PHYSICS: **Max.Marks: 70**

SECTION – I
(single correct choice type)

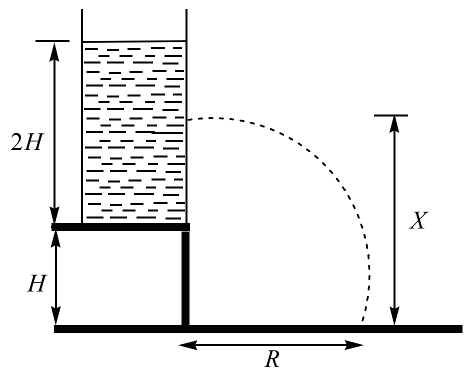
This section contains 10 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, Out of which ONLY ONE is correct

1. A plate moves normally with the speed υ_1 towards a horizontal jet of water of uniform area of cross – section. The jet discharges water at the rate of volume V per second at a speed of υ_2. The density of water is ρ. Assume that water splashes along the surface of the plate are right angles to the original motion. The magnitude of the force acting on the plate due to the jet of water is

A) $\rho V \upsilon_1$ **B)** $\rho\left(\frac{V}{\upsilon_2}\right)(\upsilon_1+\upsilon_2)^2$

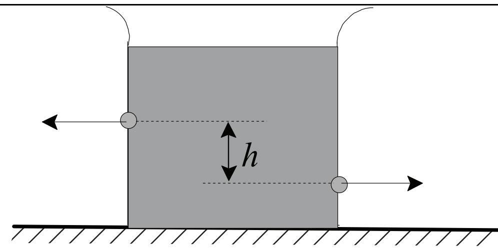
C) $\frac{\rho V}{\upsilon_1+\upsilon_2}(\upsilon_1)^2$ **D)** $\rho V(\upsilon_1+\upsilon_2)$

2. A tank is filled up to a height 2H with a liquid and is placed on a platform of height H from the ground. The distance x from the ground where a small hole is punched to get the maximum range R is



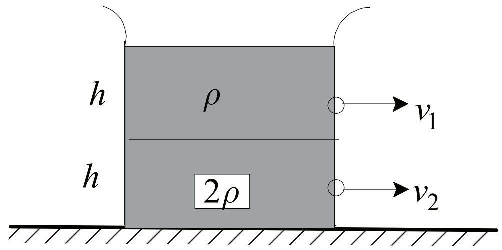
A) H **B)** $1.25H$ **C)** $1.5H$ **D)** $2H$

3. There are two identical small holes of area of cross section a on the opposite sides of a tank containing a liquid of density ρ. The difference in height between the holes is h. The tank is resting on a smooth horizontal surface. The horizontal force which will have to be applied on the tank to keep it in equilibrium is



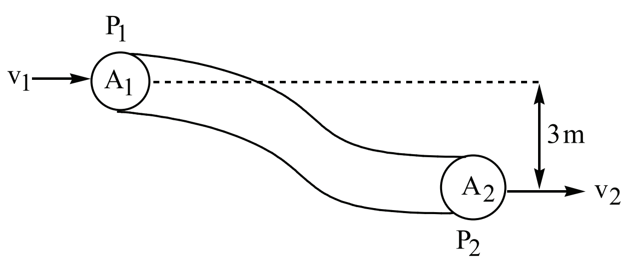
A) $gh\rho a$ B) $\frac{2gh}{\rho a}$ C) $2\rho agh$ D) $\frac{\rho gh}{a}$

4. Equal volume of two immiscible liquids of densities ρ and 2ρ are filled in a vessel as shown in the figure. Two small holes are punched at depths h/2 and 3h/2 from the surface of lighter liquid. If v_1 *and* v_2 are the velocities of efflux at these two holes, then v_1 / v_2 is



A) $\frac{1}{2\sqrt{2}}$ B) $\frac{1}{2}$ C) $\frac{1}{4}$ D) $\frac{1}{\sqrt{2}}$

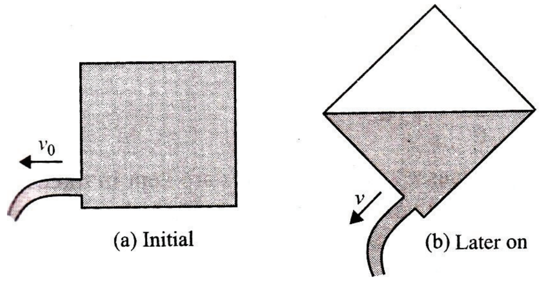
5. An ideal fluid flows in the pipe as shown in the figure. The pressure in the fluid at the bottom P_2 is the same as it is at the top P_1. If the velocity of the top $v_1 = 2m/s$. Then the ratio of areas A_1 *and* A_2 is



A) 2 : 1 B) 4 : 1 C) 8 : 1 D) 4 : 3

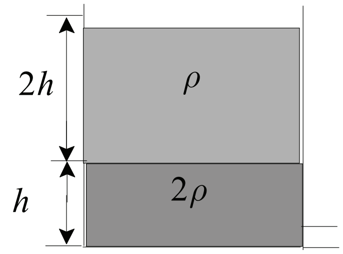
6. A square box of water has a small hole located in one of the bottom corners. When the box is full and sitting on a level surface, complete opening of the hole results in a flow of water with a speed v_0, as shown in Fig. When the box is still half empty, it is tilted

by 45^0 so that the hole is at the lowest point. Now the water will flow out with a speed of



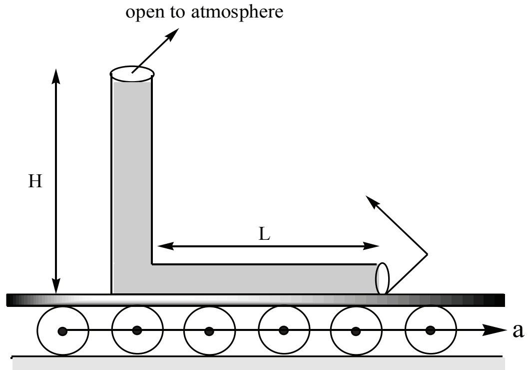
A) v_0 B) $v_0.2$ C) $\frac{v_0}{\sqrt{2}}$ D) $\frac{v_0}{\sqrt[4]{2}}$

7. The velocity of the liquid coming out of a small hole of a vessel containing two different liquids of densities 2ρ *and* ρ as shown in the figure is



A) $\sqrt{6gh}$ B) $2\sqrt{gh}$ C) $2\sqrt{2gh}$ D) $\sqrt{gh}$

8. A narrow tube completely filled with a liquid lying on a series of cylinders as shown in the figure. Assuming no sliding between any surfaces, the value of acceleration of the cylinders for which liquid will not come out of the tube from anywhere is given by

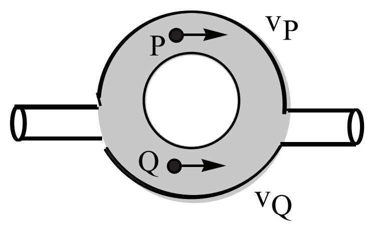


A) $\frac{gH}{2L}$ B) $\frac{gH}{L}$ C) $\frac{2gH}{L}$ D) $\frac{gH}{\sqrt{2}L}$

9. A cylindrical tank of height H is open at the top end and it has a radius r. Water is filled in it up to a height of h. The time taken to empty the tank through a hole of radius r' in its bottom is

A) $\sqrt{\frac{2h}{g}}\frac{r^2}{r'^2}$ **B)** $\sqrt{\frac{2H}{g}}\frac{r^2}{r'^2}$ **C)** $\sqrt{hH}$ **D)** None of these

10. Figure shows a liquid flowing through a tube at the rate of $0.1\ m^3/s$. The tube is branched into two semicircular tubes of cross – sectional area A/3 and 2A/3 at P and Q respectively. The velocity of liquid at Q is (the cross section of the main tube is A = $10^{-2}m^2$ *and* $v_P = 20$ m/s)

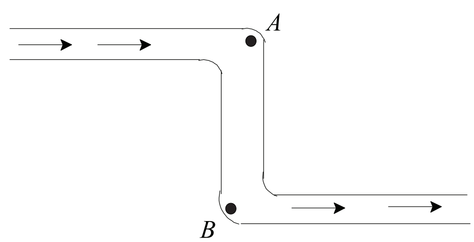


A) 5 m/s **B)** 30 m/s **C)** 35 m/s **D)** 15 m/s

SECTION II
Multiple correct answer(s) type

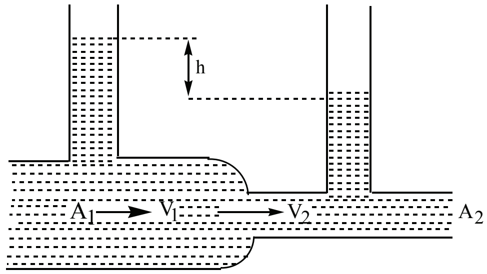
This section contains 5 multiple choice questions. Each question has four choices (A), (B), (C) and (D) out of which ONE or MORE are correct.

11. In the figure, an ideal liquid flows through the tube, which is of uniform cross section. The liquid has velocities v_A *and* v_B, *and pressures* P_A *and* P_B at the points A and B, respectively. Then



A) $v_A = v_B$ **B)** $v_A > v_B$ **C)** $P_A > P_B$ **D)** $P_B > P_A$

12. A liquid flows through a horizontal tube. The velocities of the liquid in the two sections, which have areas of cross section $A_1 = A_2$, *are* v_1 *and* v_2, respectively. The difference in the liquid in the two vertical tubes is h. Then



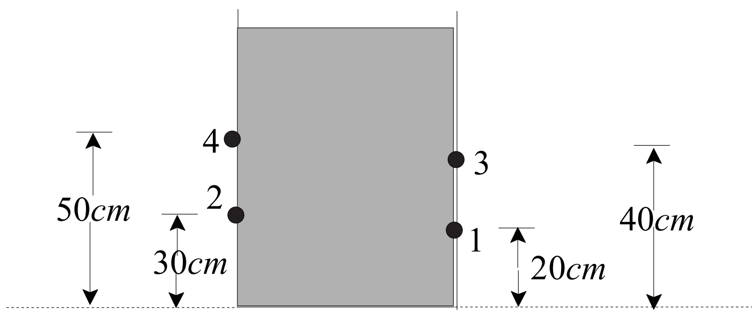
A) the volume of the liquid flowing through the tube in unit time is $A_1 v_1$

B) $v_2 - v_1 = \sqrt{2gh}$

C) $v_2^2 - v_1^2 = 2gh$

D) the energy per unit mass of the liquid is the same in both sections of the tube

13. Figure shows a cylindrical vessel of height 90 cm filled up to the brim. There are four holes in the vessel as shown. The liquid falling at maximum horizontal distance from the vessel would come from:



A) hole 1 **B)** hole 2 **C)** hole 3 **D)** Hole 4

14. Water is flowing smoothly through a closed – pipe system. At one point A, the speed of the water is 3.0 m/s while at another point B, 1.0 m higher, the speed is 4.0 m/s. The pressure at A is 20 kPa when the water is flowing and 18 kPa when the water flow stops. Then

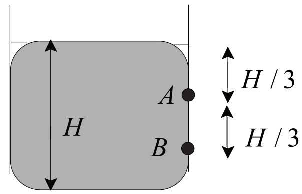
A) the pressure at B when water is flowing is 6.5 kPa

B) the pressure at B when water is flowing is 8.0 kPa

C) the pressure at B when water stops flowing is 10 kPa

D) the pressure at B when water stops flowing is 8.0 kPa

15. The area of two holes A and B are 2a and a, respectively. The holes are at height (H/3) and (2H/3) from the surface of water. Find the correct option(s).



A) The velocity of efflux at hole B is 2 times the velocity of efflux at hole A

B) The velocity of efflux at hole B is $\sqrt{2}$ time the velocity of efflux at hole A

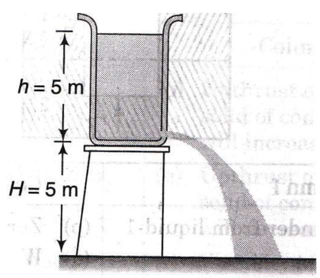
C) The discharge is same through both the holes

D) The discharge through hole A is $\sqrt{2}$ time the discharge through hole B

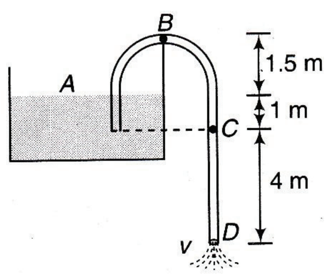
SECTION III
Integer Answer Type

This section contains 5 questions. The answer to each question is single digit integer, ranging from 0 to 9 (both inclusive).

16. A cylindrical tank 1 m in radius rests on a platform 5 m high. Initially the tank is filled with water to a height of 5 m. A plug whose area is $10^{-4} m^2$ is removed from an orifice on the side of the tank at the bottom. Calculate the initial speed with which water strikes the ground is $10\sqrt{k}\ m/s$. Find the value of k. $\left(g = 10 m/s^2\right)$

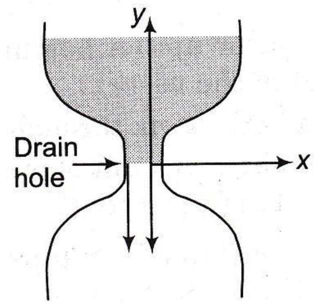


17. A siphon tube is discharging a liquid of specific gravity 0.9 from a reservoir as shown in the figure.

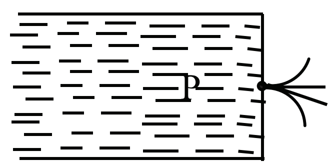


Then the velocity of the liquid through the siphon is nearly $(k \times 2)\ m/s$. Find the value of ''k''.

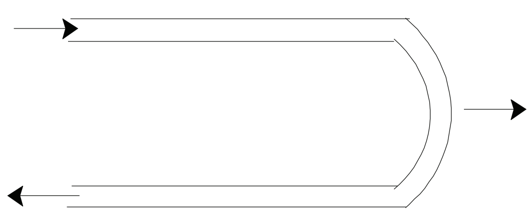
18. The shape of an ancient water clock jug is such that water level descends at a constant rate at all times. If the water level falls by 4 cm every hour, determine the shape of the jar, i.e. specify x as a function of y as $y = 0.4x^p$. Find the value of p.[The radius of drain hole is 2 mm and can be assumed to be very small compared to x.]



19. A leakage begins in water tank at position P as shown in figure. The initial gauge pressure (pressure above that of the atmosphere) at P was $5\times10^5 N/m^2$. If the density of water is $1000kg/m^3$ the initial velocity with which water gushes out is approximately is $(4\times k)\, m/s$ Find the value of k.



20. A horizontal tube of uniform cross – sectional area A is bent in the form of U as shown in figure. If the liquid of density ρ enters and leaves the tube with velocity υ, then the external force F required to hold the bend stationary is $m\rho Av^n$. Find the value of $m\times n$.



Sri Chaitanya IIT Academy., India.

AP, TELANGANA, KARNATAKA, TAMILNADU, MAHARASHTRA, DELHI, RANCHI

A right Choice for the Real Aspirant

ICON Central Office, Madhapur – Hyderabad

SEC: Sri Chaitanya-Jr.Chaina-2 (2012-P1) DATE: 18-11-18

Time: 9:00 A.M to 12.00 P.M **WTA-2** Max. Marks: 210

Key & Solutions

PHYSICS

1	D	2	C	3	C	4	D	5	B
6	D	7	B	8	A	9	A	10	A
11	AD	12	ACD	13	CD	14	AC	15	BD
16	2	17	5	18	4	19	8	20	4

CHEMISTRY

21	B	22	B	23	A	24	B	25	C
26	C	27	B	28	A	29	C	30	B
31	BC	32	ABC	33	ABD	34	ABCD	35	ABC
36	4	37	7	38	6	39	4	40	7

MATHS

41	B	42	A	43	C	44	A	45	C
46	D	47	C	48	A	49	B	50	C
51	ABCD	52	AC	53	AD	54	AC	55	AD
56	3	57	6	58	6	59	7	60	3

SOLUTIONS

Physics

1. $F=\frac{\Delta p}{\Delta t}\left(\frac{\Delta m}{\Delta t}\right)(\Delta v) \qquad =\rho\left(\frac{\Delta V}{\Delta t}\right)(v_1+v_2)=\rho V(v_1+v_2)$

2. At half of total height $h=\frac{H+2H}{2}=1.5H$

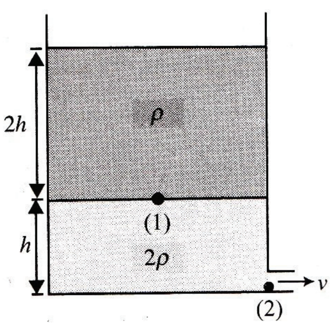
3. Thrust force, $F=F_1-F_2=\rho a v_1^2-\rho a v_2^2 \quad =\rho a(2gh_1)-\rho a(2gh_2)$
$=2\rho ag(h_1-h_2)=2\rho agh$

4. $v_1=\sqrt{2g\left(\frac{h}{2}\right)}=\sqrt{gh}$ From Bernoulli's theorem, $\rho gh+2\rho g\left(\frac{h}{2}\right)=\frac{1}{2}(2\rho)v_2^2$
$\Rightarrow v_2=\sqrt{2gh} \qquad \therefore \frac{v_1}{v_2}=\frac{1}{\sqrt{2}}$

5. Using equation of continuity, we have $v_2=\frac{A_1}{A_2}v_1$
From Bernoulli's theorem, $\qquad p_1+\rho gh_1+\frac{1}{2}\rho v_1^2$
$p_2+\rho gh_2+\frac{1}{2}\rho v_2^2 \Rightarrow g(h_1-h_2)=\frac{1}{2}(v_2^2+v_1^2)$
$\Rightarrow 60=\left(\frac{A_1^2}{A_2^2}-1\right)v_1^2 \Rightarrow \frac{A_1}{A_2}=\frac{4}{1}$

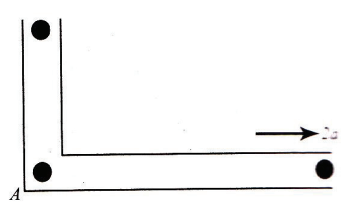
6. $V_0=\sqrt{2gh}\Rightarrow V_2=\sqrt{2g\frac{h}{\sqrt{2}}}=\frac{V_0}{\sqrt[4]{2}}$

7.



Pressure at (1), $P_1=P_{atm}+\rho g(2h)$
Applying Bernoulli's theorem between points (1) and (2)
$(P_{atm}+2\rho gh)+\rho g(2h)=P_{atm}+\frac{1}{2}(2\rho)^{v^2} \quad \Rightarrow v=2\sqrt{gh}$

8.



No sliding $\Rightarrow$ pure rolling

Therefore, acceleration of the tube = 2a (since COM of the cylinders are moving at 'a')

$P_A = P_{atm} + \rho(2a)L$ (from the horizontal limb)

Also, $P_A = P_{atm} + \rho gH$ (from the vertical limb)

$\therefore a = \frac{gH}{2L}$

9. $-\pi r^2 \frac{dh}{dt} = \pi r'^2 \sqrt{2gh}$ or $\frac{dh}{dt} = -\frac{r'^2}{r^2}\sqrt{2gh}$ or $dt = -\frac{r^2}{r'^2}\frac{1}{\sqrt{2gh}}dh$

$\therefore \int_0^t dt = -\frac{r^2}{r'^2\sqrt{2g}}\int_h^0 h^{-1/2dh}$ or $t = -\frac{r^2}{r'^2\sqrt{2g}} \times 2\left[\sqrt{h}\right]_h^0$ or $t = \sqrt{\frac{2h}{g}}, \frac{r^2}{r'^2}$

10. From the equation of continuity, $Rate = r = \frac{A}{3}V_p + \left(A + \frac{A}{3}\right)V_Q$

$\therefore V_P + 2V_Q = \frac{3r}{A} = \frac{3\times 0.1}{10^{-2}} = 30\ m/s$ As $V_P = 20\ m/s, so V_Q = 5\ m/s$

11. As per the continuity equation, $Av = constant. v_A = v_B$. As point B is at the lower level, hence $p_B > p_A$

12. $\frac{P_1}{\rho} + \frac{v_1^2}{2} = \frac{P_2}{\rho} + \frac{v_2^2}{2}$ $P_1 - P_2 = \frac{\rho}{2}\left(v_2^2 - v_1^2\right)$

But $P_1 - P_2 = \rho\left(v_2^2 - v_1^2\right)$ or $v_2^2 - v_1^2 = 2gh$

13. $R = 2\sqrt{hh'}$ R would be maximum if hh' is maximum

a. $hh' = 70\times 20 = 1400$

b. $hh' = 60\times 30 = 1800$

c. $hh' = 50\times 40 = 2000$

d. $hh' = 40\times 50 = 2000$

Clearly, the liquid coming out from holes 3 and 4 would fall at maximum horizontal distance.

14. Let p_1, h_1, v_1 and v_2 be the pressures, heights and velocities of flow at the two points, respectively. Then Bernoulli's theorem gives

$$p_1 + \rho g h_1 + \frac{1}{2}\rho v_1^2 = p_2 + \rho g h_2 + \frac{1}{2}\rho v_2^2 \qquad \text{(i)}$$

Putting $v_1 = 3.0\ m/s, v_2 = 4.0\ m/s, \left(h_2 - h_1\right) = 1\ m,\ p_1 = 20$ kPa, we get

$$p_2 = 20 + \left[10^3 \times 10(-1) + \frac{10^3}{2}[9-16]\right]\times 10^{-3}$$

= 20 – 10 – 3.5 = 6.5 kPa

15. Use $v = \sqrt{2gh}$ & $V = av$

16. (a) $v = \sqrt{2gh} = \sqrt{2\times 10\times 5}$ = 10 m/s

(b) From conservation of energy, $v'^2 = v^2 + 2gH$ $= 100 + 2\times 10\times 5 = 200$

$v'^2 = 14.1\ m/s$

17. (a) $P_A - \frac{1}{2}\rho v^2 + \rho gh = P_D$ But $P_A = P_D = P_0$

$\therefore \frac{1}{2}\rho v^2 = \rho gh$ $\therefore v = \sqrt{2gh}$

Here, $h = (4+1) = 5\ m$ $\therefore v = \sqrt{2\times 9.8\times 5} = 9.9\ m/s$

18. $a\sqrt{2gy} = \pi x^2\left(-\frac{dy}{dt}\right)$ Here, $-\frac{dy}{dt} = \frac{4\times 10^{-2}}{3600} = 1.11\times 10^{-5}\ m/s$

$a = \pi r^2 = \pi\left(2\times 10^{-3}\right)^2$ $= 1.26\times 10^{-5} m^2$

Substituting these values in Eq. (i), we have

$\left(1.26\times 10^{-5}\right)\sqrt{2\times 9.8\times y} = \pi\left(1.11\times 10^{-5}\right)x^2$

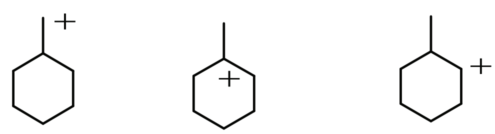
Or y = 0.4 x^4 This is the desired x – y relation.

19. $\Delta p = \frac{1}{2}\rho v^2$ $\therefore$ $v = \sqrt{\frac{2\Delta p}{\rho}} = \sqrt{\frac{2\times 5\times 10^5}{1000}}$

= 31.5 m/s

20. $F = \frac{\Delta p}{\Delta t} = \left(\frac{\Delta m}{\Delta t}\right)(\Delta v) = \rho\left(\frac{\Delta V}{\Delta t}\right)(2v) = \rho(Av)(2v) = 2\rho A v^2$

Chemistry



(I) (II) (III)

21.

	(I)	(II)	(III)
No. of + I groups	1	3	2
No. of α-H	1	7	3

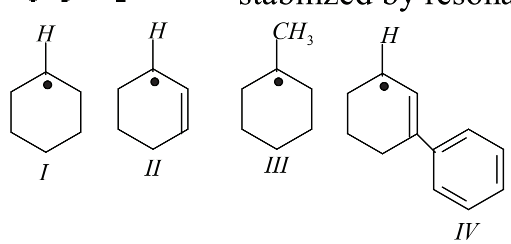
22. $(CH_3)C^-$ destabilized by 3 +I groups.

$(CH_3)_2CH^-$ destabilized by 2 +I groups.

$CH_3CH_2^-$ destabilized by 1 +I groups.

$C_6H_5CH_2^-$ stabilized by resonance.

23.



STRUTURE	I	II	III	IV
No. of +I groups	2	1	3	1
No. of α-H	4	2	7	2
No. of π- bonds in resonance.	0	1	0	4

Final Key

S.NO	SUB	Q.NO	GIVEN KEY	FINAL KEY	REMARKS
1	PHY	12	ACD	Delete	(Insufficient information) given condition [$A_1 = A_2$]
2	PHY	14	AC	AD	Wrong Key