Practice Question Set For A-Level
Subject : Physics
Paper-2 Topic: Fields And Their Consequences(Nuclear Physics)

Name of the Student:_____
Max. Marks : 20 Marks **Time : 20 Minutes**

Q1.

A radioactive source contains a nuclide which has a half-life of 12 hours. A detector placed near the source records an average count rate of 180 counts per minute. The average background count rate is 20 counts per minute.

What will be the average count rate after 24 hours?

A 40 counts per minute ⬭

B 45 counts per minute ⬭

C 50 counts per minute ⬭

D 60 counts per minute ⬭

(Total 1 mark)

Q2.

The power output of a nuclear reactor is provided by nuclear fuel which decreases in mass at a rate of 4.0×10^{-6} kg hour^{-1}.

What is the maximum possible power output of the reactor?

A 28 kW ⬭

B 50 MW ⬭

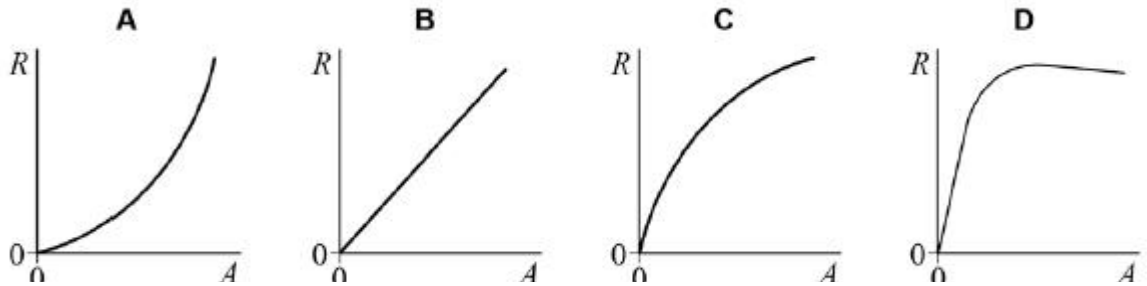
C 100 MW ⬭

D 200 MW ⬭

(Total 1 mark)

Q3.

Which graph best shows how the radius R of an atomic nucleus varies with the nucleon number A?



A ⬭

B ⬭

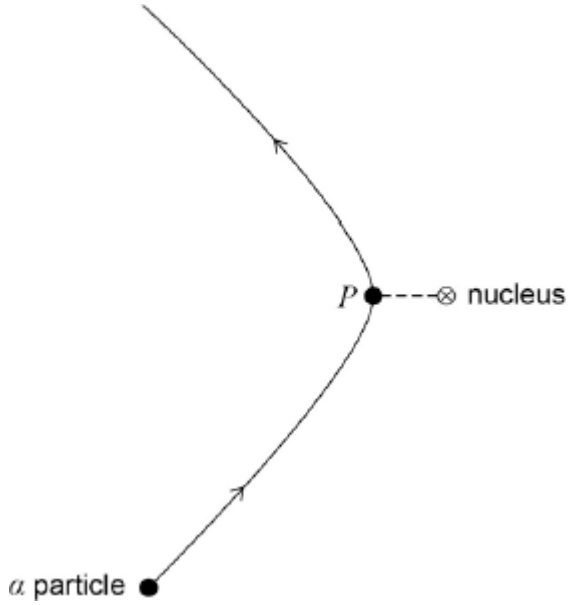
C ⬭

D ⬭

(Total 1 mark)

Q4.

The diagram shows the path of an α particle deflected by the nucleus of an atom. Point P on the path is the point of closest approach of the α particle to the nucleus.



Which of the following statements about the α particle on this path is correct?

A Its acceleration is zero at P. ⬭

B Its kinetic energy is greatest at P. ⬭

C Its potential energy is least at P. ⬭

D Its speed is least at P. ⬭

(Total 1 mark)

Q5.

The moderator of some nuclear reactors is made from graphite.

What is the principal purpose of the graphite?

A to absorb all the heat produced ⬭

B to decrease the speed of neutrons ⬭

C to absorb α and β radiation ⬭

D to prevent the reactor from going critical ⬭

(Total 1 mark)

Q6.

Which of the following is equal to $\frac{\text{radius of a nucleus of } {}^{125}_{51}\text{Sb}}{\text{radius of a nucleus of } {}^{64}_{30}\text{Zn}}$?

A 1.19 ⬭

B 1.25 ⬭

C 1.33 ⬭

D 1.40 ⬭

(Total 1 mark)

Q7.

Which of the following best describes the decay constant for a radioisotope?

A The reciprocal of the half-life of the radioisotope. ⬭

B The rate of decay of the radioisotope. ⬭

C The constant of proportionality which links half-life to the rate of decay of nuclei. ⬭

D The constant of proportionality which links rate of decay to the number of undecayed nuclei. ⬭

(Total 1 mark)

Q8.

After 64 days the activity of a radioactive nuclide has fallen to one sixteenth of its original value. The half-life of the radioactive nuclide is

A 2 days. ⬭

B 4 days. ⬭

C 8 days. ⬭

D 16 days. ⬭

(Total 1 mark)

Q9.

In the reaction shown, a proton and a deuterium nucleus, ${}^{2}_{1}\mathrm{H}$, fuse together to form a helium nucleus, ${}^{3}_{2}\mathrm{He}$

$${}^{1}_{1}\mathrm{p} + {}^{1}_{1}\mathrm{H} \longrightarrow {}^{3}_{2}\mathrm{He} + \mathrm{Q}$$

What is the value of Q, the energy released in this reaction?

mass of a proton = 1.00728 u

mass of a ${}^{2}_{1}\mathrm{H}$ nucleus = 2.01355 u

mass of a ${}^{3}_{2}\mathrm{He}$ nucleus = 3.01493 u

A 5.0 MeV

B 5.5 MeV

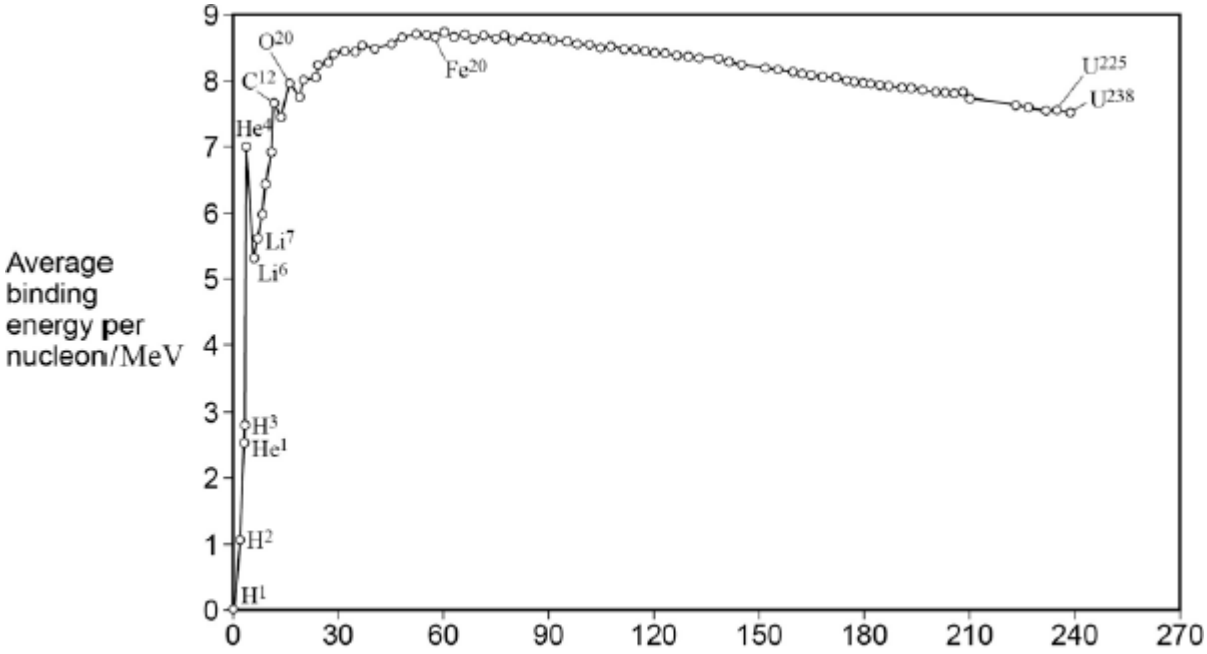
C 6.0 MeV

D 6.5 MeV

(Total 1 mark)

Q10.

The graph shows how the binding energy per nucleon varies with the nucleon number for stable nuclei.



What is the approximate total binding energy for a nucleus of $^{184}_{74}W$?

A 1.28 pJ ⬭

B 94.7 pJ ⬭

C 103 pJ ⬭

D 230 pJ ⬭

(Total 1 mark)

Q11.

For a nuclear reactor in which the fission rate is constant, which one of the following statements is correct?

A There is a critical mass of fuel in the reactor.

B For every fission event, there is, on average, one further fission event.

C A single neutron is released in every fission event.

D No neutrons escape from the reactor.

(Total 1 mark)

Q12.

The reaction shown below occurs when a proton and a deuterium nucleus, $^{2}_{1}H$, fuse to form a helium nucleus, $^{3}_{2}He$.

$$_{1}\mathrm{P} + {}_{2}\mathrm{H} \rightarrow {}_{3}\mathrm{He} + Q$$

If the energy released, Q, is 5.49 MeV, what is the mass of the helium nucleus?

mass of $^{2}_{1}$H nucleus = 2.01355 u
mass of proton = 1.00728 u
1u is equivalent to 931.3 Me V

A 0.00589 u

B 3.01494 u

C 3.02083 u

D 3.02323 u

(Total 1 mark)

Q13.

Which line, **A** to **D**, in the table gives a combination of materials that is commonly used for moderating, controlling and shielding respectively in a nuclear reactor?

	moderating	**controlling**	**shielding**
A	graphite	carbon	lead
B	cadmium	carbon	concrete
C	cadmium	boron	lead
D	graphite	boron	concrete

(Total 1 mark)

Q14.

The mass of the beryllium nucleus, $^{7}_{4}$Be , is 7.01473 u. What is the binding energy **per nucleon** of this nucleus?

Use the following data:

mass of proton = 1.00728 u
mass of neutron = 1.00867 u
1u = 931.3 MeV

A 1.6 MeV nucleon^{-1}

B 5.4 MeV nucleon^{-1}

C 9.4 MeV nucleon^{-1}

D 12.5 MeV nucleon^{-1}

(Total 1 mark)

Q15.

Which one of the following statements is **not** true about the control rods used in a nuclear reactor?

A They must absorb neutrons.

B They must slow down neutrons to thermal speeds.

C They must retain their shape at high temperatures.

D The length of rod in the reactor must be variable.

(Total 1 mark)

Q16.

The fusion of two deuterium nuclei produces a nuclide of helium plus a neutron and liberates 3.27 MeV of energy. How does the mass of the two deuterium nuclei compare with the combined mass of the helium nucleus and neutron?

A It is 5.8×10^{-30} kg greater before fusion.

B It is 5.8×10^{-30} kg greater after fusion.

C It is 5.8×10^{-36} kg greater before fusion.

D It is 5.8×10^{-36} kg greater after fusion.

(Total 1 mark)

Q17.

The mass of the nuclear fuel in a nuclear reactor decreases at a rate of 1.2×10^{-5} kg per hour. Assuming 100% efficiency in the reactor what is the power output of the reactor?

A 100 MW

B 150 MW

C 200 MW

D 300 MW

(Total 1 mark)

Q18.

The sodium isotope ${}^{24}_{11}\text{Na}$ is a radioactive isotope that can be produced by bombarding the aluminium isotope ${}^{27}_{13}\text{Al}$ with neutrons. Which line, **A** to **D**, in the table correctly represents the production of ${}^{24}_{11}\text{Na}$ from the aluminium isotope ${}^{27}_{13}\text{Al}$ and its subsequent decay?

	production	decay
A	${}^{27}_{13}\text{Al} + {}^{1}_{0}\text{n} \rightarrow {}^{24}_{11}\text{Na} + {}^{4}_{2}\alpha$	${}^{24}_{11}\text{Na} \rightarrow {}^{24}_{12}\text{Mg} + {}^{0}_{+1}\beta + \nu$
B	${}^{27}_{13}\text{Al} + {}^{1}_{0}\text{n} \rightarrow {}^{24}_{11}\text{Na} + {}^{4}_{2}\alpha$	${}^{24}_{11}\text{Na} \rightarrow {}^{24}_{12}\text{Mg} + {}^{0}_{-1}\beta + \overline{\nu}$
C	${}^{27}_{13}\text{Al} + {}^{1}_{0}\text{n} \rightarrow {}^{24}_{11}\text{Na} + {}^{3}_{2}\text{He}$	${}^{24}_{11}\text{Na} \rightarrow {}^{24}_{12}\text{Mg} + {}^{0}_{+1}\beta + \nu$
D	${}^{27}_{13}\text{Al} + {}^{1}_{0}\text{n} \rightarrow {}^{24}_{11}\text{Na} + {}^{3}_{2}\text{He}$	${}^{24}_{11}\text{Na} \rightarrow {}^{24}_{12}\text{Mg} + {}^{0}_{-1}\beta + \overline{\nu}$

(Total 1 mark)

Q19.

Why is a moderator required in a thermal nuclear reactor?

A to prevent overheating of the nuclear core

B to absorb surplus uranium nuclei

C to shield the surroundings from gamma radiation

D to reduce the kinetic energy of fission neutrons

(Total 1 mark)

Q20.

What is the binding energy of the nucleus $^{238}_{92}U$?

Use the following data:

mass of a proton =1.00728 u

mass of a neutron = 1.00867 u

mass of a $^{238}_{92}U$ nucleus = 238.05076 u

1 u = 931.3 MeV

A 1685 MeV

B 1732 MeV

C 1755 MeV

D 1802 MeV

(Total 1 mark)