University of California – Santa Barbara
Fall 2004 Physics 3 Midterm
TR Section

Enter all of your answers in your blue-book. For the multiple choice questions, you do not need to enter an explanation, just the answer. Make sure to write your name and PERM number on the cover of the blue-book.

SCORING

Question 1	5 points	Question 8	5 points
Question 2	5 points	Question 9a	3 points
Question 3	5 points	Question 9b	4 points
Question 4	5 points	Question 9c	13 points
Question 5	5 points	Question 9d	10 points
Question 6	5 points	Question 10a	15 points
Question 7	5 points	Question 10b	15 points

DO NOT TURN THE PAGE UNTIL YOU ARE INSTRUCTED TO DO SO

Question 1

Two sources of sounds have the same frequency. Under what circumstances, if any, could you hear beats between them.

Question 2

A police officer's stationary radar device indicates that the frequency of the radar wave reflected from an automobile is less than the frequency emitted by the radar device. This indicates that the automobile is

A moving toward the police officer
B moving away from the police officer
C not moving

Question 3

An opera singer's voice is able to break a thin crystal glass if the singer's voice and the glass have the same natural

A speed
B wavelength
C frequency
D amplitude

Question 4

Maximum destructive inference between two waves occurs when the waves are out of the phase by

A 90 degrees
B 180 degrees
C 45 degrees
D 360 degrees

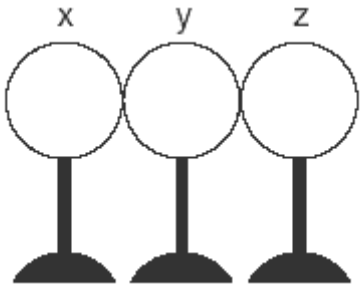
Question 5

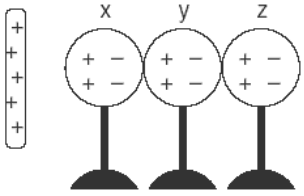
The number of water waves passing a given point each second is the waves

A frequency
B velocity
C amplitude
D wavelength

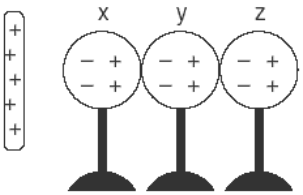
Question 6

The diagram below shows three neutral metal spheres, *x*, *y*, and *z*, in contact and on insulating stands. Which diagram best represents the charge distribution on the spheres when a positively charged rod is brought near sphere *x*, but does not touch it?

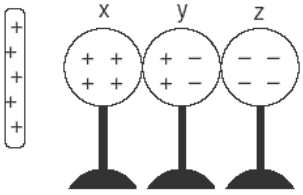




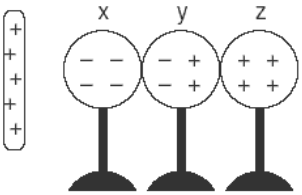
A



B



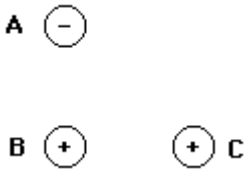
C



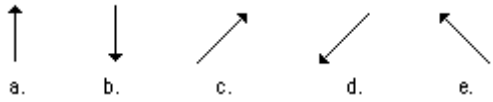
D

Question 7

Charged objects A, B, and C are oriented as shown in the diagram below.

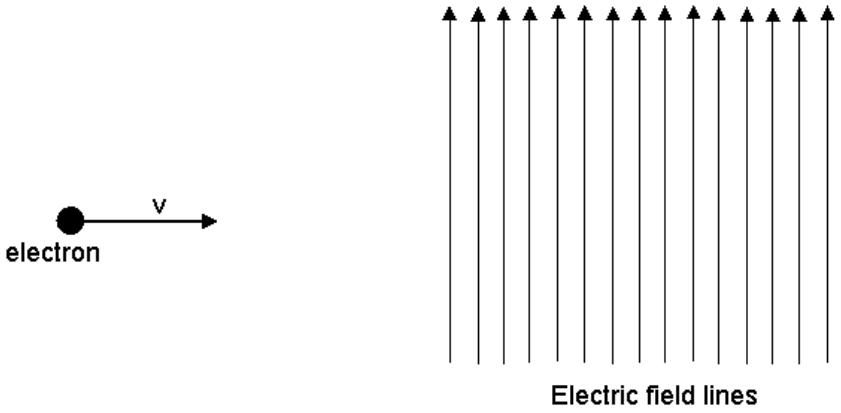


What arrow best describes the direction of the net electrical force on object B?



Question 8

An electron of velocity v enters a region of constant electric field as shown in the figure.



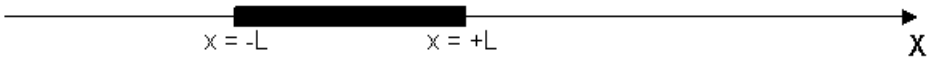
As the electron enters the electric field region, it will

A Proceed in a straight line
B Bend upwards
C Bend downwards
D Depends on whether the electron is traveling faster than the velocity of sound

Question 9

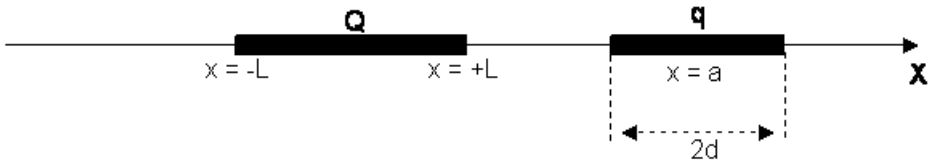
(Note: you may find the attached table of integrals useful)

A thin uniformly charged rod of total charge $+Q$ and length $2L$ lies along the x-axis, as shown in the figure.



Consider the electric field at a point P at coordinate $x=a$ ($a>L$)

(a) What is the direction of the electric field at the point P? Answer this question without doing any calculations.
(b) Imagine that $a >> L$. Without doing any complicated calculations, what is the approximate electric field at the point P? (Magnitude and direction).
(c) Now remove the approximation $a >> L$ (but still $a > L$). Find an exact expression for the electric field at the point P. (Magnitude and direction).
(d) Imagine that we now place a second thin uniformly charged rod of charge $+q$ and length $2d$ on the x-axis with its center at the $x=a$, see figure on next page.



What is the total force (magnitude and direction) on the second rod.
Note: both rods are made of insulating materials, so the (uniform) charge distribution in any one rod is not affected by the presence of the other rod.

Question 10

Two loudspeakers are placed on a wall a distance d = 2.0 m apart. A listener stands a distance L = 3.0 m from the wall directly in front of one of the speakers. A single oscillator is driving the speakers in phase at a frequency f = 300 Hz. The speed of sound is v = 343 m/sec.

(a) What is the phase difference, in degrees, between the two waves when they reach the listener.
Hint: think about the phases of the two waves as they reach the listener at a given time t.
Reminder: the phase of a sinusoidal wave is the argument of the sine (or cosine) function.

(b) What is the frequency closest to 300 Hz to which the oscillator may be adjusted such that the observer hears minimal sound.

Engineering Mathemathics III Table of Standard Integrals

$f(x)$	$\int f(x)$	Special Conditions
constant k	$kx+C$	
x	$\frac{x^2}{2}+C$	
x^2	$\frac{x^3}{3}+C$	
x^n	$\frac{x^{n+1}}{n+1}+C$	$n \neq -1$
$x^{-1} \equiv \frac{1}{x}$	$\ln\lvert x\rvert+C$	
$\sin x$	$-\cos x+C$	
$\cos x$	$\sin x+C$	
$\sin kx$	$\frac{-\cos kx}{k}+C$	
$\cos kx$	$\frac{\sin kx}{k}+C$	
$\tan kx$	$\frac{1}{k}\ln\lvert\sec kx\rvert+C$	
$\sec kx$	$\frac{1}{k}\ln\lvert\sec kx+\tan kx\rvert+C$	
e^x	e^x+C	
e^{-x}	$-e^{-x}+C$	
e^{kx}	$\frac{e^{kx}}{k}+C$	
$\cosh kx$	$\frac{1}{k}\sinh kx+C$	
$\sinh kx$	$\frac{1}{k}\cosh kx+C$	
$\frac{1}{x^2+a^2}$	$\frac{1}{a}\tan^{-1}\frac{x}{a}+C$	$a>0$
$\frac{1}{x^2-a^2}$	$\frac{1}{2a}\ln\frac{x-a}{x+a}+C$	$\lvert x\rvert > a > 0$
$\frac{1}{a^2-x^2}$	$\frac{1}{2a}\ln\frac{a+x}{a-x}+C$	$\lvert x\rvert < a$
$\frac{1}{\sqrt{x^2+a^2}}$	$\sinh^{-1}\frac{x}{a}+C$	$a>0$
$\frac{1}{\sqrt{x^2-a^2}}$	$\cosh^{-1}\frac{x}{a}+C$	$x \geq a > 0$
$\frac{1}{\sqrt{x^2+k}}$	$\ln\left(x+\sqrt{x^2+k}\right)+C$	
$\frac{1}{\sqrt{a^2-x^2}}$	$\sin^{-1}\frac{x}{a}+C$	$-a \leq x \leq a$

Throughout a and k are constants and C is the constant of integration. f^{-1} denotes the inverse function, NOT $1/f$ except for the integral of $1/x$.

SJ Schwartz, 4 December 2003