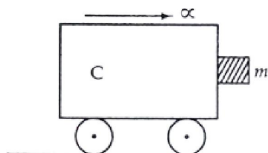


AIPMT

Physics Solutions 03-04-10

151. A block of mass m is in contact with the cart C as shown in the figure.



The coefficient of static friction between the block and the cart is μ . The acceleration α of the cart that will prevent the block from falling satisfies:

- (1) $\alpha > (mg / \mu)$ (2) $\alpha > (g / \mu m)$ (3) $\alpha \geq (g / \mu)$ (4) $\alpha < (g / \mu)$

151. (3) $f = mg$ & $f \leq \mu N \Rightarrow mg \geq \mu ma$

152. The mass of a ${}^7_3\text{Li}$ nucleus is $0.041 u$ less than the sum of the masses of all its nucleons. The binding energy per nucleon of ${}^7_3\text{Li}$ nucleus is nearly:

- (1) 46 MeV (2) 5.6 MeV (3) 3.9 MeV (4) 23 MeV

152. (2) $0.042 u = \Delta m \therefore \text{BE} / \text{nuclear} = \{(\Delta m / 7) \times 931 \text{ MeV}\}$

153. A circular disk of moment of inertia I_t is rotating in a horizontal plane, about its symmetry axis, with a constant angular speed ω_i . Another disk of moment of inertia I_b is dropped coaxially onto the rotating disk. Initially the second disk has zero angular speed. Eventually both the disks rotate with a constant angular speed ω_f . The energy lost by the initially rotating disc to friction is:

- (1) $\frac{1}{2} \frac{I_b^2}{(I_t + I_b)} \omega_i^2$ (2) $\frac{1}{2} \frac{I_t^2}{(I_t + I_b)} \omega_i^2$ (3) $\frac{I_b - I_t}{(I_t + I_b)} \omega_i^2$ (4) $\frac{1}{2} \frac{I_b I_t}{(I_t + I_b)} \omega_i^2$

153. (4) CAM: $\omega_f = \{I_t / (I_t + I_b)\} \omega_i \therefore \Delta \text{KE} = \{(1/2) I_t \omega_i^2 - (1/2) I_t \omega_f^2\}$

154. Which one of the following statement is FALSE?

- (1) Pure Si doped with trivalent impurities gives a p -type semiconductor
 (2) Majority carriers in a n -type semiconductor are holes
 (3) Minority carriers in a p -type semiconductor are electrons
 (4) The resistance of intrinsic semiconductor decreases with increase of temperature

154. (2) Majority carriers in n -type are electrons.

155. The displacement of a particle along the x axis is given by $x = a \sin^2 \omega t$. The motion of the particle corresponds to:

- (1) Simple harmonic motion of frequency ω / π
 (2) Simple harmonic motion of frequency $3\omega / 2\pi$
 (3) Non simple harmonic motion
 (4) Simple harmonic motion of frequency $\omega / 2\pi$

155. (3) $x = a / 2(1 - \cos^2 \omega t) \Rightarrow acc = d^2x / dt^2 \neq \omega^2 x \therefore$ No SHM

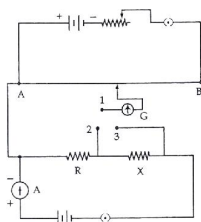
156. The radii of circular orbits of two satellites A and B of the earth, are $4R$ and R , respectively. If the speed of satellite A is $3 V$, then the speed of satellite B will be:

- (A) $3 V / 4$ (2) $6 V$ (3) $12 V$ (4) $3 V / 2$

156. (2) $v_0 = \sqrt{GM / r} \Rightarrow v_A / v_B = \sqrt{(R / 4R)} = 1 / 2$.

157. A beam of cathode rays is subjected to crossed Electric (E) and Magnetic fields (B). The fields are adjusted such that the beam is not deflected. The specific charge of the cathode rays is given by:
 (1) $B^2 / 2 VE^2$ (2) $2 VB^2 / E^2$ (3) $2 VE^2 / B^2$ (4) $E^2 / 2 VB^2$
 (Where V is the potential difference between cathode and anode)
157. (4) $qV = (1/2) mv^2 \Rightarrow v = \sqrt{(2qV / m)}$ (1)
 Also $qvB = qE \Rightarrow v = E / B$ (2)
158. A ball is dropped from a high rise platform at $t = 0$ starting from rest. After 6 seconds another ball is thrown downwards from the same platform with a speed v . The two balls meet at $t = 18$ s. What is the value of v ? [take $g = 10 \text{ ms}^{-2}$]
 (1) 75 ms^{-1} (2) 55 ms^{-1} (3) 40 ms^{-1} (4) 60 ms^{-1}
158. (1) $d_1 = (1/2)g(18)^2$ & $d_2 = \{(v \times 12) + (1/2) \cdot g \cdot (12)^2\}$ & $d_1 = d_2$
159. A ray of light travelling in a transparent medium of refractive index μ , falls on a surface separating the medium from air at an angle of incidence of 45° . For which of the following value of μ , the ray can undergo total internal reflection?
 (1) $\mu = 1.33$ (2) $\mu = 1.40$ (3) $\mu = 1.50$ (4) $\mu = 1.25$
159. (4) $C \geq 45^\circ \Rightarrow \sin C \geq (1 / \sqrt{2}), \therefore \mu (= 1 / \sin C) \leq \sqrt{2}$
160. The period of oscillation of a mass M suspended from a spring of negligible mass is T . If along with it another mass M is also suspended, the period of oscillation will now be:
 (1) T (2) $T / \sqrt{2}$ (3) $2T$ (4) $\sqrt{2}T$
160. (4) $T = 2\pi \sqrt{(m / k)} \propto \sqrt{m}$
161. A cylindrical metallic rod in thermal contact with two reservoirs of heat at its two ends conducts an amount of heat Q in time t . The metallic rod is melted and the material is formed into a rod of half the radius of the original rod. What is the amount of heat conducted by the new rod, when placed in thermal contact with the two reservoirs in time t ?
 (1) $Q / 4$ (2) $Q / 16$ (3) $2Q$ (4) $Q / 2$
161. (2) $(Q / t) \propto (A / l) \propto (r^2 / l)$ & $\pi r_1^2 l_1 = \pi r_2^2 l_2$
 $\therefore l_2 = \{r_1^2 / (r_1 / 2)^2\} \cdot l_1 = 4l_1 \Rightarrow Q_2 = Q / 16$
162. A ball moving with velocity 2 ms^{-1} collides head on with another stationary ball of double the mass. If the coefficient of restitution is 0.5, then their velocities (in ms^{-1}) after collision will be:
 (1) 0, 1 (2) 1, 1 (3) 1, 0.5 (4) 0, 2
162. (1) **CLM** : $2m + 0 = mv_1 + 2mv_2$ & $0.5 = \{(v_2 - v_1) / 2\}$
163. A transverse wave is represented by $y = A \sin (\omega t - kx)$. For what value of the wavelength is the wave velocity equal to the maximum particle velocity?
 (1) $\pi A / 2$ (2) πA (3) $2\pi A$ (4) A
163. (3) $v_w = \omega / k$ & $v_p = \omega A, \therefore \omega / k = \omega A \Rightarrow A = \lambda / 2\pi$
164. A particle has initial velocity $(3\hat{i} + 4\hat{j})$ and has acceleration $(0.4\hat{i} + 0.3\hat{j})$. Its speed after 10 s is:
 (1) 7 units (2) $7\sqrt{2}$ units (3) 8.5 units (4) 10 units
164. (2) $\vec{v} = \vec{u} + \vec{a}t$
165. An engine pumps water through a hose pipe. Water passes through the pipe and leaves it with a velocity of 2 ms^{-1} . The mass per unit length of water in the pipe is 100 kg / m . What is the power of the engine?
 (1) 400 W (2) 200 W (3) 100 W (4) 800 W
165. (1) $P = \text{KE per unit time} = (1/2) \cdot (dm / dt) \cdot v^2 = (1/2) \cdot \{(dm/dl)(dl / dt)\} v^2$
 $= (1/2) \cdot (dm / dl) \cdot v^3$

166. A thin ring of radius R meter has charge q coulomb uniformly spread on it. The ring rotates about its axis with a constant frequency of f revolutions / s. The value of magnetic induction in Wb / m^2 at the centre of the ring is:
- (1) $\mu_0 q f / 2\pi R$ (2) $\mu_0 q / 2\pi f R$ (3) $\mu_0 q / 2 f R$ (4) $\mu_0 q f / 2 R$
166. (4) $i = q.f.$, $\therefore B_{centre} = (\mu_0 i / 2R)$
167. Which one of the following bonds produces a solid that reflects light in the visible region and whose electric conductivity decreases with temperature and has high melting point?
- (1) metallic bonding (2) van der Waal's bonding
(3) ionic bonding (4) covalent bonding
167. (1)
168. A particle moves a distance x in time t according to equation $x = (t + 5)^{-1}$. The acceleration of particle is proportional to:
- (1) (velocity)^{3/2} (2) (distance)² (3) (distance)⁻² (4) (velocity)^{2/3}
168. (1) $x = \{1 / (t + 5)\}$, $\therefore v = dx / dt = - \{1 / (t + 5)^2\} = -x^2$ & $a = dv / dt = \{2 / (t + 5)^3\} = 2x^3$
169. A conducting circular loop is placed in a uniform magnetic field, $B = 0.025$ T with its plane perpendicular to the loop. The radius of the loop is made to shrink at a constant rate of 1 mm s^{-1} . The induced e.m.f. when the radius is 2 cm, is:
- (1) $2\pi\mu\text{V}$ (2) $\pi\mu\text{V}$ (3) $(\pi / 2) \mu\text{V}$ (4) $2\mu\text{V}$
169. (2) $\varepsilon = d\phi / dt = B(dA / dt) = B \cdot (d / dt) (\pi r^2) = 2\pi r B (dr / dt)$
170. The activity of a radioactive sample is measured as N_0 counts per minute at $t = 0$ and N_0 / e counts per minute at $t = 5$ minutes. The time (in minutes) at which the activity reduces to half its value is:
- (1) $\log_e 2 / 5$ (2) $5 / \log_e 2$ (3) $5 \log_{10} 2$ (4) $5 \log_e 2$
170. (4) $A = A_0 e^{-\lambda t} \Rightarrow t = 1 / \lambda \Rightarrow \lambda = 1 / 5 \text{ min}^{-1}$ & $\lambda = \ln 2 / t_{1/2}$
171. Two particles which are initially at rest, move towards each other under the action of their internal attraction. If their speeds are v and $2v$ at any instant, then the speed of centre of mass of the system will be:
- (1) $2v$ (2) Zero (3) $1.5v$ (4) v
171. (2) $F_{ext} = 0 \Rightarrow a_{cm} = 0 \Rightarrow \Delta v_{cm} = 0 \therefore (v_f)_{cm} = (v_i)_{cm} = 0$
172. A particle of mass M is situated at the center of a spherical shell of same mass and radius a . The gravitational potential at a point situated at $a / 2$ distance from the centre, will be:
- (1) $-(3GM / a)$ (2) $-(2GM / a)$ (3) $-(GM / a)$ (4) $-(4GM / a)$
172. (1) $V = V_{shell} + V_{particle} = (-GM / a) + (-GM / (a / 2))$
173. The device that can act as a complete electronic circuit is:
- (1) Junction diode (2) Integrated circuit (3) Junction transistor (4) Zener diode
173. (2)
174. A potentiometer circuit is set up as shown. The potential gradient, across the potentiometer wire, is k volt/cm and the ammeter, present in the circuit, reads 1.0 A when two way key is switched off. The balance points, when the key between the terminals (i) 1 and 2(ii) 1 and 3, is plugged in, are found to be at lengths l_1 cm and l_2 cm respectively. The magnitudes, of the resistors R and X , in ohms, are then, equal, respectively, to:



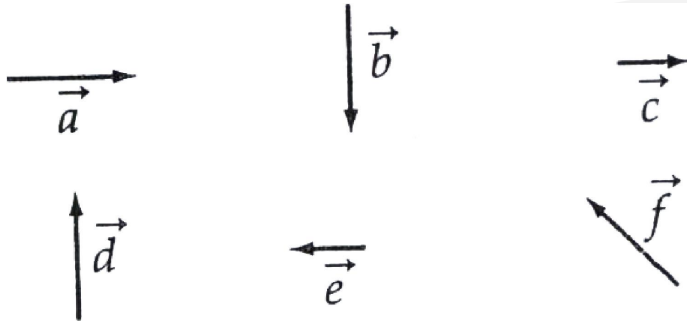
- (1) $k(l_2 - l_1)$ and kl_2 (2) kl_1 and $k(l_2 - l_1)$ (3) $k(l_2 - l_1)$ and kl_1 (4) kl_1 and kl_2
174. (2) $\{R / (R + X)\} = l_1 / l_2 \Rightarrow R / X = \{l_1 / (l_2 - l_1)\}$

175. A tuning fork of frequency 512 Hz makes 4 beats per second with the vibrating string of a piano. The beat frequency decreases to 2 beats per sec when the tension in the piano string is slightly increased. The frequency of the piano string before increasing the tension was:

- (1) 510 Hz (2) 514 Hz (3) 516 Hz (4) 508 Hz

175. (4) $512 \sim f = 4$ & $512 \sim f^1 = 2$ & $f \propto \sqrt{T} \Rightarrow f^1 > f \therefore f = 508 \text{ Hz}$

176. Six vectors, \vec{a} through \vec{f} have the magnitudes and directions indicated in the figure. Which of the following statements is true ?



- (1) $\vec{b} + \vec{c} = \vec{f}$ (2) $\vec{d} + \vec{c} = \vec{f}$ (3) $\vec{d} + \vec{e} = \vec{f}$ (4) $\vec{b} + \vec{e} = \vec{f}$

176. (3) By Triangle law of vector addition.

177. A galvanometer has a coil of resistance 100 ohm and gives a full scale deflection for 30 mA current. If it is to work as a voltmeter of 30 volt range, the resistance required to be added will be :

- (1) 900 Ω (2) 1800 Ω (3) 500 Ω (4) 1000 Ω

177. (1) $i_g (R_g + R) = 30 \text{ V} \Rightarrow R = 900 \Omega$

178. A gramophone record is revolving with an angular velocity ω . A coin is placed at a distance r from the centre of the record. The static coefficient of friction is μ . The coin will revolve with the record if :

- (1) $r = \mu g \omega^2$ (2) $r < \frac{\omega^2}{\mu g}$ (3) $r \leq \frac{\mu g}{\omega^2}$ (4) $r \geq \frac{\mu g}{\omega^2}$

178. (3) No slipping i.e., $m\omega^2 r = f$ & $f \leq \mu N$
($N = mg$) $\Rightarrow m\omega^2 r \leq \mu mg \Rightarrow r \leq (\mu g / \omega^2)$

179. Which of the following statement is false for the properties of electromagnetic waves ?

- (1) Both electric and magnetic field vectors attain the maxima and minima at the same place and same time
(2) The energy in electromagnetic wave is divided equally between electric and magnetic vectors
(3) Both electric and magnetic field vectors are parallel to each other and perpendicular to the direction of propagation of wave
(4) These waves do not require any material medium for propagation

179. (3) \vec{E} & \vec{B} are perpendicular to each other & that of direction of propagation of wave.

180. The energy of a hydrogen atom in the ground state is -13.6 eV . The energy of a He^+ ion in the first excited state will be :

- (1) -13.6 eV (2) -27.2 eV (3) -54.4 eV (4) -6.8 eV

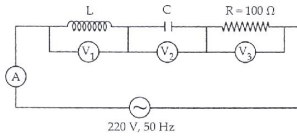
180. (1) $E = (Z^2 / n^2) (-13.6 \text{ eV})$

181. The dimension of $\frac{1}{2} \epsilon_0 E^2$, where ϵ_0 is permittivity of free space and E is electric field, is :

- (1) ML^2T^{-2} (2) $\text{ML}^{-1}\text{T}^{-2}$ (3) ML^2T^{-1} (4) MLT^{-1}

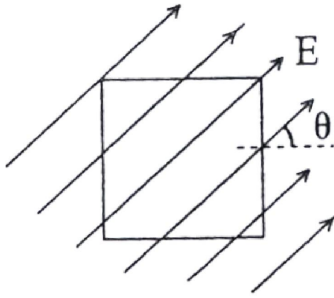
181. (2) $\frac{1}{2} \epsilon_0 E^2$ is the electrostatic energy density (i.e., Energy per unit volume)
182. In producing chlorine by electrolysis 100 kW power at 125 V is being consumed. How much chlorine per minute is liberated (E.C.E. of chlorine is 0.367×10^{-6} kg C)
- (1) 1.76×10^{-3} kg (2) 9.67×10^{-3} kg (3) 17.61×10^{-3} kg (4) 3.67×10^{-3} kg
182. (1) $dm = Zi(dt) \Rightarrow (dm / dt) = Zi$ & $Vi = W$
- $$\Rightarrow i = \frac{100 \times 10^3}{125} \times 60$$
183. A man of 50 kg mass is standing in a gravity free space at a height of 10 m above the floor. He throws a stone of 0.5 kg mass downwards with a speed 2 m/s. When the stone reaches the floor, the distance of the man above the floor will be :
- (1) 9.9 m (2) 10.1 m (3) 10 m (4) 20 m
183. (2) No external force, \therefore CLM is applicable at the instant of throwing, $\therefore 50 V_m = 0.5 V_s$
 $\therefore 50 (dx_m / dt) = 0.5 (dx_s / dt) \Rightarrow x_m = (1 / 100)x_s$
184. An alpha nucleus of energy $\frac{1}{2} mv^2$ bombards a heavy nuclear target of charge Ze . Then the distance of closest approach for the alpha nucleus will be proportional to :
- (1) $\frac{1}{Ze}$ (2) v^2 (3) $\frac{1}{m}$ (4) $\frac{1}{v^4}$
184. (3) $(1/2) mv^2 = (K.Ze.2e / r^2) + 0$ (Applying Energy Conservation)
185. A lens having focal length f and aperture of diameter d forms an image of intensity I . Aperture of diameter $\frac{d}{2}$ in central region of lens is covered by a black paper. Focal length of lens and intensity of image now will be respectively :
- (1) f and $\frac{I}{4}$ (2) $\frac{3f}{4}$ and $\frac{I}{2}$ (3) f and $\frac{3I}{4}$ (4) $\frac{f}{2}$ and $\frac{I}{2}$
185. (1) $I \propto A^2$ & f depends on R_1 & R_2 . R_1 & R_2 remain same but A reduces to $A/2$
186. If ΔU and ΔW represent the increase in internal energy and work done by the system respectively in a thermodynamical process, which of the following is true ?
- (1) $\Delta U = -\Delta W$, in a adiabatic process (2) $\Delta U = \Delta W$, in a isothermal process
 (3) $\Delta U = \Delta W$, in a adiabatic process (4) $\Delta U = -\Delta W$, in a isothermal process
186. (1) $\Delta Q = 0$ in an adiabatic process & $\Delta U = 0$ in an IT process.
187. The total radiant energy per unit area, normal to the direction of incidence, received at a distance R from the centre of a star of radius r , whose outer surface radiates as a black body at a temperature T K is given by :
- (1) $\sigma r^2 T^4 / R^2$ (2) $\sigma r^2 T^4 / 4\pi r^2$ (3) $\sigma r^4 T^4 / r^2$ (4) $4\pi \sigma r^2 T^4 / R^2$
 (Where σ is Stefan's Constant)
187. (1) $P_{\text{rad.}} = \sigma(4\pi r^2). T^4$, $\therefore (P_{\text{received}} / \text{area}) = (P_{\text{rad.}} / 4\pi R^2) = (\sigma r^2 T^4 / R^2)$

188. In the given circuit the reading of voltmeter V_1 and V_2 are 300 volts each. The reading of the voltmeter V_3 and ammeter A are respectively :



- (1) 150 V, 2.2 A (2) 220 V, 2.2 A (3) 220 V, 2.0 A (4) 100 V, 2.0 A
188. (2) $V_L = -V_C \therefore$ Circuit in Resonance
 $\therefore V_{\text{net}} = 220 \text{ V} \& i = (V_{\text{net}} / R) = 2.2 \text{ A}$.
189. A 220-volt input is supplied to a transformer. The output circuit draws a current of 2.0 ampere at 440 volts. If the efficiency of the transformer is 80%, the current drawn by the primary windings of the transformer is :
- (1) 3.6 ampere (2) 2.8 ampere (3) 2.5 ampere (4) 5.0 ampere
189. (4) $\eta = (P_{\text{out}} / P_{\text{in}}) \Rightarrow (4 / 5) = (2 \times 440 / i_p \times 220)$
190. A source S_1 is producing, 10^{15} photons per second of wavelength 500 Å. Another source S_2 is producing 1.02×10^{15} photons per second of wavelength 5100 Å.
 Then, (power of S_2) / (power of S_1) is equal to :
- (1) 1.00 (2) 0.02 (3) 0.04 (4) 0.98
190. (1) Power of $S_2 = n_2 \times (hc / \lambda_2) = 1.02 \times 10^5 \times (hc / 5100 \text{ Å})$
 Power of $S_1 = n_1 \times (hc / \lambda_1) = 10^{15} \times (hc / 5000 \text{ Å})$
 \therefore Ratio of power of S_2 to power of $S_1 = 1$.
191. A common emitter amplifier has a voltage gain of 50m an input impedance of 100Ω and an output impedance of 200Ω . The power gain of the amplifier is :
- (1) 500 (2) 1000 (3) 1250 (4) 50
191. (3) $A_p = A_v \cdot A_i = A_v^2 / (R_{\text{out}} / R_{\text{in}})$
192. A vibration magnetometer placed in magnetic meridian has a small bar magnet. The magnet executes oscillations with a time period of 2 sec in earth's horizontal magnetic field of 24 microtesla. When a horizontal field of 18 microtesla is produced opposite to the earth's field by placing a current carrying wire, the new time period of magnet will be :
- (1) 1s (2) 2s (3) 3s (4) 4s
192. (4) $T = 2\pi \sqrt{(I / MB)}$ $B_i = 24 \mu\text{T}, B_f = 6 \mu\text{T}$
 $\therefore (T_f / T_i) = \sqrt{(B_i / B_f)} = 2$
193. Two positive ions, each carrying a charge q , are separated by a distance d . If F is the force of repulsion between the ions, the number of electrons missing from each ion will be (e being the charge on an electron) :
- (1) $\frac{4\pi\epsilon_0 F d^2}{e^2}$ (2) $\sqrt{\frac{4\pi\epsilon_0 F e^2}{d^2}}$ (3) $\sqrt{\frac{4\pi\epsilon_0 F d^2}{e^2}}$ (4) $\frac{4\pi\epsilon_0 F d^2}{q^2}$
193. (3) $F = (1 / 4\pi\epsilon_0)(n^2 e^2 / d^2) \Rightarrow n^2 = (4\pi\epsilon_0 F \cdot d^2 / e^2)$
194. The potential difference that must be applied to stop the fastest photo electrons emitted by a nickel surface, having work function 5.01 eV, when ultraviolet light of 200 nm falls on it, must be :
- (1) 2.4 V (2) -1.2 V (3) -2.4 V (4) 1.2 V
194. (4) $2000 \text{ Å} \equiv 6.21 \text{ eV}$ of incident energy
 $\therefore \text{K.E} = E_{\text{incident}} - W = (6.21 - 5.01) \text{ eV}$
 \therefore p.d. applied = 1.2 V

195. A square surface of side L meter in the plane of the paper is placed in a uniform electric field E (volt/m) acting along the same plane at an angle θ with the horizontal side of the square as shown in figure. The electric flux linked to the surface, in units of volt. m, is :



- (1) EL^2 (2) $EL^2 \cos \theta$ (3) $EL^2 \sin \theta$ (4) Zero
195. (4) $\phi = EA \cos \theta$, where $\cos \theta = 90^\circ$ in the given situation.
196. A series combination of n_1 capacitors, each of value C_1 , is charged by a source of potential difference $4V$. When another parallel combination of n_2 capacitors, each of value C_2 , is charged by a source of potential difference V , it has the same (total) energy stored in it, as the first combination has. The value of C_2 , in terms of C_1 , is then :

- (1) $\frac{2C_1}{n_1 n_2}$ (2) $16 \frac{n_2}{n_1} C_1$ (3) $2 \frac{n_2}{n_1} C_1$ (4) $\frac{16C_1}{n_1 n_2}$

196. (4) $(1/2)(C_1/n_1) \cdot (4V)^2 = (1/2)n_2 C_2 \cdot V^2$
197. Electromagnets are made of soft iron because soft iron has :
- (1) low retentivity and high coercive force (2) high retentivity and high coercive force
 (3) low retentivity and low coercive force (4) high retentivity and low coercive force

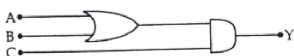
197. (3)
198. A square current carrying loop is suspended in a uniform magnetic field acting in the plane of the loop. If the force on one arm of the loop is \vec{F} , the net force on the remaining three arms of the loop is :

- (1) $3\vec{F}$ (2) $-\vec{F}$ (3) $-3\vec{F}$ (4) \vec{F}

198. (2) Force on two arms of a square loop which is \perp to magnetic field are Non-zero and are equal and opposite ; thus creating a couple. The remaining two arms will have zero force.

199. Consider the following two statements :
- (1) Kirchhoff's junction law follows from the conservation of charge.
 (2) Kirchhoff's loop law follows from the conservation of energy
- Which of the following is correct ?
- (1) Both (A) and (B) are wrong (2) (A) is correct and (B) is wrong
 (3) (A) is wrong and (B) is correct (4) Both (A) and (B) are correct

199. (4)
200. to get an output $Y = 1$ from the circuit shown below, the input must be :



- | | A | B | C |
|-----|----------|----------|----------|
| (1) | 0 | 1 | 0 |
| (2) | 0 | 0 | 1 |
| (3) | 1 | 0 | 1 |
| (4) | 1 | 0 | 0 |

200. (3) $Y = (A + B) \cdot C$