WebAssign
CH06-HW06-SP12 (Homework)

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PHYS 172-SPRING 2012, Spring 2012
Instructor: Virendra Saxena

Current Score : 27 / 27 **Due :** Thursday, February 23 2012 11:59 PM EST

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1. 4/4 points | Previous Answers MI3 6.13.X.094

You throw a ball of mass 0.2 kg straight up. You observe that it takes 2.9 s to go up and down, returning to your hand. Assuming we can neglect air resistance, the time it takes to go up to the top is half the total time, 1.45 s. Note that at the top the momentum is momentarily zero, as it changes from heading upward to heading downward.

(a) Use the momentum principle to determine the speed that the ball had just AFTER it left your hand.
$v_{initial}$ = 14.21 ✔ m/s

(b) Use the Energy Principle to determine the maximum height above your hand reached by the ball.
h = 10.302 ✔ m

- *Read the eBook*
- Section 6.13

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2. 7/7 points | Previous Answers MI3 6.14.X.096

Two protons are a distance $8. \times 10^{-9}$ m apart. What is the electric potential energy of the system consisting of the two protons?
U_{el} = 2.88e-20 ✔ joules

If the two protons move closer together, will the electric potential energy of the system increase, decrease, or remain the same?

- (•) increase
- ( ) remain the same
- ( ) decrease

✔

A proton and an electron are a distance $8. \times 10^{-9}$ m apart. What is the electric potential energy of the system consisting of the proton and the electron?
U_{el} = -2.88e-20 ✔ joules

If the proton and the electron move closer together, will the electric potential energy of the system increase, decrease, or remain the same?

- ( ) remain the same
- (•) decrease
- ( ) increase

✔

Which of the following statements are true?

- [x] If any two charged particles are released from rest, they will spontaneously move in the direction in which the potential energy of the system will be decreased.
- [ ] In some situations charged particles released from rest would move in a direction that increases electric potential energy, but not in other situations.
- [ ] If released from rest two protons would move closer together, increasing the potential energy of the system.

- *Read the eBook*
- Section 6.14

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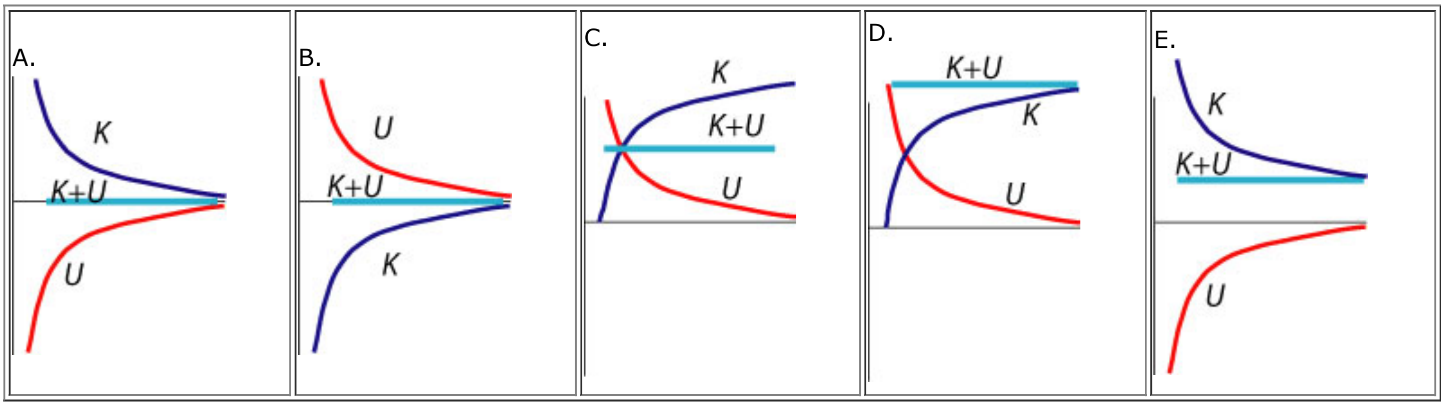
3. 2/2 points | Previous Answers MI3 6.14.X.097



Which of the diagrams above corresponds to a system of two electrons which start out far apart, moving toward each other (that is, their initial velocities are nonzero and they are heading straight at each other)?

D

Which of the diagrams above corresponds to a system of a proton and an electron which start out far apart, moving toward each other (that is, their initial velocities are nonzero and they are heading straight at each other)?

E

- *Read the eBook*
- Section 6.14

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4. 3/3 points | Previous Answers MI3 6.14.X.031

Two protons that are very far apart are hurled straight at each other, each with an initial kinetic energy of 0.17 MeV, where 1 mega electron volt is equal to $1 \times 10^{6} \times (1.6 \times 10^{-19})$ joules. What is the separation of the protons from each other when they momentarily come to a stop?

separation = 4.235e-15 m

- *Read the eBook*
- Section 6.14

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5. 11/11 points | Previous Answers MI3 6.15.P.101

In a fusion reaction, the nuclei of two atoms join to form a single atom of a different element. In such a reaction, a fraction of the rest energy of the original atoms is converted to kinetic energy of the reaction products. A fusion reaction that occurs in the Sun converts hydrogen to helium. Since electrons are not involved in the reaction, we focus on the nuclei.

Hydrogen and deuterium (heavy hydrogen) can react to form helium plus a high-energy photon called a gamma ray:

$^{1}H + ^{2}H \longrightarrow ^{3}He + \gamma$

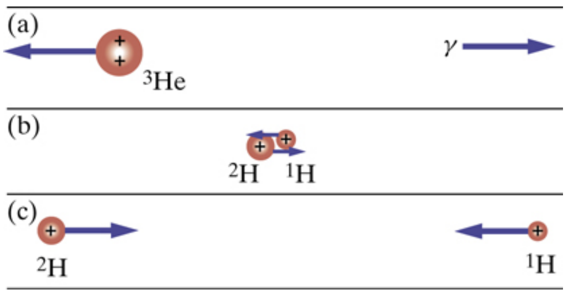
Objects involved in the reaction:

Particle	# of protons	# of neutrons	Charge	Rest Mass (atomic mass units)
^{1}H (proton)	1	0	$+e$	1.0073
^{2}H (deuterium)	1	1	$+e$	2.0136
^{3}He (helium)	2	1	$+2e$	3.0155
gamma ray	0	0	0	0

Although in most problems you solve in this course you should use values of constants rounded to 2 or 3 significant figures, **in this problem you must keep at least 5 significant figures throughout your calculation.** Problems involving mass changes require many significant figures because the changes in mass are small compared to the total mass. **In this problem you must use the following values of constants, accurate to 5 significant figures:**

Constant	Value to 5 significant figures
c (speed of light)	2.9979e8 m/s
e (charge of a proton)	1.6022e-19 coulomb
atomic mass unit	1.6605e-27 kg
$\frac{1}{4\pi\epsilon_0}$	8.9875e9 N·m^2 /C^2

The diagrams below represent different states in the fusion process:



A proton (^{1}H nucleus) and a deuteron (^{2}H nucleus) start out far apart. An experimental apparatus shoots them toward each other (with equal and opposite momenta). If they get close enough to make actual contact with each other, they can react to form a helium-3 nucleus and a gamma ray (a high energy photon, which has kinetic energy but zero rest energy). Consider the system containing all particles. Work out the answers to the following questions on paper, using symbols (algebra), before plugging numbers into your calculator.

A: Bringing the particles together

Which diagram depicts the initial state in the process of bringing the particles together?

- (selected) c
- b
- a

Which diagram depicts the final state in the process of bringing the particles together?

- (selected) b
- a
- c

Compare the initial state and final states of the system. Which quantities have changed?

- [x] kinetic energy
- [x] potential energy
- [ ] rest energy

The deuterium nucleus starts out with a kinetic energy of 2.07e-13 joules, and the proton starts out with a kinetic energy of 4.14e-13 joules. The radius of a proton is 0.9e-15 m; assume that if the particles touch, the distance between their centers will be twice that. What will be the total kinetic energy of both particles an instant before they touch?

$K_{1_H} + K_{2_H} =$ 4.92826e-13 joules

B: Reaction to make helium Now that the proton and the deuterium nucleus are touching, the reaction can occur.

Take the final state from the previous process to be the initial state of the system for this new process. Which diagram depicts the final state?

- c
- (selected) a
- b

Compare the initial state and final states of the system. Which quantities have changed?

- [x] potential energy
- [x] kinetic energy
- [x] rest energy

What is the kinetic energy of the reaction products (helium nucleus plus photon)?

$K_{He} + K_{\gamma} =$ 1.42687e-12 joules

C: Gain of kinetic energy:

What was the gain of kinetic energy in this reaction? (The products have more kinetic energy than the original particles did when they were far apart. How much more?)

$\Delta K =$ 8.058736e-1 joules

D: Fusion as energy source

Kinetic energy can be used to drive motors and do other useful things. If a mole of hydrogen and a mole of deuterium underwent this fusion reaction, how much kinetic energy would be generated?

4.853084e11 joules

(For comparison, around 1e6 joules are obtained from burning a mole of gasoline.)

- *Read the eBook*
- Section 6.15