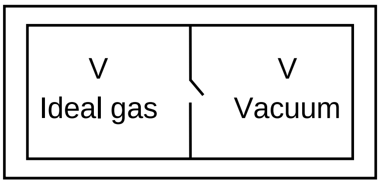
The left compartment is filled with a given mass of an ideal gas of molar mass 32 while the right compartment is filled with an equal mass of another ideal gas of molar mass 18 at same temperature. What will be the distance of P from the left wall A when equilibrium is established?

(A) 2.5m (B) 1.8m (C) 3.2m (D) 2.1m

132. What will be the molar specific heat at constant volume of an ideal gas consisting of rigid diatomic molecules?

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

133. Consider the given diagram. An ideal gas is contained a chamber (left) of volume V and is at an absolute temperature T. It is allowed to rush freely into the right chamber of volume V which is initially vacuum. The whole system is thermally isolated. What will be the final temperature of the equilibrium has been attained?



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

134. The initial pressure and volume of a given mass of an ideal gas $\left(\text{with}\frac{C_F}{C_V}=\gamma\right)$, taken in a cylinder fitted with a piston, are p_0 and V_0 respectively. At this stage the gas has the same temperature as that of the surrounding medium which is T_0. It is adiabatically compressed to a volume equal to $\frac{V_0}{2}$. Surrounding?

(A) 0 (B) $(2^{r-1}-1)\frac{p_0V_0}{\gamma-1}$ (C) $\gamma p_0V_0\ln 2$ (D) $\frac{p_0V_0}{2(\gamma-1)}$

135. One mole of a monoatomic ideal gas undergoes a quasistatic process, which is depicted by a straight line joining points (V_0, T_0) and (2 V_0, $3T_0$) in a V-T diagram. What is the value of the heat capacity of the gas at the point (V_0, T_0)?

(A) R (B) $\frac{3}{2}R$ (C) 2R (D) 0

136. For an ideal gas with initial pressure and volume p_i and V_i respectively, a reversible isothermal expansion happens, when its volume becomes V_0. Then, it is compressed to its original volume V_i by a reversible adiabatic process. If the final pressure is $p_{f'}$ then which of the following statement (s) is/are true?

(A) $p_f = p_i$ (B) $p_f > p_i$ (C) $p_f < p_i$ (D) $\frac{p_f}{V_0} = \frac{p_i}{V_i}$

137. Which of the following statements (s) is/are true?
"Internal energy of an ideal gas ...."
(A) decreases in an isothermal process.
(B) remains constant in an isothermal process.
(C) increases in an isobaric process.
(D) decreases in an isobaric expansion.

138. Temperature of an ideal gas, initially at 27ºC, is raised by 6ºC, The rms velocity of the gas molecules will
(A) increase by nearly 2% (B) decrease by nearly 2%
(C) increase by nearly 1% (D) decrease by nearly 1%

139. 2 moles of an ideal monoatomic gas is carried from a state (p_0, V_0) to state $(2p_0, 2V_0)$ along a straight line path in a p-V diagram. The amount of heat absorbed by the gas in the process is given by

(A) $3p_0V_0$ (B) $\frac{9}{2}p_0V_0$ (C) $6p_0V_0$ (D) $\frac{3}{2}p_0V_0$

140. If the pressure, temperature and density of an ideal gas are denoted by p, T and ρ, respectively, the velocity of sound in the gas is
(A) proportional to $\sqrt{p}$, when T is constant.
(B) proportional to $\sqrt{T}$.
(C) proportional to $\sqrt{p}$, when ρ is constant.
(D) proportional to T.

141. The perfect gas equation for 4g of hydrogen gas is

(A) pV = RT (B) pV = 2RT (C) $pV = \frac{1}{2}RT$ (D) PV = 4RT

142. If the rms velocity of hydrogen gas at a certain temperature is c, then the rms velocity of oxygen gas at the same temperature is

(A) $\frac{c}{8}$ (B) $\frac{c}{10}$ (C) $\frac{c}{4}$ (D) $\frac{c}{2}$

143. For air at room temperature the atmospheric pressure is 1.0×10^5 Nm^{-2} and density of air is 1.2 kgm^{-3}. For a tube of length 1.0m closed at one end the lowest frequency generated is 84Hz. The value of γ [ratio of two specific heats] for air is

(A) 2.1 (B) 1.5 (C) 1.8 (D) 1.4

144. A gas bubble of 2cm diameter rises through a liquid of density 1.75 g cm^{-3} with a fixed speed of 0.35 cms^{-1}. Neglect the density of the gas. The coefficient of viscosity of the liquid is

(A) 870 poise (B) 1120 poise (C) 982 poise (D) 1089 poise

145. The rms speed of oxygen is v at a particular temperature. If the temperature is doubled and oxygen molecules dissociate into oxygen atoms the rms speed becomes

(A) v (B) $\sqrt{2}$v (C) 2v (D) 4v

146. The pressure p, volume V and temperature T for a certain gas are related by $p = \frac{AT - BT^2}{V}$, where A and B are constants. The work done by the gas when the temperature changes from T_1 and T_2 while the pressure remains constant, is given by

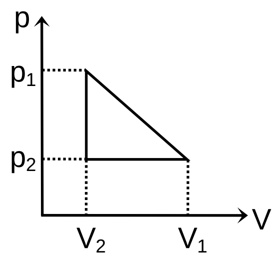
(A) $A(T_2 - T_1) + B\left(T_2^2 - T_1^2\right)$ (B) $\frac{A\left(T_2 - T_1\right)}{V_2 - V_1} - \frac{B\left(T_2^2 - T_1^2\right)}{V_2 - V_1}$

(C) $A(T_2 - T_1) - \frac{B}{2}\left(T_2^2 - T_1^2\right)$ (D) $\frac{A\left(T_2 - T_1^2\right)}{V_2 - V_1}$

147. One mole of an ideal monoatomic gas is heated at a constant pressure from 0ºC to 100ºC. Then the change in the internal energy of the gas is
(Given, R = 8.32 J mol^{-1} K^{-1})

(A) 0.83×10^3 J (B) 4.6×10^3 J (C) 2.08×10^3 J (D) 1.25×10^3 J

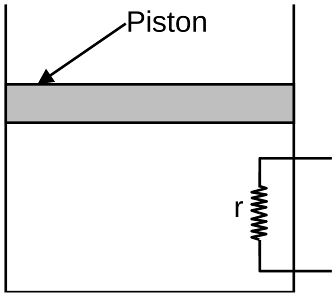
148. One mole of a vander Waals' gas obeying the equation $\left(p + \frac{a}{v^2}\right)(v - b) = RT$ undergoes the quasi-static cyclic process which is shown in the p-V diagram. The net heat absorbed by the gas in this process is



(A) $\frac{1}{2}(p_1 - p_2)(V_1 - V_2)$ (B) $\frac{1}{2}(p_1 + p_2)(V_1 - V_2)$

(C) $\frac{1}{2}\left(p_1 + \frac{a}{V_1^2} - p_2 - \frac{a}{V_2^2}\right)(V_1 - V_2)$ (D) $\frac{1}{2}\left(p_1 + \frac{a}{V_1^2} + p_2 + \frac{a}{V_2^2}\right)(V_1 - V_2)$

149. A heating element of resistance r is fitted inside an adiabatic cylinder which carries a frictionless piston of mass m and cross-section A as shown in diagram. The cylinder contains one mole of an ideal diatomic gas. The current flows through the element such that the temperatures rises with time t as $\Delta T = \alpha t + \frac{1}{2}\beta t^2$ (α and β are constants), while pressure remains constant. The atmospheric pressure above the piston is P_0. Then



(A) the ratio of increase in internal energy is $\frac{5}{2}R(\alpha+\beta t)$

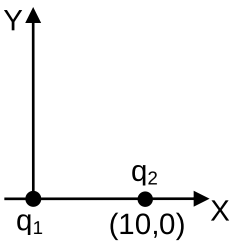
(B) the current flowing in the element is $\sqrt{\frac{5}{2r}R(\alpha+\beta t)}$

(C) the piston moves upwards with constant acceleration

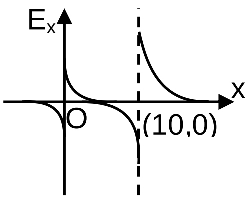
(D) the piston moves upwards with constant speed

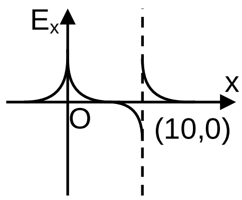
ELECTROSTATICS

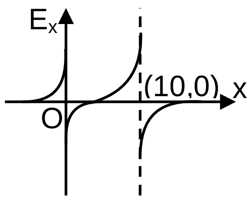
150. As shown in the figure, a point charge $q_1 = +1 \times 10^{-6}$ C is placed at the origin in xy-plane and another point charge $q_2 = +3 \times 10^{6}$ C is placed at the coordinate (10, 0).

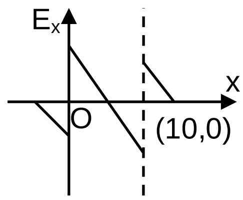


In that case, which of the following graph(s) shows most correctly the electric field vector in E_x in x-direction?

(A) 

(B) 

(C) 

(D) 

151. Four identical point masses each of mass m and carrying charge +q are placed at the corners of a square of slides a on a frictionless plane surface. If the particles are released simultaneously the kinetic energy of the system when they are infinitely far apart is

(A) $\frac{q^2}{a}\left(2\sqrt{2}+1\right)$ (B) $\frac{q^2}{a}\left(\sqrt{2}+2\right)$ (C) $\frac{q^2}{a}\left(\sqrt{2}+4\right)$ (D) $\frac{q^2}{a}\left(\sqrt{2}+1\right)$

152. A very long charged solid cylinder of radius a contains a uniform charge density ρ. Dielectric constant of the material of the cylinder is K. What will be the magnitude of electric field at a radial distance x(x < a) from the axis of the cylinder?

(A) $\rho\frac{x}{\varepsilon_0}$ (B) $\rho\frac{x}{2k\varepsilon_0}$ (C) $\rho\frac{x}{2a\varepsilon_0}$ (D) $\rho\frac{x}{2k}$

153. Two pith balls, each carrying charge +q are hung from a hook by two strings. It is found that when each charge is tripled, angle between the strings double. What was the initial angle between the strings?

(A) 30º (B) 60º (C) 45º (D) 90º

154. Eleven equal point charges, all of them having a charge + Q, are placed at all the hour positions of a circular clock of radius r, except at the 10 h position. What is the electric field strength at the centre of the clock ?

(A) $\frac{Q}{4\pi\varepsilon_0 r^2}$ from the centre towards the mark 10

(B) $\frac{Q}{4\pi\varepsilon_0 r^2}$ from the mark 10 towards the centre

(C) $\frac{Q}{4\pi\varepsilon_0 r^2}$ from the centre towards the mark 6

(D) Zero

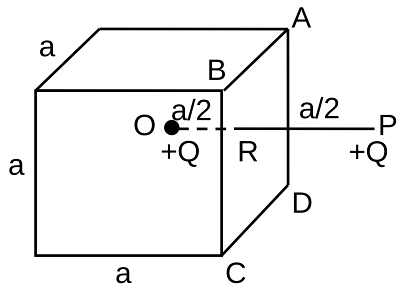
155. A negative charge is placed at the midpoint between two fixed equal positive charges, separated by a distance 2d. If the negative charge is given a small displacement x(x < < d) perpendicular to the line joining the positive charge, how the force (F) developed on it will approximately depend on x ?

(A) $F \propto x$ (B) $F \propto \frac{1}{x}$ (C) $F \propto x^2$ (D) $F \propto \frac{1}{x^2}$

156. A point charge –q is carried from a point A to another point B on the axis of a charged ring of radius r carrying a charge +q. If the point A is at a distance $\frac{4}{3}r$ from the centre of the ring and the point B is $\frac{3}{4}r$ from the centre but on the opposite side, what is the net work that need to be done for this?

(A) $-\frac{7}{5}.\frac{q^2}{4\pi\varepsilon_0 r}$ (B) $-\frac{1}{5}.\frac{q^2}{4\pi\varepsilon_0 r}$ (C) $\frac{7}{5}.\frac{q^2}{4\pi\varepsilon_0 r}$ (D) $\frac{1}{5}.\frac{q^2}{4\pi\varepsilon_0 r}$

157. Consider a region in free space bounded by the surfaces of an imaginary cube having sides of length a as shown in the figure. A charge +Q is placed at the centre O of the cube. P is such a point outside the cube that the line OP perpendicularly intersects the surface ABCD at R and also OR = RP = a/2. A charge + Q is placed at point P also. What is the total electric flux through the five faces of the cube other than ABCD?



(A) $\frac{Q}{\varepsilon_0}$ (B) $\frac{5Q}{6\varepsilon_0}$ (C) $\frac{10Q}{6\varepsilon_0}$ (D) zero

158. Four equal charges of value + Q are placed at any four vertices of a regular hexagon of side 'a'. By suitably choosing the vertices, what can be the maximum possible magnitude of electric field at the centre of the hexagon?

(A) $\frac{Q}{4\pi\varepsilon_0 a^2}$ (B) $\frac{\sqrt{2}Q}{4\pi\varepsilon_0 a^2}$ (C) $\frac{\sqrt{3}Q}{4\pi\varepsilon_0 a^2}$ (D) $\frac{2Q}{4\pi\varepsilon_0 a^2}$

159. A solid spherical ball and a hollow spherical ball of two different materials of densities ρ_1 and ρ_2 respectively have same outer radii and same mass. What will be the ratio, the moment of inertia (about an axis passing through the centre) of the hollow sphere to that of the solid sphere?

(A) $\frac{\rho_2}{\rho_1}\left(1-\frac{\rho_2}{\rho_1}\right)^{\frac{5}{3}}\frac{\rho_2}{\rho_1}$ (B) $\frac{\rho_2}{\rho_1}\left[1-\left(1-\frac{\rho_2}{\rho_1}\right)^{\frac{5}{3}}\right]$

(C) $\frac{\rho_2}{\rho_1}\left(1-\frac{\rho_1}{\rho_2}\right)^{\frac{5}{3}}$ (D) $\frac{\rho_2}{\rho_1}\left[1-\left(1-\frac{\rho_1}{\rho_2}\right)^{\frac{5}{3}}\right]$

160. Two positive charges Q and 4Q are placed at points A and B is at a distance d units to the right of A. The total electric potential due to these charges is minimum at P on the line through A and B. What is (are) the distance (s) of P from A?

(A) $\frac{d}{3}$ units to the right of A (B) $\frac{d}{3}$ units to the left of A

(C) $\frac{d}{5}$ units to the right of A (D) d units to the left of A

161. A positive charge Q is situated at the centre of a cube. The electric flux through any face of the cube is (in SI units)

(A) $\frac{Q}{6\varepsilon_0}$ (B) $4\pi Q$ (C) $\frac{Q}{4\pi\varepsilon_0}$ (D) $\frac{Q}{6\pi\varepsilon_0}$

162. A charge of 0.8 coulomb is divided into two charges Q_1 and Q_2. These are kept at a separation of 30 cm. The force on Q_1 is maximum when

(A) $Q_1 = Q_2 = 0.4$ C (B) $Q_1 \approx 0.8$ C, Q_2 negligible

(C) Q_1 negligible, $Q_2 \approx 0.8$ C (D) $Q_1 = 0.2$ C, $Q_2 = 0.6$ C

163. A particle with charge Q coulomb, tied at the end of an inextensible string of length R metre, revolves in a vertical plane. At the centre of the circular trajectory, there is a fixed charge of magnitude Q coulomb. The mass of the moving charge M is such that $Mg = \frac{Q^2}{4\pi\varepsilon_0 R^2}$ If at the highest position of the particle, the tension of the string just vanishes, the horizontal velocity at the lowest point has to be

(A) 0 (B) $2\sqrt{gR}$ (C) $\sqrt{2gR}$ (D) $\sqrt{5gR}$

164. A unit negative charge with mass M resides at the mid-point of the straight line of length 2a adjoining two fixed charges of magnitude +Q each. If it is given a very small displacement x(x << a) in a direction perpendicular to the straight line, it will

(A) come back to its original position and stay there

(B) execute oscillations with frequency $\frac{1}{2\pi}\sqrt{\frac{Q}{2\pi\varepsilon_0 Ma^3}}$ s

(C) fly to infinity

(D) execute oscillations with frequency $\frac{1}{2\pi}\sqrt{\frac{Q}{4\pi\varepsilon_0 Ma^2}}$

165. A hollow metal sphere of radius R is charged with a charge Q. The electric potential and intensity inside the sphere are respectively

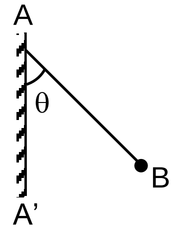
(A) $\frac{Q}{4\pi\varepsilon_0 R^2}$ and $\frac{Q}{4\pi\varepsilon_0 R}$ (B) $\frac{Q}{4\pi\varepsilon_0 R}$ and zero

(C) zero and zero (D) $\frac{4\pi\varepsilon_0 Q}{R}$ and $\frac{Q}{4\pi\varepsilon_0 R}$

166. Angle between an equipotential surface and electric lines of force is

(A) 0^o (B) 90^o (C) 180^o (D) 270^o

167. The line AA' is on charged infinite conducting plane which is perpendicular to the plane of the paper. The plane has a surface density of charge σ and B is ball of mass m with a like charge of magnitude q. B is connected by string from a point on the line AA'. The tangent of angle (θ) formed between the line AA' and the string is



(A) $\frac{q\sigma}{2\varepsilon_0 mg}$ (B) $\frac{q\sigma}{4\pi\varepsilon_0 mg}$ (C) $\frac{q\sigma}{2\pi\varepsilon_0 mg}$ (D) $\frac{q\sigma}{\varepsilon_0 mg}$

168. A charge q is placed at one corner of a cube. The electric flux through any of the three faces adjacent to the charge is zero. The flux through any one of the other three faces is

(A) $q/3\varepsilon_0$ (B) $q/6\varepsilon_0$ (C) $q/12\varepsilon_0$ (D) $q/24\varepsilon_0$

169. Two charges +q and –q are placed at a distance a in a uniform electric field. The dipole moment of the combination is $2qa(\cos\theta\hat{i} + \sin\theta\hat{j})$ where θ is the angle between the direction of the field and the line joining the two charges.

Which of the following statement(s) is/are correct?

(A) The torque exerted by the field on the dipole varnishes

(B) The net force on the dipole varnishes

(C) The torque is independent of the choice of coordinates

(D) The net force is independent of a

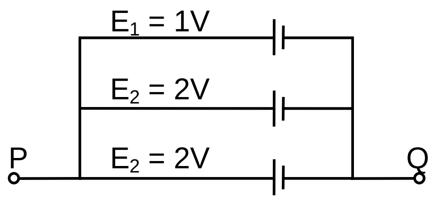
170. An infinite sheet carrying a uniform surface charge density σ lies on the xy-plane. The work done to carry a charge q from the point $A = a(\hat{i} + 2\hat{j} + 3\hat{k})$ to the point $B = a(\hat{i} - 2\hat{j} + 6\hat{k})$ (where a is a constant with the dimension of length and ε_0 is the permittivity of free space) is

(A) $\frac{3\sigma aq}{2\varepsilon_0}$ (B) $\frac{2\sigma aq}{\varepsilon_0}$ (C) $\frac{5\sigma aq}{2\varepsilon_0}$ (D) $\frac{3\sigma aq}{\varepsilon_0}$

171. Consider two concentric spherical metal shells of radii r_1 and r_2 ($r_2 > r_1$). If the outer shell has a charge q and the inner one is grounded, the charge on the inner shell is

(A) $\frac{-r_2}{r_1}q$ (B) zero (C) $\frac{-r_1}{r_2}q$ (D) –q

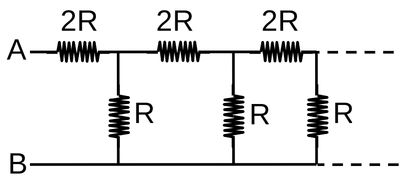
172. A circuit consists to three batteries of emf E_1 = 1 V, E_2 = 2 V and internal resistances 1 Ω, 2 Ω and 1 Ω respectively which are connected in parallel as shown in the figure. The potential difference between point P and Q is



(A) 1.0 V (B) 2.0 V (C) 2.2 V (D) 3.0 V

173. A galvanometer can be converted to a voltmeter of full scale deflection V_0 by connecting a series resistance R_1 and can be converted to an ammeter of full scale deflection I_0 by connecting a shunt resistance R_2. What is the current flowing through the galvanometer at its full scale deflection?

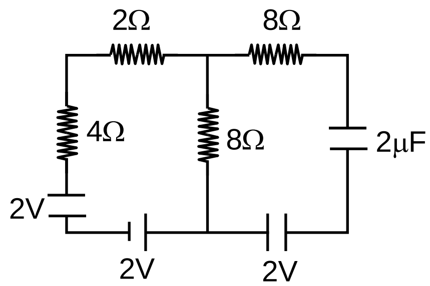
(A) $\frac{V_0 - I_0R_2}{R_1 - R_2}$ (B) $\frac{V_0 + I_0R_2}{R_1 + R_2}$ (C) $\frac{V_0 - I_0R_2}{R_2 - R_1}$ (D) $\frac{V_0 + I_0R_1}{R_1 + R_2}$

174. 

What will be the equivalent resistance between the terminals A and B of the infinite resistance network shown in the figure?

(A) $\frac{(\sqrt{3}+1)R}{2}$ (B) $\frac{(\sqrt{3}-1)R}{2}$ (C) $3\frac{R}{2}$ (D) $(\sqrt{3}+1)R$

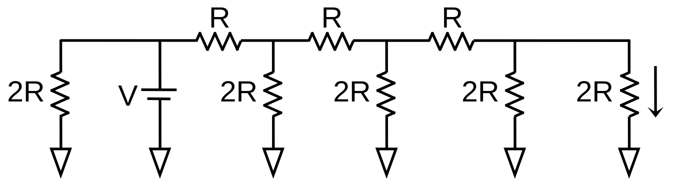
175. Consider the circuit shown.



If all the cells have negligible internal resistance, what will be the current through the 2Ω resistor when steady state is reached?

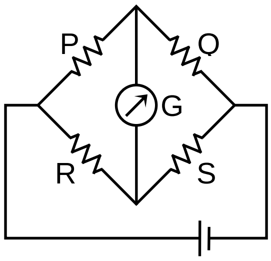
(A) 0.66A (B) 0.29A (C) 0A (D) 0.14A

176. What is the current I shown in the given circuit ?



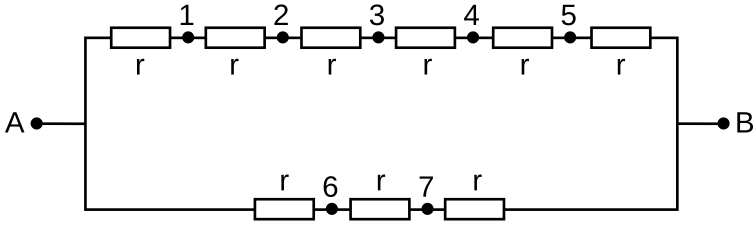
(A) $\frac{V}{2R}$ (B) $\frac{V}{R}$ (C) $\frac{V}{16R}$ (D) $\frac{V}{8R}$

177. When the value of R in the balanced Wheatstone bridge, shown in the figure, is increased from 5Ω to 7Ω, the value of S has to be increased by 3Ω in order to maintain the balance. What is the initial values of S?



(A) 2.5 Ω (B) 3 Ω (C) 5 Ω (D) 7.5 Ω

178. In the circuit shown in the figure all the resistance are identical and each has the value r Ω. The equivalent resistance of the combination between the points A and B will remains unchanged even when the following pairs of points marked in the figure are connected through a resistance R.

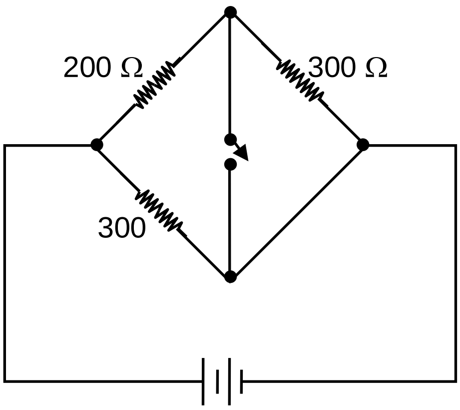


(A) 2 and 6 (B) 3 and 6 (C) 4 and 7 (D) 4 and 6

179. Four resistors, 100 Ω, 200 Ω, 300 Ω and 400 Ω are connected to form four sides of a square. The resistors can be connected in any order. What is the maximum possible equivalent resistance across the diagonal of the square?

(A) 210 Ω (B) 240 Ω (C) 300 Ω (D) 250 Ω

180. A non-zero current passes through the galvanometer G shown in the circuit when the key K is closed and its value does not change when he key is opened. Then, which of the following statement (s) is/are true?



(A) The galvanometer resistance is infinite.

(B) The current through the galvanometer is 40 mA.

(C) After the key is closed, the current through the 200 Ω resistor is same as the current through the 300 Ω resistor.

(D) The galvanometer resistance is 150 Ω.

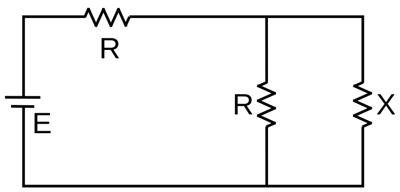
181. The magnets of two suspended coil galvanometers are of the same strength so that they produce identical uniform magnetic fields in the region of the coils. The coil of the first one is in the shape of a square of side a and that of the second one is circular of radius $\frac{a}{\sqrt{\pi}}$. When the same current is passed through the coils, the ratio of the torque experienced by the first coil to that experienced by the second one is

(A) $1 : \frac{1}{\sqrt{\pi}}$ (B) 1 : 1 (C) $\pi : 1$ (D) $1 : \pi$

182. Six wires, each of resistance r, are connected so as to form a tetrahedron. The equivalent resistance of the combination when current enters through one corner and leaves through some other corner is

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

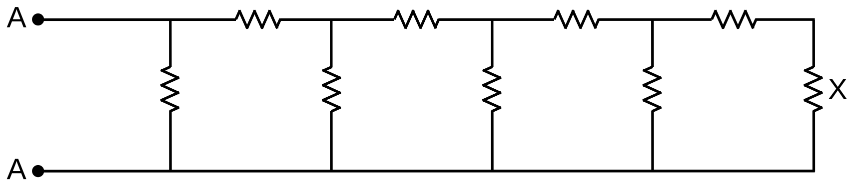
183. Consider the circuit shown in the figure.



The value of the resistance X for which the thermal power generated in it is practically independent of small variation of its resistance is

(A) X = R (B) $X = \frac{R}{3}$ (C) $X = \frac{R}{2}$ (D) X = 2R

184.



Consider the circuit shown in the figure where all the resistances are of magnitude 1 kΩ. If the current in the extreme right resistance X is 1 mA, the potential difference between A and B is

(A) 34 V (B) 21 V (C) 68 V (D) 55 V

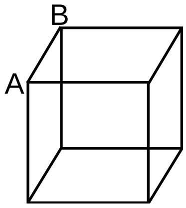
185. Two wires of same radius having lengths l_1 and l_2 and resistivity's ρ_1 and ρ_2 are connected series. The equivalent resistivity will be

(A) $\frac{\rho_1 l_2 + \rho_2 l_1}{\rho_1 + \rho_2}$ (B) $\frac{\rho_1 l_1 + \rho_2 l_2}{l_1 + l_2}$ (C) $\frac{\rho_1 l_1 - \rho_2 l_2}{l_1 - l_2}$ (D) $\frac{\rho_1 l_2 + \rho_2 l_1}{l_1 + l_2}$

186. Two equal resistances, 400Ω each are connected in series with a 8V battery. If the resistance of first one increases by 0.5% the change required in the resistance of the second one in order to keep the potential difference across it unaltered is to

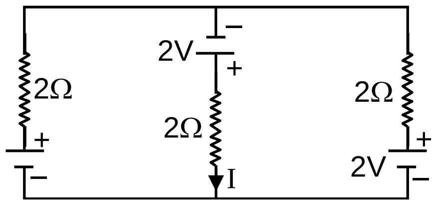
(A) increase it by 1Ω (B) increase it by 2Ω
(C) increase it by 4Ω (D) decrease it by 4Ω

187. The effective resistance between A and B in the figure is $\frac{7}{12}\Omega$ if each side of the cube has 1Ω resistance. The effective resistance between the same two points when the link AB is removed is



(A) $\frac{7}{12}\Omega$ (B) $\frac{5}{12}\Omega$ (C) $\frac{7}{5}\Omega$ (D) $\frac{5}{7}\Omega$

188. The current I is in the circuit shown is

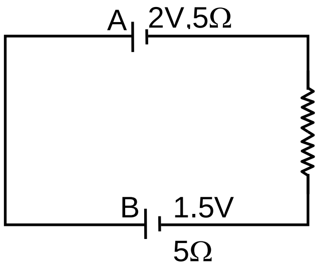


(A) 1.33 A (B) zero (C) 2.00 A (D) 1.00 A

189. A metal wire of circular cross-section has a resistance R_1. The wire is now stretched without breaking, so that its length is doubled and the density is assumed to remain the same. If the resistance of the wire now becomes R_2 then $R_2 : R_1$ is

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

190. Two cells A and B of emf 2V and 1.5V respectively, are connected as shown in figure through an external resistance 10Ω. The internal resistance of each cell is 5Ω. The potential difference E_A and E_B across the terminals of the cells A and B respectively are



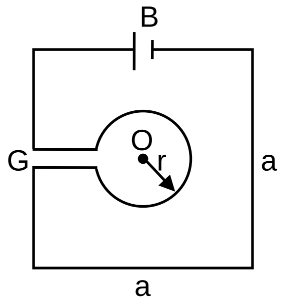
(A) $E_A = 2.0V$, $E_B = 1.5V$
(B) $E_A = 2.125V$, $E_B = 1.375V$
(C) $E_A = 1.875V$, $E_B = 1.625V$
(D) $E_A = 1.875V$, $E_B = 1.375V$

191. A galvanometer having internal resistance $10\ \Omega$ requires 0.01 A for a full scale deflection. To convert this galvanometer to a voltmeter of full-scale deflection at 120 V, we need to connected a resistance of

(A) 11990 Ω in series
(B) 11990 Ω in parallel
(C) 12010 Ω in series
(D) 12010 Ω in parallel

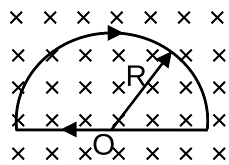
192. Four cells, each of emf E and internal resistance r, are connected in series across an external resistance R. by mistake one of the cells is connected in reverse. Then the current in the external circuit is

(A) $\frac{2E}{4r+R}$ (B) $\frac{3E}{4r+R}$ (C) $\frac{3E}{3r+R}$ (D) $\frac{2E}{3r+R}$

193. 

As shown in the figure a single conducting wire is bent to form a loop in the form of a circle of radius r concentrically inside a square of side a, where a : r = 8 : π. A battery B drives a current through the wire. If the battery B and the gap G are of magnetic field at the common centre O.

(A) $\frac{\mu_0 I}{2\pi a}\sqrt{2}\left(\sqrt{2}-1\right)$ (B) $\frac{\mu_0 I}{2\pi a}\left(\sqrt{2}+1\right)$ (C) $\frac{\mu_0 I}{\pi a}2\sqrt{2}\left(\sqrt{2}+1\right)$ (D) $\frac{\mu_0 I}{\pi a}2\sqrt{2}\left(\sqrt{2}-1\right)$

194. 

As shown in the figure a wire is bent to form a D-shaped closed loop, carrying current I, where the curved part is a semi-circle of radius R. The loop is placed in a uniform magnetic field B which is directed in to the plane of the paper. The magnetic force felt by the closed loop is

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

195. A conducting circular loop of resistance 20Ω and cross-sectional area 20 × 10^{-2} m^2 is placed perpendicular to a spatially uniform magnetic field B, which varies with time t as B = 2sin(50πt)T. Find the net charge flowing through the loop in 20ms starting from t = 0.

(A) 0.5C (B) 0.2C (C) 0C (D) 0.14C

196. A charged particle moves with constant velocity in a region where no effect of gravity is felt but an electrostatic field E together with a magnetic field B may be present. Then which of the following cases are possible?

(A) $E \neq 0, B \neq 0$ (B) $E \neq 0, B = 0$ (C) $E = 0, B = 0$ (D) $E = 0, B \neq 0$

197. To which of the following quantities, the radius of the circular path of a charged particle moving at right angles to a uniform magnetic field is directly proportional?

(A) Energy of the particle (B) Magnetic field
(C) Charge of the particle (D) Momentum of the particle

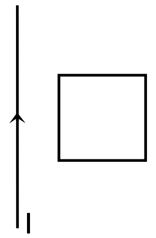
198. An electric current 'I' enters and leaves a uniform circular wire of radius r through diametrically opposite points. A particle carrying a charge q moves along the axis of the circular wire with speed v. What is the magnetic force experienced by the particle when it passes through the centre of the circle?

(A) $qv\frac{\mu_0 i}{a}$ (B) $qv\frac{\mu_0 i}{2a}$ (C) $qv\frac{\mu_0 i}{2\pi a}$ (D) Zero

199. A current 'I' is flowing along an infinite, straight wire, in the positive Z-direction and the same current is flowing along a similar parallel wire 5 m apart, in the negative Z-direction. A point P is at a perpendicular distance 3m from the first wire and 4m from the second. What will be magnitude of the magnetic field B of P?

(A) $\frac{5}{12}(\mu_0 I)$ (B) $\frac{7}{24}(\mu_0 I)$ (C) $\frac{5}{24}(\mu_0 I)$ (D) $\frac{25}{288}(\mu_0 I)$

200. A square conducting loop is placed near an infinitely long current carrying wire with one edge parallel to the wire as shown in the figure. If the current in the straight wire is suddenly halved, which of the following statements will be true?



"The loop will ……….. ".

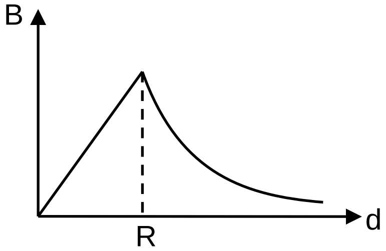
(A) stay stationary (B) move towards the wire

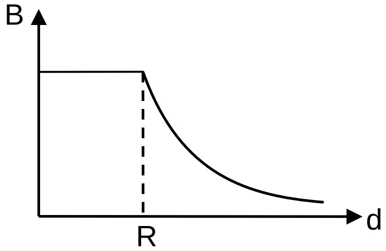
(C) move away from the wire (D) move parallel to the wire

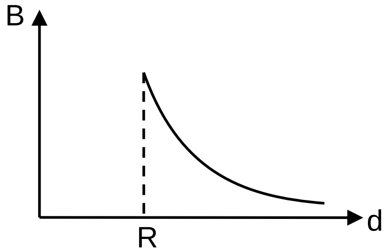
201. A proton of mass m moving with a speed v (<< c, velocity of light in vacuum) completes a circular orbit in time T in a uniform magnetic field. If the speed of the proton is increased to $\sqrt{2}$ v, what will be time needed to complete the circular orbit?

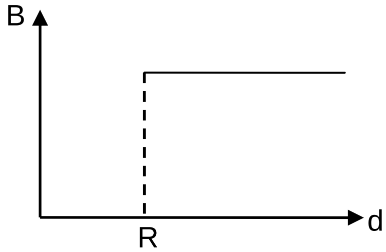
(A) $\sqrt{2}T$ (B) T (C) $\frac{T}{\sqrt{2}}$ (D) $\frac{T}{2}$

202. A uniform current is flowing along the length of an infinite, straight, thin, hollow cylinder of radius R. The magnetic field B produced at a perpendicular distance d from the axis of the cylinder is plotted in graph. Which of the following figures looks like the plot?

(A)


(B)


(C)


(D)


203. A circular loop of radius r of conducting wire connected with a voltage source of zero internal resistance produces a magnetic field B at its centre. If instead, a circular loop of radius 2r, made of same material, having the same cross-section is connected to the same voltage source, what will be the magnetic field at its centre?

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

204. A light charged particle is revolving in a circle of radius r in electrostatic attraction of a static heavy particle with opposite charge. How does the magnetic field B at the centre of the circle due to the moving charge depend on r?

(A) $B \propto \frac{1}{r}$ (B) $B \propto \frac{1}{r^2}$ (C) $B \propto \frac{1}{r^{3/2}}$ (D) $B \propto \frac{1}{r^{5/2}}$

205. The magnetic field due to a current in a straight wire segment of length L at a point on its perpendicular bisector at a distance r (r >> L)

(A) Decreases as $\frac{1}{r}$ (B) Decreases as $\frac{1}{r^2}$

(C) Decreases as $\frac{1}{r^3}$ (D) Approaches a finite limit as $r \to \infty$

206. A proton is moving with a uniform velocity of 10^6 ms^{-1} along the Y-axis, under the joint action of a magnetic field along Z-axis and an electric field of magnitude 2×10^4 Vm^{-1} along the negative X-axis. If the electric field is switched off, the proton starts moving in a circle. The radius of the circle is nearly

$\left(\text{given: } \frac{e}{m} \text{ ratio for proton} \approx 10^8 \text{ Ckg}^{-1}\right)$

(A) 0.5 m (B) 0.2 m (C) 0.1 m (D) 0.05 m

207. A proton is moving with a uniform velocity of 10^6 ms^{-1} along the Y-axis, under the joint action of a magnetic field along Z-axis and an electric field of magnitude 2×10^4 Vm^{-1} along the negative X-axis. If the electric field is switched off, the proton starts moving in a circle. The radius of the circle is nearly

$\left(\text{given: } \frac{e}{m} \text{ ratio for proton} \approx 10^8 \text{ Ckg}^{-1}\right)$

(A) 0.5 m (B) 0.2 m (C) 0.1 m (D) 0.05 m

208. A particle with charge e and mass m, moving along the X-axis with a uniform speed u, enters a region where a uniform electric field E is acting along the Y-axis. The particle starts to move in a parabola. Its focal length (neglecting any effect of gravity) is

(A) $\frac{2mu^2}{eE}$ (B) $\frac{eE}{2mu^2}$ (C) $\frac{mu}{2eE}$ (D) $\frac{mu^2}{2eE}$

209. Two long parallel wires separated by 0.1 m carry currents of 1 A and 2 A, respectively in opposite directions. A third current-carrying wire parallel to both of them is placed in the same plane such that it feels no net magnetic force. It is placed at a distance of
(A) 0.5 m from the 1st wire, towards the 2nd wire
(B) 0.2 m from the 1st wire, towards the 2nd wire
(C) 0.1 m from the 1st wire, away from the 2nd wire
(D) 0.2 m from the 1st wire, away from the 2nd wire

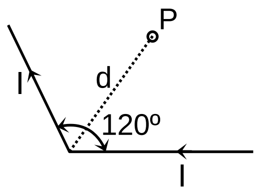
210. If χ stands for the magnetic susceptibility of the substance, μ for its magnetic permeability and μ_0 for the permeability of free space, then
(A) for a paramagnetic substance : $\chi < 0$, $\mu > 0$
(B) for a paramagnetic substance : $\chi < 0$, $\mu > \mu_0$
(C) for a diamagnetic substance : $\chi > 0$, $\mu < 0$
(D) for a ferromagnetic substance : $\chi > 1$, $\mu > \mu_0$

211. An electron enters an electric field having intensity E = $3\hat{i}+6\hat{j}+2\hat{k}\,\text{Vm}^{-1}$ and magnetic field having induction B = $2\hat{i}+3\hat{j}\,\text{ms}^{-1}$. The magnitude of the force acting on the electron is (Given $e = -1.6 \times 10^{-19}$C)
(A) 2.02×10^{-18}N (B) 5.16×10^{-16} N (C) 3.72×10^{-17} N (D) 4.41×10^{-18} N

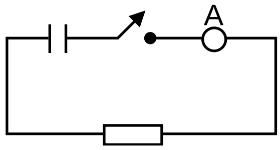
212. A rectangular coil carrying current is placed in a non-uniform magnetic field. On that coil the total
(A) Force is non-zero (B) force is zero (C) torque is zero (D) torque is non-zero

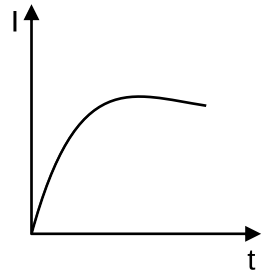
213. Two particles, A and B having equal charges, after being accelerated through the same potential difference enter into a region of uniform magnetic field and the particles describe circular paths of radii R_1 and R_2 respectively. The ratio of the masses of A and B is
(A) $\sqrt{R_1/R_2}$ (B) R_1/R_2 (C) $(R_1/R_2)^2$ (D) $(R_2/R_1)^2$

214. A long conducting wire carrying a current I is bent at 120º (see figure). The magnetic field B at a point P on the right bisector of bending angle at a distance d from the bend is (μ_0 is the permeability of free space)



(A) $\frac{3\mu_0 I}{2\pi d}$ (B) $\frac{\mu_0 I}{2\pi d}$ (C) $\frac{\mu_0 I}{\sqrt{3}\pi d}$ (D) $\frac{\sqrt{3}\mu_0 I}{2\pi d}$

215. 



When a DC voltage is applied at the two ends of a circuit kept in a closed box, it is observed that the current gradually increases from zero to a certain value and then remains constant. What do you think that the circuit contains?

(A) A resistor alone
(B) A capacitor alone
(C) A resistor and an inductor in series
(D) A resistor and a capacitor in series

216. Consider a conducting wire of length L bent in the form of circle of radius R and another conductor of length a (a <<R)is bent in the form of a square. The two loops are then placed in same plane such that the square loop is exactly at the centre of the circular loop. What will be the mutual inductance between the two loops?

(A) $\mu_0 \dfrac{\pi a^2}{L}$
(B) $\mu_0 \dfrac{\pi a^2}{16L}$
(C) $\mu_0 \dfrac{\pi a^2}{4L}$
(D) $\mu_0 \dfrac{a^2}{4\pi L}$

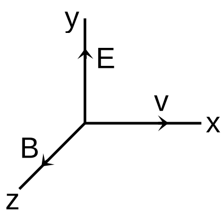
217. A 40Ω resistor, a 250 mH inductor and a 2.5 μF capacitor are connected in series with an AC source of peak voltage 5V and angular frequency 2kHz. What is the peak value of the electrostatic energy of the capacitor?

(A) 2μJ
(B) 2.5μJ
(C) 3.33μJ
(D) 5μJ

218. When a 60mH inductor and a resistor are connected in series with an AC voltage source, the voltage leads the current by 60º. If the inductor lags behind the current by 30º. What is the frequency of the AC supply?

(A) $\dfrac{1}{2\pi}\times 10^4$Hz
(B) $\dfrac{1}{\pi}\times 10^4$Hz
(C) $\dfrac{3}{2\pi}\times 10^4$Hz
(D) $\dfrac{1}{2\pi}\times 10^8$Hz

219. A particle wit charge q moves with a velocity v in a direction perpendicular to the directions of uniform electric and magnetic field, E and B respectively, which are mutually perpendicular to each other. Which one of the following gives the condition for which the particle moves undeflected in its original trajectory?



(A) $v = \dfrac{E}{B}$
(B) $v = \dfrac{E}{E}$
(C) $v = \sqrt{\dfrac{E}{B}}$
(D) $v = q\dfrac{B}{E}$

220. A parallel plate capacitor in series with a resistance of 100 Ω, and inductor of 20mH and an AC voltage source of variable frequency shows resonance at a frequency of $\frac{1250}{\pi}$ Hz. If this capacitor is charged by a DC voltage source to a voltage 25 v, what amount of charge will be stored in each plate of the capacitor?

(A) 0.2 μC (B) 2 mC (C) 0.2 mC (D) 0.2 C

221. A metallic loop is placed in a uniform magnetic field B with the plane of the loop perpendicular to B. Under which condition given an emf will be induced in the loop ?
"If the loop is ………… "

(A) moved along the direction of B
(B) squeezed to a smaller area
(C) rotated about its axis
(D) rotated about one of its diameters

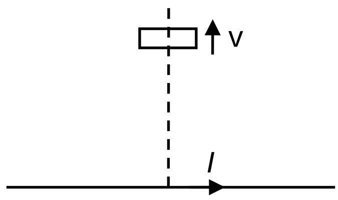
222. An alternating current is flowing through a series L-C-R circuit. It is found that the current reaches a value of 1 mA at both 200 Hz and 800 Hz frequency. What is he resonance frequency of the circuit?

(A) 600 Hz (B) 300 Hz (C) 500 Hz (D) 400 Hz

223. An electric bulb, a capacitor, a battery and a switch are all in series in a circuit. How does the intensity of ligh vary when the switch is turn on?

(A) Continues to increase gradually
(B) Gradually increases for sometime and then becomes steady
(C) Sharply rises initially and then gradually decreases
(D) Gradually increases for sometime and then gradually decreases

224. As shown in the figure, a rectangular loop of a conducting wire is moving away with a constant velocity v in a perpendicular direction from a very long straight conductor carrying a steady current I. When the breadth of the rectangular loop is very small compared to its distance from the straight conductor, how does the emf. E induced in the loop vary with time t?



(A) $E \propto \frac{1}{t^2}$ (B) $E \propto \frac{1}{t}$ (C) $E \propto -\ln(t)$ (D) $E \propto \frac{1}{t^3}$

225. When the frequency of the AC voltage applied to a series LCR circuit is gradually increased from a low value, the impedance of the circuit

(A) monotonically increases
(B) first increases and then increases
(C) first decreases and then increases
(D) monotonically decreases

226. Two coils of self-inductance 6mH and 8mH are connected in series and are adjusted for highest coefficient of coupling. Equivalent self-inductance L for the assembly is approximately

(A) 50 mH (B) 36 mH (C) 28 mH (D) 18 mH

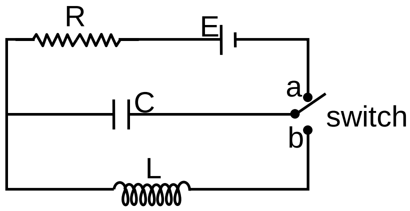
227. A charged particle of mass m_1 and charge θ_1 is revolving in a circle of radius r. Another charged particle of charge q_2 and mass m_2 is situated at the centre of the circle. If the velocity and time period of the revolving particle be v and T respectively, then

(A) $v = \sqrt{\frac{q_1q_2r}{4\pi\varepsilon_0 m_1}}$ (B) $v = \frac{1}{m_1}\sqrt{\frac{q_1q_2}{4\pi\varepsilon_0 r}}$ (C) $T = \sqrt{\frac{16\pi^3\varepsilon_0 m_1^2 r^3}{q_1q_2}}$ (D) $T = \sqrt{\frac{16\pi^3\varepsilon_0 m_2 r^3}{q_1q_2}}$

228. A straight conductor 0.1m long moves in a uniform magnetic field 0.1T. The velocity of the conductor is 15m/s and is directed perpendicular to the field. The emf induced between the two ends of the conductor is

(A) 0.10V (B) 0.015V (C) 1.50V (D) 15.00V

229. In the circuit shown below the switch is kept in position a for a long time and is then thrown to position b. The amplitude of the resulting oscillating current is given by



(A) $E\sqrt{L/C}$ (B) E/R (C) infinity (D) $E\sqrt{C/L}$

230. The conducting loop in the form of a circle is placed in a uniform magnetic field with its plane perpendicular to the direction of the field. An emf will be induced in the loop if

(A) It is translated parallel to itself

(B) It is rotated about one of its diameters

(C) It is rotated about its own axis which is parallel to the field

(D) The loop is deformed from the original shape

231. An electron in a circular orbit of radius 0.05 nm performs 10^{16} revolutions per second. The magnetic moment due to this rotation of electron is (in Am^2)

(A) 2.16×10^{-23} (B) 3.21×10^{-22} (C) 3.21×10^{-24} (D) 1.26×10^{-23}

232. A very small circular loop of radius a is initially (at t = 0) coplanar and concentric with a much large fixed circular loop of radius b. A constant current. I flows in the large loop. The smaller loop is rotated with a constant angular speed ω about the common diameter. The emf induced in the smaller loop as a function of time t is

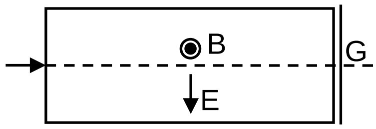
(A) $\frac{\pi a^2 \mu_0 I}{2b}\omega\cos(\omega t)$ (B) $\frac{\pi a^2 \mu_0 I}{2b}\omega\sin(\omega^2 t^2)$

(C) $\frac{\pi a^2 \mu_0 I}{2b}\omega\sin(\omega t)$ (D) $\frac{\pi a^2 \mu_0 I}{2b}\omega\sin^2(\omega t)$

233. A proton of mass m and charge q is moving in a plane with kinetic energy E. If there exists a uniform magnetic field B, perpendicular to the plane of the motion, the proton will move in a circular path of radius

(A) $\frac{2Em}{qB}$ (B) $\frac{\sqrt{2Em}}{qB}$ (C) $\frac{\sqrt{Em}}{2qB}$ (D) $\frac{\sqrt{2Em}}{mB}$

234. A stream of electrons and protons are directed towards a narrow slit in a screen (see figure). The intervening region has a uniform electric field E (vertically downwards) and a uniform magnetic field B (out of the plane of the figure) as shown. Then



(A) electrons and protons with speed $\left|\frac{E}{B}\right|$ will pass through the slit

(B) protons with speed $|E|/|B|$ will pass through the slit, electrons of the same speed will not

(C) neither electrons nor protons will go through the slit irrespective of their speed

(D) electrons will always be deflected upwards irrespective of their speed

RAY OPTICS

235. An object is placed 60cm in front of a convex mirror of focal length 30cm. A plane mirror is now placed facing the object in between the object and the convex mirror such that it covers lower half of the convex mirror. What should be the distance of the plane mirror from the object so that there will be no parallax between the images formed by the two mirrors?

(A) 40cm (B) 30cm (C) 20cm (D) 10cm

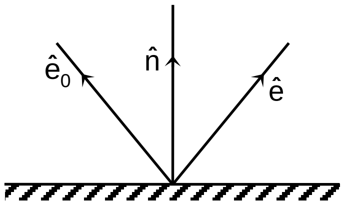
236. A thin convex lens is placed just above an empty vessel of depth 80cm. The image of a coin kept at the bottom of the vessel is thus formed 20cm above the lens. If now water is poured in the vessel up to a height of 64cm, what will be the approximate new position of the image? Assume that refractive index of water is 4/3.

(A) 21.33cm, above the lens (B) 6.67cm, below the lens

(C) 33.67cm, above the lens (D) 24cm, above the lens

237. A ray of light is reflected by a plane mirror. $\hat{e}_0, \hat{e}$ and $\hat{n}$ be the unit vectors along the incident ray, reflected ray and the normal to the reflecting surface respectively.

Which of the following gives an expression for $\hat{e}$?



(A) $\hat{e}_0 + 2(\hat{e}_0 \cdot \hat{n})\hat{n}$ (B) $\hat{e}_0 - 2(\hat{e}_0 \cdot \hat{n})\hat{n}$

(C) $\hat{e}_0 - (\hat{e}_0 \cdot \hat{n})\hat{n}$ (D) $\hat{e}_0 + (\hat{e}_0 \cdot \hat{n})\hat{n}$

238. A point object is placed on the axis of a thin convex lens of focal length 0.05 m at a distance of 0.2 m from the lens and its image is formed on the axis. If the object is now made to oscillate along the axis with a small amplitude of A cm, then what is the amplitude of oscillation of the image ?

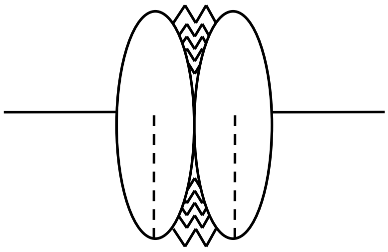
$\left[\text{you may assume, } \frac{1}{1+x} \approx 1 - x, \text{where } x << 1\right]$

(A) $\frac{4A}{9} \times 10^{-2}$m (B) $\frac{5A}{9} \times 10^{-2}$m (C) $\frac{A}{3} \times 10^{-2}$m (D) $\frac{A}{9} \times 10^{-2}$m

239. A point source is placed at coordinates (0, 1) in xy-plane. A ray of light from the source is reflected on a plane mirror placed along the X-axis and perpendicular to the xy-plane. The reflected ray passes through the point (3, 3). What is the path length of the ray from (0, 1) to (3, 3)?

(A) 5 (B) $\sqrt{13}$ (C) $2\sqrt{13}$ (D) $1+2\sqrt{13}$

240. Two identical equiconvex lenses, each of focal length f are placed side by side in contact with each other with a layer of water in between them as shown in the figure. If reractive index of the material of the lenses is greater than that of water, how the combined focal length F is related to f?

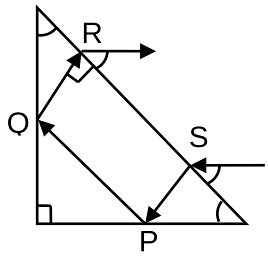


(A) F > f (B) $\frac{f}{2} < F < f$ (C) $F < \frac{f}{2}$ (D) F = f

241. There is a small air bubble at the centre of a solid glass sphere of radius r and refractive index μ. What will be the apparent distance of the bubble from the centre of the sphere, when viewed from outside?

(A) r (B) $\frac{r}{\mu}$ (C) $r\left(1-\frac{r}{\mu}\right)$ (D) Zero

242. A ray of light is incident on a right angled isosceles prism parallel to its base as shown in the figure. Refractive index of the material of the prism is $\sqrt{2}$. Then, which of the following statement (s) is/are true?

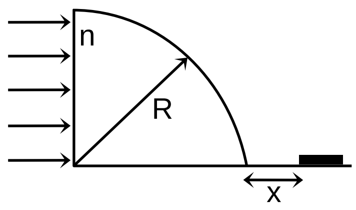


(A) The reflection at P is total internal.
(B) The reflection at Q is total internal.
(C) They ray emerging at R is parallel to the ray incident at S.
(D) Total deviation of the ray is 150º.

243. A point object is held above a thin equiconvex lens at its focus. The focal length is 0.1 m and the lens rests on a horizontal thin plane mirror. The final image will be formed at

(A) infinite distance above the lens (B) 0.1 m above the center of the lens
(C) infinite distance below the lens (D) 0.1 m below the center of the lens

244.



A parallel beam of light is incident on a glass prism in the shape of a quarter cylinder of radius R = 0.05 m and refractive index n = 1.5, placed on a horizontal table as shown in the figure. Beyond the cylinder, a patch of light is found whose the nearest distance x from the cylinder is

(A) $(3\sqrt{3}-4)\times10^{-2}$m (B) $(2\sqrt{3}-2)\times10^{-2}$m

(C) $(3\sqrt{5}-5)\times10^{-2}$m (D) $(3\sqrt{2}-3)\times10^{-2}$m

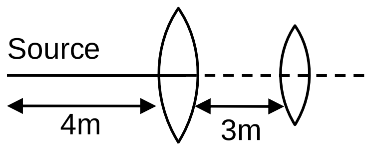
245. A ray of light strikes a glass plate at an angle of 60º, if the reflected and refracted rays are perpendicular to each other, the refractive index of glass is

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

246. Light travels through a glass plate of thickness t and having refractive index μ. If c be the velocity of light in vacuum, time taken by the light to travel through this thickness of glass is

(A) $\frac{1}{\mu c}$ (B) $\frac{tc}{\mu}$ (C) $\frac{\mu t}{c}$ (D) μ tc

247. An object is located 4m from the first of two thin converging lenses of focal lengths 2m and 1m, respectively. The lenses are separated by 3m. The final image formed by the second lens is located from the source at a distance of



(A) 8.0m (B) 5.5m (C) 6.0m (D) 6.5m

248. A ray of light is incident at an angle i on a glass slab of refractive index μ. The angle between reflected and refracted light is 90º. Then the relationship between i and μ is

(A) $i = \tan^{-1}\left(\frac{1}{\mu}\right)$ (B) tan u = μ (C) sin i = μ (D) cis i = μ

249. When light is refracted from a surface, which of its following physical parameters does not change?

(A) Velocity (B) Amplitude (C) Frequency (D) Wavelength

250. A thin plastic sheet of refractive index 1.6 is used to cover one of the slits of a double slit arrangement. The central point on the screen is now occupied by what would have been the 7th light bright fringe before the plastic was used. If the wavelength of light is 600nm, what is the thickness (in μm) of the plastic sheet?

(A) 7 (B) 4 (C) 8 (D) 6

251. A luminous object is separated from a screen by distance d. A convex lens is placed between the object and the screen such that it forms a distinct image on the screen. The maximum possible focal length of this convex lens is

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

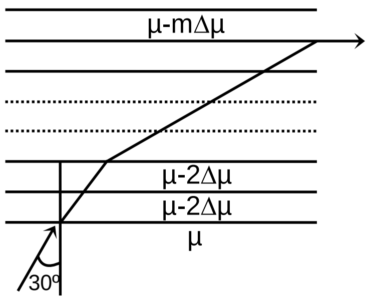
252. The intermediate image formed by the objective of a compound microscope is

(A) real, inverted and magnified (B) real, erect and magnified

(C) virtual, erect and magnified (D) virtual, inverted and magnified

253. A glass slab consists of thin uniform layers of progressively decreasing refractive indices RI (see figure) such that the RI of any layer is $\mu - m\ \Delta m$. Here, μ and $\Delta\mu$ denote the RI of 0^{th} layer and the difference in RI between any two consecutive layers, respectively. The integer m = 0, 1, 2, 3, ……. Denotes the numbers of the successive layers.

A ray of light from the 0^{th} layer enters the 1st layer at an angle of incidence of 30º. After undergoing the mth refraction, the ray emerges parallel to the interface. If μ = 1.5 and $\Delta\mu$ = 0.015, the value of m is



(A) 20 (B) 30 (C) 40 (D) 50

254. An object is placed 30 cm away from a convex lens of focal length 10 cm and a sharp image is formed on a screen. Now a concave lens is placed in contact with the convex lens. The screen now has to be moved by 45 cm to get a sharp image again. The magnitude of focal length of the concave lens is (in cm)

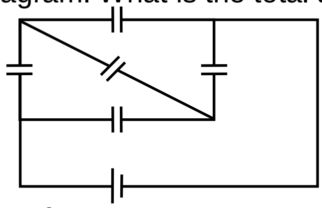
(A) 72 (B) 60 (C) 36 (D) 20

CAPACITANCE

255. A pair of parallel metal plates are kept with a serration d. One plate is at a potential +V and the other is at ground potential. A narrow beam of electrons enters the space between the plates with a velocity v_0 and in a direction parallel to the plates. What will be the angle of the beam with that the plates after it travels an axial distance L?

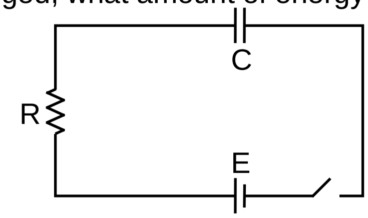
(A) $\tan^{-1}\left(\frac{eVL}{mdv_0}\right)$ (B) $\tan^{-1}\left(\frac{eVL}{mdv_0^2}\right)$ (C) $\sin^{-1}\left(\frac{eVL}{mdv_0}\right)$ (D) $\cos^{-1}\left(\frac{eVL}{mdv_0^2}\right)$

256. Five identical capacitors, of capacitance 20µF each, are connected to a battery of 150 V, in a combination as shown in the diagram. What is the total amount of charge stored ?



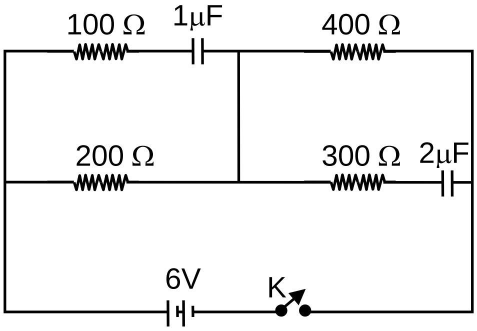
(A) 15×10^{-3}C (B) 12×10^{-3}C (C) 10×10^{-3}C (D) 3×10^{-3}C

257. A capacitor of capacitance C is connected in series with a resistance R and DC source of emf E through a key. The capacitor starts charging when the key is closed. By the time the capacitor has been fully charged, what amount of energy is dissipated in the resistance R ?



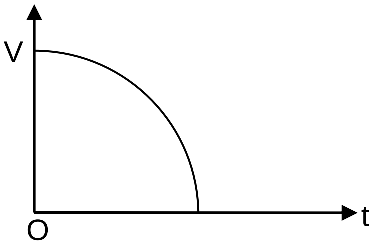
(A) $\frac{1}{2}CE^2$ (B) 0 (C) CE^2 (D) $\frac{E^2}{R}$

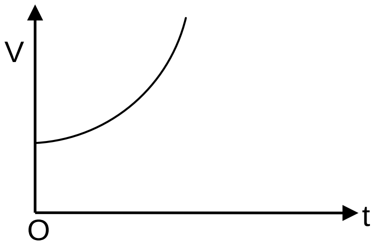
258. What will be current through the 200 Ω resistor in the given circuit, a long time after the switch K is made on ?

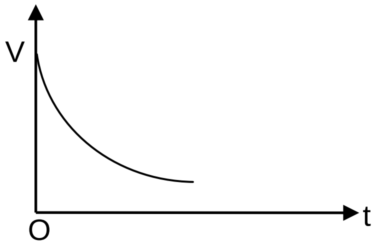


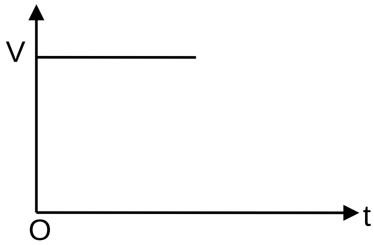
(A) Zero (B) 100 mA (C) 10 mA (D) 1 mA

259. The insulated plates of a charged parallel plate capacitor (with small separation between the plates) are approaching each other due to electrostatic attraction. Assuming no other force to be operative and no radiation taking place, which of the following graphs approximately shows the variation with time (t) of the potential difference (V) between the plates?

(A)


(B)


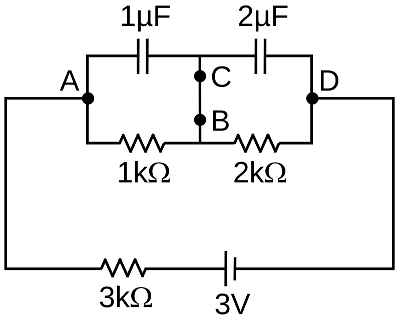
(C)


(D)


260. Three capacitors of capacitance 1.0, 2.0 and 5.0 μF are connected in series to a 10 V source. The potential difference across the 2.0 μF capacitor is

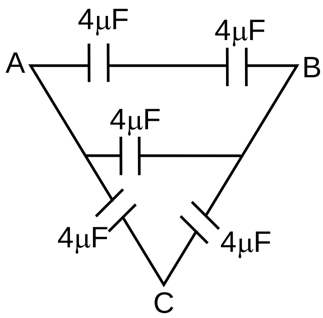
(A) $\frac{100}{17}$ V (B) $\frac{20}{17}$ V (C) $\frac{50}{17}$ V (D) 10V

261. Consider the circuit given here. The potential difference V_{BC} between the points B and C is



(A) 1 V (B) 0.5 V (C) 0 V (D) –1 V

262. Equivalent capacitance between A and B in the figure is



(A) 20μF (B) 8μF (C) 12μF (D) 16μF

263. A 1μF capacitor C is connected to a battery of 10V through a resistance 1MΩ. The voltage across C after 1s is approximately

(A) 5.6V (B) 7.8V (C) 6.3V (D) 10V

264. A current $I = I_0 e^{-\lambda t}$ is flowing in a circuit consisting of a parallel combination of resistance R and capacitance C. The total charge over the entire pulse period is

(A) $\frac{I_0}{\lambda}$ (B) $\frac{2I_0}{\lambda}$ (C) $I_0\lambda$ (D) $e^{I_0\lambda}$

265. A 5μF capacitor is connected in series with a 10μF capacitor. When a 300V potential difference is applied across this combination the total energy stored in the capacitors is

(A) 15J (B) 1.5J (C) 0.15J (D) 0.10J

266. Three capacitors 3μF, 6μF and 6μF are connected in series to a source of 120 V. The potential difference, in volt, across the 3μF capacitor will be

(A) 24 (B) 30 (C) 40 (D) 60

267. A parallel plate capacitor is charged and then disconnected from the charging battery. If the plates are now moved farther apart by pulling at them by means of insulating handles, then
(A) the energy stored in the capacitor decreases
(B) the capacitance of the capacitor increases
(C) the charge on the capacitor decreases
(D) the voltage across the capacitor increases

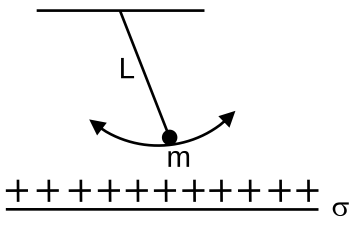
268. Half of the space between the plates of a parallel-plate capacitor is filled with a dielectric material of dielectric constant K. The remaining half contains air as shown in the figure. The capacitor is now given a charge Q. Then
(A) Electric field in the dielectric-filled region is higher than that in the air-filled region
(B) on the two halves of the bottom plate the charge densities are unequal
(C) Charge on the half of the top plate above the air-filled part is $\frac{Q}{K+1}$
(D) Capacitance of the capacitor shown above is $(1+K)\frac{C_0}{2}$, where C_0 is the capacitance of the same capacitor with the dielectric removed.

SIMPLE HARMONIC MOTION

269. A simple pendulum of length L is displaced so that its taught string is horizontal and then released. A uniform bar pivoted at one end is simultaneously released from its horizontal position. If their motions are synchronous what is the length of the bar?
(A) $\frac{3l}{2}$ (B) l (C) 2l (D) $\frac{2l}{3}$

270. In case of a simple harmonic motion, if the velocity is plotted along the X-axis and the displacement (from the equilibrium position) is plotted along the Y- axis, the resultant curve happens to be an ellipse with the ratio:
$$\frac{\text{major axis}(\text{along X})}{\text{minor axis}(\text{along Y})} = 20\pi$$
What is the frequency of the simple harmonic motion?
(A) 100Hz (B) 20Hz (C) 10Hz (D) $\frac{1}{10}$Hz

271. The bob of a pendulum of mass m, suspended by an inextensible string of length L as shown in the figure carries a small charge q. An infinite horizontal plane conductor with uniform surface charge density σ is placed below it. What will be the time period of the pendulum for small amplitude oscillations?



(A) $2\pi\sqrt{\frac{L}{\left(g-\frac{mq}{\varepsilon_0\sigma}\right)}}$ (B) $\sqrt{\frac{L}{\left(g-\frac{mq\sigma}{\varepsilon_0}\right)}}$ (C) $\frac{1}{2\pi}\sqrt{\frac{L}{\left(g-\frac{q\sigma}{\varepsilon_0 m}\right)}}$ (D) $2\pi\sqrt{\frac{L}{\left(g-\frac{q\sigma}{\varepsilon_0 m}\right)}}$

272. The velocity of a particle executing a simple harmonic motion is 13 ms^{-1}, when its distance from the equilibrium position (Q) is 3 m and its velocity is 12 ms^{-1}, when it is 5 m away from Q. The frequency of the simple harmonic motion is

(A) $\frac{5\pi}{8}$ (B) $\frac{5}{8\pi}$ (C) $\frac{8\pi}{5}$ (D) $\frac{8}{5\pi}$

273. A uniform string of length L and mass M is fixed at both ends while it is subject to a tension T. It can vibrate at frequencies (v) given by the formula (where n = 1,2,3,…)

(A) $v = \frac{n}{2}\sqrt{\frac{T}{ML}}$ (B) $v = \frac{n}{2L}\sqrt{\frac{T}{M}}$ (C) $v = \frac{1}{2n}\sqrt{\frac{T}{Ml}}$ (D) $v = \frac{n}{2}\sqrt{\frac{TL}{M}}$

274. A particle vibrating simple harmonically has an acceleration of 16 cms^{-2} when it is at a distance of 4cm from the mean position. Its time period is

(A) 1s (B) 2.572s (C) 3.142s (D) 6.028s

275. When a particle executive SHM oscillates with a frequency v, then the kinetic energy of the particle

(A) Changes periodically with a frequency of v
(B) Changes periodically with a frequency of 2v
(C) Changes periodically with a frequency of v/2
(D) Remains constant

276. The displacement of particle in a periodic motion in given by $y = 4\cos^2\left(\frac{t}{2}\right)$ sin (1000 t). This displacement may be considered as the result of superposition of n independent harmonic oscillations. Here n is

(A) 1 (B) 2 (C) 3 (D) 4

ERROR & MEASUREMENT

277. The density of the material of a cube can be estimated by measuring its mass and the length of one of its sides. If the maximum error in the measurement of mass and length are 0.3% and 0.2% respectively, the maximum error in the estimation of the density of the cube is approximately.

(A) 1.1% (B) 0.5% (C) 0.9% (D) 0.7%

KINEMATICS

278. A body starts from rest, under the action of an engine working at a constant power and moves along a straight line. The displacement s is given as a function of time (t) as

(A) $s = at + bt^2$, a and b are constants (B) $s = bt^2$, b is a constant
(C) $s = at^{3/2}$, a is a constant (D) s = at, a is a constant

279. Two particles are simultaneously projected in the horizontal direction from a point P at a certain height. The initial velocities of the particles are oppositely directed to each other and have magnitude v each. The separation between the particles at a time when their position vectors (drawn from the point P) are mutually perpendicular, is

(A) $\frac{v^2}{2g}$ (B) $\frac{v^2}{g}$ (C) $\frac{4v^2}{g}$ (D) $\frac{2v^2}{g}$

280. A projectile thrown with an initial velocity of 10 ms^{-1} at an angle a with the horizontal, has a range of 5 m. Taking g = 10 ms^{-2} and neglecting air resistance, what will be the estimated value of a?

(A) 15º (B) 30º (C) 45º (D) 75º

GRAVITATION

281. Assume that the earth moves around the sun in a circular orbit of radius R and there exists a planet which also move around the sun in a circular orbit with an angular speed twice as large as that of the earth. The radius of the orbit of planet is

(A) $2^{-2/3}R$ (B) $2^{2/3}R$ (C) $2^{-1/3}R$ (D) $\frac{R}{\sqrt{2}}$

282. The ratio of accelerations due to gravity $g_1 : g_2$ on the surfaces of two planets is 5 : 2 and the ratio of their respective average densities $\rho_1 : \rho_2$ is 2 : 1. What is the ratio of respective escape velocities $v_1 : v_2$ from the surface of the planets?

(A) 5 : 2 (B) $\sqrt{5} : \sqrt{2}$ (C) $5 : 2\sqrt{2}$ (D) 25 : 4

283. The ratio of the diameter of the sun to the distance between the earth and the sun is approximately 0.009. The approximate diameter of the image of the sun formed by a concave spherical mirror of radius of curvature 0.4 m is

(A) 4.5×10^{-6} m (B) 4.0×10^{-6} m (C) 3.6×10^{-3} m (D) 1.8×10^{-3} m

284. If the temperature of the sun gets doubled, the rate of energy received on the earth will increase by a factor of

(A) 2 (B) 4 (C) 8 (D) 16

285. Two particles of mass m_1 and m_2 : approach each other due to their mutual gravitational attraction only. Then

(A) Acceleration of both the particles are equal

(B) Acceleration of the particle of mass m_1 is proportional to m_1

(C) Acceleration of the particle of mass m_1 is proportional to m_2

(D) Acceleration of the particle of mass m_1 is inversely proportional to m_1

286. A satellite has kinetic energy K, potential energy V and total energy E. Which of the following statements is true?

(A) K = – V/2 (B) K = V/2 (C) E = K/2 (D) E = – K/2

287. An artificial satellite moves in a circular orbit around the earth. Total energy of the satellite is given by E. The potential energy of the satellite is

(A) –2E (B) 2E (C) $\frac{2E}{3}$ (D) $-\frac{2E}{3}$

ELASTICITY & VISCOSITY

288. A liquid of bulk modulus k is compressed by applying an external pressure such that its density increases by 0.01%. The pressure applied on the liquid is

(A) $\frac{k}{10000}$ (B) $\frac{k}{1000}$ (C) 1000 k (D) 0.01 k

289. A solid rectangular sheet has two different coefficients of linear expansion a_1 and a_2 along its length and breadth respectively. The coefficient of surface expansion is (for $a_1 t << 1$, $a_2 t << 1$)

(A) $\frac{a_1 + a_2}{2}$ (B) $2(a_1 + a_2)$ (C) $\frac{4a_1a_2}{a_1 + a_2}$ (D) $a_1 + a_2$

MECHANICAL WAVES

290. The velocity of sound in air at 20ºC and 1atm pressure is 344.2 m/s. At 40ºC and 2atm pressures the velocity of sound in air is approximately
(A) 350 m/s (B) 356 m/s (C) 363 m/s (D) 370 m/s

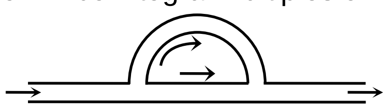
291. A train is moving with a uniform speed of 33 m/s and an observer is approaching the train with the same speed. If the train blows a whistle of frequency 1000 Hz and the velocity of sound is 333 m/s, then the apparent frequency of the sound that the observer hears is
(A) 1220 Hz (B) 1099 Hz (C) 1110 Hz (D) 1200 Hz

292. The length of an open organ pipe is twice the length of another closed organ pipe. The fundamental frequency of the open pipe is 100 Hz. The frequency of the third harmonic of the closed pipe is
(A) 100Hz (B) 200Hz (C) 300Hz (D) 150Hz

293. A whistle whose air column is open at both ends has a fundamental frequency of 5100 Hz. If the speed of sound in air is 340 ms^{-1}, the length of the whistle, in cm, is
(A) 5/3 (B) 10/3 (C) 5 (D) 20/3

294. A car is moving with a speed of 72 $km\text{-}h^{-1}$ towards a roadside source that emits sound at a frequency of 850 Hz. The car driver listens to the sound while approaching the source and again while moving away from the source after crossing it. If the velocity of sound is 340 ms^{-1}, the difference of the two frequencies, the driver hears is
(A) 50 Hz (B) 85 Hz (C) 100 Hz (D) 150 Hz

295. Sound waves are passing through two routes-one in straight path and the other along a semicircular path of radius r and are again combined into one pipe and superposed as shown in the figure. If the velocity of sound waves in the pipe is v, then frequencies of resultant waves of maximum amplitude will be integral multiples of **[WBJEE-2014]**



(A) $\frac{v}{r(\pi-2)}$ (B) $\frac{v}{r(\pi-1)}$ (C) $\frac{2v}{r(\pi-1)}$ (D) $\frac{v}{r(\pi+1)}$

WORK POWER & ENERGY

296. Work done for a certain spring when stretched through 1mm is 10joule. The amount of work that must be done on the spring to stretch it further by 1mm is
(A) 30J (B) 40J (C) 10J (D) 20J

HEAT TRANSFER

297. The temperature of a blackbody radiation enclosed in a container of volume V is increased from 100ºC to 1000ºC. The heat required in the process is
(A) 4.79×10^{-4} cal (B) 9.21×10^{-5} cal (C) 2.17×10^{-4} cal (D) 7.54×10^{-4} cal

THERMAL PROPERTIES

298. Three bodies of the same material and having masses m, m and 2m are at temperatures 40ºC, 50ºC and 60ºC respectively. If the bodies are brought in thermal contact the final temperature will be

(A) 45ºC (B) 54ºC (C) 52ºC (D) 48ºC

CIRCULAR MOTION

299. A simple pendulum of length L swings in a vertical plane. The tension of the string when it makes an angle θ with the vertical and the bob of mass m moves with a speed v is (g is the gravitational acceleration)

(A) mv^2 / L (B) $mg \cos \theta + mv^2 / L$

(C) $mg \cos \theta - mv^2 / L$ (D) $mg \cos \theta$

300. A particle is moving uniformly in a circular path of radius r. When it moves through an angular displacement θ, then the magnitude of the corresponding linear displacement will be

(A) $2r\cos\left(\frac{\theta}{2}\right)$ (B) $2r\cot\left(\frac{\theta}{2}\right)$ (C) $2r\tan\left(\frac{\theta}{2}\right)$ (D) $2r\sin\left(\frac{\theta}{2}\right)$

MAGNETISM

301. The intensity of magnetization of a bar magnet is 5.0×10^4 Am^{-1}. The magnetic length and the area of cross-section of the magnet are 12 cm and 1 cm^2 respectively. The magnitude of magnetic moment of this bar magnet is (in SI unit)

(A) 0.6 (B) 1.3 (C) 1.24 (D) 2.4

ANSWER KEY

1.	(B)	**2.**	(D)	**3.**	(C)	**4.**	(C)	**5.**	(AD)	**6.**	(A)	**7.**	(B)
8.	(BC)	**9.**	(D)	**10.**	(C)	**11.**	(B)	**12.**	(A)	**13.**	(A)	**14.**	(D)
15.	(B)	**16.**	(D)	**17.**	(D)	**18.**	(BD)	**19.**	(A)	**20.**	(D)	**21.**	(D)
22.	(D)	**23.**	(C)	**24.**	(A)	**25.**	(ABCD)	**26.**	(C)	**27.**	()	**28.**	(B)
29.	(*)	**30.**	(AC)	**31.**	(D)	**32.**	(B)	**33.**	(ABD)	**34.**	(C)	**35.**	(B)
36.	(C)	**37.**	(C)	**38.**	(AD)	**39.**	(D)	**40.**	(B)	**41.**	(B)	**42.**	(C)
43.	(B)	**44.**	(C)	**45.**	(A)	**46.**	(D)	**47.**	(A)	**48.**	(D)	**49.**	(D)
50.	(C)	**51.**	(D)	**52.**	(D)	**53.**	(B)	**54.**	(B)	**55.**	(D)	**56.**	(B)
57.	(B)	**58.**	(C)	**59.**	(A)	**60.**	(B)	**61.**	(A)	**62.**	(B)	**63.**	(D)
64.	(C)	**65.**	(A)	**66.**	(A)	**67.**	(A)	**68.**	(B)	**69.**	(AB)	**70.**	(B)
71.	(C)	**72.**	(A)	**73.**	(B)	**74.**	(A)	**75.**	(D)	**76.**	(B)	**77.**	(C)
78.	(A)	**79.**	(B)	**80.**	(B)	**81.**	(A)	**82.**	(A)	**83.**	(A)	**84.**	(D)
85.	(A)	**86.**	(B)	**87.**	(C)	**88.**	(D)	**89.**	(A)	**90.**	(ACD)	**91.**	(C)
92.	(C)	**93.**	(B)	**94.**	(A,C)	**95.**	(B)	**96.**	(D)	**97.**	(A)	**98.**	(C)
99.	(C)	**100.**	(C)	**101.**	(A)	**102.**	(A)	**103.**	(D)	**104.**	(C)	**105.**	(B)
106.	(D)	**107.**	(C)	**108.**	(D)	**109.**	(C)	**110.**	(D)	**111.**	(C)	**112.**	(D)
113.	(D)	**114.**	(A)	**115.**	(B)	**116.**	(C)	**117.**	(D)	**118.**	(C)	**119.**	(C)
120.	(B)	**121.**	(A)	**122.**	()	**123.**	(B)	**124.**	(B)	**125.**	(C)	**126.**	(C)
127.	(C)	**128.**	(C)	**129.**	(A)	**130.**	(A)	**131.**	(B)	**132.**	(B)	**133.**	(A)
134.	(B)	**135.**	(C)	**136.**	(B)	**137.**	(B)	**138.**	(C)	**139.**	(C)	**140.**	(BC)
141.	(B)	**142.**	(C)	**143.**	(D)	**144.**	(D)	**145.**	(C)	**146.**	(C)	**147.**	(D)
148.	(A)	**149.**	(A)	**150.**	(A)	**151.**	(C)	**152.**	(B)	**153.**	(D)	**154.**	(A)
155.	(A)	**156.**	(B)	**157.**	(A)	**158.**	(C)	**159.**	(D)	**160.**	(A)	**161.**	(A)
162.	(A)	**163.**	(B)	**164.**	(B)	**165.**	(B)	**166.**	(B)	**167.**	(D)	**168.**	(D)
169.	(BCD)	**170.**	(A)	**171.**	(C)	**172.**	(B)	**173.**	(A)	**174.**	(D)	**175.**	(C)
176.	(C)	**177.**	(D)	**178.**	(A)	**179.**	(D)	**180.**	(BCD)	**181.**	(B)	**182.**	(D)
183.	(C)	**184.**	(A)	**185.**	(B)	**186.**	(B)	**187.**	(C)	**188.**	(A)	**189.**	(C)
190.	(C)	**191.**	(A)	**192.**	(A)	**193.**	(D)	**194.**	(A)	**195.**	(C)		
196.	(ACD)	**197.**	(D)	**198.**	(D)	**199.**	(C)	**200.**	(C)	**201.**	(B)	**202.**	(C)
203.	(B)	**204.**	(D)	**205.**	(B)	**206.**	(A)	**207.**	(A)	**208.**	(D)	**209.**	(C)
210.	(BD)	**211.**	()	**212.**	(AD)	**213.**	(C)	**214.**	(D)	**215.**	(C)	**216.**	(B)
217.	(D)	**218.**	(A)	**219.**	(A)	**220.**	(C)	**221.**	(BD)	**222.**	(D)	**223.**	(C)
224.	(A)	**225.**	(B)	**226.**	(C)	**227.**	()	**228.**	(B)	**229.**	(D)	**230.**	(BD)
231.	(D)	**232.**	(C)	**233.**	(B)	**234.**	(CD)	**235.**	(A)	**236.**	(A)	**237.**	(B)
238.	(D)	**239.**	(A)	**240.**	(B)	**241.**	(D)	**242.**	(AC)	**243.**	(B)	**244.**	(C)
245.	(D)	**246.**	(C)	**247.**	(B)	**248.**	(B)	**249.**	(C)	**250.**	(A)	**251.**	(D)
252.	(A)	**253.**	(D)	**254.**	(D)	**255.**	(D)	**256.**	(D)	**257.**	(A)	**258.**	(C)
259.	(A)	**260.**	(C)	**261.**	(B)	**262.**	(B)	**263.**	(C)	**264.**	(A)	**265.**	(C)
266.	(D)	**267.**	(D)	**268.**	(BCD)	**269.**	(A)	**270.**	(C)	**271.**	(D)	**272.**	(B)
273.	(A)	**274.**	(C)	**275.**	(B)	**276.**	(C)	**277.**	(C)	**278.**	(C)	**279.**	(C)
280.	(A)	**281.**	(A)	**282.**	(C)	**283.**	(D)	**284.**	(D)	**285.**	(C)	**286.**	(A)
287.	(A)	**288.**	(A)	**289.**	(D)	**290.**	(B)	**291.**	(A)	**292.**	(C)	**293.**	(B)
294.	(C)	**295.**	(A)	**296.**	(A)	**297.**	()	**298.**	(B)	**299.**	(B)	**300.**	(D)
301.	(A)												