DPP - Daily Practice Problems

Name :

Date :

Start Time :

End Time :

PHYSICS 56

SYLLABUS : Nuclei

Max. Marks : 120 **Time : 60 min.**

GENERAL INSTRUCTIONS

- The Daily Practice Problem Sheet contains 30 MCQ's. For each question only one option is correct. Darken the correct circle/ bubble in the Response Grid provided on each page.
- You have to evaluate your Response Grids yourself with the help of solution booklet.
- Each correct answer will get you 4 marks and 1 mark shall be deduced for each incorrect answer. No mark will be given/ deducted if no bubble is filled. Keep a timer in front of you and stop immediately at the end of 60 min.
- The sheet follows a particular syllabus. Do not attempt the sheet before you have completed your preparation for that syllabus. Refer syllabus sheet in the starting of the book for the syllabus of all the DPP sheets.
- After completing the sheet check your answers with the solution booklet and complete the Result Grid. Finally spend time to analyse your performance and revise the areas which emerge out as weak in your evaluation.

DIRECTIONS (Q.1-Q.21) : There are 21 multiple choice questions. Each question has 4 choices (a), (b), (c) and (d), out of which **ONLY ONE** choice is correct.

Q.1 The energy released per fission of uranium 235 is about 200 MeV. A reactor using U-235 as fuel is producing 1000 kilowatt power. The number of U-235 nuclei undergoing fission per sec is, approximately-

(a) 10^6 (b) 2×10^8 (c) 3×10^{16} (d) 931

Q.2 Power output of $_{92}U^{235}$ reactor if it takes 30 days to use up 2kg of fuel, and if each fission gives 185 MeV of useable energy is-

(a) 5.846 kW (b) 58.46 MW
(c) .5846 kW (d) None

Q.3 How many electrons, protons and neutrons are there in a 6 gm of $_6C^{12}$.

(a) 6×10^{23}, 6×10^{23}, 6×10^{23}
(b) 36×10^{23}, 36×10^{23}, 36×10^{23}
(c) 12×10^{23}, 12×10^{23}, 12×10^{23}
(d) 18×10^{23}, 18×10^{23}, 18×10^{23}

Q.4 Nuclear radius of $_8O^{16}$ is 3×10^{-15} m. Find the density of nuclear matter.

(a) 7.5×10^{17} kg m^{-3} (b) 5.7×10^{17} kg m^{-3}
(c) 2.3×10^{17} kg m^{-3} (d) 1.66×10^{17} kg m^{-3}

Q.5 Consider the decay of radium-226 atom into an alpha particle and radon-222. Then, what is the mass defect of the reaction-

Mass of radium -226 atom = 226.0256 u
Mass of radon - 222 atom = 222.0715 u
Mass of helium - 4 atom = 4.0026 u

(a) 0.0053 u (b) 0.0083 u
(c) 0.083 u (d) None

RESPONSE GRID	1. ⓐⓑⓒⓓ	2. ⓐⓑⓒⓓ	3. ⓐⓑⓒⓓ	4. ⓐⓑⓒⓓ	5. ⓐⓑⓒⓓ

Space for Rough Work

Q.6 If mass equivalent to one mass of proton is completely converted into energy then determine the energy produced?

(a) 931.49 MeV (b) 731.49 MeV

(c) 911.49 MeV (d) 431.49 MeV

Q.7 If mass equivalent to one mass of electron is completely converted into energy then determine the energy liberated.

(a) 1.51 MeV (b) 0.51 MeV

(c) 3.12 MeV (d) 2.12 MeV

Q.8 If the mass defect in the formation of helium from hydrogen is 0.5%, then the energy obtained, in kWH, in forming helium from 1 kg of hydrogen will be-

(a) 1.25 (b) 125×10^4

(c) 1.25×10^8 (d) 1.25×10^6

Q.9 The half life of radioactive Radon is 3.8 days. The time at the end of which 1/20th of the Radon sample will remain undecayed is

(Given $\log_{10} e = 0.4343$)

(a) 3.8 days (b) 16.5 days

(c) 33 days (d) 76 days

Q.10 In the nuclear reaction,

${}_{92}U^{238} \rightarrow {}_{Z}Th^{A} + {}_{2}He^{4}$, the values of A and Z are-

(a) A = 234, Z = 94 (b) A = 234, Z = 90

(c) A = 238, Z = 94 (d) A = 238, Z = 90

Q.11 The mass of helium nucleus is less than that of its constituent particles by 0.03 a.m.u. The binding energy per nucleon of ${}_{2}He^{4}$ nucleus will be-

(a) 7 MeV (b) 14 MeV

(c) 3.5 MeV (d) 21 MeV

Q.12 If the binding energy of deuterium is 2.23 MeV, then the mass defect will be- (in a.m.u.)

(a) 0.0024 (b) – 0.0024

(c) – 0.0012 (d) 0.0012

Q.13 The ratio of the radii of the nuclei ${}^{27}_{13}Al$ and ${}_{52}Te^{125}$ is approximately -

(a) 6 : 10 (b) 13 : 52

(c) 40 : 177 (d) 14 : 73

Q.14 The radius of the ${}_{30}Zn^{64}$ nucleus is nearly (in fm)-

(a) 1.2 (b) 2.4

(c) 3.7 (d) 4.8

Q.15 How many electrons, protons, and neutrons are there in a nucleus of atomic number 11 and mass number 24?

(a) 11, 12, 13 (b) 11, 11, 13

(c) 12, 11, 13 (d) 11, 13, 12

Q.16 Energy of each photon obtained in the pair production process will be, if the mass of electron or positron is 1/2000 a.m.u-

(a) 0.213 MeV (b) 0.123 MeV

(c) 0.321 MeV (d) 0.465 MeV

Q.17 Deuterium is an isotope of hydrogen having a mass of 2.01470 amu. Find binding energy in MeV of this isotope

(a) 2.741 MeV (b) 2.174 MeV

(c) 1.741 MeV (d) 0.741 MeV

Q.18 The binding energy per nucleon for ${}_{3}Li^{7}$ will be, if the mass of ${}_{3}Li^{7}$ is 7.0163 a.m.u.

(a) 5.6 MeV (b) 39.25 MeV

(c) 1 MeV (d) zero

RESPONSE GRID					
	6. ⓐⓑⓒⓓ	7. ⓐⓑⓒⓓ	8. ⓐⓑⓒⓓ	9. ⓐⓑⓒⓓ	10. ⓐⓑⓒⓓ
	11. ⓐⓑⓒⓓ	12. ⓐⓑⓒⓓ	13. ⓐⓑⓒⓓ	14. ⓐⓑⓒⓓ	15. ⓐⓑⓒⓓ
	16. ⓐⓑⓒⓓ	17. ⓐⓑⓒⓓ	18. ⓐⓑⓒⓓ		

Space for Rough Work

Q.19 Sun radiates energy in all direction. The average energy recieved at earth is 1.4 kW/m^2. The average distance between the earth and the sun is 1.5×10^{11} m. If this energy is released by conservation of mass into energy, then the mass lost per day by the sun is approximately

(Use 1day = 86400 sec)

(a) 4.4×10^9 kg (b) 7.6×10^{14} kg

(c) 3.8×10^{12} kg (d) 3.8×10^{14} kg

Q.20 Fission of nuclei is possible because the binding energy per nucleon in them

(a) increases with mass number at high mass number

(b) decreases with mass number at high mass number

(c) increases with mass number at low mass numbers

(d) decreases with mass number at low mass numbers

Q.21 Half life of Bi^{210} is 5 days. If we start with 50,000 atoms of this isotope, the number of atoms left over after 10 days is

(a) 5,000 (b) 25,000

(c) 12,500 (d) 20,000

DIRECTIONS (Q.22-Q.24) : In the following questions, more than one of the answers given are correct. Select the correct answers and mark it according to the following codes:

Codes :

(a) 1, 2 and 3 are correct **(b)** 1 and 2 are correct

(c) 2 and 4 are correct **(d)** 1 and 3 are correct

Q.22 On disintegration of one atom of U^{235} the amount of energy obtained is 200 MeV. The power obtained in a reactor is 1000 KW. Then

(1) atoms disintegrated per second in reactor is 3.125×10^{16}

(2) atoms disintegrated per second in reactor is 3.125×10^{18}

(3) decay in mass per hour is 4×10^{-8} kg

(4) decay in mass per hour is 4×10^{-6} kg

Q.23 Which of the following are not examples of nuclear fusion?

(1) Formation of *Ba* and *Kr* from U^{235}

(2) Formation of *Pu* – 235 from U^{-235}

(3) Formation of water from hydrogen and oxygen

(4) Formation of *He* from *H*

Q.24 Which of the following are mode of radioactive decay?

(1) Positron emission (2) Electron capture

(3) Alpha decay (4) Fusion

DIRECTIONS (Q.25-Q.27) : Read the passage given below and answer the questions that follows :

In a living organism, the quantity of C^{14} is the same as in the atmosphere. But in organisms which are dead, no exchange takes place with the atmosphere and by measuring the decay rate of ^{14}C in the old bones or wood, the time taken for the activity to reduce to this level can be calculated. This gives the age of the wood or bone.

Given : $T_{1/2}$ for ^{14}C is 5370 years and the ratio of $^{14}C/^{12}C$ is 1.3×10^{-12}.

Q.25 The decay rate of ^{14}C in 1g of carbon in a living organism is

(a) 25 Bq (b) 2.5 Bq

(c) 0.25 Bq (d) 5 Bq

RESPONSE GRID					
	19. ⓐⓑⓒⓓ	20. ⓐⓑⓒⓓ	21. ⓐⓑⓒⓓ	22. ⓐⓑⓒⓓ	23. ⓐⓑⓒⓓ
	24. ⓐⓑⓒⓓ	25. ⓐⓑⓒⓓ			

Space for Rough Work

Q.26 If in an old sample of wood of 10g the decay rate is 30 decays per minute, the age of the wood is

(a) 50 years (b) 1000 years

(c) 13310 years (d) 15300 years

Q.27 The decay rate in another piece is found to be 0.30 Bq per gm then we can conclude

(a) the sample is very recent

(b) the observed decay is not that of ^{14}C alone

(c) there is a statistical error

(d) all of these

DIRECTIONS (Q. 28-Q.30) : Each of these questions contains two statements: Statement-1 (Assertion) and Statement-2 (Reason). Each of these questions has four alternative choices, only one of which is the correct answer. You have to select the correct choice.

(a) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.

(b) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.

(c) Statement -1 is False, Statement-2 is True.

(d) Statement -1 is True, Statement-2 is False.

Q.28 **Statement-1 :** Amongst alpha, beta and gamma rays, γ-has maximum penetrating power.

Statement-2 : The alpha particle is heavier than beta and gamma rays.

Q.29 **Statement-1 :** The mass of β-particles when they are emitted is higher than the mass of electrons obtained by other means.

Statement-2 : β-particle and electron, both are similar particles.

Q.30 **Statement-1 :** Electron capture occurs more often than positron emission in heavy elements.

Statement-2 : Heavy elements exhibit radioactivity.

RESPONSE GRID				
26. ⓐⓑⓒⓓ	27. ⓐⓑⓒⓓ	28. ⓐⓑⓒⓓ	29. ⓐⓑⓒⓓ	30. ⓐⓑⓒⓓ

DAILY PRACTICE PROBLEM SHEET 56 - PHYSICS			
Total Questions	30	Total Marks	120
Attempted		Correct	
Incorrect		Net Score	
Cut-off Score	28	Qualifying Score	48
Success Gap = Net Score – Qualifying Score			
Net Score = (Correct × 4) – (Incorrect × 1)			

Space for Rough Work

DAILY PRACTICE PROBLEMS

PHYSICS SOLUTIONS

56

1. **(c).** The energy produced per second is

$$= 1000 \times 10^3 \text{ J} = \frac{10^6}{1.6\times10^{-19}} \text{ eV } 6.25 \times 10^{24} \text{ eV}$$

The number of fissions should be, thus

$$\text{number} = \frac{6.25\times10^{24}}{200\times10^6} = 3.125 \times 10^{16}$$

2. **(b).** No. of atoms in 2kg $_{92}U^{235} = \frac{2}{235} \times N_A$

$$= \frac{2}{235} \times (6.02 \times 10^{26}) = 5.12 \times 10^{24}$$

$$\text{Fission rate} = \frac{5.12\times10^{24}}{30\times24\times60\times60} = 1.975 \times 10^{18} \text{ per sec}$$

Usable energy per fission = 185 MeV

∴ Power output

$= (185 \times 10^6)(1.975 \times 10^{18})(1.6 \times 10^{-19})$ watt

$= 58.4 \times 10^6$ watt = 58.46 MW

3. **(d).** ∴ 6 gm of $_6C^{12}$ contains atoms $= \frac{6\times10^{23}}{2}$ and each atom of $_6C^{12}$ contains electron, protons and neutrons = 6, 6, 6

∴ No. of electron, protons and neutron in 6 gm of $_6C^{12} = 18 \times 10^{23}, 18 \times 10^{23}, 18 \times 10^{23}$

4. **(c).** Use ρ = Mass/volume

$$= \frac{1.66\times10^{-27}\times16}{(4/3)\pi(3\times10^{-15})} = 2.35 \times 10^{17} \text{ kg m}^{-3}$$

5. **(a).** Mass defect Δm = M (Ra 226) – M(Rn 222) – M (α)
= 226.0256 – 222.0175 – 4.00026 = 0.0053 u.

6. **(a).** $E = mc^2 = (1.66 \times 10^{-27})(3 \times 10^8)^2$ J
$= 1.49 \times 10^{-10}$ J

$$= \frac{1.49\times10^{-10}}{1.6\times10^{-13}} \text{ MeV} = 931.49 \text{ MeV}$$

7. **(b).** $E = mc^2$
$= (9.1 \times 10^{-31})(3 \times 10^8)^2$ J = 0.51 MeV

8. **(c).** $\Delta E = \Delta mc^2$

$$\Delta m = \frac{0.5}{100} \text{kg} = 0.005 \text{ kg}$$

$c = 3 \times 10^8$ m/s

$\Delta E = 0.005 \times (3 \times 10^8)^2$

$\Delta E = 4.5 \times 10^{14}$ J or watt-sec

$$\Delta E = \frac{4.5\times10^{14}}{60\times60} = 1.25 \times 10^{11} \text{ watt hour}$$

$\Delta E = 1.25 \times 10^8$ kWH

9. **(b).** By the forumula $N = N_0 e^{-\lambda t}$

Given $\frac{N}{N_0} = \frac{1}{20}$ and $\lambda = \frac{0.6931}{3.8} \Rightarrow 20 = e^{\frac{0.631\times t}{3.8}}$

Taking log of both sides

$$\text{or } \log 20 = \frac{0.6931\times t}{3.8}\log_{10} e$$

$$\text{or } 1.3010 = \frac{0.6931\times t\times0.4343}{3.8} \Rightarrow t = 16.5 \text{ days}$$

10. **(b).** A = 238 - 4 = 234, Z = 92 - 2 = 90

11. **(a).** Δm = 0.03 a.m.u., A = 4

$$\Rightarrow \Delta E = \frac{\Delta m\times931}{A}$$

$$\Rightarrow \Delta E = \frac{0.03\times931}{4} = 7 \text{ MeV}$$

12. **(a).** ∵ ΔE = Δm × 931 MeV

$$\Rightarrow \Delta m = \frac{\Delta E}{931} = \frac{2.23}{931} = 0.0024 \text{ a.m.u.}$$

13. **(a).** $\frac{R_{Al}}{R_{Te}} = \frac{(27)^{1/3}}{(125)^{1/3}} = \frac{3}{5} = \frac{6}{10}$

14. **(d).** $R = R_0 A^{1/3} = 1.2 \times 10^{-15} \times (64)^{1/3}$
$= 1.2 \times 10^{-15} \times 4 = 4.8$ fm

15. **(b).** Number of protrons in nucleus = atomic number = 11
Number of electrons = number of protons = 11.
Number of neutrons = mass number A – atomic number Z
N = 24 – 11 = 13

16. **(d).** ∵ equivalent mass of each photon = 1/2000 amu
∵ 1 amu = 931 MeV

$$\therefore \text{Energy of each photon} = \frac{931}{2000} = 0.465 \text{ MeV}$$

17. **(c).** Deuterium, the isotope of hydrogen consits of one proton and neutron. Therefore mass of nuclear constituents of deuterium = mass of proton + mass of neutron
= 1.00759 + 1.00898 = 2.01657 amu.
mass of nucleus of deuterium = 2.01470 amu.
Mass defect = 2.01657 – 2.01470 = 0.00187 amu.
Binding energy = ΔE = 0.00187 × 931 MeV = 1.741 MeV.

18. **(a).** $E = \frac{\Delta E}{A} = \frac{\Delta m\times931}{A}$ MeV

$\Delta m = (3m_p + 4m_n)$ – mass of Li^7

$\Delta m = (3 \times 1.00759 + 4 \times 1.00898) - 7.01653$

Δm = 0.04216 a.m.u.

$$\Delta E = \frac{0.04216\times931}{7} = \frac{39.25}{7} = 5.6 \text{ MeV}$$

19. **(d).** The sun radiates energy in all directions in a sphere. At a distance R, the energy received per unit area per second is 1.4 KJ (given). Therefore the energy released in area $4\pi R^2$ per sec is $= 1400 \times 4\pi R^2$ Joule the energy released per day $= 1400 \times 4\pi R^2 \times 86400$J

where $R = 1.5 \times 10^{11}$ m, Thus

$\Delta E = 1400 \times 4 \times 3.14 \times (1.5 \times 10^{11})^2 \times 86400$

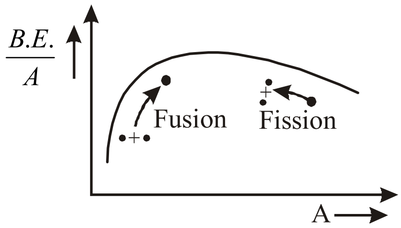
The equivalent mass is

$\Delta m = \Delta E/c^2$

$$\Delta m = \frac{1400 \times 4 \times 3.14 \times (1.5 \times 10^{11})^2 \times 86400}{9 \times 10^{16}}$$

$\Delta m = 3.8 \times 10^{14}$ kg

20. **(b)**



21. **(c)** $N_t = N_0\left(\frac{1}{2}\right)^{t/T} = 50000\left(\frac{1}{2}\right)^{10/5} = 12500$

22. **(d).** Power received from the reactor,

$P = 1000$ KW $= 1000 \times 1000$ W $= 10^6$ J/s

$$P = \frac{10^6}{1.6 \times 10^{-19}} \text{ eV/sec.}$$

$P = 6.25 \times 10^{18}$ MeV/sec

$\therefore$ number of atoms disintegrated per sec

$$= \frac{6.25 \times 10^{18}}{200} = 3.125 \times 10^{16}$$

Energy released per hour $= 10^6 \times 60 \times 60$ Joule

Mass decay per hour $= \Delta m = \frac{\Delta E}{c^2}$

$$\Rightarrow \Delta m = \frac{10^6 \times 60 \times 60}{(3 \times 10^8)^2}$$

$\Rightarrow \Delta m = 4 \times 10^{-8}$ kg

23. **(a)**

24. **(a)** In fusion two lighter nuclei combines, it is not the radioactive decay.

25. **(c)** The number of ^{12}C atoms in 1g of carbon,

$$N = \frac{N_A}{12} \times m \Rightarrow N = \frac{6.022 \times 10^{23}}{12} \times 1$$

$= 5.02 \times 10^{22}$ atoms.

The ratio of $^{14}C/^{12}C$ atoms $= 1.3 \times 10^{-12}$ (Given)

$\therefore$ Number of ^{14}C atoms $= 5.02 \times 10^{22} \times 1.3 \times 10^{-12}$

$= 6.5 \times 10^{10}$

$\therefore$ Rate of decay $R_0 = \lambda N_0 = \frac{0.693}{T_{1/2}} N_0$

$$\therefore R_0 = \frac{0.693 \times 6.5 \times 10^{10}}{5730 \times 365 \times 24 \times 3600}$$

$= 0.25$ Bq $= 0.25$ (decays/s)

26. **(c)** For 10g sample, number of decays = 0.5 per second. i.e. $R = 0.05$ and $R_0 = 0.25$ for each gram of ^{14}C

$$\frac{R}{R_0} = e^{-\lambda t} \Rightarrow t = \frac{1}{\lambda}\frac{\ln(R_0/R)}{1} = \frac{\ln(R_0/R)}{(0.693/T_{1/2})}$$

$$\Rightarrow t = \frac{5730 \text{ years}}{0.693} \times \ln\left(\frac{0.25}{0.05}\right) = 13310 \text{ years}$$

27. **(d)** If there are no other radioactive ingredients, the sample is very recent. But the error of measurement must be high unless the statistical error itself is large. In any case, for an old sample, the activity will not be higher than that of a recent one.

28. **(d)** The penetrating power is maximum in case of gamma rays because gamma rays are an electromagnetic radiation of very small wavelength.

29. **(b)** β-particles, being emitted with very high velocity (up to 0.99 c). So, according to Einstein's theory of relatively, the mass of a β-particle is much higher compared to is its rest mass (m_0). The velocity of electrons obtained by other means is very small compared to c (Velocity of light). So its mass remains nearly m_0. But β-particle and electron both are similar particles.

30. **(b)** Electron capture occurs more often than positron emission in heavy elements. This is because if positron emission is energetically allowed, electron capture is necessarily allowed, but the reverse is not true *i.e.* when electron caputre is energetically allowed, positron emission is not necessarily allowed.