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| **Qn** | **Answer** | **Marks** |
| 1 (a) | (i) … one which obeys all the gas laws under all conditions and whose internal energy is independent of volume. | 1 |
| (ii) The pressure of a fixed mass of gas, at constant volume is directly proportional to the absolute temperature. | 1 |
| (iii)  h  R  mm scale  X  Heat  F  F  Dry air  Thermometer  Stirrer  Rubber tubing  Water bath   * Dry air is trapped in a flask F by mercury in a rubber tubing which joins up with a reservoir R and F is immersed in a water bath. * The position of R is adjusted until the mercury level at the trapped air is at mark X. The temperature θ of the water bath and the mercury level difference h are recorded. * The temperature of the gas in F is varied by heating the bath. * The heating is stopped and after stirring the reservoir position is adjusted again to restore the mercury level to mark X. The new values of θ and h are recorded. * The procedure is repeated for different values of θ.   In each case the absolute temperature of the gas in F is T = θ + 273 and the pressure P = (H + h) mmHg, where H is the atmospheric pressure in mmHg.  A graph of P against θ is plotted.  It is a straight line which when extrapolated cuts the temperature axis at -273oC, i.e at T = 0 K (since T = θ +273).  P  θ  -273oC  0 K  Thus, the pressure, P, is directly proportional to the absolute temperature, T, at constant volume. | 1  ½  ½  ½  ½  ½  ½  ½  ½ |
| (b) | (i) …a process which when taken from state P1, V1, T1 to state P2, V2, T2 can be returned from P2, V2, T2 to P1, V1, T1 through exactly the same values of pressure and volume and temperature at every stage. | 1 |
| (ii)   * Thick-walled, non-conducting vessel so that no heat may be transferred * The process must occur very fast so as to give no time for heat transfer. | 1½  1½ |
| (iii) From the first law of thermodynamics  δQ = δW + δU  where δQ = heat supplied to the gas  δW = work done by the gas  δU = gain in internal energy  Now, for an adiabatic process, δQ = 0  ∴ - δW = δU  So the work done in compressing the gas, which is (– δW), results in increase of internal energy of the gas. So the gas heats up. | 1  1  1 |
| (c) | V  P  P1  P3  P2  V1  V2  For the first process  ∴  ∴ P2 =  = 3 x 105  = 3 x 105 x 0.8223.5  = 1.51 x 105 Pa  Now  ∴ V2 =  For the second process P3V3 = P2V2  ∴ P3 =   = 1.51 x 105 x  = 1.51 x 105 x 1.990.714  = **2.47 x 105 Pa** | 1  1  1  1  1  1 |
| ***Total = 20*** | | |
| 2 (a) | (i)   * The volume of the molecules is negligible compared with the volume occupied by the gas. * The attraction between molecules is negligible. * The molecules make perfectly elastic collisions. * The duration of collisions is negligible compared to the time between collisions. | 1  1  1  1 |
| (ii) Consider N molecules of a gas, each of mass m, contained in a cube of side *l*.  z  x  y  *l*  *l*  *l*  m  u  c  w  v  A  Take one of the molecules, having a velocity c at an instant, where c has components of u, v and w respectively in the directions of the three perpendicular axes Ox, Oy and Oz as shown.  Thus c2 =u2 + v2 + w2  Consider the component u, perpendicular to the face A. Its velocity after collision is –u (reversed due to elastic collision).  Thus, momentum change on impact is  mu – (-mu) = 2mu  Since the duration of collision is assumed negligible, the time between collisions at A is 2*l/*u  The rate of change of momentum =  =  By Newton’s second law, the force on A =  ∴ pressure on A =  This is the pressure due to one molecule. For the N molecules, having different velocities and hence components of different magnitudes in the Ox direction u1, u2, u3, …….,uN, the pressure on A is  ……………. (1)  Let be the average value of all the squares of the components in the Ox direction.  Then    Since the pressure is the same on all the faces of the cube, it follows that    Thus,  But c2 = u2 + v2 + w2  Therefore the mean square speed,  ∴ = | ½  ½  ½  ½  ½  ½  ½  ½  ½  ½  ½  ½ |
| (b) | (i) The pressure of a saturated vapour is independent of volume  A saturated vapour does not obey the gas laws | 1  1 |
| (ii)  P  V  *Both axes must be labelled* | ½  ½ |
| (iii)   * At first, when the vapour is not saturated, it tends to obey Boyle’s law approximately * Eventually the vapour becomes saturated when it starts condensing. * So the pressure remains constant as the volume is decreased. * When all the vapour has turned into liquid, the volume cannot decrease anymore. Hence the vertical portion of the graph | ½  ½  ½  ½ |
| (c) | Total pressure, p = pair + pvap  ∴ pair = p – pvap = (3.00 – 1.013) x 105 Pa at 100oC  = 1.987 x 105 Pa  Let p2 = air pressure at 20oC  Then p2 =  =  = 1.561 x 105 Pa  ∴ final pressure = 1.561 x 105 + 0.023 x 105  = **1.584 x 105 Pa** | 1  ½  1  ½  1  1 |
| ***Total = 20*** | | |