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| **Qn** | **Answer** | **Marks** |
| 1. (a) | (i) … energy which just removes an electron completely from the atom. | 1 |
| (ii) By convention the energy of the atom when its electron is at infinity, is regarded as zero.  This would imply that work is done to move an electron towards the nucleus.  But the reverse is true. Instead work is done when taking an electron away from the nucleus. So the ionization energy is negative | 1  ½  ½ |
| (b) | (i) Let the minimum velocity be v  Then ½mv2 = 10.4 eV  ∴ v =  = **1.91 x 106 m s-1** | 1  1  1 |
| (ii) Let λ = wavelength  Then  = E3 – E2  ∴ λ =  =  = **6.875 x 10-7 m** | 1  1  1 |
| (c) | * The continuous spectrum is a result of the fact that many of the electrons make more than one encounter with the target atoms before losing all their energy, each encounter resulting in emission of a photon of energy. * Therefore several photons, with a range of wavelengths, are emitted leading to such a spectrum. * This spectrum has a definite minimum wavelength which results from those electrons which lose all their energy in one encounter. * Line spectra result when high-energy electrons penetrate deep into the atom and displace electrons from very deep energy levels. * The subsequent fall of an electron from a higher energy level into the vacancy results in the emission of a high-energy X-ray photon with energy characteristic of the fall involved and therefore of the target metal. | 1  1  1  1  1 |
| (d) | (i) 2d sinθ = nλ, where n = 1  ∴ sinθ =  = 0.323  ∴ θ = **18.8o** | 1  1 |
|  | (ii) KCl is made up of K+ ions and Cl- ions  1 mole of K+  + 1 mole of Cl- gives 1 mole of KCl  Each K+ ion or Cl- ion occupies a volume d3 , where d is the spacing between a K+ and a Cl- (neighbouring)  Therefore each molecule of KCl occupies a volume of 2d3  There are NA molecules in one mole of a substance, where NA = 6.02 x 1023  So volume of 1 mole = 2NAd3  Now density =  =  = **2.08 x 103 kg m-3** | ½  ½  ½  ½  1  1 |
| ***Total = 20*** | | |
| 2. (a) | (i) Half-life is the time taken for half the atoms to disintegrate.  Decay constant is the ratio of the activity to the number of radioactive nuclei present | 1  1 |
| (ii) The number of radioactive atoms present | 1 |
| (b) | (i)   |  |  | | --- | --- | | α-particle | β-particle | | * Positively charged * Heavy – (relative mass 4) * Less penetrating power | * Negatively charged * Weightless * Greater penetrating power | | 1  1  1 |
| (ii)  Mica end window  Argon gas at reduced pressure  Glass bead  (to prevent sparking)  Protective gauze  Wire anode Cathode  To ampl  and  counter  +V  R  A  C  It consists of a cylindrical metal cathode C and a thin coaxial wire anode, A, containing argon at low pressure.   * The anode, A, is kept at a positive potential V e.g500V relative to the cathode, C. * When an ionising particle enters the tube, a few electrons and ions are produced in the gas. * If V is above the breakdown potential of the gas, the electrons gain enough energy to cause further ionisation leading to breakdown (avalanche). * The electrons move to the anode A and the positive ions towards the cathode C. * The current in the high resistance R produces a p.d which is amplified and passed to a counter such as scaler or ratemeter. * Argon mixed with a halogen helps to stop the discharge quickly.   This way the G-M tube is able to detect individual passages of ionizing particles | ½  ½  1  ½  1  1  ½  ½  ½ |
| (c) | (i) In a radioactive decay the rate of disintegration is directly proportional to the number of atoms, N, present at the instant.  Thus  = -kN  where k is the radioactive decay constant  So  ∴  = -kt  ∴ **N = Noe-kt** | ½  ½  ½  ½ |
| (ii) From  = -kt, where N = ½No and t = T½, we have  = -kT½  ∴ T½ = | 1  1 |
| (d) | The original number of radioactive atoms, No = x 6.02 x 1023  Original activity, Ao = kNo  Now k =  = 0.131 year-1  and A = Aoe-kt = kNoe-kt  = 0.131 x x 6.02 x 1023 e-(0.131 x 5.3)  = **1.31 x 1021 per year** | ½  ½  ½  ½  1  1 |
| ***Total = 20*** | | |