MODERN PHYSICS-II

EXERCISE – I

SINGLE CORRECT

1. C

1 a.m.u. = $\frac{1}{12}$ [mass of one $_6c^{12}$]

For $C \Rightarrow A = 12$

2. A

$R = R_o A^{1/3}$

Surface area $\Rightarrow \pi R^2$

$= \pi(R_o A^{1/3})^2$

$= \pi R_0^2 A^{2/3}$

3. B

- (7.4 × 2000 - 8.2 × 110 - 8.2 × 90)
= 160 MeV
Energy B E of Products
BE of Reactants
1640-1480 = 16 MeV

4. A

$C^{13} \rightarrow C^{12} + n$

- (7.68 × 12 - 7.5 × 13)
(92.16 - 7.5 × 13)
5.34 MeV
Energy Requered = $(BP)_{R-}$
97-50 - 92.16 $(BP)_P$

5. B

$^AX + {}^AX \rightarrow {}^{2A}Y$

$E_2 - 2E_1 = 0$

6. B

One fission = 200 MeV
Power = $200 \times 10^6 \times 1.6 \times 10^{-19}$
= 10^3J/S
1.5×10^{-19} J = 1eV.
Fission / sec = x
$X \times 3.2 \times 10^{-11} = 10^3$
$x = 0.3125 \times 10^{14}$
$x = 3.125 \times 10^{13}$.

$\frac{1 \times 10^3}{200 \times 10^6 \times 1.6 \times 10^{-19}}$

$= 3.125 \times 10^{13}$

7. C

Total energy radiated by star is 10^{16}J/s
energy from one fission is of the order of
$10^6 \times 1.6 \times 10^{-19}$J
No of reactions per sec= $10^{16} \times 10^{13} / 1.6$
$= 10^{29} / 1.6$
No of deutrons used/sec = $3 \times 10^{29} / 1.6$
Time to use 10^{40} deutrons = 10^{29} t
$t = 10^{40} / 10^{29} \cong 10^{11}$
order about 10^{12} sec

8. C

3B → E_b ; A + e → E_a

$e = E_a - 3E_b \Rightarrow 3E_b = E_a - e$

9. C

BE/ Nucleon $\Rightarrow$

$^4_2He \Rightarrow \frac{28}{4} = 7\,MeV$

$^7_3Li \Rightarrow \frac{52}{7} = 7.4\,MeV$

$^{12}_6C \Rightarrow \frac{90}{12} = 7.5\,MeV$

$^{14}_7N \Rightarrow \frac{98}{14} = 7\,MeV$

Elements with more BE/nucleon is more stable.

10. B

Two smaller nuclei combining to form a larger nucleus is called a Fusion reaction.

11. D

(939 + 940 - 1876)
= 3 MeV (Captures)

12. B

$K.E_\alpha = \frac{A\,50\,Mev}{(A+4)} = 48$ MeV

0.96 × 50 MeV = 48 MeV
A = 100

13. B

$_{92}U^{238} \rightarrow {}_{82}Pb^{206} + x\,{}_2He^4 + y\,{}_{-1}e^0 + Q$

A = 206 + 4x = 238
4x = 32
x = 8
2x - y + 82 = 92
2x - y = 10
16 - y = 10
y = 6

14 D

$M_x = e^0_{-1} + {}_0\gamma^0 + M_y$

$M_x = M_y$

15. C

$^{226}_{88}R_a \rightarrow {}^{206}_{82}P_b + x\alpha + y\beta$

226 = 206 + 4x
x = 5

16. C

$(BE)_W = 7.5 \times 120 = 900$

$(BE)_x = 8.0 \times 90 = 720$

$(BE)_y = 8.5 \times 60 = 510$

$(BE)_Z = 3.0 \times 5.0 = 150$

To release energy $\Rightarrow (BE)_{Products} > (BE)_{Reactants}$

17. B

$N_1 = N_0 e^{-10\lambda_0 t}$ $\quad N_2 = N_0 e^{-\lambda_0 t}$

18. C

$A = \lambda N$

$A_1 = \frac{0.693}{2} N_0 e^{-\frac{0.693}{2}t}$

$A_2 = \frac{0.693}{4} N_0\, e^{\frac{-0.693}{4}t}$ $\quad \frac{A_1}{A_2} = 2e^{\frac{0.693}{4}t - \frac{0.693}{2}t}$

$= 2e^{\frac{-0.693}{2}}$

19. C

$N_1 = N_0 e^{-\lambda t}$

$= N_0 e^{-1}$ $\quad = \frac{N_0}{e}$

20. B

$0.9N_0 = N_0 e^{-\lambda t}$

$N = N_0 e^{-2\lambda t}$ $\quad N = N_0\, 0.9 \times 0.9$

$N = 0.81\, N_0$

21. C

$A_1 = A_0 e^{-\lambda t}$

$A_2 = 2A_0 e^{-\lambda(t - t^1)}$

$\frac{A_1}{A_2} = \frac{1}{2} e^{-\lambda t^1}$ $\quad \log\frac{2A_1}{A_2} = -\lambda t^1$

$t' = \frac{T}{\log_2}\left|\log\frac{A_2}{A_1}\right|$

22. D

$R_1 = R_0 e^{-\lambda t_1}$

$R_2 = R_0 e^{-\lambda t_2}$ $\quad \frac{R_2}{R_1} = e^{-\lambda(t_2 - t_1)}$

23. A

$\lambda_1 : \lambda_2 = 1 : 2$

$\lambda_1 A_0 = \lambda_2 B_0$ $\quad A_0 = 2B_0$

24. B

$\frac{A_0}{\sqrt{3}} = A_0 e^{-\lambda 1}$ $\quad A' = A_0 e^{-\lambda 4}$

$A' = \frac{A_0}{9}$

25. B

Give $t_{1/2} = 1620\text{yr}$ $\quad t_{1/2} = \frac{0.693}{\lambda}$

$\lambda = \frac{0.693}{1620 \times 365 \times 24 \times 60 \times 60}$

No of mols (n) = $\frac{\text{mass}}{\text{At.wt}} = \frac{5}{223}$

$N_0 = n \times N_A = 6.023 \times 10^{23}$

At t = 5hr = 5 × 3600

$N(t) = N_0\, e^{-\lambda t}$

$N(t) = 3.23 \times 10^{15}$

26. C

$A_1 = A_0 e^{-\lambda t_1}$ $\quad A_2 = A_0 e^{-\lambda t_2}$

$A_2 = A_1 e^{(t_1 - t_2)\lambda} \Rightarrow A_2 = A_1\, e^{\frac{(t_1 - t_2)}{T}}$

27. A

$f_1 = 1 - e^{-\lambda\frac{1}{\lambda}}$ $\quad = 0.634$

$f_2 = 1 - e^{-\lambda\frac{Ln2}{\lambda}}$ $\quad = 1 - e^{\ln 2^{-1}}$

$= \left(1 - \frac{1}{2}\right) = \frac{1}{2}$

28. C

$\xrightarrow{R} A \xrightarrow{\lambda} B$

$\frac{dN}{dt} = R - \lambda N$ N = be the number of at any time t)

$\int_0^N \frac{dN}{R - \lambda N} = \int_0^N dt$

$N = \frac{R(1 - e^{-\lambda t})}{\lambda}$

$2(1 - e^{-\lambda t}) = 1$ $\quad e^{-\lambda t} = \frac{1}{2}$

$\frac{t}{2} = \ln 2$ $\quad t = 2 \times 0.693 = 1.386$

29. B

$R_1 = \lambda N_o e^{-\lambda T_1}$ $\quad R_2 = \lambda N_o e^{-\lambda T_2}$

Atoms decayed N_1-N_2

$= \frac{R_1 - R_2}{\lambda} = R_1 - R_2$

30. A

Zero

31. C

$\frac{-dN_1'}{dt} = \lambda_1 N_1'$

$$\frac{-dN_2'}{dt} = \lambda_2 N_2'$$

$$\frac{-dN}{dt} = \frac{-dN_1'}{dt} + \left(\frac{-dN_2'}{dt}\right)$$

$$= \lambda_1 N_1' + \lambda_2 N_2'$$

$$= \lambda_1 N_1' e^{-\lambda_1 t} + \lambda_2 N_2' e^{-\lambda_2 t}$$

32. D

A given Nucleus may decay after t = 0 at any time

33. A

$$\lambda_1 : \lambda_2 = 1 : 2$$

$$\lambda_1 A_0 = \lambda_2 B_0$$

$$A_0 = 2B_0$$

34. C

$$\text{Probability} = \frac{\text{favourable}}{\text{Total}}$$

Surviving Nucleus after 6 half lives in $\frac{N_o}{2^6}$

Total $\frac{N_o}{2^5}$

Prob = $\frac{N_o}{2^6} / \frac{N_o}{2^5} = \frac{1}{2}$

35. B

Initial = N_o

Total decayed in 10 years

$$\frac{N_o}{2} + \frac{N_o}{2^2} = \frac{3}{4} N_o$$

Prob = $= \frac{\frac{3}{4} N_o}{N_o}$ Prob = 75%

36. B

Let sample is x ` x $\rightarrow$ Y

2% 14%

$\frac{2x}{100}$ $\frac{14x}{100}$ $\lambda = \frac{Ln2}{45}$

$$\text{Total} = \frac{16x}{100}$$

$$\frac{2}{100} x = \frac{16x}{100} e^{-\lambda t} = 2^{-3}$$

$$\lambda t = 3\ln 2 = 45x3 = 135$$

37. A

Prob of decay by $\lambda_1 \Rightarrow \frac{dN_1}{N_1} = \lambda_1 t$

$$\lambda_2 \Rightarrow \frac{dN_2}{N_2} = \lambda_2 t$$

$$\text{Total Prob} = \frac{dN}{N} = \lambda dt$$

$$\lambda dt = \lambda_1 dt + \lambda_2 dt$$

$$\lambda = \lambda_1 + \lambda_2$$

38. E

$N = N_0 (1 - e^{-\lambda t})$

39. C

No effect of concentration on activity.

40. C

$$\xrightarrow{1000} A \xrightarrow{\lambda} B$$

$\frac{dN}{dt} = R - \lambda N = 0$ $R = \lambda N$

$1000 = \frac{1}{40 x 60} N$ $N = 24 x 10^5$

41. C

At t = 0

$N_o = 20 x 10^5$ $N = N_o \frac{R}{\lambda}(1 - e^{-\lambda t})$

42. B

$$\text{time} = \frac{3200 x 10^3}{2000}$$

$1600 \rightarrow 1600$ sec.

Remaining after two half time

$$\frac{N_o}{4} = \frac{10^8}{4} = 25 x 10^6$$

43. C

$v = \frac{kq}{r}$ $1 = \frac{9x10^9 q}{1.6x10^{-3}}$

$q = \frac{1.6}{9} x10^{-12}$ q = ne= n x 1.6 x 10^{-19}

$n = 6.25x10^{10} t$

44. D

13.6 z^2= 13.6 x 4 = 54.4

Second electron = 54.4 + 24.6 = 79

45. A

It is difficult to over come attractive forces

46. A

The nucleus of Atom is positively charged So striking it with +ve proton or α particle would be relatively difficult

47. C

Photon thermal energy or excess energy is always liberated in the form of gamma radiation

48. D

Half of total number of nucleus are left after one half life.