PHYSICS

BOOKS - HC VERMA PHYSICS (HINGLISH)

THE NUCLEOUS

Examples

1. Calculate the radius of $\hat{\ } 70Ge$

Watch Video Solution

2. Calculate the binding energy of an alpha particle from the following data:

$massof_1^1 Ha \rightarrow m = 1.007825u$

mass of neutron $= 1.008665u$

mass of $\_4^2Hea \rightarrow m = 4.00260u$.

Take $1u = 931 MeVc^{-2}$

Watch Video Solution

3. The atomic mass of $\_1^1H$ is $1.00783u$. Calculate the mass excess of hydrogen.

Watch Video Solution

4. The decay constant for the radioactive nuclide $64Cu$ is $1.516 \times 10^{-5} s^{-1}$. Find the activity of a sample containing $1 \mu g$ of $\hat{}\ 64Cu$. Atomic weight of copper $= 63.5 gmo \le^{-1}$. Neglect the mass difference between the given radioisotope and normal coper.

Watch Video Solution

5. The half-life of a radioactive nuclide is 20 hours. What fraction of original activity will remain after 40 hours?

A. $\frac{1}{4}$

B. $\frac{1}{3}$

C. $\frac{1}{2}$

D. $\frac{1}{6}$

Answer: A

Watch Video Solution

6. The binding anergy per nucleon is $8.5MeV$ for $A = 120$ and is $7.6MeV$ for $A = 240$ (see in figure). Suppose a nucleus with $A = 240$ breaks into two nuclei of nearly equal mass numbers. Calculate the energy released in the process.

Watch Video Solution

7. Consider two deuterons moving towards each other with equal speeds in a deuteron gas. What should be their kinetic energies (when they are widely separated) so that the closest separation between them becomes $2fm$? Assume that the nuclear force is not effective for separations greater than $2fm$. At what temperature will the deuterons have this kinetic energy on an average?

Watch Video Solution

Worked Out Examples

1. Calculate the electric potential energy due to the electri repulsion between two nuclei of $\hat{} 12C$ when they $\rightarrow uch$ each other at the surface.

Watch Video Solution

2. Find the binding energy of $\_26^{56}Fe$. Atomic mass of $\hat{} 56Fe$ is $55.9349u$ and that of $\hat{} 1H$ is $1.00783u$. Mass of neutron $= 1.00867u$.

Watch Video Solution

3. Find the kinetic energy of the α - particle emitted in the decay $\hat{} 238Pu \rightarrow^{234} U + \alpha$. The atomic masses needed are as following:

$\hat{} 238Pu238.04955u$

$\hat{} 234U234.04095u$

$\hat{} 4He4.002603u$.

Neglect any recoil of the residual nucleus.

Watch Video Solution

4. Calculate the Q-value in the following decays:

(a) $\hat{} 19O \rightarrow^{19} F + e + \overrightarrow{v}$.

(b) $\hat{} 25A1 \rightarrow^{25} Mg + e^{+} + v$.

The atomic masses needed are as follows :

$\hat{} 19O19.003576u$

$\hat{} 19F18.998403u$

$\hat{} 25A124.990432u$

$\hat{} 25Mg24.985839u$

Watch Video Solution

5. Find the maximum energy that a beta particle can have in the following decay

$\hat{} 176Lu \rightarrow^{176} Hf + e + \overrightarrow{v}.$

Alomic mass of $\hat{} 176Lu$ is $175.942694u$ and that of $\hat{} 176Hf$ is $175.941420u.$

Watch Video Solution

6. Consider the beta decay

$\hat{} 198Au \rightarrow^{198} Hg* + B\eta^{-1} + \overrightarrow{v}.$

where $\hat{} 198Hg^{*}$ represents a mercury nucleus in an excited state at energy $1.088MeV$ above the ground state. What can be the maximum kinetic energy of the electron emitted? The atomic mass of $\hat{} 198Au$ is $197.968233u$ and that of $\hat{} 198Hg$ is $197.966760u$.

Watch Video Solution

7. The half-life of $\hat{} 198Au$ is $2.7 days$. Calculate (a) the decay constant, (b) the average-life and (C) the activity of $1.00 mg$ of $\hat{} 198Au$. Take atomic weight of $\hat{} 198Au$ to be $198 g mol^{-1}$.

Watch Video Solution

8. A radioactive sample has 6.0×10^{18} active nuclei at a certain instant. How many of these nuclei will still be in the same active state after two half-lives?

Watch Video Solution

9. The activity of a radioactive sample falls from `600 s^(-1) to 500 s^(-1) in 40 minutes. Calculate its half-life.

Watch Video Solution

10. The number of $\hat{} 238U$ atoms in an ancient rock equals the number of $\hat{} 206Pb$ atoms. The half-life of decay of $\hat{} 238U$ is $4.5 \times 10^9 y$. Estimate the age of the rock assuming that all the $\hat{} 206Pb$ atoms are formed from the decay of $\hat{} 238U$.

Watch Video Solution

11. Equal masses of two samples of charcoal A and B are burnt separately and the resulting carbon dioxide are collected in two vessels. The radioactivity of $\hat{} 14C$ is measured for both the gas samples. The gas from the charcoal A gives $2100 counts$ per week and the gas from the charcoal A gives 2100 counts per week and the gas from the charcoal B

gives 1400 counts per week. Find the age difference between the two samples. Half-life of $\hat{}\ 14C = 5730y$.

Watch Video Solution

12. Suppose, the daughter nucleus in a nuclear decay is itself radioactive. Let λ_p and λ_d be the decay constants of the parent and the daughter nuclei. Also, let N_p and N_d be the number of parent and daughter nuclei at time t. Find the condition for which the number of daughter nuclei becomes constant.

Watch Video Solution

13. A radioactive sample decays with an average life of $20ms$. A capacitor of capacitance $100\mu F$ is charged to some potential and then the plates are connected through a resistance R. What should be the value of R so that the ratio of the charge on the capacitor to the activity of the radioactive sample remains constant in time?

Watch Video Solution

Watch Video Solution

14. A radioactive nucleus can decay by two different processes. The half-life for the first process is t_1 and that for the second process is t_2. Show that the effective half-life t of the nucleus is given by

$$\frac{1}{t} = \frac{1}{t_1} + \frac{1}{t_2}.$$

Watch Video Solution

15. Calculate the energy released when three alpha particles combine to form a $\hat{}\ 12C$ nucleus. The atomic mass of $\_\ 2^4He$ is $4.002603u$.

Watch Video Solution

Short Answer

1. If neutrons exert only attractive force, why don't we have a nucleus containing neutrons alone?

Watch Video Solution

2. Consider two pairs of neutrons. In each pair, the separation between the neutrons is the same. Can the force between the neutrone have different magnitudes for the two pairs?

Watch Video Solution

3. A molecule of hydrogen contains two protons and two electrons. The nuclear force between these two protons is always neglected while discussing the behaviour of a hydrogen molecule. Why?

Watch Video Solution

4. Is it easier to take out a nucleon (a) from carbon or from iron (b) from iron or from lead?

Watch Video Solution

5. Suppose we have 12 protons and 12 neutrons. We can assemble them to form either a $\hat{}\ 24Mg$ nucleus or two $\hat{}\ 12C$ nuclei. In which of the two cases more energy will be liberated?

Watch Video Solution

6. What is the difference between cathode rays and beta rays? When the two are travelling in space, can you make out which is the cathode ray and which is the beta ray?

Watch Video Solution

7. If the nucleons of a nucleus are separated from each other, the total mass is increased. Where does this mass come from?

Watch Video Solution

8. In beta decay, an electron (or a positron) is emitted by a nucleus. Does the remaining atom get oppositely charged?

Watch Video Solution

9. When a boron nucleus ($_5^{10}B$) is bombarded by a neutron, an $\alpha - partic \leq$ is emitted. Which nucleus will be formed as a result?

Watch Video Solution

10. Does a nucleus lose mass when it suffers gamma decay?

Watch Video Solution

11. In a typical fission reaction, the nucleus is split into two middle-weight nuclei of unequal masses. Which of the two (heavier or lighter) has greater kinetic energy? Which one has greater linear momentum?

Watch Video Solution

12. If three helium nuclei combine to form a carbon nucleus, energy is liberated. Why can't helium nuclei combine on their own and minimise the energy?

Watch Video Solution

Objective 1

1. The mass of a neutral carbon atom in ground state is

A. exact $12u$

B. less than 12 u

C. more than $12u$

D. depends on the form of carbon such as graphite or charcoal.

Answer: A

Watch Video Solution

2. The mass number of a nucleus is equal to

A. the number of neutrons in the nucleus

B. the number of protons in the nucleus

C. the number of nucleons in the nucleus

D. none of them

Answer: C

Watch Video Solution

3. As compared to $\hat{}\ 12C$ atom, $\hat{}\ 14C$ atoms has

A. to extra protons and two extra electrons

B. two extra protons but no extra electron

C. two extra neutrons and no extra electron

D. two extra neutrons and two extra electrons

Answer: C

Watch Video Solution

4. The mass number of a nucleus is equal to

A. always less than its atomic number

B. always more than its atomic number

C. equal to its atomic number

D. sometimes more than and sometimes equal to its atomic number.

Answer: D

Watch Video Solution

5. The graph of $1n\left(\frac{R}{R_0}\right)$ versus $1nA(R = radius$ of a nucleus and $A =$ its mass number) is

A. a straight line

B. a parabola

C. an ellipse

D. none of them

Answer: A

Watch Video Solution

6. Let F_{pp}, F_{pn} and $F_{\cap}$ denote the magnitudes of the nuclear force by a proton on a proton, by a proton on a neutron and by a neutron on a neutron respectively. When the separation is $1fm$,

A. $F_pp > F_pn = F_{\cap}$

B. $F_pp = F_pn = F_{\cap}$

C. $F_pp > F_pn > F_\cap$

D. $F_pp < F_pn = F_\cap$

Answer: B

Watch Video Solution

7. Let F_pp, F_pn and $F_\cap$ denote the magnitudes of the nuclear force by a proton on a proton, by a proton on a neutron and by a neutron on a neutron respectively. When the separation is $1fm$,

A. $F_pp > F_pn = F_\cap$

B. $F_pp = F_pn = F_\cap$

C. $F_pp > F_pn > F_\cap$

D. $F_pp < F_pn = F_\cap$

Answer: D

Watch Video Solution

8. Two protons are kept at a separation of $10nm$. Let F_n and F_e be the nuclear force and the electromagnetic force between them.

A. $F_e = F_n$

B. $F_e > > F_n$

C. $F_e < < F_n$

D. F_e and F_n differ only slightly

Answer: B

Watch Video Solution

9. As the mass number A increases, the binding energy per nucleon in a nucleus.

A. increases

B. decreases

C. remains the same

D. varies in a way that depends on the actual value of A

Answer: D

Watch Video Solution

10. Which of the following is a wrong description of binding energy of a nucleus?

A. It is the energy required to break a nucleus into its constituent nucleons.

B. It is the energy made available when free nucleons combine to form a nucleus.

C. It is the sum of the rest mass energies of its nucleons minus the rest mass energy of the nucleus.

D. It is the sum of the kinetic energy of all the nucleons in the nucleus.

Answer: D

Watch Video Solution

11. In one average-life,

A. half the active nuclei decay

B. less than half the active nuclei decay

C. more than half the active nuclei decay

D. all the nuclei decay

Answer: C

Watch Video Solution

12. In a radioactive decay, neither the atomic number nor the mass number changes. Which of the following particles is emitted in the decay?

A. Proton

B. Neutron

C. Electron

D. Photon

Answer: D

Watch Video Solution

13. During a negative beta decay,

A. an atomic electron is ejected

B. an electron which is already present within the nucleus is ejected

C. a neutron in the nucleus decays emitting an electron

D. a proton in the nucleus decays emitting an electron

Answer: C

Watch Video Solution

14. A freshly prepared radioactive source of half-life $2h$ emits radiation of intensity which is 64 times the permissible safe level. The minimum time after which it would be possible to work safely with this source is

A. $6h$

B. $12h$

C. $24h$

D. $128h$

Answer: B

Watch Video Solution

15. The decay constant of a radioactive sample is λ. The half-life and the average-life of the sample are respectively

A. `1//(lambda) and (1n2//(lambda)

B. `(1n 2//(lambda)) and 1//(lambda)

C. $\lambda(1n2)$ and $1/(\lambda)$

D. $\lambda/(1n2)$ and $1/\lambda)$

Answer: B

Watch Video Solution

16. An α particle is bombarded on $\hat{} 14N$. As a result, a $\hat{} 17O$ nucleus is formed and a particle is emitted. This particle is a

A. neutron

B. proton

C. electron

D. positron

Answer: B

Watch Video Solution

17. Ten grams of $\hat{} 57Co$ kept in an open container beta-decays with a half-life of 270 days. The weight of the material inside the container after 540 days will be very nearly

A. 10 g

B. 5 g

C. 2.5 g

D. 1.25 g

Answer: A

Watch Video Solution

18. Free $\hat{} 238U$ nuclei kept in a train emit alpha particles. When the train is stationary and a uranium nucleus decays, a passenger measues that the separation betwee the alpha particle and the recoiling nucleus becomes x in time

$tafterthedecay. If adecaytakesplacewhenthetra \in ismov \in gataun$ if

v

$, thedis\tan cebetweentheαpartic \leq$ and $therecoil \in gνc \leq usatatime$

t` after the decay, as measured by the passenger will be

A. $x + vt$

B. $x - vt$

C. x

D. depends on the direction of the train

Answer: C

Watch Video Solution

19. During a nuclear fission reaction,

A. a heavy nucleus breaks into two fragments by itself

B. a light nucleus bombarded by thermal neutrons breaks up

C. a heavy nucleus bombarded by thermal neutrons breaks up

D. two light nuclei combine to give a heavier nucleus and possibly other products

Answer: C

Watch Video Solution

Objective 2

1. As the mass number A increases, which of the following quantities related to a nucleus do not change?

A. Mass

B. Volume

C. Density

D. Binding energy

Answer: C

Watch Video Solution

2. The heavier nuclei tend to have larger N/Z ratio because

A. a neutron is heavier than a proton

B. a neutron is an unstable particle

C. a neutron does not exert electric repulsion

D. Coulomb forces have longer range compared to the nuclear forces

Answer: C::D

Watch Video Solution

3. A free neutron decays to a proton but a free proton does not decay to a neutron. This is because

A. neutron is a composite particle made of a proton and an electron whereas proton is a fundamental particle

B. neutron is an uncharged particle whereas proton is a charged particle

C. neutron has larger rest mass than the proton

D. weak forces can operate in a neutron but not in a proton.

Answer: C

Watch Video Solution

4. Consider a sample of a pure beta-active material

A. All the beta particles emitted have the same energy.

B. The beta particles originally exist inside the nucleus and are ejected at the time of beta decay.

C. The antineutrino emitted in a beta decay has zero mass and hence zero momentum.

D. The active nucleus changes to one of its isobars after the beta decay.

Answer: D

Watch Video Solution

5. In which of the following decays the atomic number decreases?

A. α decay

B. β^{+} decay

C. β^{-} decay

D. γ decay

Answer: D

Watch Video Solution

6. In which of the following decays the element does not change?

A. α decay

B. β^{+} decay

C. β^{-} decay

D. γ decay

Answer: A::B

Watch Video Solution

7. Magnetic field does not cause deflection in

A. α rays

B. beta-plus rays

C. beta-minus rays

D. gamma rays

Answer: D

Watch Video Solution

8. Which of the following are electromagnetic waves?

A. α rays

B. beta-plus rays

C. beta-minus rays

D. gamma rays

Answer: D

Watch Video Solution

9. Two lithium nuclei in a lithium vapour at room temperature do not combine to form a carbon nucleus because

A. a lithium nucleus is more tightly bound than a carbon nucleus

B. carbon nucleus is an unstable particle

C. it is not energetically favourable

D. Coulomb repulsion does not allow the nuclei to come very close.

Answer: D

Watch Video Solution

10. For nuclei with $A > 100$,

A. the binding energy of the nucleus decreases on an average as A increases

B. the binding energy per nucleon decreases on an average as A increases

C. if the nucleus breaks into two roughly equal parts, energy is released

D. if two nuclei fuse to form a bigger nucleus, energy is released

Answer: B::C

Watch Video Solution

Exercises

1. Assume that the mass of a nucleus is approximately given by $M = Am_p$ where A is the mass number.Estimate the density of matter in kgm^{-3} inside a nucleus.

Watch Video Solution

2. A neutron star has a density equal to that of the nuclear matter. Assuming the staar to be spherical, find the radius of a neutron star whose mass is 4.0×10^{30}kg (twice the mass of the sun).

Watch Video Solution

3. Calculate the mass of an `alpha-particle.Its binding energy is 28.2 meV.

Watch Video Solution

4. how much energy is released in the following reaction:^7Li+p rarralpha+alpha. $A \rightarrow msmasspf\ \hat{}\ 7Li = 7.0160u$and that of ^4He=4.0026 u`.

Watch Video Solution

5. Find the binding energy per nucleon of _79^197Au` if its atomic mass is 196.96 u.

Watch Video Solution

6. (a)Calculate the energy relaeased if ^238U$emitsan$alpha -partical . (b)calculate the energy to be supplied to ^238U if $twopro \to ns$ and $two \ne utronsare \to beemiedo \ne byo \ne . Thealo$

$\hat{}\ 238U$, ^234Thand ^4He`are 238.0508U,234.04363 u and 4.00260 u

respectively.

Watch Video Solution

7. Find the energy liberated in the reaction

^223Ra rarr $\hat{}\ 209(Pb) +$ ^14C

$. Thea \to micmasses \ne ededareasfollows.\ \hat{}\ 223Ra$^209(Pb) $\hat{}\ 14C$

$223.18u208.981u14.003u.$

Watch Video Solution

8. Show that the minimum energy needed to sepatate a proton from a nucleus with Z protons and N neutrons is

$\Delta E = \left(M_z - 1 + M_H - M_{Z,N}c^2\right)$

where

$M_{Z,N} = massof$ and $a \to mwithZpro \to ns$ and $N \ne utrons \in thevc$

M_H=` mass of a hydrogen atom. this energy is known as proton-separation energy.

Watch Video Solution

9. Calculate the minimum energy needed to separate a neutron form a nucleus with Z protons and N neutrons in terms of the masses $M_{Z,N}, M_{Z,N-1}$ and the mass of the neutron.

Watch Video Solution

10. $\hat{}\ 32P$ beta-decays to $\hat{}\ 32S$.Find the sum of the energy of the antineutrino and the kinetic energy of the $\beta - partic \leq$. Neglect the recoil of the daughter nucleus. Atomic mass of $\hat{}\ 32P = 31.974u$ and that of $\hat{}\ 32S = 31.972u$.

Watch Video Solution

11. A free neutron beta-decays to a proton with a half-life of 14 minutes . (a)What is the decay constant ?(b)Find the energy liberated in the process.

Watch Video Solution

12. Complete the following decay schemes.

(a)_88^226Ra rarr alpha $+(b)\ \_\ 8^{19}O \rightarrow$ _19^9F $+(c)\ \_\ 25^{13}Al \rightarrow$ _12^25Mg +`.

Watch Video Solution

13. In the decay $\hat{}\ 64(Cu) \rightarrow$ ^64(Ni)+e^+v,

$the \max i\mu mk \in etice \neq rgycarriedbythe \neq tr \in owhichwasemied \rightarrow \in kgm$

s^(-1)`?Use the formula applicable to photon.

Watch Video Solution

14. Potassium-40 can decay in three modes .It can decay by β^- -emission, $\beta^+ - emission$ or $e \leq ctron \cap ature. (a) Writetheequationshow \in gthe$

_18^40(Ar), _19^40K and _20^40(Ca)` are 39.9624 u,39.9640 u,and 39.9626 u respectively.

Watch Video Solution

15. Lithium (Z=3) has two stable isotopes $\hat{}6Li$and $\hat{}7Li$.When neutrons are bombarded on lithium sample electrons and α -particles are ejected.Write down the nuclear processes taking place.

Watch Video Solution

16. The masses of ^{11}C and ^{11}B are respectively 11.0114 u and 11.0093 u.Find the maximum energy a position can have in the β^+-decay of ^{11}C to ^{11}B.

Watch Video Solution

17. $\hat{} 228Th$emits an alpha particle to reduce to $\hat{} 224Ra$.Calculate the kinetic energy of the alpha particle emitted in the following decay:

$\hat{} 228Th \rightarrow 224Ra * + \alpha$

224Ra** rarr $224Ra + \gamma(217keV)$.

Atomic mass of 228Th$is228.028726u, t\hat{o}f224Ra$is 224.020196 u and that of _2^4He` is 4.00260 u.

Watch Video Solution

18. Calculate the maximum kinetic energy of the bera particle emitted in the following decay scheme:

^12N rarr $12C * + e^{+} + v$

^12C rarr $\hat{} 12C + \gamma(4.43MeV)$.

The atomic mass of 12N$is12.018612u$.

Watch Video Solution

19. The decay constant of _80^197Hg$(e \leq ctron \cap ature \rightarrow _79^{197}Au$)is $1.8 \times 10^{-4} s^{-1}$.(a)What is the half-life?(b)What is the average-life ?(c)How much time will it take to convert 25% of mercury into gold?

Watch Video Solution

20. The half-life of ^198Au $is 2.7 days. (a) F \in d the activity of a samp \leq conta \in \in g$1.00 mu g of $\hat{}\ 198 Au$.(b) What will be the activity after 7 days ? Take the atomic weight of 198Au $\rightarrow be$198 g mol^-1`.

Watch Video Solution

21. Radioactive $138I$ has a half-life of 8.0 days .A sample containing $138I$ has activity $20\mu Ci$at t=0.(a) What is its activity at t=4.0 days?(b) What is its decay constant at t=4.0 days?

Watch Video Solution

22. The decay constant of ^238Uis4.9xx10^-18 s^-1. $(a)W\hat{i}stheavara \geq -l$ if $eof\ \hat{}\ 238U$?(b)What is the half-life of ^238U$?(c)Byw\widehat{f}ac \rightarrow rdoestheactivityofs\ \hat{}\ 238U$ sample decreases in 9×19^{9} years?

Watch Video Solution

23. A certain sample of a radioactive marerial decays at the rate of 500 per second at a cartain time .the count rate falls to 200 per second after 50 minutes .(a) What is decay constant of the sample? (b) what is its half-life?

Watch Video Solution

24. the count rate from a radioactive sample falls from 4.0×10^{6}per second to 1.0×10^{6} per second in 20 hours.What will be the count rate 100 hours after the begning ?

Watch Video Solution

Watch Video Solution

25. The half-life of ^226Ra$is1602y. Calcatetheactivityof0.1gof$RaCl_2 $\in whichalltheradiumis \in thef$ or mof ^ $226Ra$.Taken atomic weight of Ra to be the 226 g mol^{-1} and that of C1 to be $35.5gmol^{-1}$.

Watch Video Solution

26. The half-life of a radioisotope is 10 h . Find the total number of disintergrations in the tenth hour measured from a time when the activity was 1 Ci.

Watch Video Solution

27. The selling rate of a radioactive isotope is decided by its activity. What will be the second-hand rate of a oe month old ^32P(t_(1//2)=14.3 days)source if it was originally purchased for 800 rupees?

Watch Video Solution

28. ^57Co$decays \rightarrow$ ^ $57Fe$ byβ^+ -emission.The resulting ^57Fe $is \in itsexcitedstate$ and $comes \rightarrow thegroundstatebyemi \in g$gamma $-rays. The half-l$ if eofbeta^+$-decayis270days$ and $t\hat{o}fthe$ gamma$-emissionis$10^(-8)$s. Asamp \le of$ ^ $57Co$ given 5.0×10^9 gamma rays per second.How much time will elapse before the emission rate of gamma rays drops to 2.5×10^9 per second ?

Watch Video Solution

29. Carbon (Z=6) with mass number 11 decays to boron (Z=5).(a) Is it a β^+ -decay? (b) the half-life of the decay scheme is 20.3 minutes .How much time will elapse before a mixture of 90% carbon-11 and 10% boron-11(by the number pf atoms)converts itself into a mixture of 10% carbon-11 and 90% boron -11?

Watch Video Solution

30. 4×10^{23} tritium atoms are contained in a vessel. The half-life of decay of trituim nuclei is 12.3 y. Find (a) the activity of the sample ,(b) the number of decays in the next 10 hours (c) the number of decays in the next 6.15 y.

Watch Video Solution

31. A point source emitting alpha particles is placed at a distance of 1 m from a counter which records any alpha particle falling on its $1 cm^2$ window. If the source contains 6.0×10^{16} active nuclei and the counter records a rate of 50000 counts//second, find the decay constant. Assume that the source emits alpha particles fall nearly normally on the window.

Watch Video Solution

32. ^238U$decays \rightarrow$ ^ $206(Pb)$ with a half-life of $4.47 \times 10^9 y. Thishappens \in a\nu mberofsteps. Canyoujust$ if $ya \sin g \leq$

$238U$and 0.600 mg of 206(Pb)`.assuming that all the lead has come form uranium ,find the life of the rock.

Watch Video Solution

33. When charcoal is prepared from a living tree, it shows a disintergration rate of 15.3 disintergrations of ^14C $pergramper \min ute. Asamp \leq f$ or $manancient\pi eceofcharcoalshows$ $\hat{} 14C$activity to be 12.3 disintergrations per gram per minute. How old is this sample ? Half-life of ^14C` is 5730 y.

Watch Video Solution

34. Natural water contains a small amount of tritium (_1^3H) $. Thisiso \top e\beta - decayswithahalf - l \text{ if } eof12.5years. Amounta \in ee$ $. Amongotherth \in gshef \in dsasea \leq d \perp t \leq ofwhisky. Onreturmhear$ $\_ 1^3H$ radioactivity as compared to a recently purchased bottle marked '8 years old' .Estimate the time of that unsuccessful attempt.

Watch Video Solution

35. The count rate of nuclear radiation coming from a radioactive sample containing ^128I

$varies with time as follows. Time t(\min ute): 0 25 50 75 100 Count rate R$

(10^9 s^(-1)): 30 16 8.0 3.8 2.0

(a) plot In (R_0 / R)against t. (b) From the slope of the best straight line through the points,Find the decay constant λ.(c) Calculate the half-life `t_(1//2).

Watch Video Solution

36. The half-life of $40k$ is 1.30×10^9 y. A sample if 1.00g of pure KCl gives 160 counts s^{-1}.Calculate the relative abundance of ^40K$\left(\frac{t}{i} on of \hat{} 40K\right.$ present) in natural potassium .

Watch Video Solution

37. _80^197Hg$decay \rightarrow _79^{197}Au$ through electron capture with a decay constant of 0.257 per day.(a)What other particle or particles are emitted in the decay?(b) assume that the electron is captured from the K shell. Use Moseley's law $\sqrt{v} = a(Z - b)$with a $a = 4.95 \times 10^7 s^{-1/2}$ and b=1 to find the wavelenghth of the K_a x-ray emitted following the electron capature.

Watch Video Solution

38. A radioactive isotope is being produced at a constant rate $dN/dt = R$ in an experiment. The isotope has a half-life $t_{1/2}$.Show that after a time $t > > t_{1/2}$,the number of active nuclei will become constant. Find the value of this constant.

Watch Video Solution

39. Consider the situation of the previous problem.suppose the production of the radioactive isotope starts at t=0. Find the number of active nuclei at time t.

Watch Video Solution

40. In an agriculture experiment, a solution containing 1 mole of a radioactive meterial $\left(t_{1/2} = 14.3 days\right)$ was injected into the roots of a plants.the plant was allowed 70 hours to settle down and then activity eas measured in its fruit. If the activity measured was $1 \mu Ci$ what per cent of activity is transmitted from the root to the fruit in steady state?

Watch Video Solution

41. A vessel of vloume $125 cm^3$ contains tritium (^3H,t_(1//2)=12.3 y)` at 500 kPa and 300 k. Calculate the activity of the gas.

Watch Video Solution

42. _83^212Bi$candi\sin tegrateeitherbyemi \in gan$alpha $-partic \leq$ or $byemi \in ga$beta $-partic \leq. (a)writethetwoequationsshow \in gthe \prod uctsofthedecays. ($ alpha and beta $-decaysare \in theratio7/13. Theoverallhalf - l$ if eof ^ $212Bi$ is one hour. If 1 g pure ^212Bi$istakenat$12.00` noon,what will be the composition of this sample at 1 p.m the same day?

Watch Video Solution

43. A sample contains a mixture of ^110Ag and ^ $108Ag$ isotopes each having an activity of 8.0×10^8disintergrations per second. ^108Ag $isknown \rightarrow havelar \geq rhalf - l$ if $ethan$ ^ $110Ag$.The activity A is measured as a fuction of time and the following data are obtained .

(a) plot in $(A/A_0)versustime. (b)Seet\hat{f}$ or $lar \geq valuesoftime, theplotis \neq arlyl$ ^ $108Ag$ from this portion of the plot .(c) use the half-life of ^108Ag

$\rightarrow calcatetheactivityc$ or $respond \in g \rightarrow \hat{} 110Ag$ in the first 50 s .

(d) Plot In (A/A_0)versus time for ^110Ag

f or $thefirst50s.(e)f \in dthehalf - l$ if $eof \hat{} 110Ag.$

Watch Video Solution

44. A human body excreates (removes by waste discharge, sweating, etc,) certain materials by a law similar to radioactivity.If technitium is injected in some form in 24 hours.a patient is given an injection containing ^99Tc

$. Thisiso \top eisradioactivewithahalf - l$ if $eof6hours. Theactivityom$

6 mu Ci. $Howμchtimewillelapsebef$ or $etheactivityfalls \rightarrow$ 3 mu Ci`?

Watch Video Solution

45. A charged capacitor of capacitance C is discharged through a resistance R. A radioactive sample decays with an average-life τ.Find the value of R for which the ratio of the electrostatic field energy stored in the capacitor to the activity of the radioactive sample remains constant in time.

Watch Video Solution

46. Radioactive isotopes are produced in a nuclear physics experiment at a constant rate $dN/dt = R$ .An inductor of inductance 100 mH, a resistor of resistance 100Ω and a battery are connected to form a series circuit.the circuit is switched on at the instant the production of radioactive isotope starts. It is found that `i//N remains constant in time where i is the current in the circuit at time t and N is the number of active nuclei at time t. Find the half-life of the isotope.

Watch Video Solution

47. Calculate the energy released by $1g$ of natural uranium assuming $200MeV$ is released in eaech fission event and that the fissionable isotope $\hat{}\ 235U$ has an abundance of 0.7% by weight in natural uranium.

Watch Video Solution

48. A uranium rector develops thermal energy at a rate of 300 MW. Calculate the amount of ^235U`being consumed every second .Average energy released per fission is 200 MeV.

Watch Video Solution

49. A town has a population of 1 million. The average electric power needed per person is 300W. A reactor is to be designed to supply power to this town. The efficiency with which thermal power is converted into electric power is aimed at 25%.(a) Assuming 200 MeV of thermal energy to come form each fission event on an average, find the number of events on an place every day. (b) Assuming the fission to take place largely through ^235U, $atw\hat{r}atewilltheamountof\ \hat{}\ 235U$ decrease ? Express uour answer in kg per day. (c) Assuming that uranium is needed per month (30 days)?

Watch Video Solution

50. Calculate the Q-values of the following fusion reactions:

(a)_1^2H+ $\_ 1^2H \rightarrow$ _1^3H+ $\_ 1^1H.$

_1^2H+ $\_ 1^2H \rightarrow$ _2^3(He)+n $\_ 1^2H +$ _1^3H rarr $\_ 2^4(He) + n.$

Atomic masses are $m($_1^2H)=2.014102 u, m($\_ 1^3H) = 3.016049u, m($ _2^3(He))=3.016029 u, m($\_ 2^4(He)) = 4.002603u.$

Watch Video Solution

51. Consider the fusion in helium plasma. Find the temperature at which the average thermal energy 1.5 kT equals the Coulomb potential energy at 2 fm.

Watch Video Solution

52. Calculate the Q-values of the fusion reaction

^4(He)+ $\hat{} \ 4He =$ ^8(Be).

$Insucha fusione \neq r \geq tically favourab \leq ? A \rightarrow micmassof$

$\hat{} \ 8(Be)$ is 8.0053u and that of ^4(He)`is 4.0026 u.

Watch Video Solution

53. Calculate the energy that can be obtained from 1 kg of water through the fusion reaction

^2H+ $\hat{\ } 2H \rightarrow$ ^3H +p.

Assume that $1.5 \times 10^{-2}\%$ of natural water is heavy water D_2O(by number of molecules) and all the deuterium is used for fusion.

Watch Video Solution