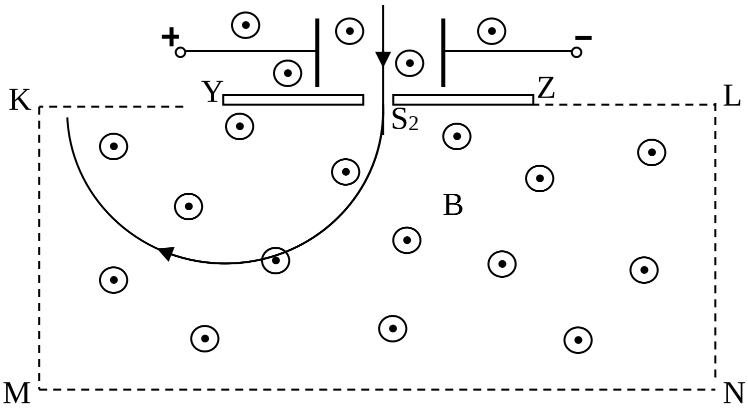
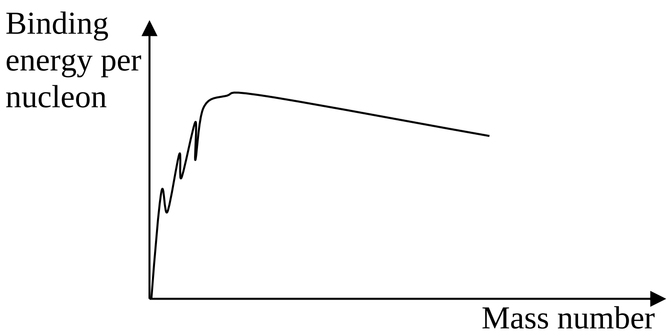
Qn	Answer	Marks
1. (a)	(i) …the ratio of the charge of the ion to the mass of the ion.	1
	(ii) …different forms of the same element having the same atomic number but different mass numbers	1
	(iii) …a twelfth of the mass of the carbon atom ${}^{12}_{6}C$	1
(b)	(i) 	1
	(ii) Let Q = charge on the ion v = velocity of the ion E = electric field intensity between Then for ions that pass straight through S_2 Magnetic force on the ion = electric force on the ion i.e. BQv = EQ $v = \frac{E}{B} = \frac{400}{0.5} = \mathbf{800\ m\ s^{-1}}$	1 1 1
	(iii) Beyond S_2 describe a circular path of radius, say r, striking a horizontal photographic plate through Y, at a distance 2r from S_2. Let M = mass of the ion Then $BQv = \frac{Mv^2}{r}$ $\therefore \quad r = \frac{Mv}{BQ}$ 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
	(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.	1½
	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
(d)	(i)	

RADIOACTIVITY	NUCLEAR FISSION	
- Occurs spontaneously	-Not spontaneous. It is effected by bombardment of the nucleus with a neutron	1
- One of the resulting nucleus is of dominant mass	-There are nuclei of comparable masses among the products	1

(ii) $^{226}_{88}Ra \rightarrow\ ^{222}_{86}Rn +\ ^{4}_{2}He$

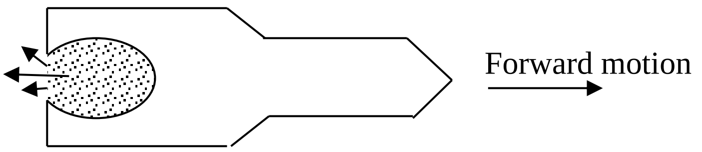
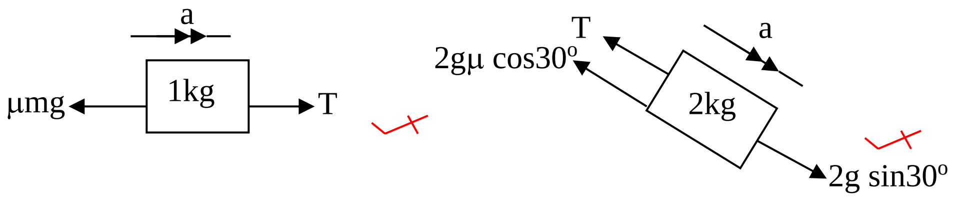
Energy released	= Mass of Ra - (mass of Rn + mass He)	1
	= 226.0254 – (222.0175 + 4.0026)	
	= 0.0053 u	1
	= 0.0053 x 931 = **4.9343 MeV**	1

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 m_1 originally moving with velocity u_1 collides with another particle of mass m_2 which is originally moving with velocity u_2. Then m_1 exerts a force F_1 on m_2 to change the velocity of m_2 from u_2 to v_2 (according to the first law).
Also m_2 exerts a force F_2 on m_1 to change the velocity of m_1 from u_1 to v_1.
Suppose the collision lasts for time δt. Then, according to the second law

$$F_1 = k\frac{m_2(v_2 - u_2)}{\delta t}$$, where k is a constant

	and $F_2 = k\frac{m_1(v_1 - u_1)}{\delta t}$ According to the third law, $F_2 = -F_1$ $\therefore\ k\frac{m_1(v_1 - u_1)}{\delta t} = -k\frac{m_2(v_2 - u_2)}{\delta t}$ $\therefore\ m_1v_1 - m_1u_1 = -m_2v_2 + m_2u_2$ $\therefore\ \mathbf{m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2}$ ∴ ***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 = $A v \rho$ Now, the force exerted on the spring = rate of change of momentum $\therefore\ A v \rho . v = kx$, where x = compression of the spring $\therefore\ v^2 = \frac{kx}{A\rho}$ $\therefore\ v \sqrt{\frac{kx}{A\rho}} = \sqrt{\frac{512 \times 0.05}{4 \times 10^{-4} \times 1000}}$ $= \mathbf{8\ m\ s^{-1}}$	1 1 1 1
(c)	 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)	 (i) $T - 0.3g = 1a$ ………………… (1) $2g\sin 30^o - T - (2 \times 0.3g\cos 30^o) = 2a$ $\therefore\ g - T - 0.3g\sqrt{3} = 2a$ …………… (2) Eq(1) + Eq(2): $g - 0.3g - 0.3g\sqrt{3} = 3a$	1 1 1 1

	∴ a = $\frac{0.18g}{3}$ = **0.589 m s^{-1}** ✓	1
	(ii) From (1): T = a + 0.3g ✓ = 0.589 + 2.943 = **3.53 N** ✓	1 1
Total = 20		