A-Level Physics

Nuclear Physics (Multiple Choice)

Question Paper

Time available: 23 minutes
Marks available: 20 marks

1. What was deduced or observed in the Rutherford scattering experiment?

A All gold atoms are not alike. ⬭

B Alpha particles are helium nuclei. ⬭

C Some particles were deflected through angles greater than $90°$. ⬭

D The motion of most alpha particles was reversed. ⬭

(Total 1 mark)

2. Which row is correct for α, β and γ radiation?

		α	β	γ	
A	Is it deflected by a magnetic field?	yes	yes	no	⬭
B	Is it deflected by an electric field?	yes	yes	yes	⬭
C	Does it have a positive charge?	yes	no	yes	⬭
D	Does it come from outside the nucleus?	no	yes	no	⬭

(Total 1 mark)

3. A sample of radioactive material consists of 200 g of nuclide **P** and 100 g of nuclide **Q**.

Nuclide **P** has a half-life of 2 days and nuclide **Q** has a half-life of 4 days.

What is the total mass of nuclides **P** and **Q** after 12 days?

A 3.1 g ⬭

B 12.5 g ⬭

C 15.6 g ⬭

D 18.8 g ⬭

(Total 1 mark)

4. A nuclide has a half-life of $10\ \text{ms}$.

The decay constant for this nuclide lies between

A $1\ \text{s}^{-1}$ and $10\ \text{s}^{-1}$. ⬭

B $10\ \text{s}^{-1}$ and $10^2\ \text{s}^{-1}$. ⬭

C $10^2\ \text{s}^{-1}$ and $10^3\ \text{s}^{-1}$. ⬭

D $10^3\ \text{s}^{-1}$ and $10^6\ \text{s}^{-1}$. ⬭

(Total 1 mark)

5. Which is **not** true for gamma radiation?

A It is more penetrating than alpha or beta radiation of the same energy through the same material. ⬭

B Its intensity is inversely proportional to the square of the distance from its source. ⬭

C It is emitted with discrete frequencies. ⬭

D When it is absorbed it makes the absorber radioactive. ⬭

(Total 1 mark)

6. In a thermal reactor, induced fission occurs when a $^{235}_{92}\text{U}$ nucleus captures a neutron.

Which statement is true?

A The moderator absorbs excess neutrons. ⬭

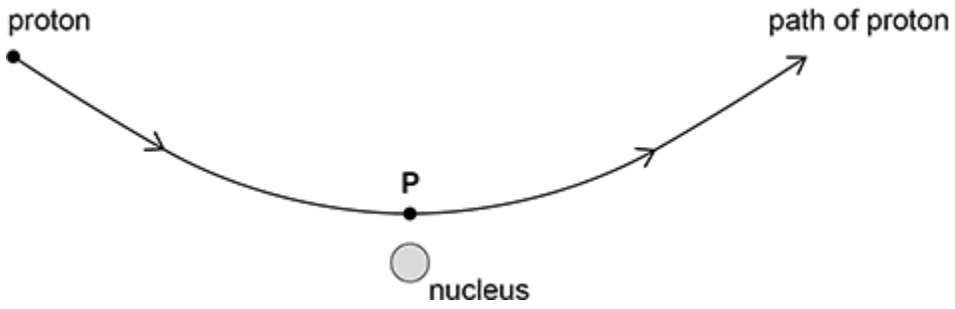
B A large number of neutrons should be produced per fission to sustain the reaction. ⬭

C Slow neutrons are required for this induced fission. ⬭

D The control rods slow down neutrons. ⬭

(Total 1 mark)

7. The diagram shows the path of a proton being deflected by the nucleus of an atom. Point **P** is the position of the proton when it is closest to the nucleus.



What is **not** true about the proton along its path at **P**?

A Its rate of change of momentum is at a minimum. ⬭

B Its kinetic energy is at a minimum. ⬭

C Its potential energy is at a maximum. ⬭

D Its acceleration is at a maximum. ⬭

(Total 1 mark)

8. A point source emits gamma radiation. The intensity I of the radiation is measured at different distances d from the source.

Which graph will show a straight line through the origin?

A I plotted against d ⬭

B I plotted against d^2 ⬭

C I plotted against d^{-1} ⬭

D I plotted against d^{-2} ⬭

(Total 1 mark)

9. When a small radioactive source is placed in a cloud chamber, straight tracks about 4 cm long are observed. The same source is placed 10 cm from a Geiger tube and a count rate is detected. When a sheet of aluminium 5 mm thick is placed between the source and the Geiger tube the count rate falls to the background count rate.

Which types of radiation are emitted by the source?

A α, β and γ ⬭

B β and γ ⬭

C α and γ ⬭

D α and β ⬭

(Total 1 mark)

10. A deuterium nucleus and a tritium nucleus fuse together to form a helium nucleus and a particle **X**. The equation for this process is:

$$^{2}_{1}\mathrm{H} + ^{3}_{1}\mathrm{H} \rightarrow ^{4}_{2}\mathrm{He} + \mathrm{X}$$

What is **X**?

A electron ⬭

B neutron ⬭

C positron ⬭

D proton ⬭

(Total 1 mark)

11. What effect are the control rods intended to have on the average kinetic energy and number of fission neutrons in a thermal nuclear reactor?

	Average kinetic energy of fission neutrons	Number of fission neutrons	
A	unchanged	unchanged	⬭
B	reduced	unchanged	⬭
C	unchanged	reduced	⬭
D	increased	reduced	⬭

(Total 1 mark)

12. During a single fission event of uranium-235 in a nuclear reactor the total mass lost is 0.23 u. The reactor is 25% efficient.

How many events per second are required to generate 900 MW of power?

A 1.1×10^{14} ⬭

B 6.6×10^{18} ⬭

C 1.1×10^{20} ⬭

D 4.4×10^{20} ⬭

(Total 1 mark)

13. A Geiger counter is placed near a radioactive source and different materials are placed between the source and the Geiger counter.

The results of the tests are shown in the table.

Material	Count rate of Geiger counter / s^{-1}
None	1000
Paper	1000
Aluminium foil	250
Thick steel	50

What is the radiation emitted by the source?

A α only ⬭

B α and γ ⬭

C α and β ⬭

D β and γ ⬭

(Total 1 mark)

14. A pure sample of nuclide **X** containing N nuclei has an activity A.
The half-life of **X** is 6000 years.

A pure sample of nuclide **Y** containing $3N$ nuclei has an activity $6A$.

What is the half-life of nuclide **Y**?

A 1000 years ⬭

B 3000 years ⬭

C 12 000 years ⬭

D 18 000 years ⬭

(Total 1 mark)

15. Cobalt-60 has a half-life of 5.27 years.

What is the total activity of 1.0 g of cobalt-60?

A 4.2×10^{13} Bq ⬭

B 2.2×10^{14} Bq ⬭

C 2.5×10^{15} Bq ⬭

D 1.3×10^{21} Bq ⬭

(Total 1 mark)

16. The radius of a nucleus of the iron nuclide $^{56}_{27}Fe$ is 4.35×10^{-15} m.

What is the radius of a nucleus of the uranium nuclide $^{238}_{92}U$?

A 2.69×10^{-15} m ⬭

B 2.89×10^{-15} m ⬭

C 6.55×10^{-15} m ⬭

D 7.05×10^{-15} m ⬭

(Total 1 mark)

17. β particles are emitted from a radioactive source in a school laboratory.

What is correct for these particles?

A A strong magnetic field will not deflect them. ⬭

B They are absorbed by aluminium. ⬭

C They do not damage human tissue. ⬭

D Their range in air is shorter than that of α particles. ⬭

(Total 1 mark)

18. 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)

19. 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)

20. 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)