University of California – Santa Barbara
Fall 2004 Physics 3 Final
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.

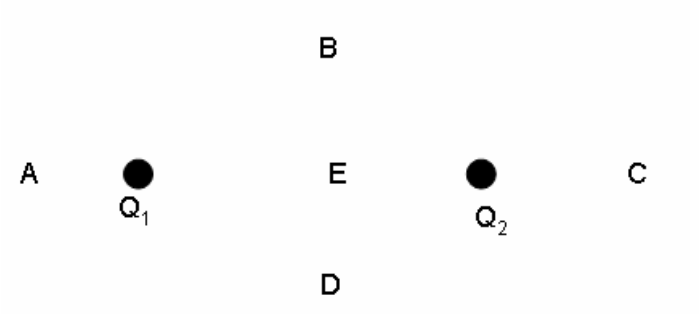
SCORING

Question 1	5 points	Question 10	5 points
Question 2	5 points	Question 11	5 points
Question 3	5 points	Question 12	5 points
Question 4	5 points	Question 13	5 points
Question 5	5 points	Question 14	10 points
Question 6	5 points	Question 15	10 points
Question 7	5 points	Question 16	5 points
Question 8	5 points	Question 17	10 points
Question 9	5 points		

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

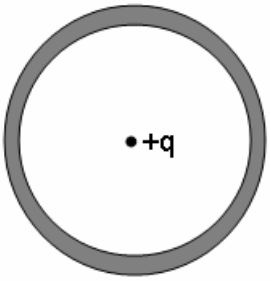
Question 1

In the Figure below, Q_1 is negative and has magnitude less than Q_2 which is positive. Where (A, B, C, D, or E) could a positive charge be placed and possibly have a zero net force on it?



Question 2

A metal shell surrounds a positive charge, see the Figure.

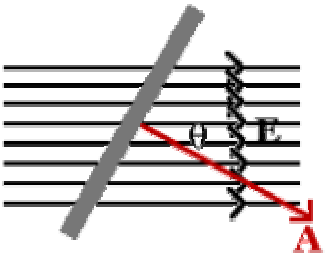


The charge on the inner surface of the shell is

A: +q
B: + ½ q
C: -q
D: - ½ q
E: 0

Question 3

An electric field of 1000 N/C crosses an imaginary area (shown here edge on) of 100 cm^2. If the angle θ is 60^o what is the electric flux?



A: 1 Nm^2/C
B: 5 Nm^2/C
C: 10 Nm^2/C
D: 50 Nm^2/C
E: 100 Nm^2/C
F: 500 Nm^2/C
G: 1000 Nm^2/C
H: 5000 Nm^2/C
I: 10000 Nm^2/C
J: 50000 Nm^2/C

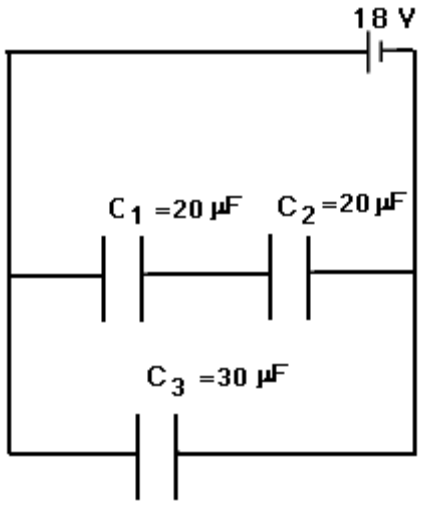
Question 4

A 1.5 volt battery is connected to a voltmeter with infinite internal resistance. The voltage read is

A: 1.5 V
B: A little less than 1.5 V
C: A little more than 1.5 V

Question 5

What is the equivalent capacitance of the two capacitors connected in series (see Figure below).



A: 10 μF
B: 20 μF
C: 30 μF
D: 40 μF

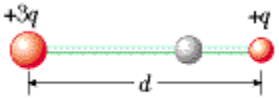
Question 6

A voltage of 5 volts is applied across a resistance of 10 Ω. What is the power dissipated in the resistor

A: Zero, because of energy conservation
B: Depends on how long the current flows
C: 0.5 W
D: 2.5 W
E: 5.0 W
F: 50 W

Question 7

Two small beads having positive charges 3q and q are fixed on the opposite ends of a horizontal insulating rod, extending from the origin to the point $x = d$. As shown in the Figure, a third small, charged bead is free to slide on the rod.



At what position is the third bead in equilibrium? ($x=0$ is the position of the +3q charge)

A: $x = 0.366d$
B: $x = 0.634d$
C: $x = 0.900d$
D: $x = 0.237d$
E: depends on the sign of the third charge

Question 8

A police car has an 1000 Hz siren. It is traveling at 35 m/s on a day when the speed of sound through air is 350 m/s. The car approaches and passes an observer who is standing along the roadside. What change of frequency does the observer hear?

A: 81 Hz C: 202 Hz
B: 111 Hz D: 1111 Hz

Question 9

Two copper wires have the same length, but the second one has twice the diameter of the first. If the resistance of the first wire is 2 Ω, then the resistance of the second is

A: 0.5 Ω D: 4.0 Ω
B: 1.0 Ω E: 6.0 Ω
A: 2.0 Ω F: 8.0 Ω

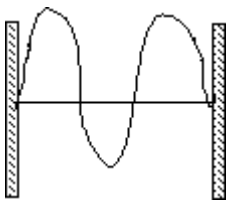
Question 10

The wavelengths of the sounds produced by two horns are 6 m and 7 m respectively. What beat frequency is heard when the horns are sounded on a day when the velocity of sound is 336 m/s?

A: 53.5 Hz C: 4 Hz
B: 8 Hz D: None of the above

Question 11

A stretched string, fixed at both ends, vibrates at a frequency of 12 Hz with a standing transverse wave pattern as shown. What is this spring's fundamental frequency?



A: 36 Hz C: 8 Hz
B: 16 Hz D: 4 Hz

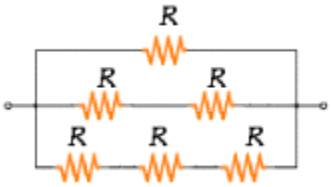
Question 12

The wave equation for a particular wave is $y(x,t) = 4 \sin[\pi(x-400t)/2]$, where all numerical values are in the appropriate SI units.

(a) What is the amplitude of the wave
(b) What is the wavelength of the wave
(c) What is the velocity of the wave

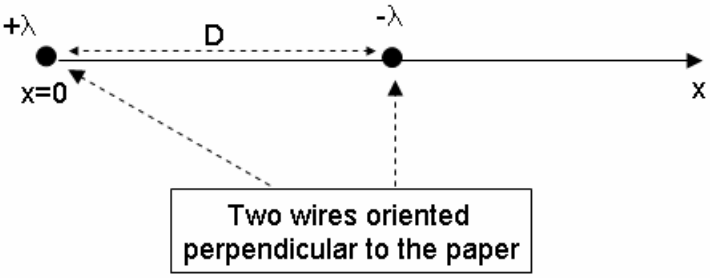
Question 13

Find the equivalent resistance of this network



Question 14

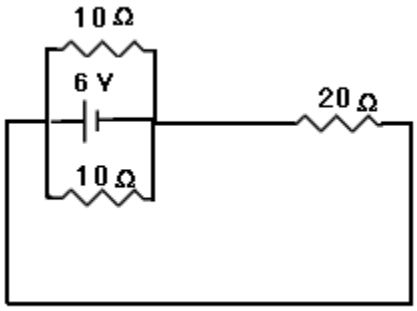
Consider two infinitely long, infinitely thin, and oppositely charged wires. The charge per unit length is ±λ, and the separation between the wires is D, see Figure below.



Find the electric field, magnitude and direction, at any point on the x-axis.

Question 15

Consider the circuit below.



(a) What is the voltage drop across the 20 Ω resistor.
(b) What is the current through the 20 Ω resistor.
(c) What is the total current supplied by the battery

Question 16

An isolated capacitor of unknown capacitance has been charged to a voltage of 100 V. When it is connected in parallel to a 10 μF uncharged capacitor, the voltage is 30 V. What is the unknown capacitance?

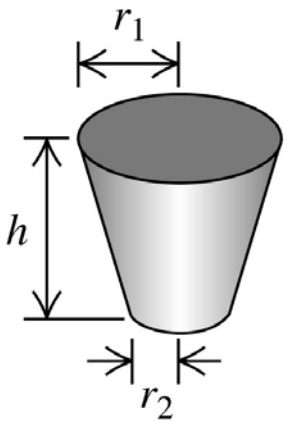
Question 17

Consider a truncated cone of radii r_1 and r_2, and height h (see Figure below). The resistivity of the material is ρ.

(a) Calculate the resistance of this object between the two flat end faces.

(b) Verify that for $r_1 = r_2$ your answer agrees with the resistance of a cylinder which we calculated in class and is given in the textbook.

HINT: Slice the cone into many thin disks



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