Solutions to Nuclear, Particle and Medical Physics – Test A

1. (from 0.5) up to 3 fm / 3×10^{-15} m **[1]**

2. (a) Rest mass is the same **[1]**
   Charge is opposite (or both zero) **[1]**
   (b) Annihilation **[1]**
   Photons produced **[1]**

3. (a) $^{238}_{92}U \rightarrow ^{234}_{90}Th + ^{4}_{2}\alpha$
   Accept He in place [illegible]
   Uranium [illegible] **[1]**
   [illegible] as [illegible] **[1]**
   [illegible] an[illegible] 90 correctly written with product
   [illegible]bol (even if not Th) **[1]**
   4 and 2 correctly written with other product **[1]**
   (b) charge = $1.6 \times 10^{-19} \times 2 = 3.2 \times 10^{-19}$ (C) **[1]**
   mass = $1.67 \times 10^{-27} \times 4 = 6.68 \times 10^{-27}$ (kg) **[1]**
   charge : mass ratio = $\frac{3.2\times10^{-19}}{6.68\times10^{-27}} = 4.79 \times 10^{7}$ **[1]**

4. alpha particles are strongly ionising **[1]**
   alpha particles have short range in air **[1]**
   Then any two from:
   - point the source away from people **[1]**
   - keep the source as far from the body as possible **[1]**
   - stand behind a screen **[1]**
   - put the source back inside a lead container when not in use **[1]**

5. alpha particles are fired at a thin metal foil [illegible]
   most alpha particles pass straight [illegible] which
   shows the atom is mostly [illegible] **[1]**
   some alpha partic[illegible] through small
   angles, wh[illegible] there is charge present **[1]**
   v[illegible] al[illegible] particles were deflected through
   a[illegible] >90°, which shows that there is a strong
   charge density at the centre of the atom **[1]**

6. use a gamma source **[1]**
   use a Geiger counter / GM tube and counter **[1]**
   measure the count rate at different distances in a straight line from the source **[1]**
   correct for background radiation **[1]**

7. background count rate is significant / contributes to a large percentage of the count rate **[1]**
   results will be more accurate **[1]**

8. (a) ln*A* calculated **[1]**
   all values correct and to the same number of [illegible]
   and no unit **[1]**

t / s	A / s^{-1}	[illegible]A
0	[illegible]	[illegible]
60	[illegible]	2.67
1[illegible]	287	2.46
180	148	2.17
240	91	1.96
300	42	1.62
360	29	1.46
420	19	1.28

   (b) graph
   horiz
   scale
   the g
   all po
   straig
   (c) gradi
   the li
   all va
   calcu
   negat
   if all
   (d) nume
   posit
   unit a

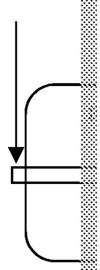
9. $\lambda = 0.693$
   $7.60 \times 10^{-}$
   $100 = 65 \times$
   ln65 – ln1
   56.7 hours

10. charge on
   $= 3.2 \times 10$
   charge on
   $= 2.08 \times 1$
   8.99×10^{9}

   95.7 mN

11. reactants 2
   products 2
   difference
   0.191×1.6
   $3.17 \times 10^{-}$
   $3.17 \times 10^{-}$
   $2.86 \times 10^{-}$
   $2.86 \times 10^{-}$
   1.72×10^{1}

12. (a)



Diag
vacu
catho
anode
high
Acce

(b) high-speed electrons / electrons with high kinetic energy **[1]**
(electrons) arrive at / hit the anode **[1]**
loss of k.e. converted to X-ray <u>photon</u>(s) **[1]**
Must refer to photons not just X-rays

13. (a) loss of intensity **[1]**
(b) Compton effect **[1]**
X-ray photon makes inelastic interaction with an electron **[1]**
X-ray photon loses energy / increases in wavelength **[1]**

14. (a) acoustic impedance **[1]**
(b) (i) bone is more dense / solids are more dense than gases **[1]**
particles / molecules packed more tightly **[1]**
vibrations / compressions in longitudinal wave more easily passed on
(ii) λ in air = 6.6×10^{-5} m **[1]**
λ in bone 8.2×10^{-4} m **[1]**
difference ≡ $7.5(4) \times 10^{-4}$ **[1]**
$\left(\dfrac{7.5\times10^{-4}}{6.6\times10^{-5}}\times100=\right)$ 1100 % **[1]**

Preview of Answers Ends Here