**IIT JEE 2009 Physics Paper1 Code 1 Solutions**

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Then          (A)    at θ = 30o, the block will start sliding down the plane          (B)    the block will remain at rest on the plane up to certain q and then it will topple          (C)    at θ = 60o, the block will start sliding down the plane and continue to do so at higher angles          (D)    at θ = 60o, the block will start sliding down the plane and on further increasing q, it will topple at certain q    **Sol.   (B)**  At θ = 30º, the weight W of the block passes through the base , and hence the block will not topple          For sliding and not toppling, tan q >  (= 1.732)          For toppling, tan q > 2/3 (= 0.67)  inclined plane  Free Body Diagram at just toppling condition    **MULTIPLE CORRECT CHOICE TYPE**  **9.**     For the circuit shown in the figure  circuit          (A)    the current I through the battery is 7.5 mA          (B)    the potential difference across RI is 18 V          (C)    ratio of powers dissipated in R1 and R2 is 3          (D)    If R1 and R2 are interchanged, magnitude of the power dissipated in R1, will decrease by a factor of 9.    **Sol.   (A & D)**          24 - 2 × 103 I - 6 × 103 (I - i) = 0          24 - 2 × 103 I - 1.5 × 103 i = 0          Hence I = 7.5 mA          i = 6mA  circuit2          24 - 6 × 103 I' - 2 × 103 (I' - i') = 0          24 - 6 × 103 I' - 1.5 × 103 i' = 0          I' = 3.5 mA          i' = 2mA       P1/P2 = 62/22  =  9    **10.**   Cv and Cp denote the molar specific heat capacities of a gas at constant volume and constant pressure respectively. Then  (A)    Cp - Cv is larger of a diatomic ideal gas than for a monoatomic ideal gas.  (B)    Cp + Cv is larger of a diatomic ideal gas than for a monoatomic ideal gas.  (C)    Cp/Cv is larger of a diatomic ideal gas than for a monoatomic ideal gas.  (D)    Cp.Cv is larger of a diatomic ideal gas than for a monoatomic ideal gas.    **Sol.   (B & D)**          CP and CV for diatomic is greater than monoatomic.  So, CP + CV, CP . CV is greater for diatomic ideal gas.          For Monoatomic gas                  Cv = 3/2 R, Cp = 5/2 R          For diatomic gas                  Cv = 5/2 R Cp = 7/5 R  **11.**    A student performed the experiment of determination of focal length of a concave mirror by u - v method using an optical bench of length 1.5 meter. The focal length of the mirror used is 24 cm. The maximum error in the location of the image can be 0.2 cm. The 5 sets of (u, v) values recorder by the student (in cm) are: (42, 56), (48, 48),  (60, 40), (66, 33), 78, 39). The data set(s) that cannot come from experiment and is (are) incorrectly recorded, is (are)          (A)    (42, 56)          (B)    (48, 48)          (C)    (66, 33)          (D)    78, 39)    **Sol.   (C & D)**           1/f = 1/v + 1/u             (mirror formula)  f  = -24 cm  the data set (66, 33) does not satisfy the mirror equation.    **12.** If the resultant of all the external forces acting on a system of particles is zero, then from an inertial frame one can surely say that          (A)    linear momentum of the system does not change in time          (B)    kinetic energy of the system does not change in time          (C)    angular momentum of the system does not change in time          (D)    potential energy of the system does not change in time  **Sol.   (A)**          Linear momentum remains constant if net external force on the system of particle is zero.    **COMPREHENSION TYPE**  When a particle is restricted to move along x-axis between x = 0 and x = a, where a is a nanometer dimension, its energy can take only certain specific values. The allowed energies of the particle moving in such a restricted region, correspond to the formation of standing waves with nodes at its ends x = 0 and x = a. The wavelength of this standing wave is related to the linear momentum p of the particle according to the de Broglie relation. The energy of the particle of mass m is related to its linear momentum as  E = p2/2m. Thus, the energy of the particle can be denoted by a quantum number 'n' taking values 1, 2, 3, ....... (n = 1 called the ground state) corresponding tot eh number of loop in the standing wave.  Use the model described above to answer the following three questions for a particle moving in the line x = 0 to x = a. Take h = 6.6 × 10-34 Js and  e = 1.6 × 10-19 C.    **13.**  The allowed energy for the particle for a particular value of n is proportional to          (A)    a-2          (B)    a-3/2          (C)    a-1          (D)    a2    **Sol.   (A)**  a = nλ/2 => λ = 2a/n   λdeBroglie = h/p   2a/n = h/p => p = nh/2a   E = p2/2m = (n2 h2)/(8a2 m)   => E ∝ 1/a2  **14.**    If the mass of the particle is m = 1.0 × 10-30 kg and a = 6.6 nm, the energy of the particle in its ground state is closest to          (A)    0.8 meV          (B)    8 meV          (C)    80 meV          (D)    800 meV    **Sol.   (B)**          E = h2/(8a2 m)             = (6.6 × 10-34 )2/(8 × (6.6 × 10-9 )2 × 10-30 × 1.6 × 10-19 )             = 8 meV    **15.**   The speed of the particle that can take discrete values is proportional to          (A)    n-3/2          (B)    n-1          (C)    n1/2          (D)    n    **Sol.   (D)**         mv = nh/2a         v = nh/2am         v ∝ n    **Paragraph**  Scientists are working hard to develop nuclear fusion reactor. Nuclei of heavy hydrogen,  known as deuteron and denoted by D can be thought of as a candidate for fusion reactor. The D-D reaction is 2H1 + 2H1 --> 3H2 + n + energy. In the core of fusion reactor, a gas fo heavy hydrogen is fully ionized into deuteron nuclei and electrons. This collision of  nuclei and electrons is known as plasma. The nuclei move randomly in the reactor core and occasionally come close enough for nuclear fusion to take place. Usually, the temperatures in the reactor core are too high and no material wall can be used to confine the plasma. Special techniques are used which confine the plasma for a time t0 before the particles fly away from the core. In n is the density (number/volume) of deuterons, the product nt0 is called Lawson number. In one of the criteria, a reactor is termed successful if Lawson number is greater than 5 × 1014 s/cm3.  It may be helpful to use the following: Botzmann constant k = 8.6 - 10-5 eV/K; e2/(4π ε0 ) = 1.44 × 10-9 eVm.    **16.**    In the core of nuclear fusion reactor, the gas becomes plasma because of          (A)    strong nuclear force acting between the deuterons          (B)    Coulomb force acting between the deuterons          (C)    Coulomb force acting between the deuteron-electron pairs          (D)    the high temperature maintained inside the reactor core    **Sol.   (D)**          Plasma state is achieved at high temperatures.    **17.**    Assume that two deuteron nuclei in the core of fusion reactor at temperature T are moving towards each other, each with kinetic energy 1.5 kT, when the separation between them is large enough to neglect Coulomb potential energy. Also neglect any interaction from other particles in the core. The minimum temperature T required for them to reach a separation of 4 × 10-15 m is in the range          (A)    1.0 × 109 K < T < 2.0 × 109 K          (B)    2.0 × 109 K < T < 3.0 × 109 K          (C)    3.0 × 109 K < T < 4.0 × 109 K          (D)    4.0 × 109 K < T < 5.0 × 109 K    **Sol.   (A)**          2 × 1.5 kT = e2/(4π ε0 ) (conservation of energy)          T = 1.4 × 109 K    **18.**    Results of calculations for four different designs of a fusion reactor using D-D reaction are given below. Which of these is most promising based on Lawson criterion?  (A)    deuteron density = 2.0 × 1012 cm-3, confinement time = 5.0 × 10-3 s  (B)    deuteron density = 8.0 × 1014 cm-3, confinement time = 9.0 × 10-1 s  (C)    deuteron density = 4.0 × 1023 cm-3, confinement time = 1.0 × 10-11 s  (D)    deuteron density = 1.0 × 1024 cm-3, confinement time = 4.0 × 10-12 s    **Sol.   (B)**          nt0 > 5 × 1014 (as given  **19.**    Column II shows five systems in which two objects are labeled as X and Y. Also in each case a point P is shown. Column I gives some statement about X and/or Y. Match these statements to the appropriate system(s) from Column II.     |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Column I** | | **Column II** | | | | (A) | The force exerted by X on Y has a magnitude Mg. | (p) | physics | Block Y of mass M left on a fixed inclined plane X, slides on it with a constant velocity | | (B) | The gravitational potential energy of X is continuously increasing. | (q) | magnet | Two rings magnets Y and Z, each of mass M, are kept in frictionless vertical plastic stand so that they repel each other. Y rests on the base X and Z hangs in air in equilibrium. P is the topmost point of the stand on the common axis of the two rings. The whole system is in a lift that is going up with a constant velocity. | | (C) | Mechanical energy of the system X + Y is continuously decreasing. | (r) | pully | A pulley Y of mass m0 is fixed to a table through a clamp X. A block of mass M hangs from a string that goes over the pulley and is fixed at point P of the table. The whole system is in a lift that is going up with a constant velocity. | | (D) | The torque of the weight of Y about point P is zero. | (s) | non viscous liquid | A sphere Y of mass M is put in a nonviscous liquid X kept in a container at rest. The sphere is released and it moves down in the liquid. | |  |  | (t) | viscous liquid | A sphere Y of mass M is falling with its terminal velocity in a viscous liquid X kept in a container. |     **Sol.   (A) --> (p, t), (B) --> (q, s, t), (C) --> (p, r, t), (D) --> (q)**    **20.**   Six point charges, each of the same magnitude q, are arranged in different manners as shown in column II. In each case, a point M and a line PQ passing through m are shown. Let E be the electric field and V be the electric potential at M (potential at infinity is zero) due to the given charge distribution when it is at rest. Now, the whole system is set into rotation with a constant angular velocity about the line PQ. Let B the magnetic field at M and m be the magnetic moment of the system in this condition. Assume each rotating charge to be equivalent to a steady current.   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Column I** | | **Column II** | | | | (A) | E = 0 | (p) | regular hexagon | Charges are at the corners of a regular hexagon. M is at the centre of hexagon. PQ is perpendicular to the plane of the hexagon. | | (B) | V ¹ 0 | (q) | line | Charges are on a line perpendicular to PQ at equal intervals. M is the mid-point between the two innermost charges. | | (C) | B = 0 | (r) | ring | Charges are placed on two coplanar insulating rings at equal intervals. M is the common centre of the rings. PQ is perpendicular to the plane of the rings. | | (D) | μ = 0 | (s) | ractangle | Charges are placed at the corners of a rectangle of sides a and 2a and at the mid points of the longer sides. M is at the centre of the rectangle, PQ is parallel to the longer sides. | |  |  | (t) | coplaner ring | Charges are placed on two coplanar, identical insulating rings at equal intervals. M is the mid points between the centers of the rings. PQ is perpendicular to the line joining the centers and coplanar to the rings. | |