

PHYSICS 200  
MIDTERM # 2

Friday, Nov. 9th, 2007

Name:

Student Number:

Questions 1-7: short answer/multiple choice.

1 point each. Write answers in boxes here →

Questions 8-10: SHOW YOUR WORK

9 points total

16 total points available

ANSWERS:

#1

#2

#3

#4

#5

#6

#7

write  
ALL  
that apply  
for these  
ones

Formula sheet at the back (may be removed)

- ① A massless particle has energy 13 MeV. What is its velocity?

②



A metal surface is illuminated with light whose wavelength is short enough to produce photoelectrons. If we now switch to light with half the wavelength but keep the total power of the beam the same, what happens to the maximum kinetic energy of the electrons?

- a) It stays the same
- b) It doubles (increases by 100%)
- c) It increases, but by less than 100%
- d) It is cut in half
- e) It increases by more than 100%

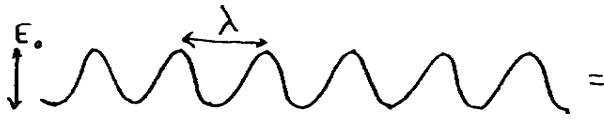
- ③ An  $\alpha$  particle is a bound state of two protons and two neutrons. The mass of an  $\alpha$  particle is

- a) greater than  $2m_p + 2m_n$
- b) equal to  $2m_p + 2m_n$
- c) less than  $2m_p + 2m_n$
- d) any of the above, depending on its velocity

4



The picture on the right above represents the photons making up an electromagnetic wave. Which of the pictures below best represents the photons making up a wave with the same amplitude and half the wavelength?

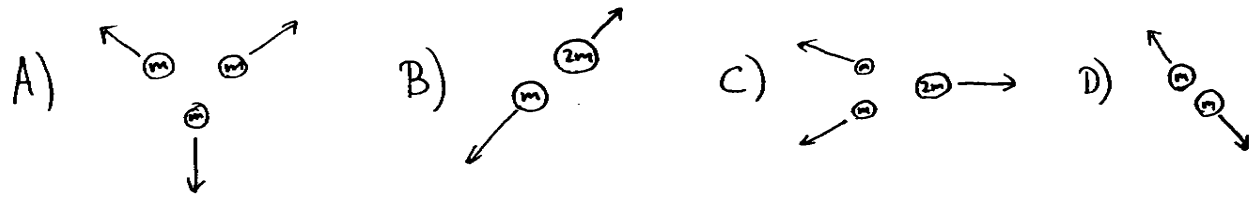


- A) ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ →
- B) ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ →
- C) ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ →
- D) ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ →
- E) ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ →

NOTE: size represents energy in the pictures to the right

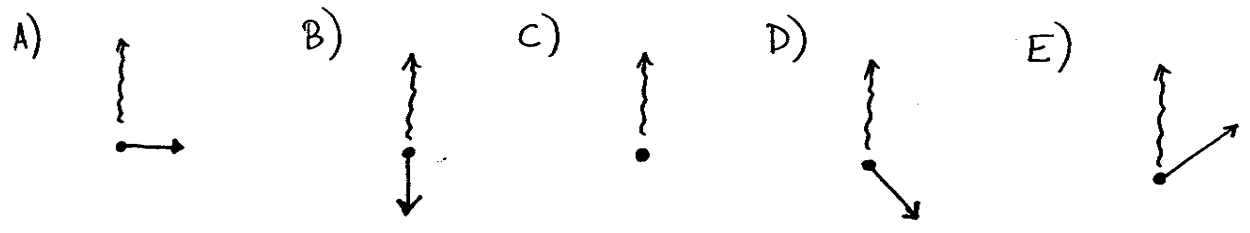
5

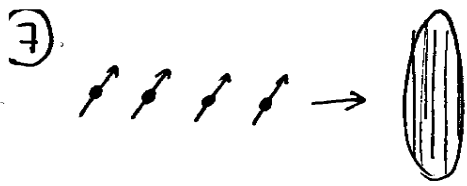
A nucleus of mass  $3m$  decays into smaller nuclei. Which of the following represent(s) a possible final state? GIVE ALL ANSWERS THAT APPLY



6

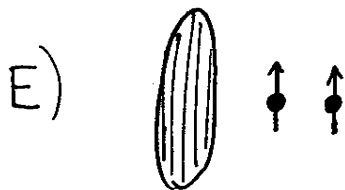
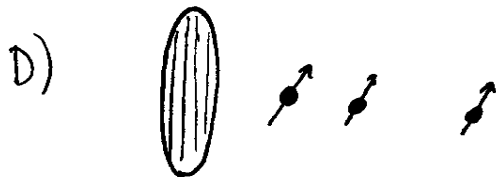
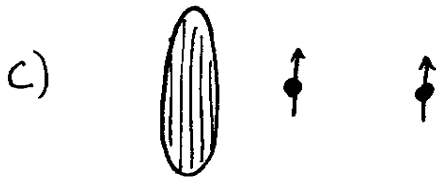
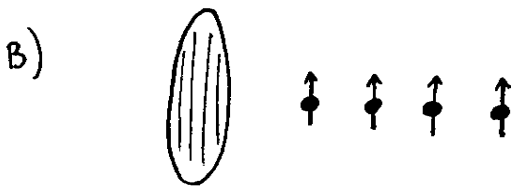
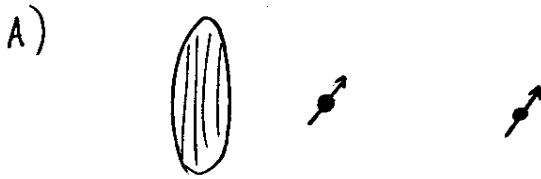
A photon scatters off an initially stationary electron. Which of the following represent(s) a possible final state? GIVE ALL ANSWERS THAT APPLY





Four equally spaced photons polarized at  $45^\circ$  to the vertical are incident upon a vertically oriented polarizer, as shown. Which

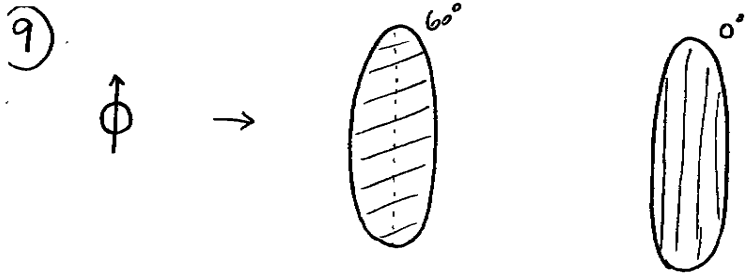
of the following pictures represents a possible outcome of this experiment?



GIVE ALL ANSWERS THAT APPLY.

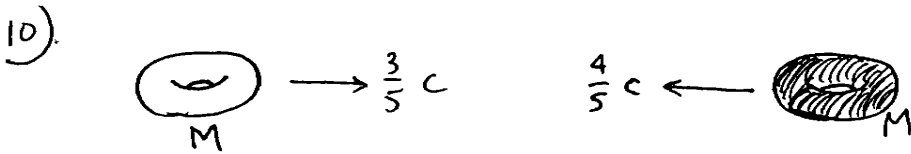
(note: E represents a case where the 1st 2 photons are absorbed & the last 2 are transmitted, while in C, the 2nd and 4th photons are transmitted)

8) A particle of mass  $140 \text{ MeV}/c^2$  decays into 2 photons. If the particle was initially at rest, what are the wavelengths of the photons? (2 points)



A vertically polarized photon is incident on a polarizer oriented at  $60^\circ$  to the vertical, followed by a polarizer oriented

vertically. What is the probability that the photon will pass through both polarizers? (3 points)



A plain donut of mass  $M$  is travelling in the  $+\hat{x}$  direction at velocity  $\frac{3}{5}c$  while a chocolate donut is travelling in the  $-\hat{x}$  direction with speed  $\frac{4}{5}c$ .

a) What is the momentum of the chocolate donut in the frame of the plain donut? (3 points)

b) If the two donuts collide inelastically and stick together, what is the mass of the resulting object? (1 point)

(NOTE: this question isn't worth much for the amount of work required, so it's best to do everything else first).