The Brigade School	Physics	Class 10		Time:
Date : 26-11-2020		Radioactivity Answer key		MM :45

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1 Which one is unstable amongst proton, neutron, electron and α-particle? 1

ANS: Neutron.

2 What is the origin of X-rays and γ-radiations? 1

ANS: X-rays are produced due to the transition of electrons in the inner orbits of an atom, while the γ-radiations are given out from the nucleus.

3 What is the use of a photograph taken with a metallic plate in front of the screen? 1

ANS: A photograph taken with a metallic plate in front of the screen helps us to detect the flaws and cracks in metal casting.

4 An α-particle absorbs an electron. What does it change to? 1

ANS: An α-particle after absorbing an electron becomes helium ion (He^{+}).

5 Name the radioactive radiations emitted from a radioactive element. 1

ANS: Carbon dating, Isotope C–14

7 Why do doctors wear lead aprons and spectacles while working near X-ray machine? 1

ANS: X-rays do not penetrate the lead and thus doctor's body is not exposed to X-rays.

8 What is the difference between an electron and a β-particle? 2

ANS: Basically β-particle and an electron has no difference. β-particle is the name given to an electron emitted from the nucleus.

9 An element X changes to another element Y with the emission of beta particle. Write down the equation showing changes in the nucleus. Take the proton number and mass number of X, as Z and A respectively. 2

ANS: $${}^{A}_{Z}X \xrightarrow[\text{emission}]{\beta\text{-particle}} {}^{A}_{Z+1}Y + \underset{(\beta\,-\,\text{particle})}{{}^{0}_{-1}e}$$

10 A radioactive element ${}^{A}_{Z}X$ first emits a β particle and then an alpha particle and the resulting nucleus can be represented ${}^{P}_{Q}Y$. What are the values of *P* and *Q* in terms of *A* and *Z*? 2

ANS: ${}^{A}_{Z}X \xrightarrow{\beta\text{–particle}}$ nucleus of some other element say ${}^{A}_{Z+1}U$ having the same mass number but the atomic number increases by 1. On further emission of an alpha particle $({}^{4}_{2}\text{He})$ ${}^{A}_{Z+1}U \xrightarrow{\alpha\text{–particle}} {}^{A-4}_{Z-1}Y$ Hence the values of *P* and *Q* are respectively equal to
P = A–4, *Q* = Z–1

11 Following equations reflect the nuclear reactions described incompletely. Fill in the gaps in these equations by employing the conservation of masses and the atomic numbers of the reacting species and products. 2

(*a*) ${}^{27}_{13}\text{Al} + {}^{4}_{2}\text{He} \longrightarrow {}^{30}_{14}\text{Si} + *$ (*b*) ${}^{39}_{19}\text{K} + * \longrightarrow {}^{42}_{20}\text{Ca} + {}^{1}_{1}\text{H}$

ANS: (a) ${}^{1}_{1}\text{H}$ (b) ${}^{4}_{2}\text{He}$

12 Complete the following nuclear reactions successfully demonstrated with the following energetic projectiles: α-particles, protons, γ-rays, neutrons. 2

(*a*) ${}^{24}_{12}\text{Mg} + * \longrightarrow {}^{23}_{11}\text{Na} + {}^{1}_{1}\text{H}$ (*b*) ${}^{27}_{13}\text{Al} + {}^{1}_{1}\text{H} \longrightarrow * + {}^{1}_{0}n$

ANS: (a) γ-radiation (b) ${}^{27}_{14}\text{Si}$

13 A certain nucleus X has a mass number 14 and atomic number 6. The nucleus X changes to ${}^{14}_{7}\text{Y}$ after the loss of a particle. 2
(a) Name the particle emitted.
(b) Represent this change in the form of an equation.

ANS: (a) β-particle is emitted.
(b) The required equation is as shown below. ${}^{14}_{6}\text{X} \longrightarrow {}^{14}_{7}\text{Y} + {}^{0}_{-1}e$

14 In nuclear reaction ${}^{27}_{12}\text{Mg} \xrightarrow{-\beta} \text{Al} \xrightarrow{-\gamma}$ (a) ${}^{27}_{12}\text{Mg}$ emits a β-particle and is transformed to aluminium. What is the mass number and the atomic number of aluminium? (b) Aluminium emits a γ ray. What is the resulting nucleus? 2

ANS: (a) ${}^{27}_{12}\text{Mg} \xrightarrow{-\beta} {}^{27}_{13}\text{Al}$
Mass number of aluminium = 27
Atomic number of aluminium = 13
(b) ${}^{27}_{13}\text{Al} \xrightarrow{-\gamma}$ No change in the nucleus

15 Select the pairs of isobars and isotopes from the following nuclei: 2
${}^{14}_{6}\text{C}, {}^{13}_{7}\text{N}, {}^{14}_{7}\text{N}, {}^{16}_{8}\text{O}, {}^{13}_{6}\text{C}, {}^{30}_{15}\text{P}, {}^{17}_{8}\text{O}, {}^{24}_{11}\text{Na}, {}^{31}_{15}\text{P}, {}^{18}_{8}\text{O}, {}^{22}_{11}\text{Na}, {}^{23}_{11}\text{Na}, {}^{23}_{12}\text{Mg}$

ANS: Isotopes: $({}^{13}_{6}\text{C}, {}^{14}_{6}\text{C}), ({}^{13}_{7}\text{N}, {}^{14}_{7}\text{N}), ({}^{16}_{8}\text{O}, {}^{17}_{8}\text{O}, {}^{18}_{8}\text{O}), ({}^{30}_{15}\text{P}, {}^{31}_{15}\text{P}), ({}^{22}_{11}\text{Na}, {}^{23}_{11}\text{Na}, {}^{24}_{11}\text{Na})$ Isobars: $({}^{13}_{6}\text{C}, {}^{13}_{7}\text{N}), ({}^{23}_{11}\text{Na}, {}^{23}_{12}\text{Mg}), ({}^{14}_{6}\text{C}, {}^{14}_{7}\text{N})$

16 (a) Give one difference between a chemical change and a nuclear change.
(b) Copy and complete the following nuclear equations by filling the correct values in the blanks: 2

$$^{238}_{92}\mathrm{P} \xrightarrow{-\alpha} {}^{\cdots\cdots}_{\cdots\cdots}\mathrm{P}_1 \xrightarrow{-\beta} {}^{\cdots\cdots}_{\cdots\cdots}\mathrm{P}_2 \xrightarrow{-\beta} {}^{\cdots\cdots}_{\cdots\cdots}\mathrm{P}_3$$

ANS: (a) In a chemical change, atomic number of an element is not changed.
In a nuclear change, atomic number of an element is changed.
(b)

$$^{238}_{92}\mathrm{P} \xrightarrow{-\alpha} {}^{234}_{90}\mathrm{P}_1 \xrightarrow{-\beta} {}^{234}_{91}\mathrm{P}_2 \xrightarrow{-\beta} {}^{234}_{92}\mathrm{P}_3$$

17 A nucleus $^{A}_{Z}X$ emits an alpha particle followed by γ-emission; thereafter it emits two β-particles to form X_3.
(a) Copy and complete the values of A and Z for X_3:

$$^{A}_{Z}X \xrightarrow{-\alpha} X_1 \xrightarrow{-\gamma} X_2 \xrightarrow{-2\beta} {}^{\cdots\cdots}_{\cdots\cdots}\mathrm{X}_3$$

2

(b) Out of alpha (α), beta (β) and gamma (γ) radiations –
(i) which radiation is the most penetrating?
(ii) which radiations are negatively charged?

ANS: (a)

$$^{A}_{Z}X \xrightarrow{-\alpha} {}^{A-4}_{Z-2}X_1 \xrightarrow{-\gamma} {}^{A-4}_{Z-2}X_2 \xrightarrow{-2\beta} {}^{A-4}_{Z}X_3$$

(b) (i) γ-radiation
(ii) β-radiations

18 Which of the radioactive radiations
(a) can cause severe genetical disorders?
(b) are deflected by an electric field? 2

ANS: (a) Gamma radiations can cause severe genetical disorders.
(b) α and β radiations are deflected by an electric field.

19 (a) When an alpha particle gains two electrons it becomes neutral and becomes an atom of an element which is a rare gas. What is the name of this rare gas?
(b) (i) Define radioactivity.
(ii) What happens inside the nucleus that causes the emission of beta particle?
(iii) Express the above change in the form of an equation. 3

ANS: (a) Helium gas.
(b) (i) Radioactivity is the process of spontaneous emission of alpha, beta and gamma radiations from nuclei of atoms during their decay.
(ii) Inside a nucleus the change of a neutron into a proton causes the emission of beta particle.
(iii)

$$^{1}_{0}n \longrightarrow {}^{1}_{1}p + {}^{0}_{-1}e$$

20 A nucleus $_{11}Na^{24}$ emits a beta particle to change into Magnesium (Mg).
(a) Write the symbolic equation for the process.
(b) What are numbers 24 and 11 called?
(c) What is the general name of $^{24}_{12}\mathrm{Mg}$ with respect to $^{24}_{11}\mathrm{Na}$? 3

ANS: (a)
$^{24}_{11}Na \longrightarrow {}^{24}_{12}Mg + {}^{0}_{-1}e$ (b) 24-Mass number (number of protons and neutrons)
11-Atomic number (number of protons) (c) $^{24}_{12}Mg$ and $^{24}_{11}Na$ are named as isobars.

21 How many alpha and beta particles are emitted when Uranium nucleus $^{238}_{92}U$ decays to Lead $^{206}_{82}Pb$? 3

ANS: Due to an alpha $^{4}_{2}He$ decay, the mass number of the new element formed decreases by 4 and atomic number decreases by 2.
i.e., number of α-decays = $\frac{238-206}{4} = \frac{32}{4} = 8$ This would give atomic number Z = 92 – (8 × 2) = 92 – 16 = 76
Due to a beta $(^{0}_{-1}e)$ decay, the atomic number increases by 1 and mass number remains the same. Therefore, number of β decays = 82 – 76 = 6.

22 The following are the different types of radiation:
alpha (α), beta (β), gamma (γ), infrared, radio, ultraviolet, visible
(a) Which radiations are not electromagnetic radiations?
(b) Which radiation is the most penetrating? 3
(c) Which radiation has the longest wavelength?
(d) Which radiation consists of particles that are the same as $^{4}_{2}He$ nuclei?

ANS: (a) Alpha and beta both are not electromagnetic radiations.
(b) Gamma radiation is the most penetrating.

(c) Radio waves has the longest wavelength.
(d) Alpha radiation consists of particles that are the same as $^{4}_{2}He$ nuclei.

23 (a) Arrange α, β and γ rays in ascending order with respect to their
(i) penetrating power, (ii) ionising power, (iii) biological effect.
(b) (i) Represent the change in the nucleus of a radioactive element when a b-particle is emitted. 4
(ii) What is the name given to elements with same mass number and different atomic number?
(iii) Under which conditions does the nucleus of an atom tend to be radioactive?

ANS: (a) Arrangement of α, β and γ in ascending order with respect to their
(i) Penetrating power: γ > β > α, (ii) Ionising power: α > β > γ
(iii) Biological effect: γ > β > α
(b) (i) When a β particle is emitted from the nucleus of a radioactive element, the nucleus represent the following change.
$^{1}_{0}n \longrightarrow {}^{1}_{1}p + {}^{0}_{-1}e + \overline{\nu}$
(neutron) (proton) (β-particle) (antineutrino) (ii) Isobars
(iii) The nucleus of an atom tends to be radioactive if the atomic number of the atom is more than 82, and there is an imbalance of protons and neutrons as compared to the normal stable atom.