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| **Qn** | **Answer** | **Marks** |
| 1. (a) | (i) …the ratio of the charge of the ion to the mass of the ion. | 1 |
| (ii) …different forms of the same element having the same atomic number but different mass numbers | 1 |
| (iii) …a twelfth of the mass of the carbon atom | 1 |
| (b) | Y  Z  S2  K  L  M  N  B  (i) | 1 |
| (ii) Let Q = charge on the ion  v = velocity of the ion  E = electric field intensity between  Then for ions that pass straight through S2  Magnetic force on the ion = electric force on the ion  i.e. BQv = EQ  v =  =  = **800 m s-1** | 1  1  1 |
| (iii) Beyond S2 describe a circular path of radius, say r, striking a horizontal photographic plate through Y, at a distance 2r from S2.  Let M = mass of the ion  Then BQv =  ∴ r =  Now, since all the ions carry the same charge and have the same velocity, difference in r will reveal different mass numbers.  So isotopes can be identified. | 1  1  1 |
| (c) | (i) The mass of a nucleus is less than the total mass of the nucleons when they are separate. The difference is called the mass defect. | 1 |
|  | Binding energy per nucleon  /MeV  Mass number  (ii) | 1 |
| (iii) The graph has a peak. The elements with mass number smaller than that for the peak will release energy if they underwent fusion because the resulting nucleus is of higher binding energy per nucleon.  On the other hand elements with mass number greater than that for the peak will release energy if they underwent fission because the resulting nuclei then are of higher binding energy per nucleon. | 1½  1½ |
| (d) | (i)   |  |  | | --- | --- | | RADIOACTIVITY | NUCLEAR FISSION | | * Occurs spontaneously | * Not spontaneous. It is effected by bombardment of the nucleus with a neutron | | * One of the resulting nucleus is of dominant mass | * There are nuclei of comparable masses among the products | | 1  1 |
| (ii)  →  +  Energy released = Mass of Ra - (mass of Rn + mass He)  = 226.0254 – (222.0175 + 4.0026)  = 0.0053 u  = 0.0053 x 931 = **4.9343 MeV** | 1  1  1 |
| ***Total = 20*** | | |
| 2. (a) | (i) If no external force acts on a system of colliding bodies, the total momentum of the bodies remains constant. | 1 |
| (ii) Suppose a particle of mass m1 originally moving with velocity u1­ collides with another particle of mass m2 which is originally moving with velocity u2. Then m1 exerts a force F1 on m2 to change the velocity of m2 from u2 to v2 (according to the first law).  Also m2 exerts a force F2 on m1 to change the velocity of m1 from u1 to v1.  Suppose the collision lasts for time δt. Then, according to the second law  F1 = , where k is a constant  and F2 =  According to the third law, F2 = -F1  ∴  =  ∴ m1v1  - m1u1 = -m2v2 + m2u2  ∴  **m1u1 + m2u2 = m1v1 + m2v2**  ∴ ***Total momentum before collision = Total momentum after collision*** |  |
| (b) | Let v = velocity of the water as it leaves the nozzle  A = cross-sectional area of the nozzle  Then the mass issuing per second = Avρ  Now, the force exerted on the spring = rate of change of momentum  ∴ Avρ.v = kx, where x = compression of the spring  ∴ v2 =  ∴ v  =  = **8 m s-1** | 1  1  1  1 |
| (c) | Forward motion  When the fuel in the combustion chamber is burnt, the molecules of the products gain tremendous kinetic energy and collide with the walls of the combustion chamber.  Due to the high rate of change of momentum, a force is created on the chamber’s walls.  Now, because of the opening in the rear, there is a net force in the forward direction of the rocket. So the rocket is pushed forward. | 1  1  1 |
| (d) | a  2g sin30o  T  2gμ cos30o  2kg  1kg  μmg  T  a  (i) T – 0.3g = 1a ………………… (1)  2g sin30o – T – (2 x 0.3g cos30o) = 2a  ∴ g – T – 0.3g = 2a …………… (2)  Eq(1) + Eq(2): g – 0.3g – 0.3g = 3a  ∴ a =  = **0.589 m s-1** | 1  1  1  1  1 |
| (ii) From (1): T = a + 0.3g  = 0.589 + 2.943  = **3.53 N** | 1  1 |
| ***Total = 20*** | | |