Alpha, Beta & Gamma

TOPIC QUESTIONS

Level	A Level
Subject	Physics
Exam Board	AQA
Paper Type	Multiple Choice

Time Allowed : 30min

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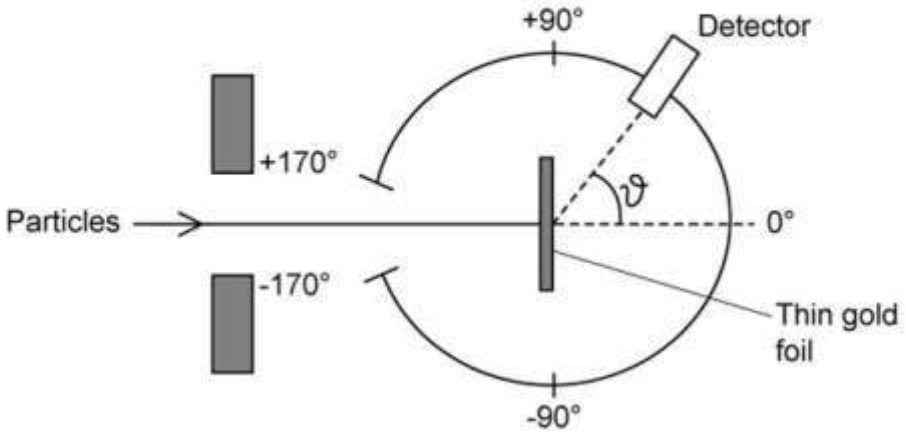
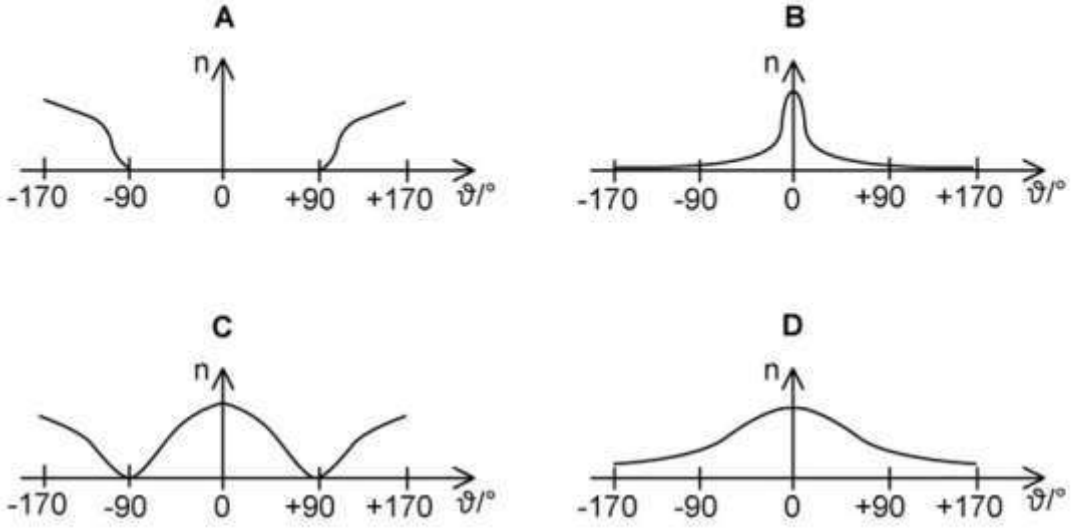
1.

In an α–particle scattering experiment, a student set up the apparatus, as shown in the diagram below, to determine the number *n* of α–particles incident per unit time on a detector held at various angles *θ*.

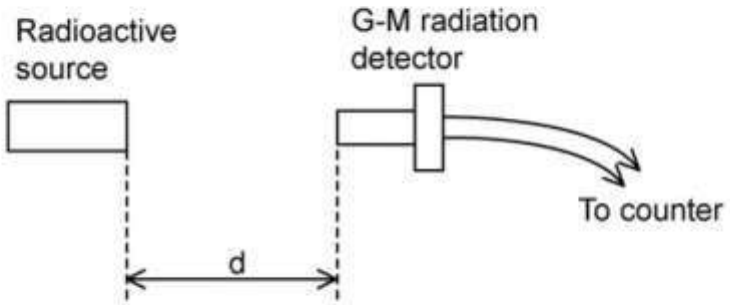


Which of the following graphs best represents the variation of *n* with *θ*?



2.

A student detects the counts from a radioactive source using a G–M radiation detector as shown in the diagram. The student places the source at different distances, *d*, and measures the count rate.



When the detector is placed 0.50 m the source, it receives a mean count rate of 1750 counts per minute. The mean background radiation is measured as 70 counts per minute.

The count rate should not exceed 5000 counts per minute.

What is the smallest distance of *d* the source can be placed at to avoid exceeding the limit?

A 4 cm **B** 6 cm **C** 9 cm **D** 29 cm

3.

A γ ray detector with a cross–sectional area of 5.0×10^{-3} m^2 is placed 0.20 m from a source.

A corrected count rate of 1.2 counts s^{-1} is recorded. The γ ray detector detects 1 in 100 of the γ photons incident on the facing surface of the detector.

How many photons are produced by the source every second?

Assume the source emits γ rays uniformly in all directions.

A 8000 **B** 10 000 **C** 12 000 **D** 14 000

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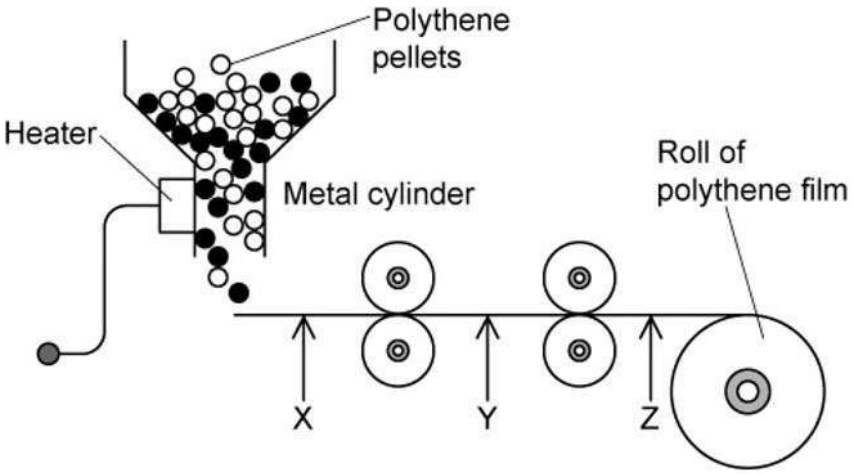
4.

Polythene film is made by extruding polythene and drawing it into a long sheet which is wound onto a roll, as shown in the diagram below.



The manufacturer has to carefully choose a radioactive isotope which will effectively remove any electrostatic charge that has built up on the film. The manufacturer also has to consider the point X, Y or Z at which the radioactive isotope should be placed along the assembly line.

Which point should the radioactive be placed at, and which type of radiation should the manufacturer choose to remove excess electrostatic charge?

	Point	Type of radiation
A	X	alpha
B	X	gamma
C	Y	beta
D	Z	alpha

5.

A scientist is working with a sample of potassium–42 which initially has an activity of 2.0×10^7 decays per second. When potassium–42 decays it emits β^- particles and gamma rays.

To determine the dose received by a scientist working with the source the number of gamma ray photons incident on each cm^2 of the body has to be known.

One in every five of the decaying nuclei produces a gamma ray photon. The scientist is initially working 1.50 m from the source with no shielding.

The scientist returns 12 hours later to find the dose at the same distance has reduced to 7gamma rays per cm^2 per second.

At what distance from the source could the scientist now work and receive the same dose of photons per second per cm^2 as 12 hours earlier?

A 1.30 m **B** 1.20 m **C** 1.10 m **D** 1.00 m

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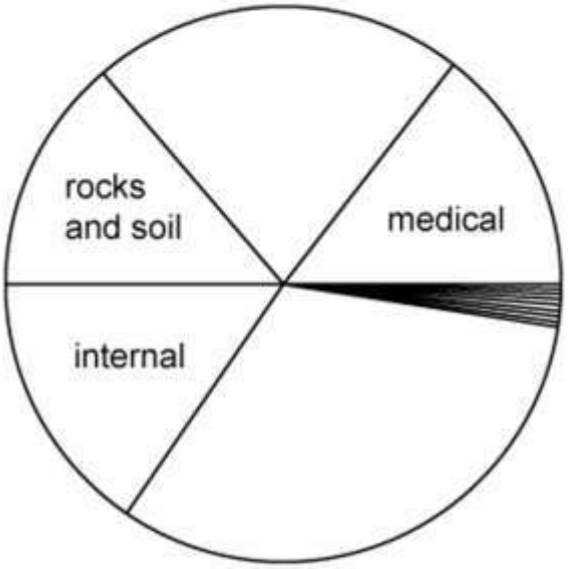
6.

Radiation can be both useful and dangerous. The diagram below shows some contributors to background radiation.



Which of the following is **not** a major contributor to background radiation?

A Cosmic rays

B Isotopes in food & drink

C Fallout from testing nuclear devices

D Buildings

7.

β particles are emitted from a radioactive source.

Which of the following statements is correct for these particles?

A They are absorbed by aluminium

B They are absorbed by paper

C They will not be deflected by a magnetic field

D They do not damage human tissue

8.

In the Rutherford scattering experiment most α particles passed through the foil undeflected.

What is a correct deduction from this result?

A The charge of the atom is neutral

B The nucleus has a positive charge

C Most of the mass of an atom is within the nucleus

D The diameter of the nucleus is much less than the diameter of the atom

9.

Which expression correctly describes the inverse square law for radiation?

A $I = kx$ **B** $I = \frac{k}{x}$ **C** $I = kx^2$ **D** $I = \frac{k}{x^2}$

10.

Which of the following statements is what the Rutherford scattering experiment has led to?

A the quark model of hadrons

B the discovery of the electron

C evidence for wave–particle duality

D the discovery of the nucleus

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11.

A series of radioactive decays starts with an isotope of thorium, nucleon (mass) number 230, proton (atomic) number 90.

Which line in the table shows the nucleon number and proton number of the isotope after the emission of 4 α particles and 2 β^- particles?

	Nucleon number	Proton number
A	214	84
B	222	84
C	222	82
D	214	82

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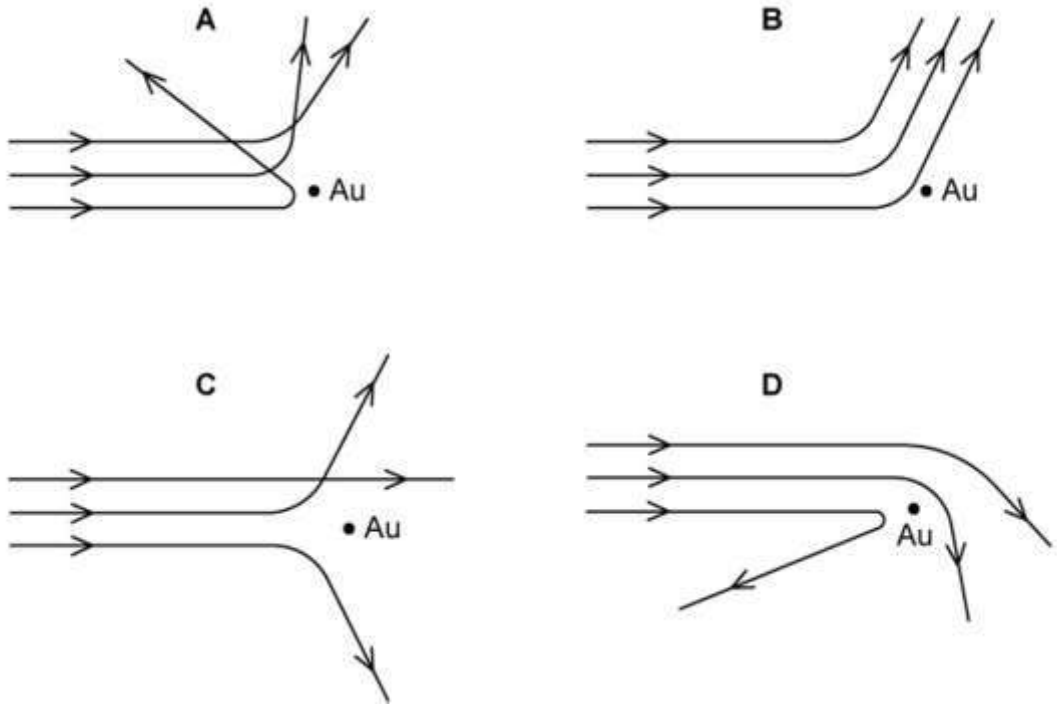
12.

In an experiment to investigate the structure of the atom, alpha particles accelerated to the same speed were fired at gold nuclei.

The diagrams below represent possible paths taken by two alpha particles at two different times and the maximum forces acting on the alpha particles as a result of the electrostatic forces between a gold nucleus, labelled Au, and the alpha particles.

Which diagram best represents the possible paths of the alpha particles and the forces acting on them?



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	500
Paper	350
Aluminium foil	350
Thick steel	150

What is the radiation emitted by the source?

A α only

B α and γ

C α and β

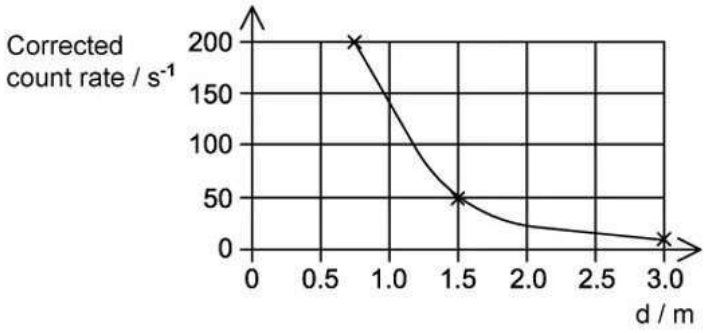
D β and γ

14.

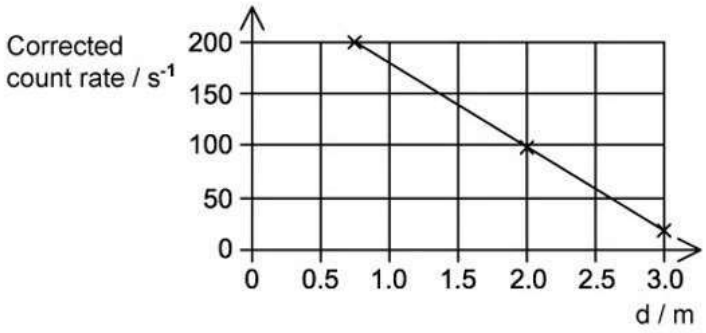
A detector and counter are used to measure the count rate from a gamma source.

Which graph shows how the corrected count rate will vary with distance, *d*, between the source and detector?

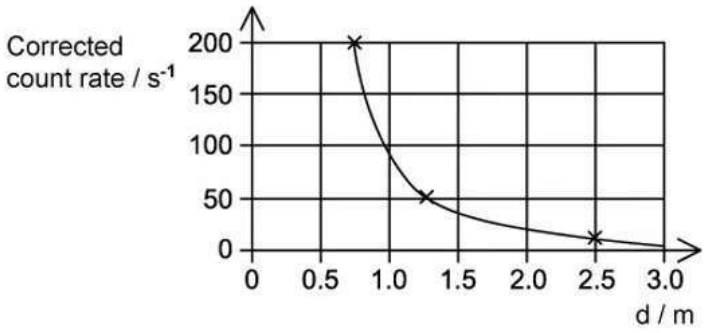
A



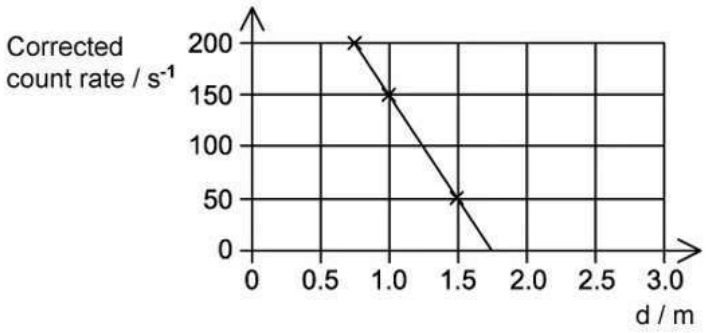
B



C

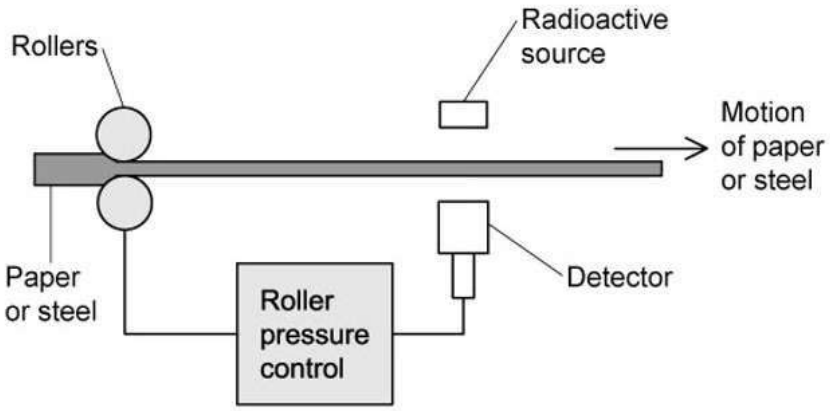


D



15.

The diagram below shows an arrangement used to maintain a constant thickness of sheet paper or steel as it is being rolled. A radioactive source and detector are used to monitor the thickness.

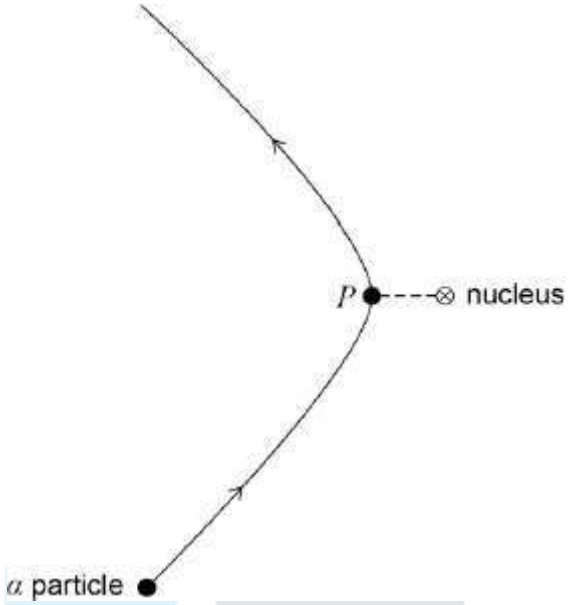


Alpha, beta or gamma sources could be selected for use in such an arrangement.

Which source would be the most suitable in each case?

	Paper	Steel
A	alpha	beta
B	beta	alpha
C	alpha	gamma
D	beta	gamma

16. The diagram shows the path of an α particle deflected by the nucleus of an atom. Point P on the path isthe 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.

17. 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 tothe rate of decay of nuclei.

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

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

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A 1.19

B 1.25

C 1.33

D 1.40

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

A 2 days.

B 4 days.

C 8 days.

D 16 days.

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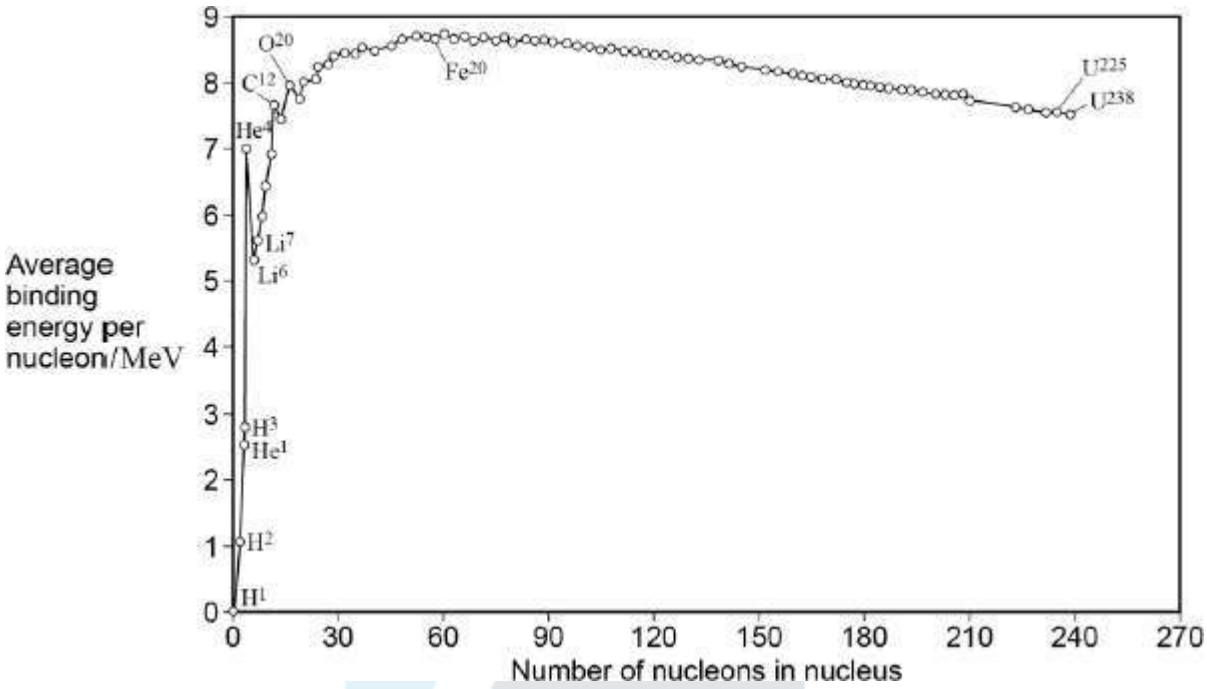
20. The graph shows how the binding energy per nucleon varies with the nucleon number for stablenuclei.



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

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