

| Question number | Answer | Notes | Marks |
|-----------------|--|--|-------|
| 13 (a) (i) | 77 | | 1 |
| (ii) | 115 | | 1 |
| (b) | (nuclei with) same number of protons / same atomic number / same element ; different numbers of {neutrons / nucleons} / different mass number; | ACCEPT: atoms / elements for nuclei REJECT: molecules / substances for nuclei IGNORE: electrons | 2 |
| (c) | 192; 78; | | 2 |
| (d) | alpha not penetrating enough (of the tumour) / ionises before reaching whole tumour ; gamma too penetrating / travels straight through / too weakly ionising / OWTTE ; beta will penetrate the tumour but no further / stays in tumour and doesn't affect horse / ionises within tumour (but no further) / OWTTE ; | IGNORE: doesn't penetrate skin IGNORE: bald 'weak' or 'strong' IGNORE: general properties of alpha, beta and gamma | 3 |
| (e) (i) | C | | 1 |
| (ii) | activity decreases over time ; relate activity to situation e.g. C remains sufficiently active (over the treatment) / A and B not effective over period of treatment / A and B would need source to be replaced / D continues to be radioactive / cause damage (after treatment) ; | ACCEPT: calculation of period of activity IGNORE: bald 'weak' or 'strong' | 2 |

Total 12 marks