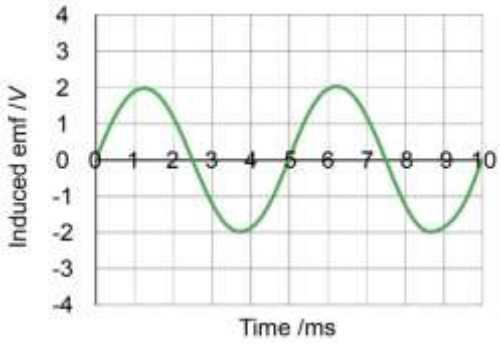
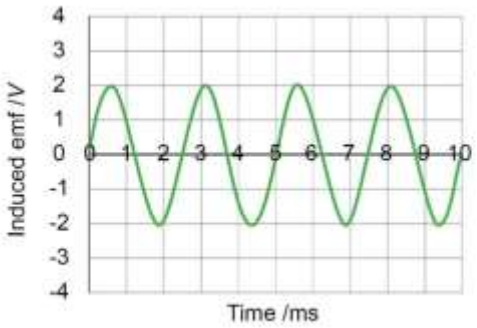
Field and Particle

1 A dynamo is rotated at a constant rate and produces a varying e.m.f. shown below.

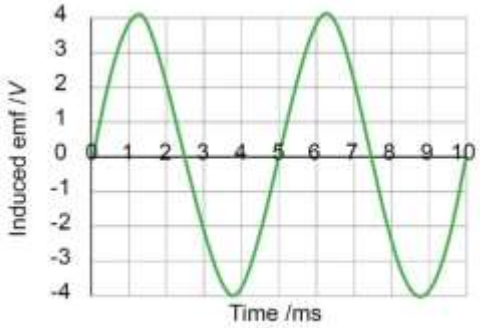


The rate of rotation is doubled.
Which of the following traces shows the new variation of the e.m.f.?

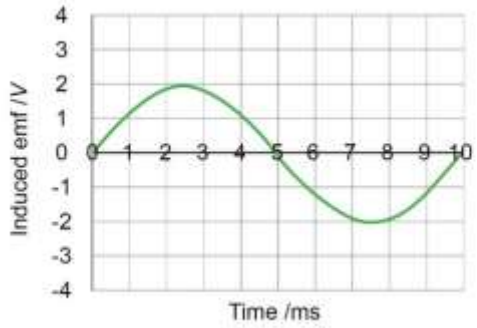
A



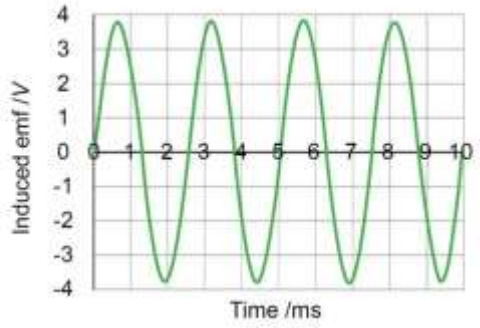
B



C

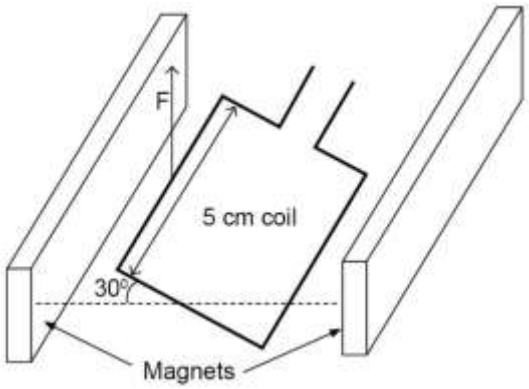


D



Your answer

2 A coil with side length 5.0 cm is free to rotate with its axis parallel to the face of two magnets. The current in the coil is 0.4 A . There is a uniform magnetic field of flux density 40 mT between the magnets.



What is the magnitude of the force F acting on one side of the coil?

A 0.9×10^{-4} N

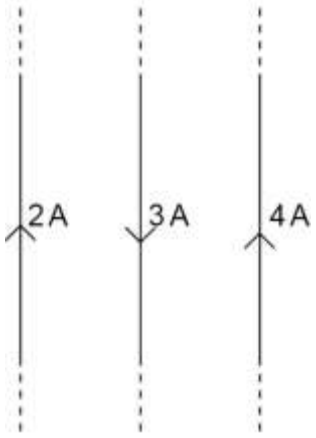
B 1.0×10^{-4} N

C 4.0×10^{-4} N

D 8.0×10^{-4} N

Your answer

3 Three equally spaced identical long straight wires carry different currents.



In which direction will the middle wire try to move when the currents are switched on?

A to the left

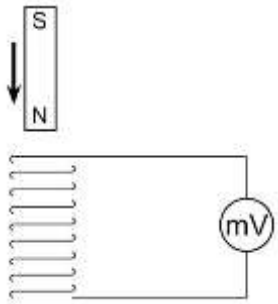
B to the right

C out of the page, towards the viewer

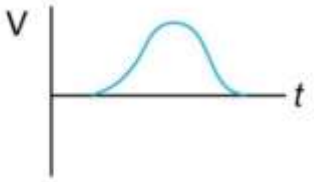
D Into the page, away from the viewer

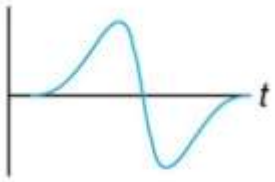
Your answer

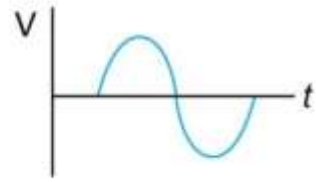
4 A bar magnet is allowed to fall vertically through a coil.

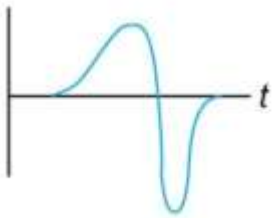


Which graph shows the variation in induced e.m.f. *V* across the ends of the coil with time *t* while the magnet passes through the coil?

A 

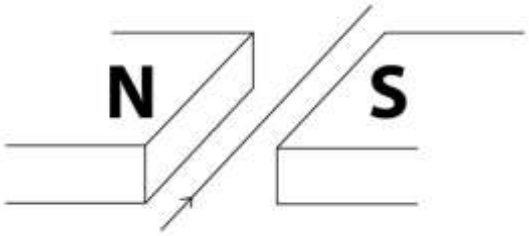
B 

C 

D 

Your answer

5 The diagram shows a wire, carrying a current I, placed between the poles of a magnet.



In which direction does the force on the wire act?

A down

B up

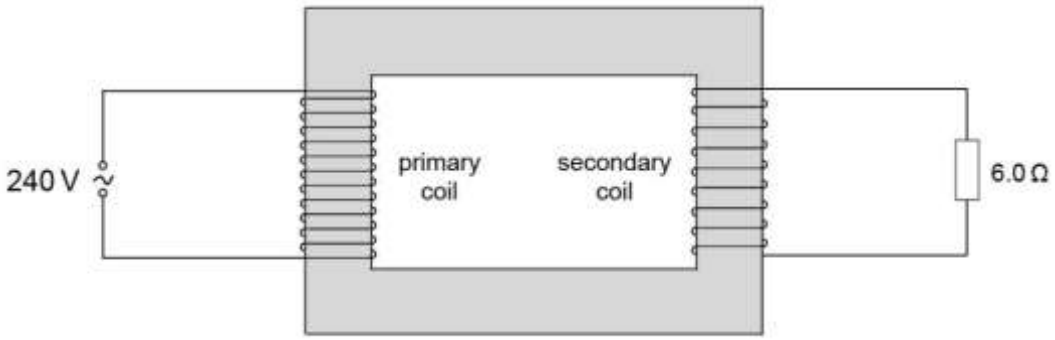
C towards the N pole of the magnet

D towards the S pole of the magnet

Your answer

6 The diagram shows an iron-cored transformer assumed to be 100% efficient.

The ratio of the secondary turns to the primary turns is 1:20.



A 240V a.c. supply is connected to the primary coil and a 6.0Ω resistor is connected to the secondary coil.

What is the current in the primary coil?

A 0.10 A

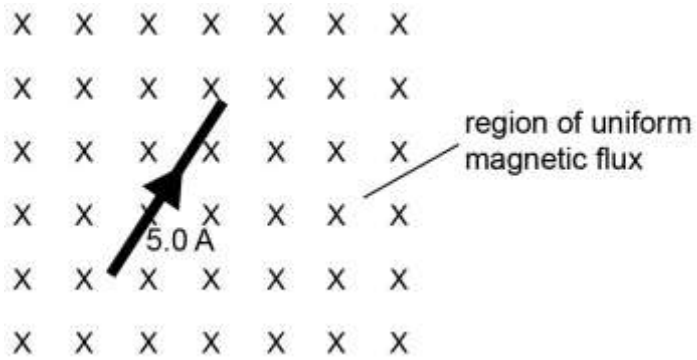
B 0.14 A

C 2.0 A

D 40 A

Your answer

7 A wire of length 3.0 cm is placed at right angles to a magnetic field of flux density 0.040 T.



The wire carries a current of 5.0 A.

What is the magnitude of the force which the field exerts on the wire?

A less than 0.006 N

B 0.0060 N

C Greater than 0.0060 N but less than 0.60 N

D 0.60 N

Your answer ☐

8 The relationship *flux = permeance x current-turns* for a magnetic circuit is analogous to a relationship between *potential difference, current* and *conductance* in an electrical circuit. Which of the following combinations correctly matches the magnetic and electrical circuit terminology?

	potential difference	*current*	*conductance*
A	permeance	current-turns	flux
B	flux	current-turns	permeance
C	current-turns	flux	permeance
D	current-turns	permeance	flux

Your answer ☐

9 A transformer with a 4000 turn primary and 1000 turn secondary transfers 200 kW from the grid to local supply.
Which of these combinations is possible for this transformer?

	primary voltage / V	secondary current / A
A	100	500
B	400	125
C	1000	800
D	4000	50

Your answer

10 Transformers may be constructed using insulated steel laminations.
Here are three true statements about such a transformer construction.

1. Steel laminations have a low permeance

2. The insulation reduces the effects of eddy currents

3. Steel laminations have a high conductivity

Which combination of these factor(s) is important in designing an efficient transformer?

A Statement 1

B Statement 1 and 2

C Statements 2 and 3

D All three statements

Your answer

11 Which of the following is equivalent to the unit of e.m.f.?

A Wb m^{-2}

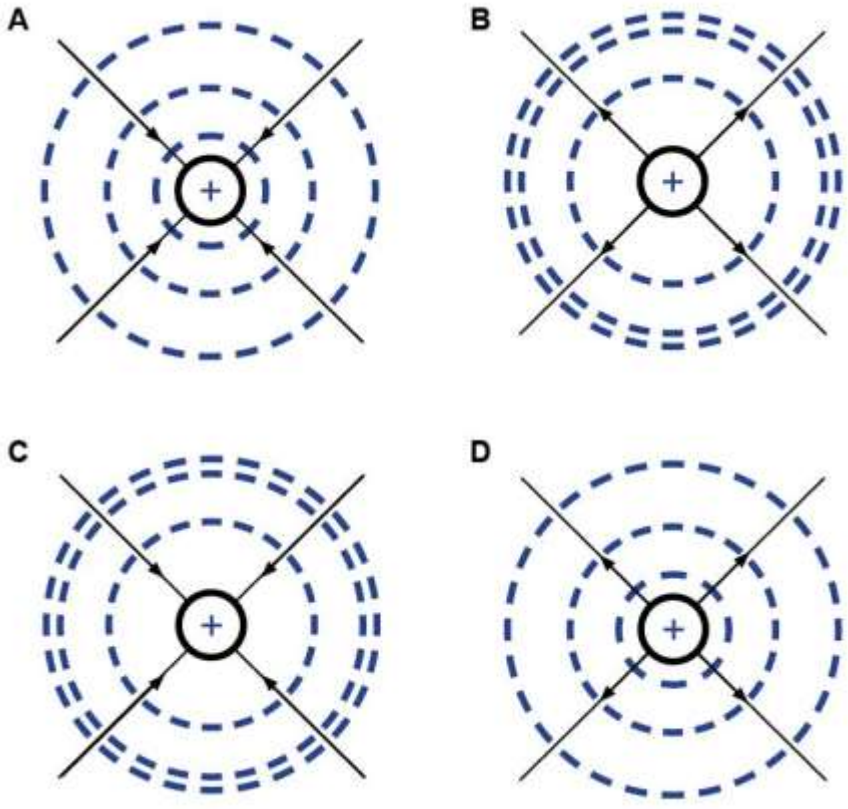
B Wb m^2

C T s^{-1}

D T m^2 s^{-1}

Your answer

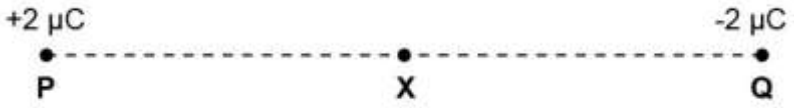
12. Which of the diagrams shows correctly the electric field lines (arrowed lines) and equipotential lines (dashed lines) near a proton?



Your answer

13 Charges of +2 μC and -2μC are situated at points **P** and **Q** respectively, as shown.

X is midway between point **P** and **Q**.



Which of the following correctly describes the electric field and the electric potential at point **X**?

	electric field	electric potential
A	towards Q	zero
B	towards Q	negative
C	towards P	zero
D	towards P	positive

Your answer ☐

14 The charge on a uranium nucleus is 1.5×10^{-17} C and the charge on the α-particle is 3.2×10^{-19} C.

What is the electrostatic force between a uranium nucleus and an α-particle when separated by a distance of 1.0×10^{-13} m.

A 4.3×10^{-20} N

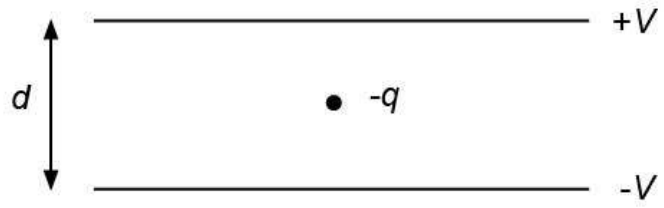
B 4.3×10^{-13} N

C 4.3 N

D 4.3×10^{10} N

Your answer ☐

15 An oil droplet has a charge – q and is situated between two parallel horizontal metal plates as shown in the diagram.



The separation of the plates is d.

The droplet is observed to be stationary when the upper plate is at a potential $+V$ and the lower plate at potential $-V$.

For this to occur the weight of the droplet is equal in magnitude to

A $\frac{Vq}{d}$

B $\frac{2Vq}{d}$

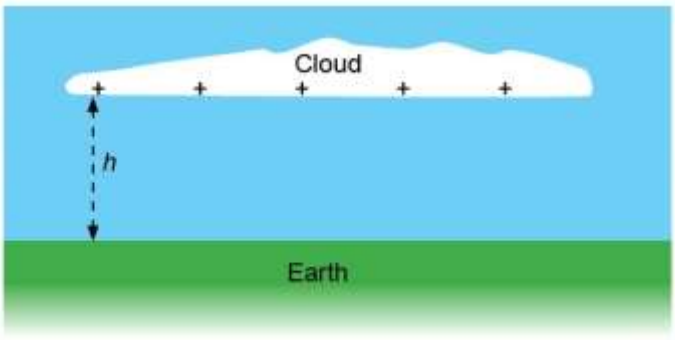
C $\frac{Vd}{q}$

D $\frac{2Vd}{q}$

Your answer

16 A thundercloud and the Earth's surface may be regarded as a pair of charged parallel plates separated by a distance *h* as shown in the diagram.

The capacitance of the system is *C*.



When a lightning flash of mean current I and time *t* occurs, the electric field strength between the cloud and Earth is reduced by

A $\frac{It}{Ch}$

B $\frac{It}{C}$

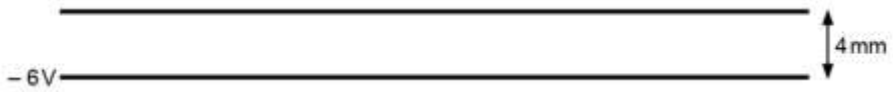
C $\frac{It}{h}$

D CIt

Your answer

17 Two horizontal metal plates are separated by 4mm.

The lower plate is at a potential of -6V.



What potential should be applied to the upper plate to create an electric field of strength 4000 Vm^{-1} upwards in the space between the plates?

A +22V

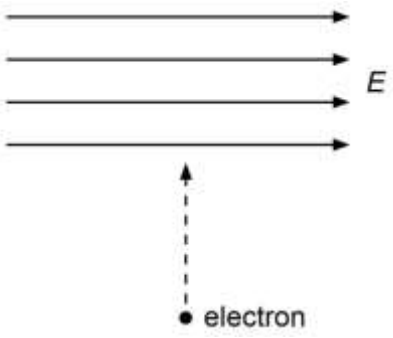
B +10V

C -10V

D -22V

Your answer

18 An electron is projected at right angles to a uniform electric field *E*.



In the absence of other fields, in which direction is the electron deflected?

A Into the paper

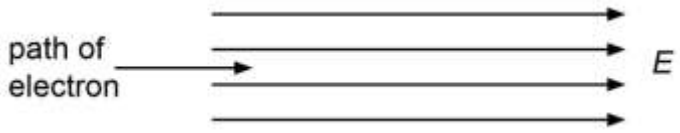
B Out of the paper

C To the left

D To the right

Your answer

19 An electron enters a region of space where there is a uniform electric field *E* as shown below.



Initially, the electron is moving parallel to, and in the direction of the electric field.

What is the subsequent path and change of speed of the electron?

	path	**change of speed**
A	linear	decreases
B	linear	increases
C	curved	decreases
D	curved	increases

Your answer ☐

20 Four particles independently move at the same speed in a direction perpendicular to the same magnetic field.

Which particle is deflected most?

A a neutron

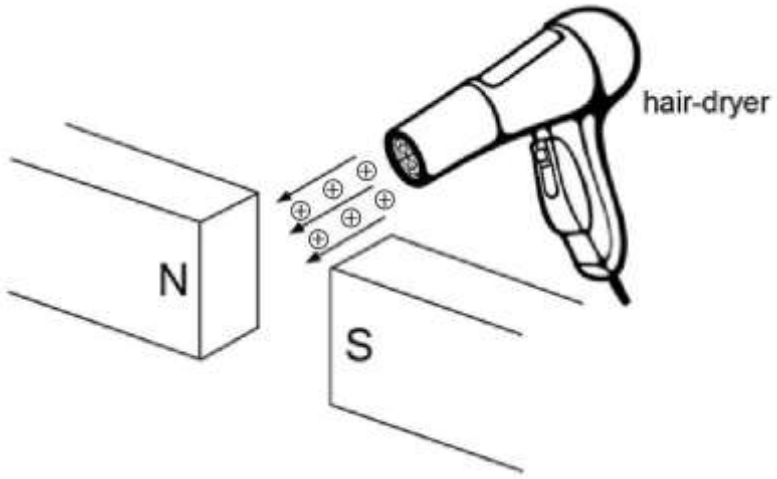
B a helium nucleus

C an electron

D a proton

Your answer ☐

21 Hot air from a hair-dryer contains many positively charged ions.



In which direction are the ions deflected?

A towards the north pole N

B Towards the south pole S

C downwards

D upwards

Your answer

22 Which statement correctly describes a nucleon?

A a neutron or a proton

B a neutron, proton or an electron

C any atomic nucleus

D A radioactive atomic nucleus

Your answer

23 In Rutherford's alpha scattering experiment most of the alpha particles passed directly through a metal foil without deviation, some alpha particles continued through the foil but were deviated, a very small number rebounded back from the foil.

Which of the following statements are conclusions which can be drawn from this experiment?

1. most of the atom is empty space

2. the space between nuclei is many orders greater than the diameter of the nuclei

3. alpha particles are deviated when they collide with the nucleus

A only 1 is true

B 1 and 2 are true

C 1 and 3 are true

D 1, 2 and 3 are all true

Your answer

24 What is the relativistic factor for a particle travelling at 80% of the speed of light?

A 0.22

B 1.0

C 1.7

D 2.2

Your answer

25 Which of the following is the correct expression for the electric potential energy of a de Broglie wave in an atom of radius r = λ/2 ?

A $-\frac{e^2}{4\pi\varepsilon_0\lambda}$

B $-\frac{e^2}{2\pi\varepsilon_0\lambda}$

C $-\frac{e^2}{\pi\varepsilon_0\lambda^2}$

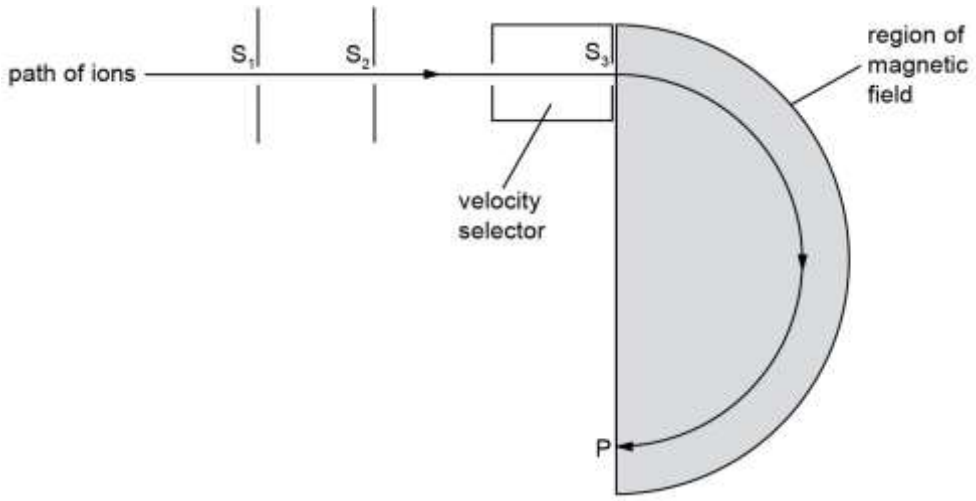
D $-\frac{e}{2\pi\varepsilon_0\lambda^2}$

Your answer

26 The diagram shows the principle of a simple form of mass spectrometer.

Ions are passed through narrow slits, S_1 and S_2 into the velocity selector.

The selected ions, after passage through the slit S_3, are deviated by the uniform magnetic field.



Which of the following quantities must be the same for all ions arriving at point P?

A charge

B charge ÷ mass

C mass

D momentum

Your answer

27 A student conducts an experiment using an α-particle source.

When considering safety precautions, what can be considered the maximum range of α-particles in air?

A Between 0 and 5 mm

B Between 5 mm and 200 mm

C Between 200 mm and 500 mm

D Between 500 mm and 1000 mm

Your answer ☐

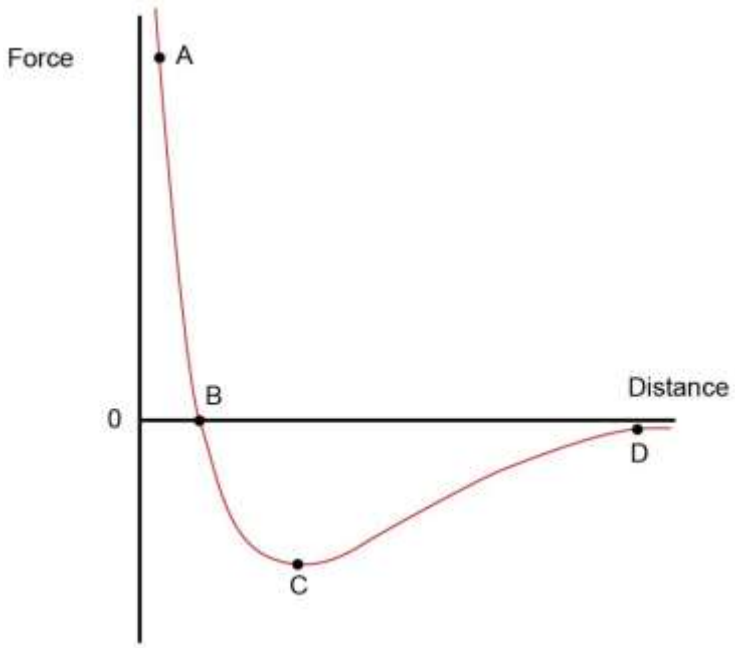
28 As a result of successive decays in a radioactive series, the nucleon number of an isotope decreases by 4 while its proton number is unchanged.

Which of the following combination of α and β particles being emitted would give this outcome?

	Number of α particles	Number of β particles
A	1	1
B	1	2
C	1	4
D	2	2

Your answer ☐

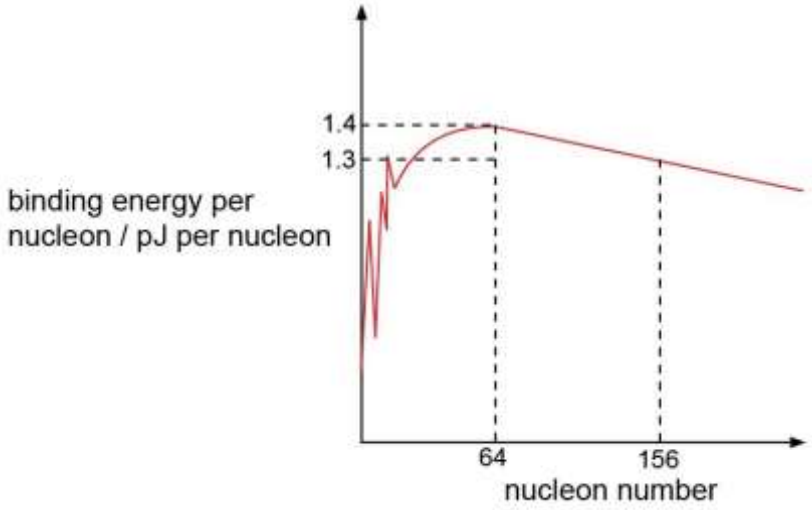
29 The graph below shows the variation of the strong nuclear force with nucleon separation.



Which of the points **A**, **B**, **C** or **D** shows the repulsive nature of the strong nuclear force?

Your answer

30 The sketch graph shows how the binding energy per nucleon varies with the nucleon number for naturally occurring nuclides.



What is the total binding energy of the nuclide $^{156}_{64}\text{Gd}$

A 83 pJ

B 90 pJ

C 203 pJ

D 218 pJ

Your answer

31 Which of the following is the effective dose in gray when 3×10^{10} beta particles, with mean energy per particle of 9×10^{-14} J, are absorbed by a tumour of mass 50g?

A 5×10^{-5} Gy

B 3×10^{-2} Gy

C 5×10^{-2} Gy

D 2×10^{22} Gy

Your answer

32 The nuclear fission reactor in a power station produces more than one neutron per atom decaying. Which combination of the following action(s) would allow the reactor to continue in a stable self-sustaining reaction?

1. Reduce the temperature of operation

2. Insert control rods to absorb excess neutrons

3. Reduce the amount of fissile material to a sub-critical mass

A 1 and 2

B Only 2

C 1 and 3

D Only 3

Your answer

33 An isotope of Argon, $^{40}_{18}Ar$ has a binding energy of 344 MeV.
What is the binding energy in joules per nucleon?

A 1.375×10^{-12} J

B 3.056×10^{-12} J

C 5.5×10^{-11} J

D 8.6×10^{-11} J

Your answer