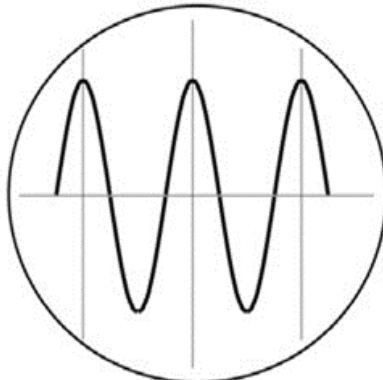
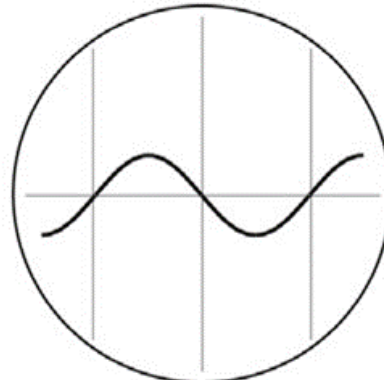


PA13001

An oscilloscope is used to analyze two musical notes (I and II) recorded with a microphone. Two traces are obtained as shown below. The oscilloscope settings are the same in both cases.



Note I



Note II

Which one of the following statements is true?

Compared to Note II, Note I is

- (A) louder and has higher pitch
- (B) louder and has lower pitch
- (C) softer and has higher pitch
- (D) softer and has lower pitch

PA13002

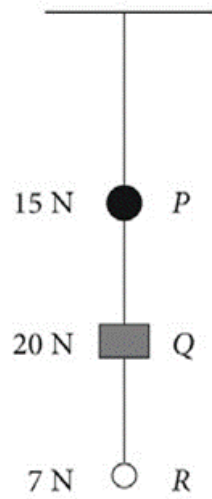
A 2.0 g mass of radioactive thorium decays over 72 days, leaving 0.25 g of thorium unchanged.

What is the half-life of thorium?

- Ⓐ 12 days
- Ⓑ 24 days
- Ⓒ 48 days
- Ⓓ 72 days

PA13003

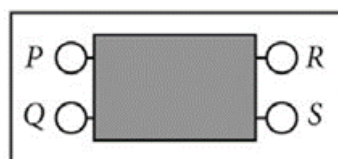
The objects P , Q and R of weight 15 N (newtons), 20 N and 7 N , are hung with light threads as shown in the figure.



What is the tension in the thread between P and Q ?

- (A) 42 N
- (B) 35 N
- (C) 27 N
- (D) 15 N
- (E) 7 N

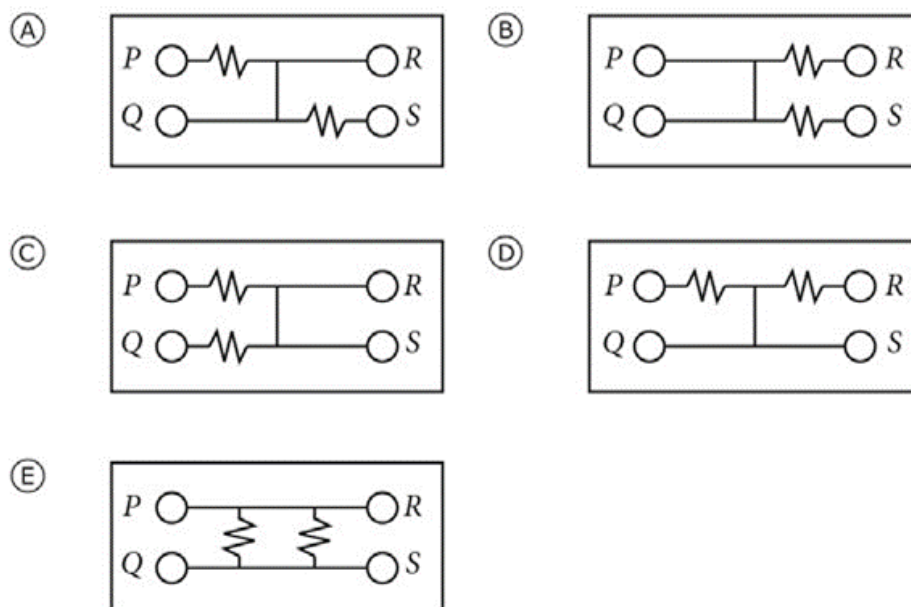
The figure shows a box with four terminals: P , Q , R and S . The following observations were made.



1. There is a measurable resistance between P and Q .
2. Resistance between P and R is twice that between P and Q .
3. There is no measurable resistance between Q and S .

Which of the following circuits is most likely to be within the box?

Assume that all the resistances shown are equal.



PA13005

A stone is dropped from rest down a deep well. It takes 2 s to reach the bottom.

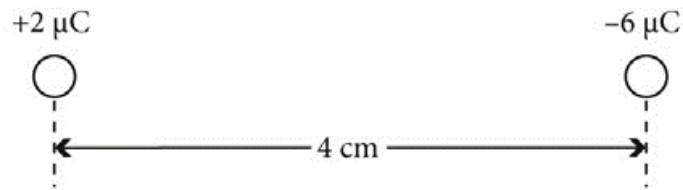
How deep is the well?

Assume that the air resistance on the falling stone is negligible and that the acceleration due to gravity $g = 9.8 \text{ ms}^{-2}$.

- Ⓐ 4.9 m
- Ⓑ 9.8 m
- Ⓒ 19.6 m
- Ⓓ 39.2 m
- Ⓔ 78.4 m

PA13006

Two small charges of $+2\ \mu\text{C}$ (microcoulombs) and $-6\ \mu\text{C}$ respectively are placed 4 cm apart as shown.

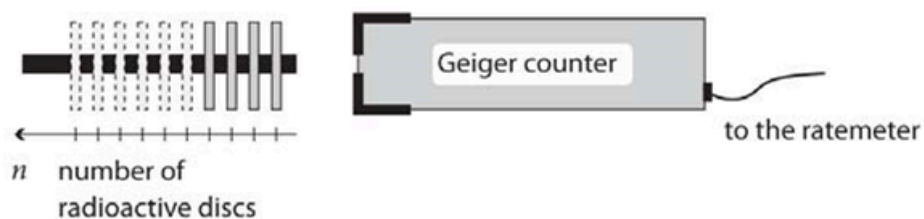


Where should a third charge $-8\ \mu\text{C}$ be placed so that there is no net force on the $-6\ \mu\text{C}$ charge?

- (A) 4 cm left of the $-6\ \mu\text{C}$ charge
- (B) 16 cm left of the $-6\ \mu\text{C}$ charge
- (C) 16 cm right of the $-6\ \mu\text{C}$ charge
- (D) 8 cm left of the $-6\ \mu\text{C}$ charge
- (E) 8 cm right of the $-6\ \mu\text{C}$ charge

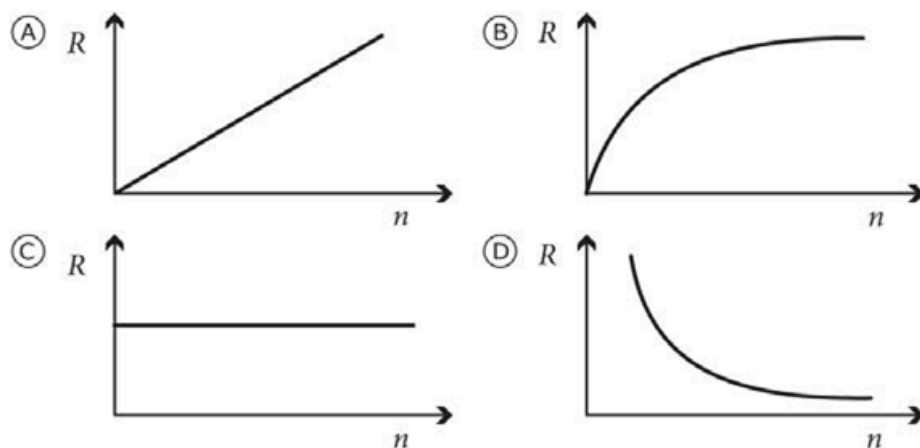
PA13007

Small very thin metallic discs of an alloy of ^{90}Sr are mounted on a rod a small distance from a Geiger counter, as shown in the figure.



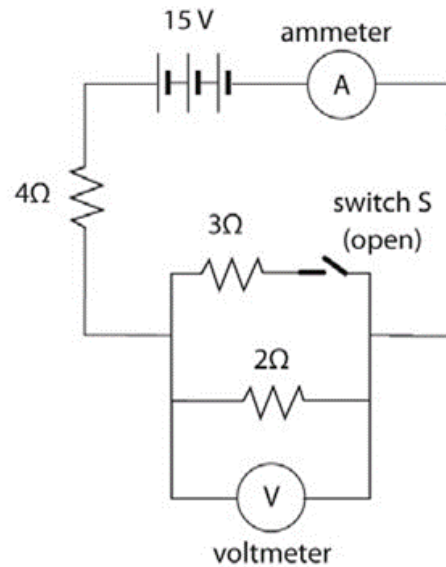
^{90}Sr is a radioactive isotope producing only beta radiation.

Which one of the following graphs best shows how the reading R of the Geiger counter ratemeter varies with n , the number of discs on the rod?



PA13009

In the electric circuit shown below switch S is open.



What is the effect on the ammeter and voltmeter readings when switch S is **closed**?

- (A) The ammeter reading increases; the voltmeter reading decreases.
- (B) The ammeter reading decreases; the voltmeter reading increases.
- (C) The ammeter reading increases; the voltmeter reading increases.
- (D) The ammeter reading decreases; the voltmeter reading decreases.

PA13021

In the electromagnetic spectrum there are different types of radiation.

Which one of the following lists gives the radiation types in order of increasing wavelength?

- Ⓐ γ -radiation, X-rays, visible light, radio waves
- Ⓑ X-rays, radio waves, visible light, γ -radiation
- Ⓒ radio waves, γ -radiation, visible light, X-rays
- Ⓓ γ -radiation, X-rays, radio waves, visible light

PA13022

100 g of water with a temperature of 90 °C is poured into an aluminium box with a temperature of 20 °C. The mass of the box is 50 g.

What will the final temperature of the system be? Assume that there is no heat exchange with the environment. Show your work.

The specific heat of water is 4.2 kJ/(kg K). The specific heat of aluminium is 0.92 kJ/(kg K).

PA13023

The speed of waves on the water surface is 0.32 ms^{-1} in deep water and 0.20 ms^{-1} in shallow water.

If the wavelength in deep water is 0.016 m , what is the wavelength in shallow water?

PA13024

A small charged plastic foam ball is held at rest by the electric field between two large horizontal oppositely charged plates.

If the charge on the ball is $5.7 \mu\text{C}$ and its mass is $1.4 \times 10^{-4} \text{ kg}$, what is the magnitude of the electric field strength? Show your work.

PA13025

The table shows the work-function energy (W) for the photoelectric effect in three different metals.

<u>Metal</u>	<u>W</u>
Ca	$4.60 \times 10^{-19} \text{ J}$
Li	$4.65 \times 10^{-19} \text{ J}$
Zn	$6.94 \times 10^{-19} \text{ J}$

Which of these metals will emit electrons when hit by visible light with wavelength 400 nm? Explain your reasoning.

PA13026

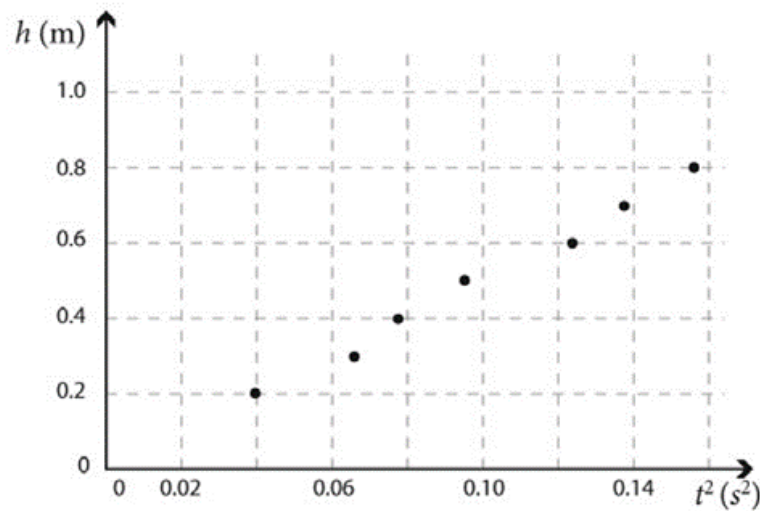
A particle with charge q and mass m moves at speed v in a uniform magnetic field B at right angles to the direction of the field. The particle moves in a circle.

Show that the period T of the particle's revolution does not depend on v .

Show your work.

PA13027A

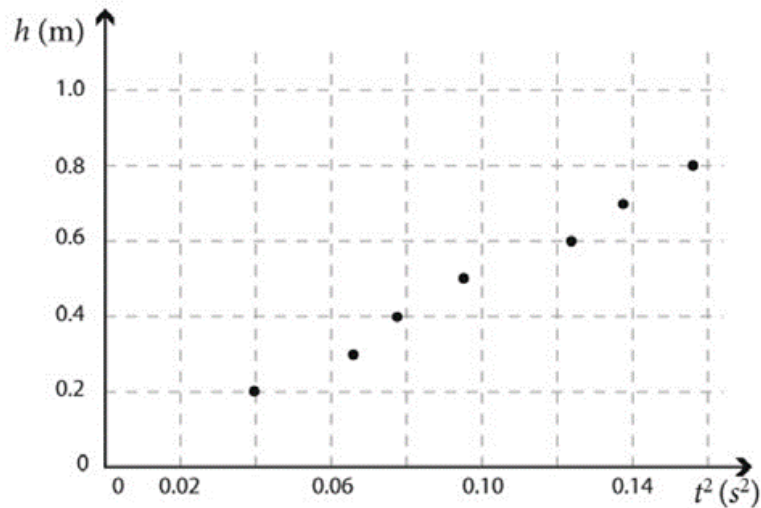
In an experiment to measure the acceleration due to gravity, g , the time, t (s), taken for a metal ball to fall freely from rest was measured for different starting heights h (m). The graph shows values of h plotted against values of t^2 .



Using the data shown in the graph, calculate a value of g and give an estimate of the uncertainty (experimental error) in the value of g . Show your work.

PA13027B

In an experiment to measure the acceleration due to gravity, g , the time, t (s), taken for a metal ball to fall freely from rest was measured for different starting heights h (m). The graph shows values of h plotted against values of t^2 .



Using the data shown in the graph, calculate a value of g and give an estimate of the uncertainty (experimental error) in the value of g . Show your work.

PA23050

A table with metal legs and a wooden top is inside a room with a temperature of about 20 °C. Which statement explains why the metal legs feel colder than the wooden top?

- Ⓐ The heat capacity of the metal legs is lower than the wooden top.
- Ⓑ The metal has a lower temperature than the wooden top.
- Ⓒ The metal conducts heat better than wood.
- Ⓓ The molecules move faster in metal than in wood.

Which statement is the BEST explanation of the greenhouse effect?

- Ⓐ Because of holes in the ozone layer, more solar radiation reaches the surface of the Earth, and it gets warmer.
- Ⓑ Light rays from the sun pass through the atmosphere and warm the surface of the Earth. Some of the heat radiation from the surface is absorbed by certain gases in the atmosphere and retained.
- Ⓒ The release of gas like CO₂ in the atmosphere results in the increase of the temperature of the Earth.
- Ⓓ Light from the sun makes the molecules in the atmosphere vibrate, and it gets warmer.

PA23142

A satellite observes the temperatures on Earth. What type of electromagnetic radiation should the sensors be able to detect?

- Ⓐ radio waves
- Ⓑ infrared light
- Ⓒ visible light
- Ⓓ ultraviolet light

PA23072

A block of mass 2.0 kg travels horizontally at a speed 2.5 m/s towards a massless spring with spring constant 800 N/m . After the block collides with the spring, its speed decreases and the spring compresses. What is the maximum distance that the spring will compress? (Ignore friction and air resistance.)

Show your work.

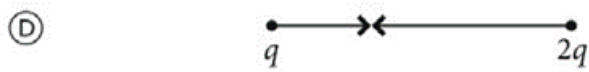
PA23022

The planet Venus, like Earth, revolves around the sun in approximately a circular orbit. Venus is closer to the sun than the Earth is.

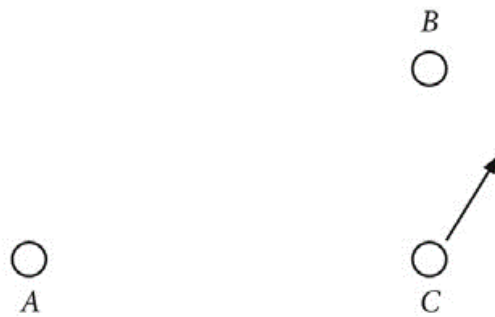
Using Newton's Second Law and Law of Gravity, show that Venus moves faster than Earth in its orbit.

PA23030

Two particles have charges q and $2q$, respectively. Which figure BEST describes the electric forces acting on the two particles?

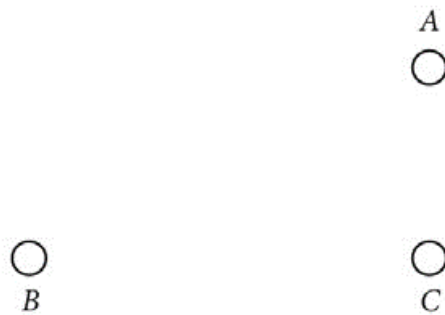


PA23078



The figure above shows three point charges, A , B , and C . The combined force from A and B on C is shown as an arrow.

The two charges A and B are then interchanged. Draw an arrow on the figure below to show what the combined force from A and B will be on C .



<p>Laser Radiation Caution: Do not stare into the beam. Class II Laser Product</p>

Suzanne has a red laser pointer of wavelength 630-680 nm and maximum output of less than 1 mW. The label on Suzanne's laser pointer is shown above. Which statement explains how laser light can damage Suzanne's eyes?

- Ⓐ The energy of a photon of red light is large enough to damage the light sensitive cells in her eyes.
- Ⓑ Red light from a laser has higher photon energy than red light from an incandescent light globe.
- Ⓒ The laser pointer produces more photons per second than a 100 W incandescent light globe.
- Ⓓ Red light photons in the laser pointer beam are spread over a smaller area than photons from a light globe.

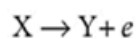
PA23128

Ultraviolet light is responsible for sunburns. Explain why you don't get sunburned while sitting behind a glass window.

PA23058

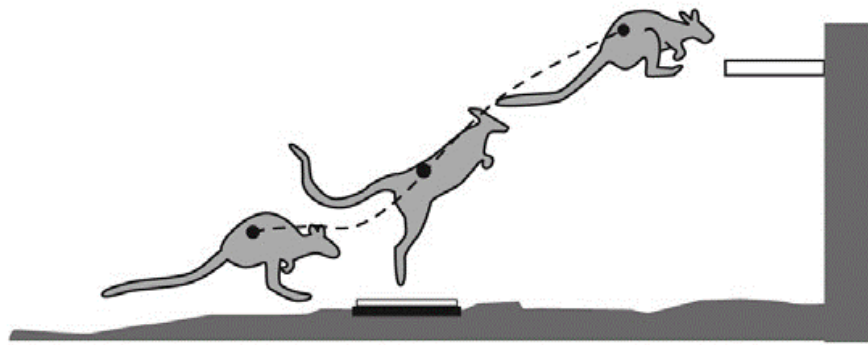
When a stream of helium nuclei moves towards a very thin, gold foil, most of the nuclei pass through the foil. Which hypothesis is supported by this result?

- Ⓐ The nucleus of the gold atom is very heavy compared to the entire atom.
- Ⓑ The wave nature of the helium nuclei allows them to penetrate the gold foil.
- Ⓒ The nucleus of the gold atom is very small compared to the entire atom.
- Ⓓ A helium nucleus has about the same mass as a gold nucleus.



The beta (β) decay of a radioactive isotope can be represented by a general reaction, as shown above. The electron emerges at high speed and may completely leave the material containing X and Y. What is the BEST explanation of the origin of the emitted electron?

- (A) a transition from a higher to a lower internal electron energy level of X
- (B) a proton and neutron combining in the nucleus of Y
- (C) an electron knocked out of X by collision with another atom
- (D) a neutron changing to a proton and an electron in the nucleus of X



A kangaroo hops along and then jumps from a flat plate on the ground up to a ledge, as shown above. When a jumping kangaroo is in contact with the plate, its feet exert a force on the plate in the vertical direction, and the plate exerts a force on the kangaroo's feet in the vertical direction. Which statement BEST describes the magnitudes of these forces?

- (A) Both forces equal the mass of the kangaroo.
- (B) Both forces equal half the mass of the kangaroo.
- (C) They vary in size but stay equal to each other.
- (D) The force from the plate becomes larger than the force from the feet.

PA23014

Lisa threw a small stone straight up into the air.

What forces act on the stone after it was thrown?

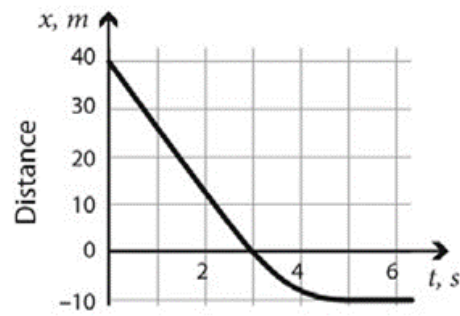
PA23025

Two ice skaters, one with a mass of 80 kg and the other with a mass of 60 kg, are standing on the ice face to face. They push each other so that they slide from each other. After a few seconds, the distance between them is 4 m.

What distance has the skater with a mass of 60 kg moved? (Ignore friction and air resistance.)

Show your work.

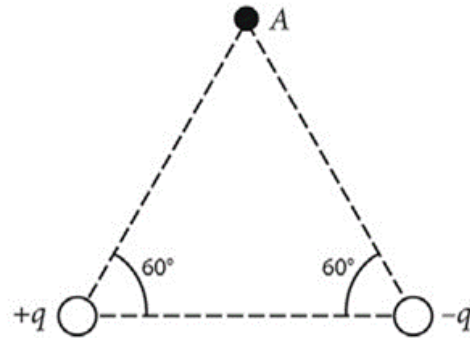
PA23028



The graph shown above represents a cyclist approaching and passing the finishing line in a race. If the cyclist weighs 60 kg, what is her momentum as she crosses the finishing line?

- (A) 2400 kg · m/s
- (B) 800 kg · m/s
- (C) 600 kg · m/s
- (D) 0 kg · m/s

PA23034



Two point charges are at rest at a certain distance from each other, as shown in the figure above. Draw an arrow from point A showing the direction of the total electric field at point A produced by these two charges.

PA23044

Describe how you would demonstrate “electromagnetic induction” to a group of students. Include a description of the equipment you would use, but do not explain the phenomenon.

PA23082

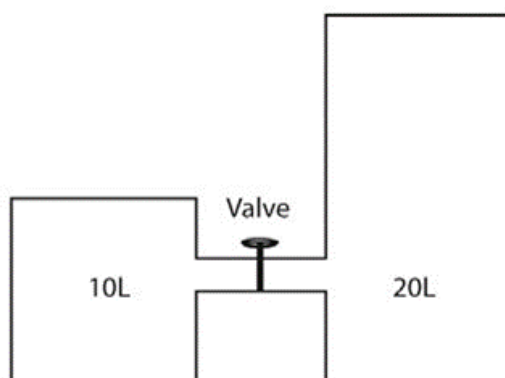
The sand on a beach is very hot on a warm and sunny day and is cold at night.
As a contrast, the temperature of the sea varies very little between day and night.
What does this observation tell you about the specific heat capacity of sand compared to that of water?

PA23140

All bodies send out electromagnetic radiation. The characteristic features of the radiation depend strongly on the temperature of the body. At some temperatures, the emitted radiation is observed by our eyes and called "light". At which temperatures of the emitting body is the electromagnetic radiation, at maximum intensity, in the visible light range?

- Ⓐ at temperatures of the order of tens of degrees Celsius
- Ⓑ at temperatures of the order of hundreds of degrees Celsius
- Ⓒ at temperatures of the order of thousands of degrees Celsius
- Ⓓ at temperatures of the order of millions of degrees Celsius

PA23084



A narrow tube with a closed valve links a 10 liter container filled with a gas at a pressure of 1 atmosphere to a 20 liter container filled with nitrogen at a pressure of 2 atmospheres. Both containers have a temperature of 27 °C. If the valve that separates the two containers is opened, allowing the gases to mix at 27 °C, what will the total pressure (in atmospheres) be in the two containers?

Show your work.

PA23059

How many neutrons are there in the nucleus of the atom $^{238}_{92}\text{U}$?

- Ⓐ 0
- Ⓑ 92
- Ⓒ 146
- Ⓓ 238

PA23138

Which is the BEST description of an atomic nucleus?

- Ⓐ a tight group of electrons, protons, and neutrons
- Ⓑ electrons and protons moving around a core of neutrons
- Ⓒ a tight group of protons and neutrons
- Ⓓ protons moving around a core of neutrons

PA23137

A particular atomic nucleus is represented by a symbol that includes three labels. What is the correct symbol for a nucleus consisting of six protons and eight neutrons?

(The first elements according to mass are hydrogen, helium, lithium, beryllium, boron, carbon, nitrogen, and oxygen.)