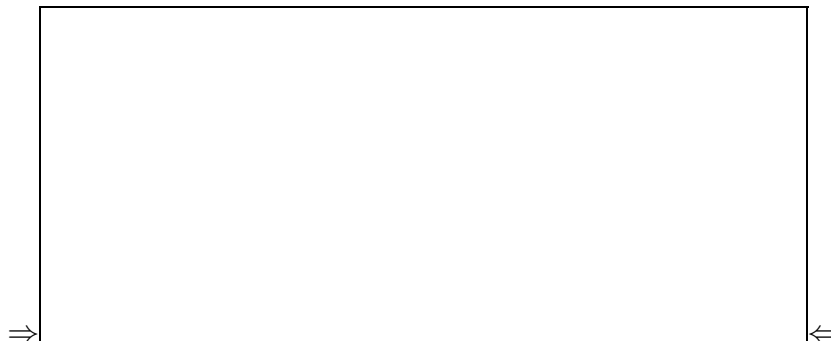


Physics 273– Practice Exam I
Fall 2011
Prof. Mohan Kalelkar



Your name sticker with **exam code**

1. The exam will last from 1:45pm to 2:50pm. Use a # 2 pencil to make entries on the answer sheet. Enter the following id information now, before the exam starts.
2. In the section labelled NAME, enter your last name, then fill in the empty circle for a blank, then enter your first name, another blank, and finally your middle initial.
3. Under STUDENT # enter your 9-digit Student ID Number. Under COURSE enter 273. Under CODE enter the exam code given above.
4. During the exam, you may use pencils, a calculator, and **ONE** $8\frac{1}{2}'' \times 11''$ sheet of paper with formulas and notes.
5. There are 16 multiple-choice questions on the exam. For each question, mark only one answer on the answer sheet. There is no subtraction of points for an incorrect answer, so even if you cannot work out the answer to a question, you should make an educated guess. At the end of the exam, hand in only the answer sheet. Retain this question paper for future reference and study.
6. Useful numerical constants are given on the next page. Before starting the exam, make sure that your copy contains the page of constants and all 16 questions. Bring your exam to the proctor if this is not the case.

Elementary charge $e = 1.6 \times 10^{-19} \text{ C}$

1 electron volt (eV) = $1.6 \times 10^{-19} \text{ J}$

Speed of light $c = 3 \times 10^8 \text{ m/s}$

Planck's constant $h = 6.63 \times 10^{-34} \text{ J} \cdot \text{s} = 1240 \text{ nm} \cdot eV/c$

$\hbar = h/2\pi$

Compton wavelength of electron $h/mc = 0.0024 \text{ nm}$

Ground-state energy of hydrogen = -13.6 eV

Rydberg constant $R = 0.0109678 \text{ nm}^{-1}$

Avogadro's number = 6.02×10^{23} molecules/mole

Electron mass = $9.11 \times 10^{-31} \text{ kg} = 0.511 \text{ MeV}/c^2$

Proton mass = $1.673 \times 10^{-27} \text{ kg} = 938.3 \text{ MeV}/c^2$

Neutron mass = $1.675 \times 10^{-27} \text{ kg} = 939.6 \text{ MeV}/c^2$

Atomic mass unit $1 u = 931.5 \text{ MeV}/c^2$

Powers of ten:

femto(f) 10^{-15}	pico(p) 10^{-12}	nano(n) 10^{-9}	micro(μ) 10^{-6}	milli(m) 10^{-3}
centi(c) 10^{-2}	kilo(k) 10^{+3}	Mega(M) 10^{+6}	Giga(G) 10^{+9}	Tera(T) 10^{+12}

1. A 1.00 meter stick lies at rest in the x-y plane at an angle of 45° with respect to the x-axis. What length for the stick would be measured by an observer moving along the x-axis at $0.500c$ relative to the stick?
 - a) About $0.612 m$
 - b) About $0.707 m$
 - c) About $0.866 m$
 - d) About $0.935 m$
 - e) About $1.000 m$

2. A cosmic ray hitting the atmosphere creates a pion which decays after a time t as measured by an observer at rest with respect to the PION. If the pion had been in flight at speed v according to observers on the ground, then what is the total distance the pion traveled, according to the ground observers?
 - a) $tc\sqrt{1 - v^2/c^2}$
 - b) $tv\sqrt{1 - v^2/c^2}$
 - c) tv
 - d) $tc/\sqrt{1 - v^2/c^2}$
 - e) $tv/\sqrt{1 - v^2/c^2}$

3. A spaceship is moving at speed $0.70c$ to the right relative to *earth*. Standing at the rear of the ship, a woman fires a space gun, and the bullet goes forward inside the ship at a speed of $0.90c$ relative to the *spaceship*. What is the bullet's speed as measured from earth?
 - a) $0.20c$
 - b) $1.60c$
 - c) $0.92c$
 - d) $0.98c$
 - e) $0.54c$

4. A spaceship is moving at speed v relative to earth. Observers on earth measure the ship's length to be L . When the spaceship doubles its speed to $2v$, observers on earth measure its length to be $0.7L$. What was the ship's original speed v ?
 - a) About $0.38c$
 - b) About $0.41c$
 - c) About $0.44c$
 - d) About $0.47c$
 - e) About $0.51c$

5. A student steps into the Physics Lecture Hall. At the same instant according to earth time, another student steps into Hill Center, which is located 80 m away. In a reference frame moving at $0.90c$ along the line between the buildings, what is the time difference (absolute value) between these two events?
- a) $0.55\ \mu\text{s}$
 - b) Zero
 - c) $0.13\ \mu\text{s}$
 - d) $0.24\ \mu\text{s}$
 - e) $0.30\ \mu\text{s}$
6. Particle A has mass M and speed $0.4c$. Particle B has the same mass M but speed $0.8c$. What is the ratio of the momentum of A to that of B ?
- a) About 0.25
 - b) About 0.33
 - c) About 0.50
 - d) About 0.65
 - e) About 0.75
7. A particle of mass M has a total energy that is three times its rest energy. What is its momentum?
- a) $2Mc$
 - b) $3Mc$
 - c) $\sqrt{3}Mc$
 - d) $9Mc$
 - e) $\sqrt{8}Mc$
8. Two particles each have mass M , and each has kinetic energy $0.6Mc^2$. However, they are moving in opposite directions. They collide head-on and stick together. What is the mass of the composite?
- a) $1.2M$
 - b) $1.6M$
 - c) $2.0M$
 - d) $3.2M$
 - e) None of the other answers

9. A proton has a kinetic energy of 1000 MeV . In which of the following ranges does its speed v lie?
- a) $v < 0.80c$
 - b) $0.80c \leq v < 0.85c$
 - c) $0.85c \leq v < 0.90c$
 - d) $0.90c \leq v < 0.95c$
 - e) $v \geq 0.95c$
10. A spaceship moving away from the earth at a speed of $0.8c$ sends out a radio signal at a frequency of $1.0 \times 10^9 \text{ Hz}$. What frequency will observers on earth detect for the signal?
- a) $1.0 \times 10^9 \text{ Hz}$
 - b) $1.1 \times 10^8 \text{ Hz}$
 - c) $3.3 \times 10^8 \text{ Hz}$
 - d) $3.0 \times 10^9 \text{ Hz}$
 - e) $9.0 \times 10^9 \text{ Hz}$
11. An example of the remarkable sensitivity of the human eye is that the retina can detect visible light (entering the eye) of power as low as 10^{-18} W . If light of wavelength 600 nm reflects off an object, what is the minimum number of photons per second that must enter the eye in order to see the object?
- a) About 3
 - b) About 100
 - c) About 1000
 - d) About 300
 - e) About 30
12. Photon A has twice the energy of photon B. What is the ratio of the momentum of photon A to that of photon B?
- a) $\sqrt{2}$
 - b) 8
 - c) 4
 - d) 2
 - e) None of the other answers

13. In the preceding problem, what is the ratio of the speed of photon A to that of photon B?
- a) $\sqrt{2}$
 - b) 8
 - c) 4
 - d) 2
 - e) None of the other answers
14. When light of wavelength λ shines on mercury, which has a work function of 4.5 eV , the photoelectrons have a maximum kinetic energy K . If light of the same wavelength λ shines on beryllium, which has a work function of 3.9 eV , what will be the maximum kinetic energy of the photoelectrons?
- a) $K - 0.6 \text{ eV}$
 - b) $K + 0.6 \text{ eV}$
 - c) $K - 8.4 \text{ eV}$
 - d) $K + 8.4 \text{ eV}$
 - e) None of the other answers
15. The threshold wavelength for photoemission in silver is 262 nm . For what wavelength will the photoelectric stopping potential be 1.36 V ?
- a) About 175 nm
 - b) About 368 nm
 - c) About 204 nm
 - d) About 912 nm
 - e) About 127 nm
16. A photon of wavelength 0.0040 nm undergoes Compton scattering off a free electron initially at rest. The electron acquires a kinetic energy of 0.07 MeV . What is the wavelength of the scattered photon?
- a) About 0.0045 nm
 - b) About 0.0052 nm
 - c) About 0.0064 nm
 - d) About 0.0070 nm
 - e) About 0.0088 nm