

INTRODUCTORY ELECTRICITY & MAGNETISM

Questions	182
Field	Physics
Target Audience	Physical Sciences
Target Level	First-year Undergraduate
Topics	<ul style="list-style-type: none">▪ Cross Products▪ Coulomb's Law▪ Electric Fields▪ Point Charge Distributions▪ Continuous Charge Distributions (Integration)▪ Electric Potential▪ Electric Potential Energy▪ Electromotive Force▪ Resistance▪ Capacitance▪ Kirchhoff's Laws▪ Magnetic Fields▪ Magnetic Fields Due to Current Carrying Wires▪ Forces on Wires in Magnetic Fields▪ Forces on Charges in Electric and/or Magnetic Fields▪ EM Waves▪ Two Source Interference▪ Double Slit Interference▪ Single Slit Diffraction▪ Diffraction Gratings

Outline

The material in this module is designed to cover a single-semester course in electricity and magnetism for physical sciences students at the first-year university level. The questions are designed to span the topics listed above, allowing for practice, homework or testing throughout the semester.

Using the Maple engine that is part of Maple TA, a custom grading engine has been developed to provide even more flexible grading of scalar and vector responses. This partial grading engine can be configured to, among other things, assign part marks for missing units, transposed or missing vector components or missing algebraic terms. Please see the included help document for detailed usage instructions. Beyond the 181 questions, there are 99 alternative versions of the 181 questions that use the built-in Maple TA grading instead.

The vast majority of the questions are algorithmic and take numeric or algebraic responses. Solutions are provided for most questions. Dynamically labelled diagrams are included in many questions. Information fields are included on all questions indicating topics and difficulty level. Questions that use the custom grading engine also provide detailed feedback about how the grade was calculated.

The module was first implemented in Winter 2012 at the University of Guelph and has seen a subsequent round of updates.

A general Maple TA Syntax Sheet as well as a Partial Grading Syntax Sheet specific to the custom grading engine used in this module are included. Sample homework assignments are provided, spanning the course material.

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MAPLE TA SYNTAX SHEET

Expression	Entry Syntax
$x \cdot y$	$x*y$
$\frac{x}{y}$	x/y
x^y	x^y
$\frac{a}{b \cdot c}$	$a/(b*c)$ (although it will accept $a/b/c$)
\sqrt{x}	$\text{sqrt}(x)$ or $x^{(1/2)}$ (do not use $x^{0.5}$)
$x^{\frac{2}{3}} = \sqrt[3]{x^2}$	$x^{(2/3)}$
$ x $	$\text{abs}(x)$
$\ln(x)$	$\ln(x)$
$\log_n(x)$	$\log[n](x)$
e^x	$\text{exp}(x)$
e	e or $\text{exp}(1)$
π	pi or Pi
∞	infinity
$\sin^2(x) = (\sin(x))^2$	$\sin(x)^2$ or $(\sin(x))^2$

Notes

Maple TA likes to make the following substitutions when displaying equations

Simple Form	Maple TA Will Show
$\sec(x)^2$	$1+\tan(x)^2$
$\csc(x)^2$	$1+\cot(x)^2$
$\sec(x)*\tan(x)$	$\sin(x)/\cos(x)^2$
$\csc(x)*\cot(x)$	$\cos(x)/\sin(x)^2$

PARTIAL GRADING SYNTAX SHEET

The following are special rules that **do not** apply to all Maple TA courses. Please consult the separate Maple TA Syntax Sheet for general input rules.

Ensure that you enter the multiplication symbol * between terms, between units, and between algebraic terms.

eg. $1.05 \cdot 10^5 \cdot N$, $k \cdot q/r$

Use brackets to ensure terms are interpreted correctly.

eg. $1.05 \cdot 10^{(-5)} \cdot N$, $u \cdot l / (2 \cdot \text{Pi} \cdot r)$

Scientific notation can be entered in several equivalent manners.

eg. $1.05 \cdot 10^5$, $1.05 \cdot 10^{(-5)}$ [NOT $1.05 \cdot 10^{-5}$], $1.05e5$, $1.05E5$, $1.05e-5$ [NOT $1.05e(-5)$]

In some situations, Preview will misinterpret the number of significant figures you have entered. However, this will not be reflected in the grading.

eg. $1.05 \cdot 10^5$ appears as $1.0500000 \cdot 10^5$, but will be graded as $1.05 \cdot 10^5$

For vectors, enter the text "ihat", "jhat", "khat" or "xhat", "yhat", "zhat" for the unit vectors.

eg. $1.05 \cdot m \cdot \text{ihat} + (3.22 \cdot 10^5 \cdot m) \cdot \text{khat}$

Unless otherwise noted, the following notation must be used:

Variable	Enter
π	Pi
μ_0	u
$\frac{1}{4\pi\epsilon_0}$	k

Introductory Electricity & Magnetism **Sample Assignments**

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Assignment #1 - Electric Fields and Forces (Point Charges)

Question 1: Score 2/2

A charged particle of mass $5.19 \times 10^{-25} \text{ kg}$ is suspended motionless in the air by an electric field.

If the electric field is $2.65 \times 10^{-25} \frac{\text{N}}{\text{C}}$ upwards, what is the magnitude and sign of the charge of the particle?



Correct

Your Answer: 19.2°C

Correct Answer: 19.2°C

Response-Specific Grading

Comment: " Correct value and significant figures 100.0% "
Dimensions are correct
Total = 100.0%

Question 2: Score 2/2

After rubbing a balloon against someone's hair, a balloon has accumulated a static electric charge. The air inside the balloon has the same density as the air outside of the balloon, and the balloon itself

weighs 2.87 mN . How many free electrons are there on the surface of the balloon if an electric field of magnitude $3.43 \times 10^{10} \frac{\text{N}}{\text{C}}$ is required to keep the balloon floating at a constant height?



Correct

Your Answer: 5.23e5

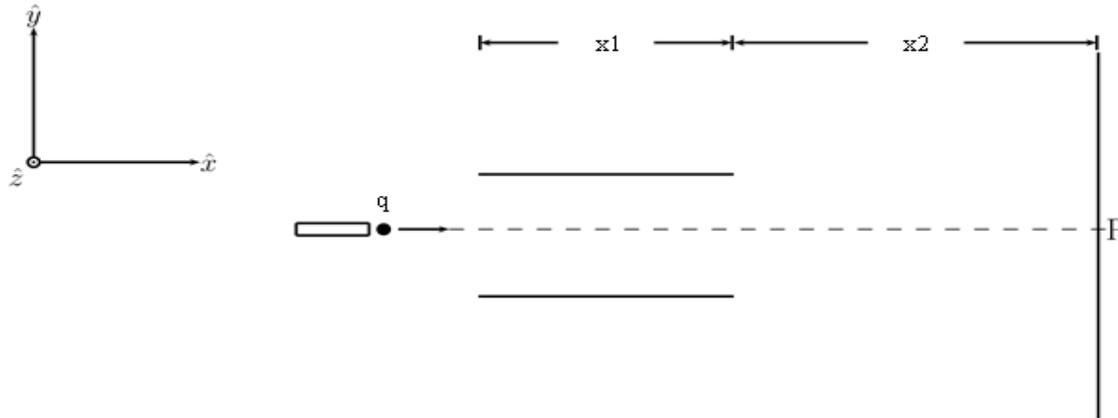
Correct Answer: .523e6

Response-Specific Grading

Comment: " Correct value and significant figures 100.0% "
Total = 100.0%

Question 3: Score 3/3

A particle with charge $q > 0$ and mass m is fired from a gun, with an initial speed v in the \hat{x} direction. The particle passes through a region between two plates where the electric field is (approximately) uniform and equal to E and in the positive \hat{y} direction. The particle then passes through a region with no fields, before finally hitting a screen.



Correct

Relative to the point P, where does the particle hit the screen? Provide an algebraic answer in terms of the given parameters. Neglect gravity.

Your Answer: $qE x_1 / m v^2 (1/2 x_1 + x_2)$

Correct Answer: $qE x_1 / m v^2 (1/2 x_1 + x_2)$

Response-Specific Grading

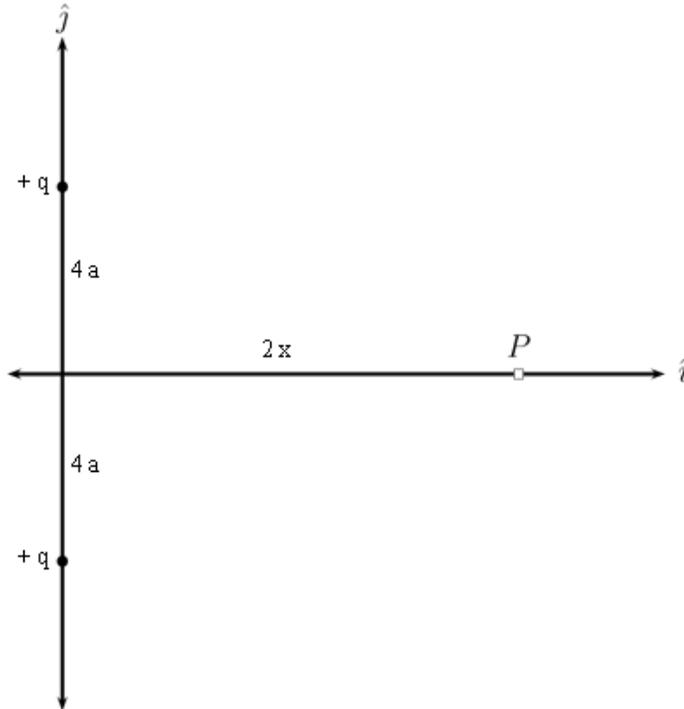
Comment: " Algebraic Term Match 100.0% "

Total = 100.0%

Question 4: Score 3/3

Point charges $+q$ and $+q$ are positioned as shown.

Find an algebraic expression for the electric field at point P, in terms of the given parameters.



Correct

Entry Notes:

Ensure that you explicitly enter the multiplication symbol $*$ between terms.

If necessary, use the letter k to represent the Coulomb constant $k = \frac{1}{4\pi\epsilon_0}$.

Your Answer: $4*k*q/(4*x^2+16*a^2)^{(3/2)}*x*\hat{i}$

Correct Answer: $4*k*q/(4*x^2+16*a^2)^{(3/2)}*x*\hat{i}$

Response-Specific Grading

Component	\hat{i}
Response	$4*k*q/(4*x^2+16*a^2)^{(3/2)}*x$
Algebraic Term Match	100.0%
Sub-Total	= 100.0%

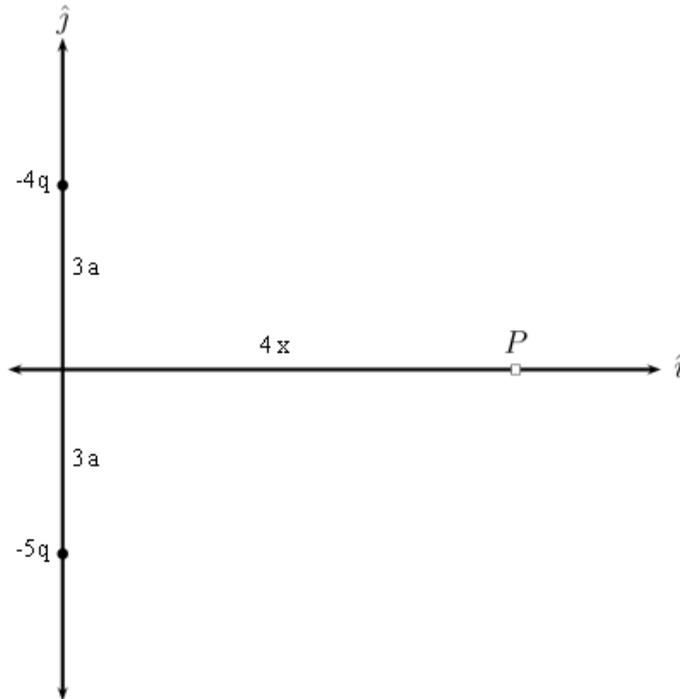
Comment:

" Number of Components X 1 "

Sub-Total	100.0%
No Rearranging X	1.0
Total	100.0%

Question 5: Score 5/5

Find an algebraic expression for the electric field at point P, in terms of the given parameters.



Correct

Entry Notes:

Vector components can be entered using \hat{i} , \hat{j} and \hat{k} .
Ensure that you explicitly enter the multiplication symbol * between terms.

If necessary, use the letter k to represent the Coulomb constant $k = \frac{1}{4\pi\epsilon_0}$.

eg. $\frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r^2} \hat{i} + \frac{1}{4\pi\epsilon_0} \frac{q_2 q_3}{r^2} \hat{k}$ could be entered as $(k*q1*q2/(r^2))*\hat{i} + (k*q2*q3/(r^2))*\hat{k}$.

Your Answer: $-36*k*q/(16*x^2+9*a^2)^{(3/2)}*x*\hat{i}-3*k*q/(16*x^2+9*a^2)^{(3/2)}*a*\hat{j}$

Correct Answer: $-36*k*q/(16*x^2+9*a^2)^{(3/2)}*x*\hat{i}-3*k*q/(16*x^2+9*a^2)^{(3/2)}*a*\hat{j}$

Response-Specific Grading

Component	\hat{i}		
Response	$-36*k*q/(16*x^2+9*a^2)^{(3/2)}*x$		
	Algebraic Term Match		100.0%
	Sub-Total	=	100.0%
	Number of Components	X	1/2

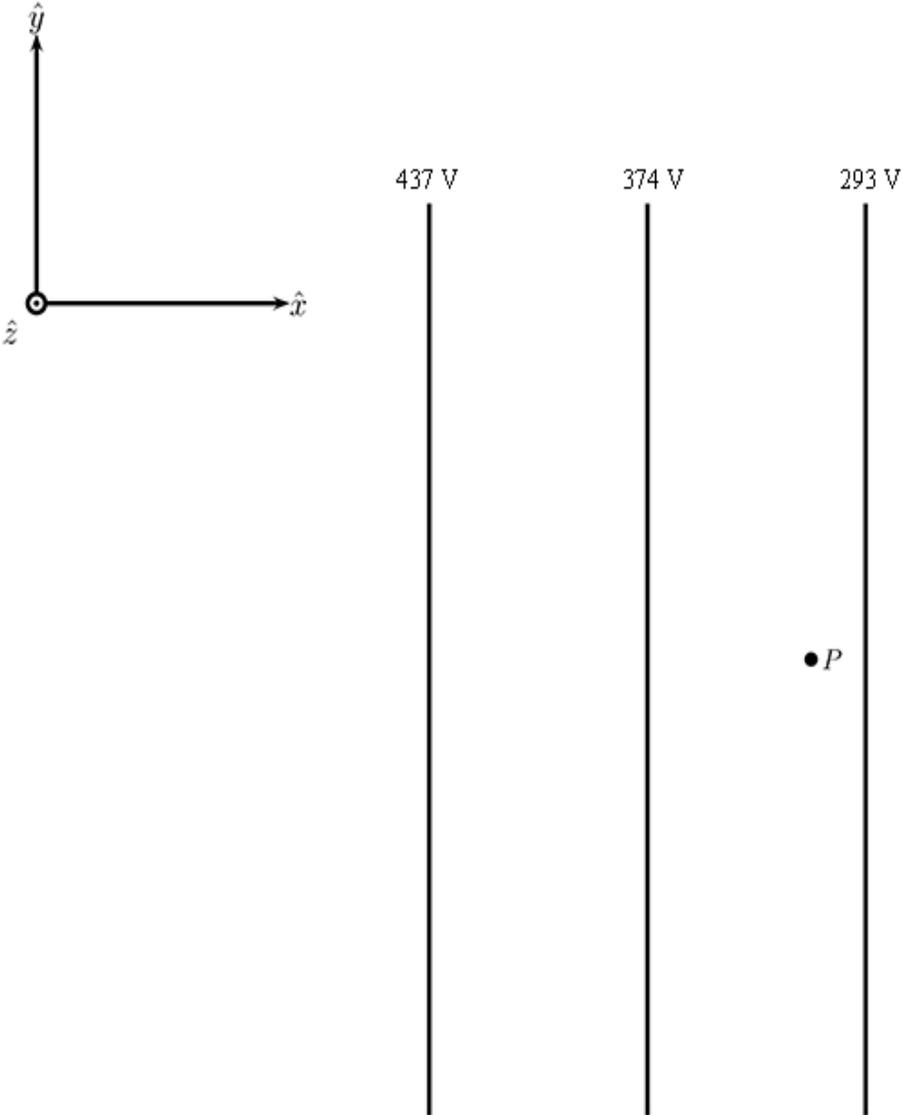
Component	\hat{j}		
Response	$-3*k*q/(16*x^2+9*a^2)^{(3/2)}*a$		
	Algebraic Term Match		100.0%
	Sub-Total	=	100.0%
	Number of Components	X	1/2

Comment:

Sub-Total			100.0%
	No Rearranging	X	1.0
Total			100.0%

Assignment #2 - Electric Potential and Energy (Point Charges)

Question 1: Score 2/2

Your response	Correct response
 <p>The diagram shows a 2D coordinate system with a vertical \hat{y} axis and a horizontal \hat{x} axis. A point charge z is located at the origin, represented by a circle with a dot. Three vertical equipotential lines are shown at different potentials: 437 V, 374 V, and 293 V. A point P is marked with a dot on the 293 V line.</p>	<p>Please select the most appropriate description of the electric field associated with the equipotential lines in the diagram.</p> <p>The magnitude of the electric field is: Changing</p> <p>The direction of the electric field is: Constant</p> <p>The direction of the electric field at P is in the direction: + x</p>



Correct

Please select the most appropriate description of the electric field associated with the equipotential lines in the diagram.

The magnitude of the electric field is: **Changing** (33%)

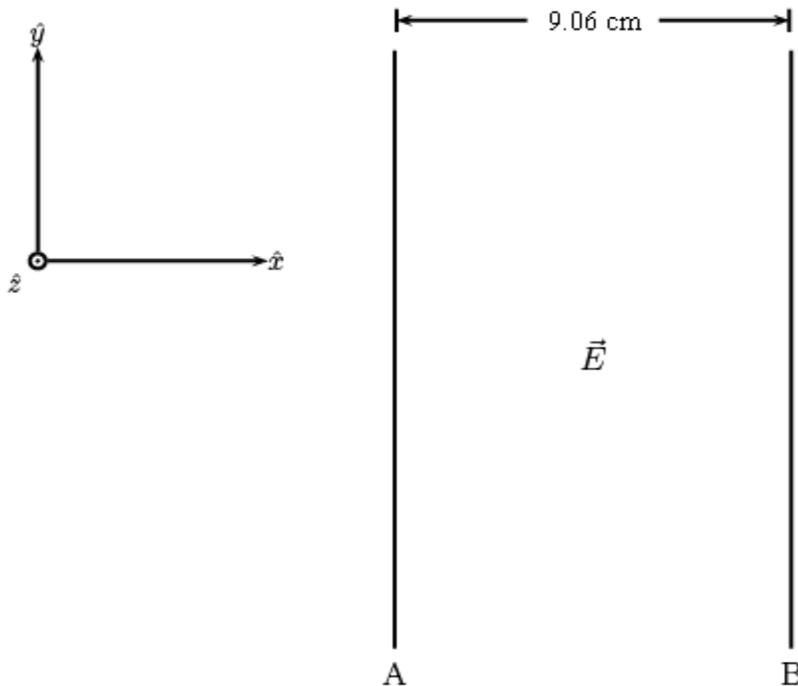
The direction of the electric field is: **Constant** (33%)

The direction of the electric field at P is in the direction: **+ x** (33%)

Comment:

Question 2: Score 2/2

Two infinite parallel plates are separated by a distance 9.06 cm . The electric field between the plates is measured to be $-499 \text{ V/m } \hat{x}$.



Correct

What is the magnitude of the potential difference between the plates?

Your Answer: 45.2*V

Correct Answer: 45.2*V

Response-Specific Grading

Comment: „ Correct value and significant figures 100.0% „
Dimensions are correct
Total = 100.0%

Question 3: Score 3/3

A charged particle of mass $1.87 \times 10^{-24} \text{ kg}$ is travelling from infinity towards a second charged particle that is fixed in space. The moving particle has a charge of $7.56 \times 10^{-14} \text{ C}$, while the fixed particle has a charge of $2.75 \times 10^{-12} \text{ C}$. If the particles come within 3.47 mm of each other, what was the initial speed of the travelling particle?



Correct

Your Answer: 7.59*10^5*m/s

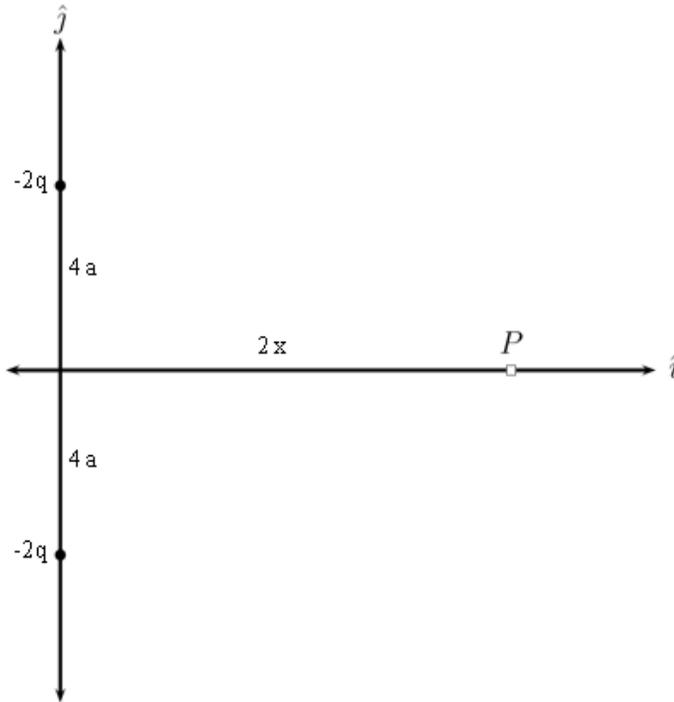
Correct Answer: .759e6*m/s

Response-Specific Grading

Comment: „ Correct value and significant figures 100.0% „
Dimensions are correct
Total = 100.0%

Question 4: Score 3/3

Find an algebraic expression for the electric potential at point P, in terms of the given parameters.



Correct

Entry Notes:

Ensure that you explicitly enter the multiplication symbol * between terms.

If necessary, use the letter k to represent the Coulomb constant $k = \frac{1}{4\pi\epsilon_0}$.

Your Answer: $-2*k*q/(4*a^2+x^2)^{(1/2)}$

Correct Answer: $-2*k*q/(4*a^2+x^2)^{(1/2)}$

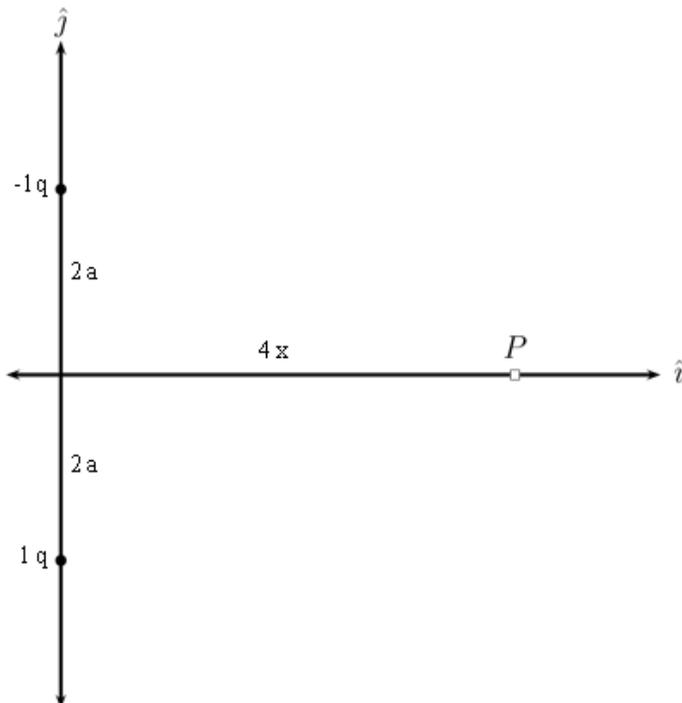
Response-Specific Grading

Comment: " Algebraic Term Match 100.0% "

Total = 100.0%

Question 5: Score 5/5

Find an algebraic expression for the electric potential at point P, in terms of the given parameters.



Correct

Entry Notes:

Ensure that you explicitly enter the multiplication symbol * between terms.

If necessary, use the letter k to represent the Coulomb constant $k = \frac{1}{4\pi\epsilon_0}$.

Your Answer: 0

Correct Answer: 0

Response-Specific Grading

Comment: " Algebraic Term Match 100.0% "

Total = 100.0%

Assignment #3 - Continuous Charge Distributions

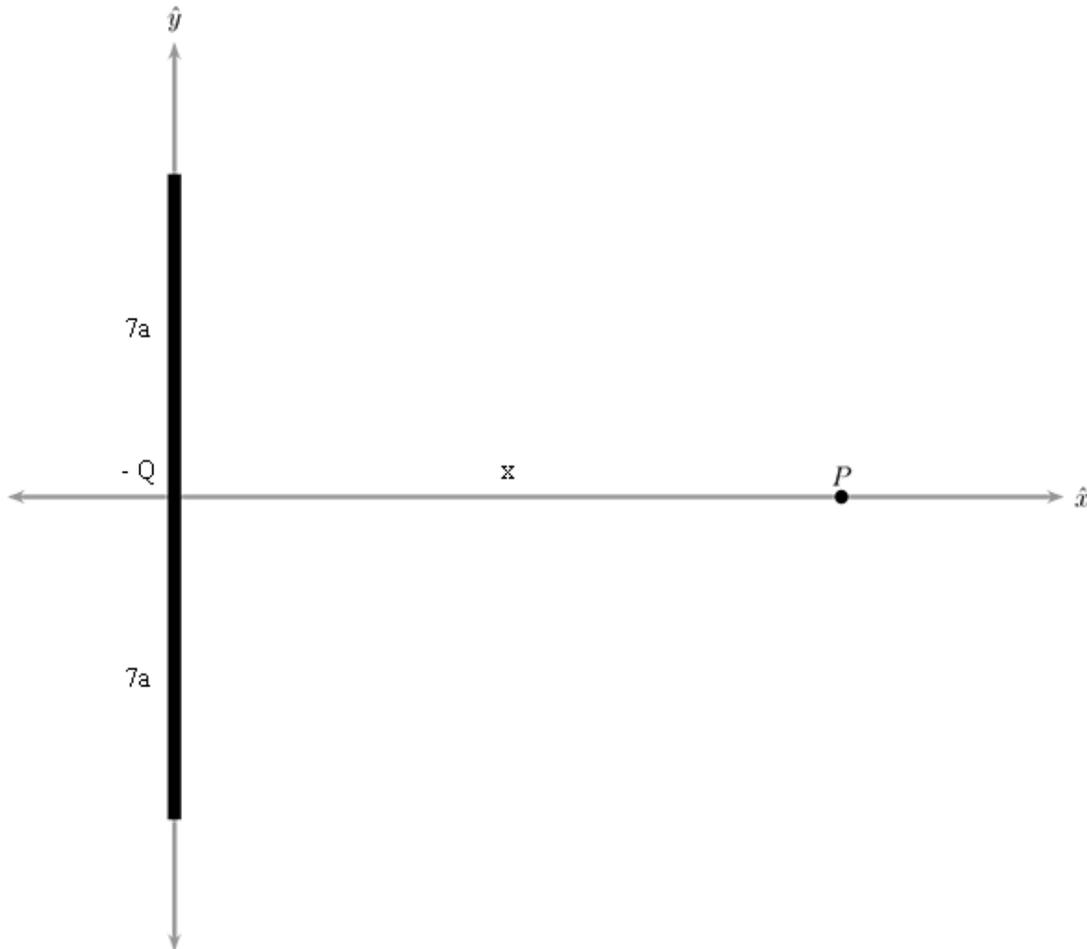
Question 1: Score 5/5

A thin, uniform line of charge extends from $+7a$ to $-7a$ along the y -axis and contains a total charge $-Q$.

Set up an integral for the electric field at an arbitrary point along the x -axis due to the line of charge. Use symmetry to reduce the integral to a single expression. Provide the *integrand* of this integral as your answer, in terms of the given parameters.

e.g. Integral: $\vec{E} = \int_{-a}^a \frac{Q}{x^2 + y^2} \hat{y} dy$, Integrand: $\frac{Q}{x^2 + y^2} \hat{y}$

In order to find the electric field, one needs to evaluate an integral that adds up the contributions from each infinitesimal piece of the line, dy , from $-7a$ to $+7a$.



Note: Use the letter 'k' for the Coulomb constant, $\frac{1}{4\pi\epsilon_0}$.

Your Answer: $-1/14*k*Q/a/(x^2+y^2)^{(3/2)}*x\hat{i}$

Response-Specific Grading

Component	\hat{i}		
Response	$-1/14*k*Q/a/(x^2+y^2)^{(3/2)}*x$		
	Algebraic Term Match		100.0%
	Sub-Total	=	100.0%
Comment:	Number of Components	X	1

	Sub-Total		100.0%
	No Rearranging	X	1.0
	Total		100.0%

Question 2: Score 5/5

A thin ring of radius $3w$ is centered at the origin in the $\hat{y} - \hat{z}$ plane. A charge $+Q$ is uniformly distributed on the ring.

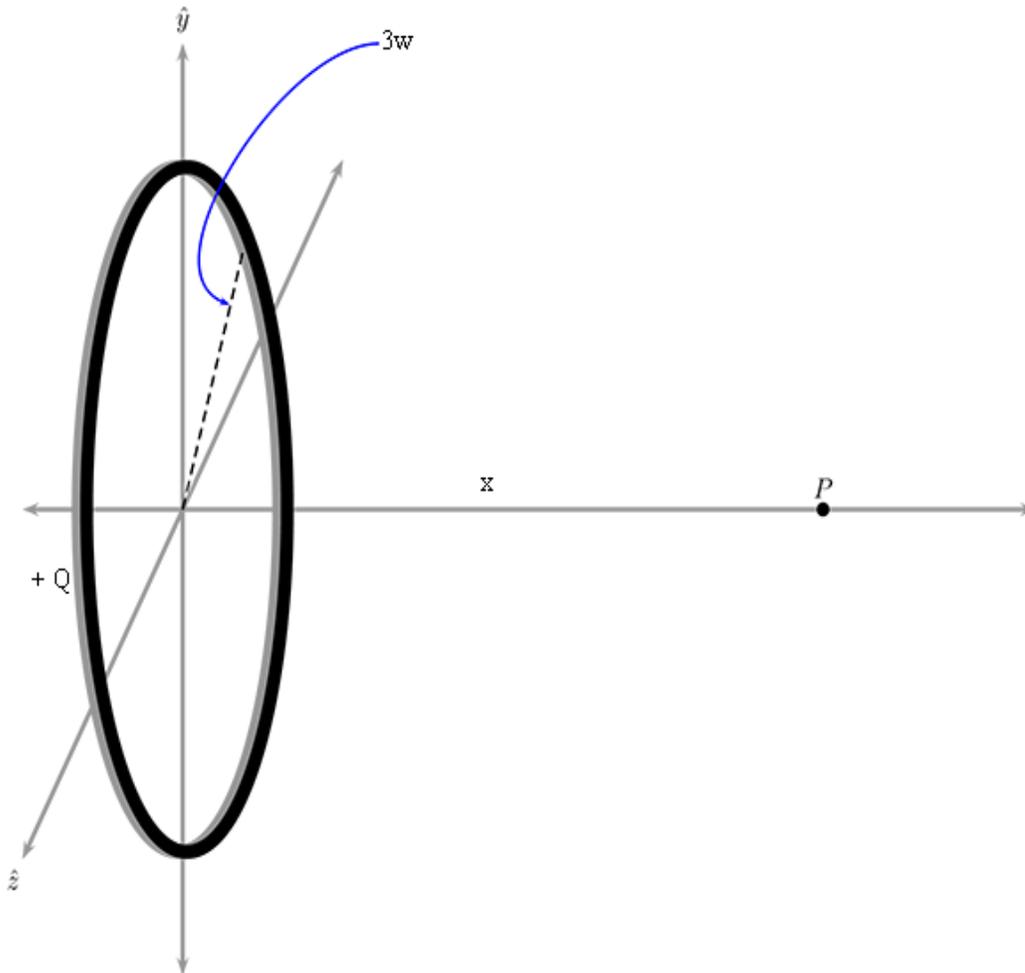
Use symmetry to set up a single expression for the electric field at an arbitrary point along the x -axis due to the ring of charge.

Provide the *integrand* of this integral as your answer, in terms of the given parameters.

e.g. Integral: $\vec{E} = \int_{-\alpha}^{\alpha} \frac{Q}{x^2 + y^2} \hat{y} dy$, Response: $\frac{Q}{x^2 + y^2} \hat{y}$

In order to find the electric field, one needs to evaluate an integral that adds up the contributions from each infinitesimal piece

of the line, ds , from 0 to $2\pi \cdot (3w)$.



Note: Use the letter 'k' for the Coulomb constant, $\frac{1}{4\pi\epsilon_0}$.

Your Answer: $\frac{1}{6}k\frac{Q}{\pi w}(x^2+9w^2)^{3/2}x$

Response-Specific Grading

Component	\hat{i}		
Response	$\frac{1}{6}k\frac{Q}{\pi w}(x^2+9w^2)^{3/2}x$		
	Algebraic Term Match		100.0%
	Sub-Total	=	100.0%
Comment:	Number of Components	X	1

	Sub-Total		100.0%
		No Rearranging	X 1.0
	Total		100.0%

Question 3: Score 5/5

A solid disc of radius $7b$ is centered at the origin in the $\hat{y} - \hat{z}$ plane. A charge $-Q$ is uniformly distributed on the disc.

Use symmetry to set up a single expression for the electric field at an arbitrary point along the x -axis due to the ring of charge.

Use the fact that one can treat the disc as an infinite number of thin rings, and the fact that the electric field due to a single thin

ring of radius R is:

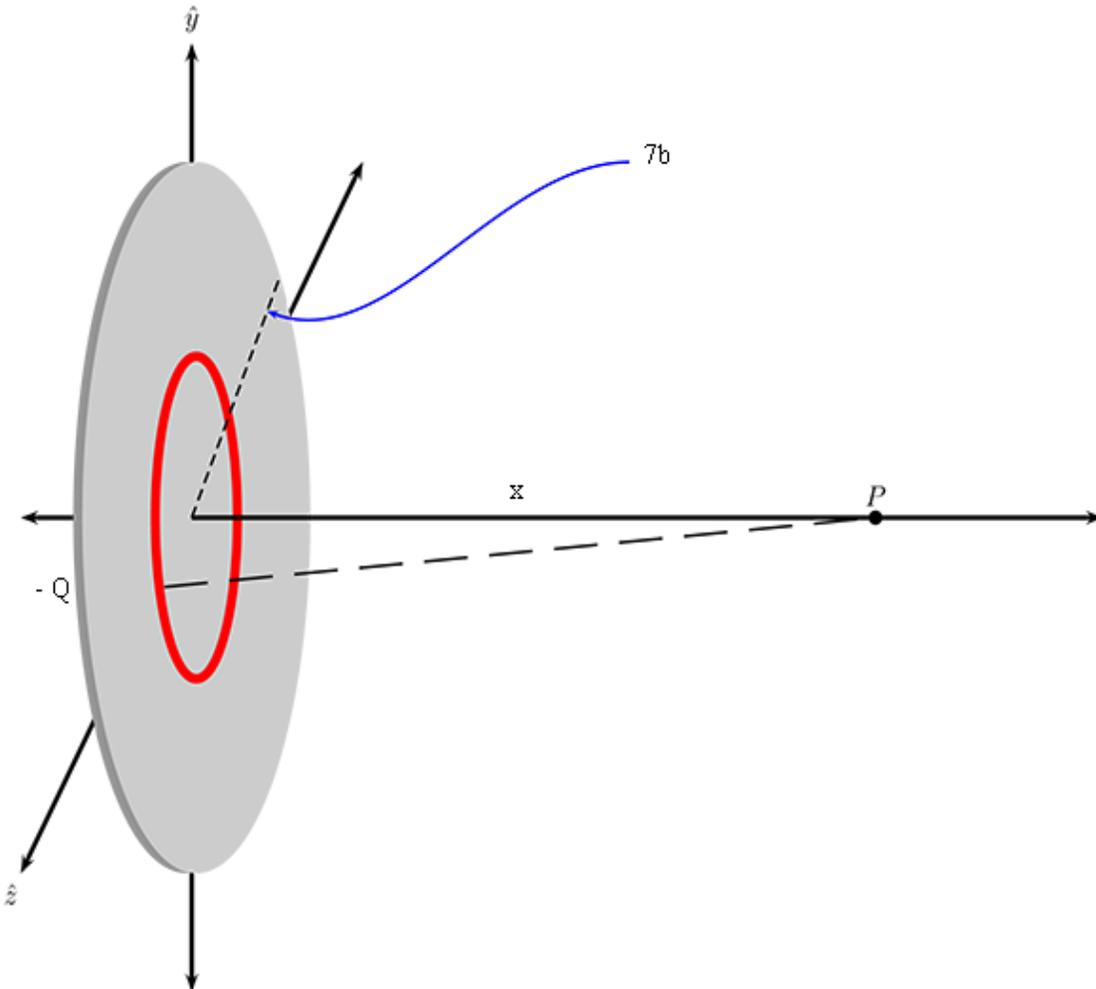
$$k \frac{dQ \cdot x}{(x^2 + R^2)^{\frac{3}{2}}} \hat{x}.$$

Provide the *integrand* of this integral as your answer, in terms of the given parameters.

e.g. Integral: $\vec{E} = \int_{-a}^a \frac{Q}{x^2 + y^2} \hat{y} dy$, Response: $\frac{Q}{x^2 + y^2} \hat{y}$

In order to find the electric field, one needs to evaluate an integral that adds up the contributions from each infinitesimal ring that

makes up the disc, dr , from 0 to $7b$.



Correct

Note: Use the letter 'k' for the Coulomb constant, $\frac{1}{4\pi\epsilon_0}$.

Your Answer: $-1/7*k*x^2*Q/b/(x^2+r^2)^{3/2}$ ihat

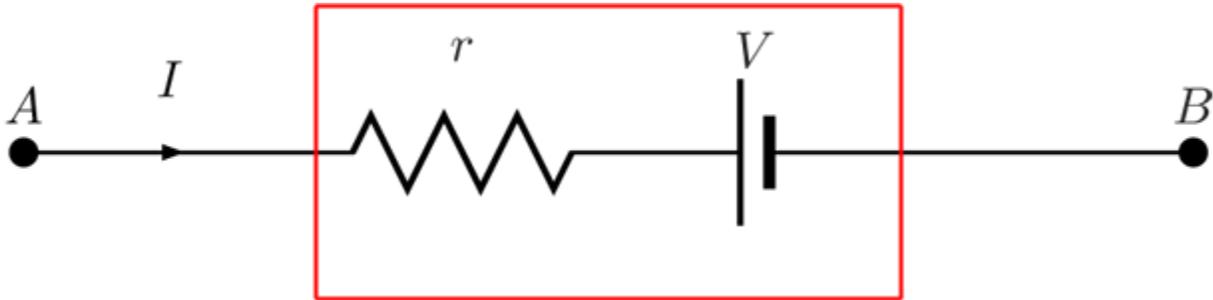
Response-Specific Grading

Component	\hat{i}		
Response	$-1/7*k*x^2*Q/b/(x^2+r^2)^{3/2}$		
	Algebraic Term Match		100.0%
	Sub-Total	=	100.0%
Comment:	Number of Components	X	1

	Sub-Total		100.0%
		No Rearranging	X 1.0
	Total		100.0%

Assignment #4 - EMF, Resistance and Capacitance

Question 1: Score 1/1



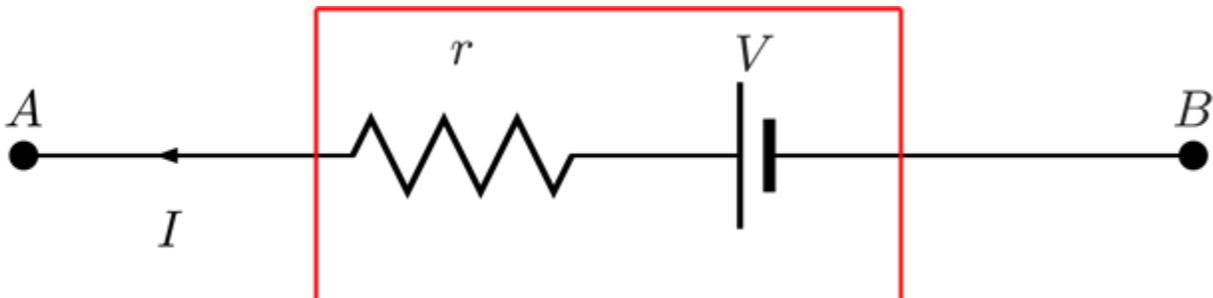
A battery with internal voltage 5.46 V and terminal voltage 17.6 V has a current passing through it in the direction indicated. If the internal resistance of the battery is $6.44\ \Omega$, what is the magnitude of the current?

Your Answer: 1.89*A

Response-Specific Grading

Comment: „ Correct value and significant figures 100.0% „
Dimensions are correct
Total = 100.0%

Question 2: Score 1/1



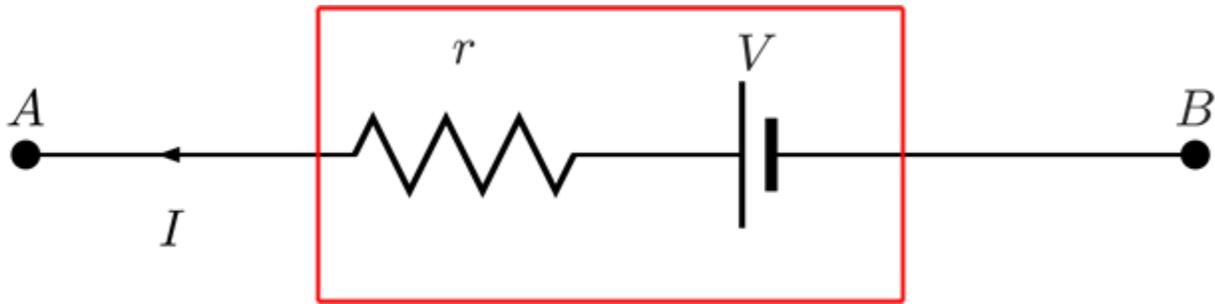
A battery with internal voltage 15.4 V and internal resistance $5.31\ \Omega$ has a current 0.421 A passing through it in the direction indicated. What is the terminal voltage V_{AB} of the battery?

Your Answer: 13.2*V

Response-Specific Grading

Comment: „ Correct value and significant figures 100.0% „
Dimensions are correct
Total = 100.0%

Question 3: Score 1/1



A battery with internal voltage 12.7 V and terminal voltage 7.89 V has a current 0.513 A passing through it in the direction indicated. What is the internal resistance r of the battery?

Note: Enter *ohm* for Ω .

Your Answer: 9.38*ohm

Response-Specific Grading

Comment: „ Correct value and significant figures 100.0% „
Dimensions are correct
Total = 100.0%

Question 4: Score 1/1

A current of 9.21 A is passed through a gold wire of length 6.75 mm , resulting in a potential difference of 2.16 mV between the two ends of the wire. If these measurements are made at room temperature, what is the cross-sectional area of the wire?

(The resistivity of gold at room temperature is $\rho = 2.44 \times 10^{-8}\ \Omega \cdot \text{m}$.)

Your Answer: $7.02 \cdot 10^{-7} \text{ m}^2$



Response-Specific Grading

Comment: „ Correct value and significant figures 100.0% „
Dimensions are correct
Total = 100.0%

Question 5: Score 1/1

A particular phone battery has a capacity of $2.77 \times 10^4 J$. If completely charging it from empty takes 44.8 min and draws an average current of 415 mA , what is the voltage applied across the terminals of the battery?



Correct

Your Answer: 24.8*V

Response-Specific Grading

Comment: „ Correct value and significant figures 100.0% „
Dimensions are correct
Total = 100.0%

Question 6: Score 1/1

The 5 V line in a USB cable does not provide exactly 5 V , but fluctuates around this value. If, while charging an iPhone over a USB, one measures the power used to be 2.39 W , and the current to be 519 mA , what is the actual voltage provided by the 5 V line?



Correct

Your Answer: 4.61*V

Response-Specific Grading

Comment: „ Correct value and significant figures 100.0% „
Dimensions are correct
Total = 100.0%

Question 7: Score 1/1

A spherical capacitor has 2.39 J of energy stored inside when 6.90×10^{15} electrons are on the negative plate. Calculate the capacitance.



Correct

Your Answer: $2.55 \times 10^{-7} \text{ F}$

Response-Specific Grading

Comment: „ Correct value and significant figures 100.0% „
Dimensions are correct
Total = 100.0%

Question 8: Score 1/1

A cylindrical capacitor of capacitance $9.68 \mu\text{F}$ has developed a potential difference of 1.76 V between the positive and negative surfaces. How many electrons are there on the negative surface?



Your Answer: 1.06×10^{14}

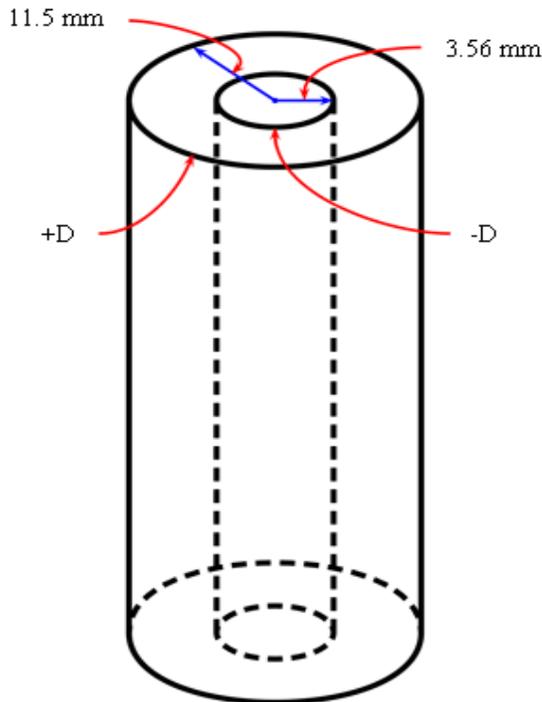
Response-Specific Grading

Comment: " Correct value and significant figures 100.0% "

Total = 100.0%

Question 9: Score 1/1

A cylindrical capacitor has inner and outer radii as labelled in following diagram.



Assuming that the surface charge densities are $+D$ and $-D$, calculate the capacitance per unit length of the capacitor.

Your Answer: $4.74 \times 10^{-11} \text{ F/m}$

Response-Specific Grading

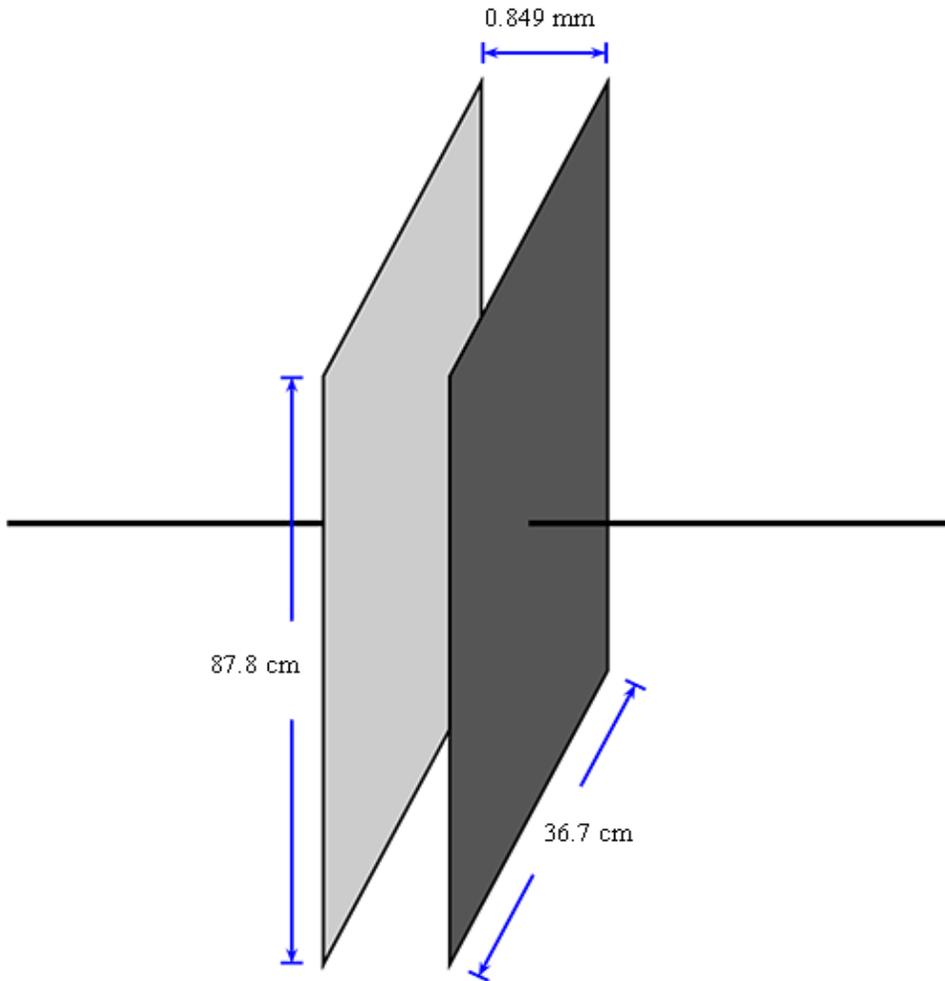
Comment: " Correct value and significant figures 100.0% "

Dimensions are correct

Total = 100.0%

Question 10: Score 1/1

What is the capacitance of the following capacitor?



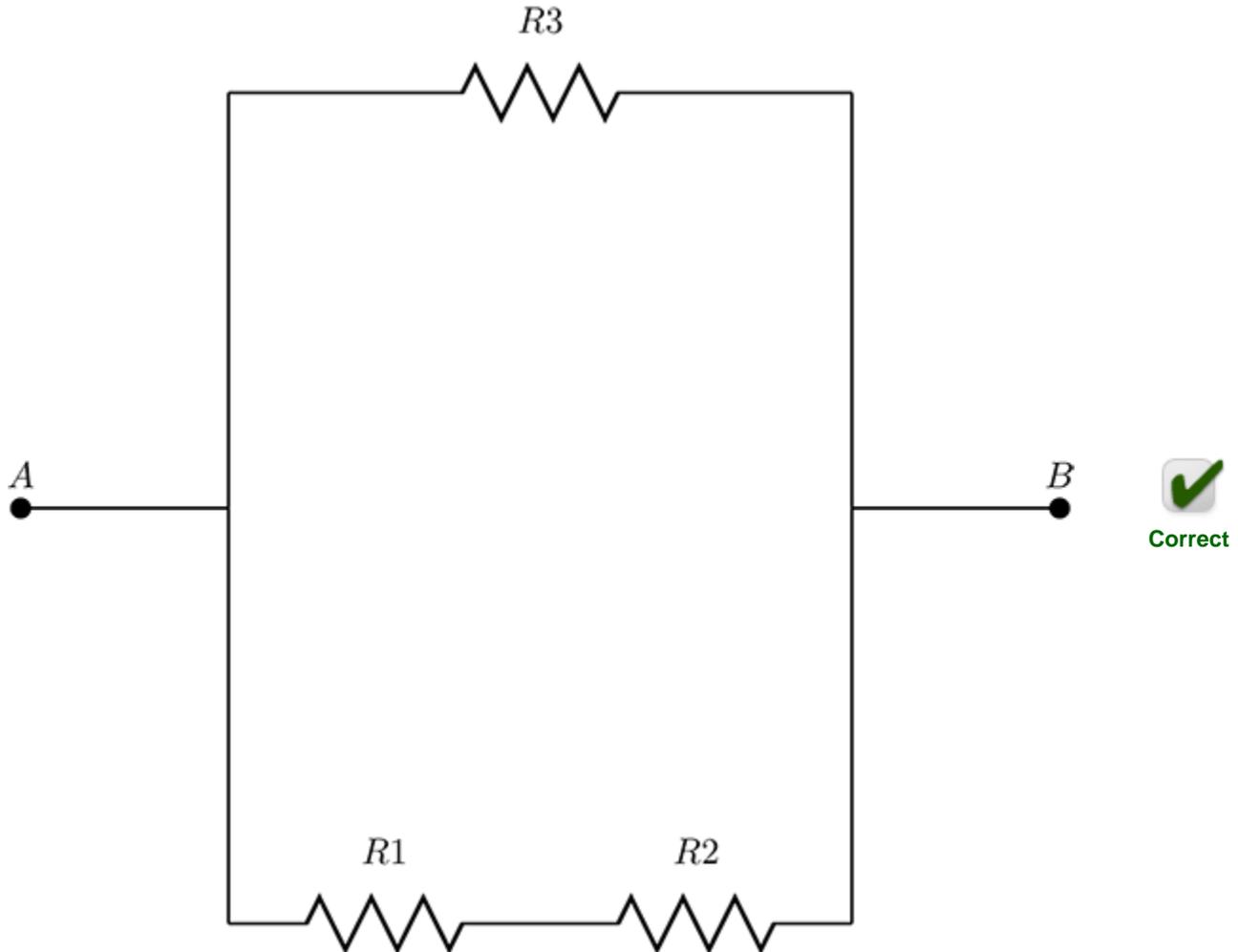
Your Answer: 3.36*nF

Response-Specific Grading

Comment: „ Correct value and significant figures 100.0% „
Dimensions are correct
Total = 100.0%

Assignment #5 - Circuit Elements and Kirchhoff's Laws

Question 1: Score 2/2



What is the total resistance of the circuit between A and B ?

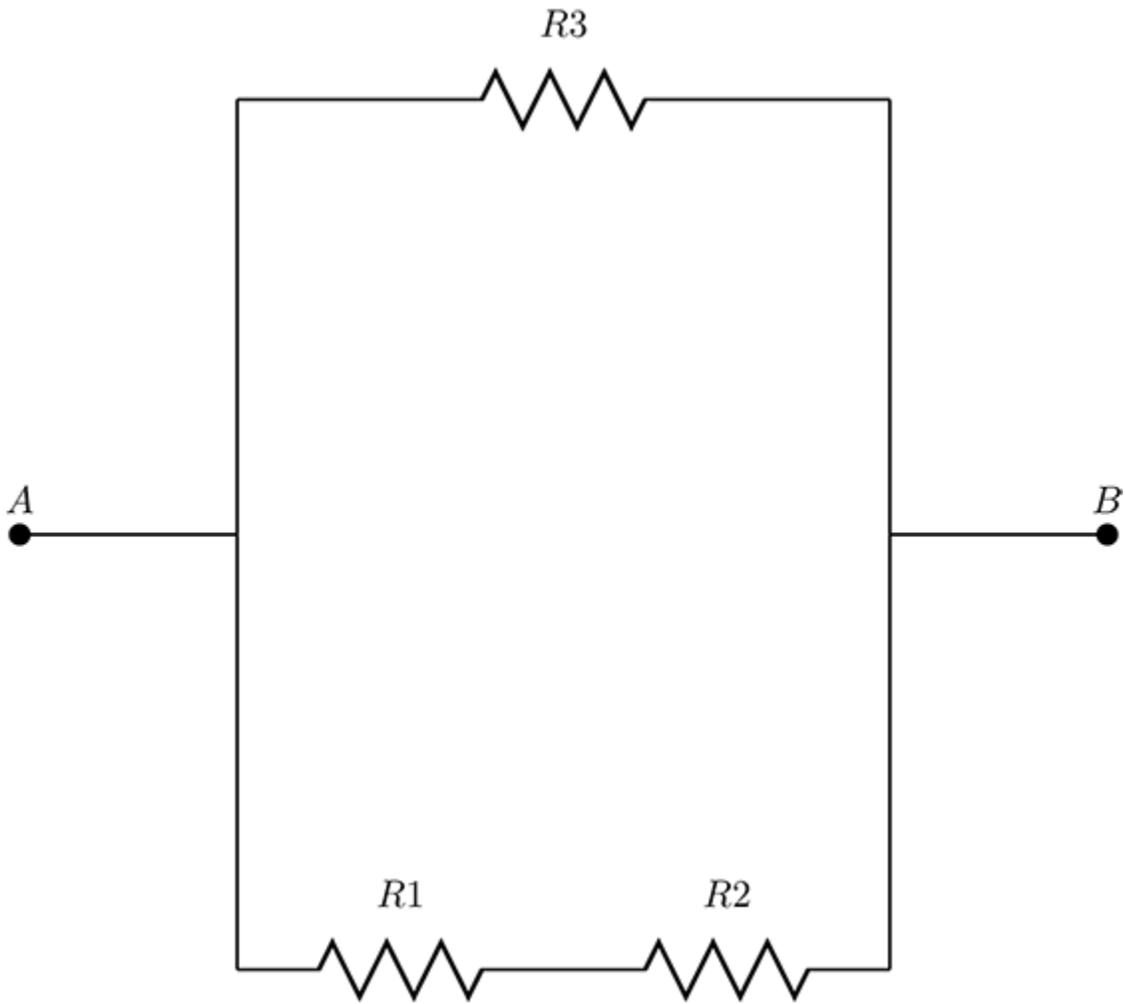
Your Answer: $1/(1/(R_1+R_2)+1/R_3)$

Response-Specific Grading

Comment: " Algebraic Term Match 100.0% "

Total = 100.0%

Question 2: Score 2/2



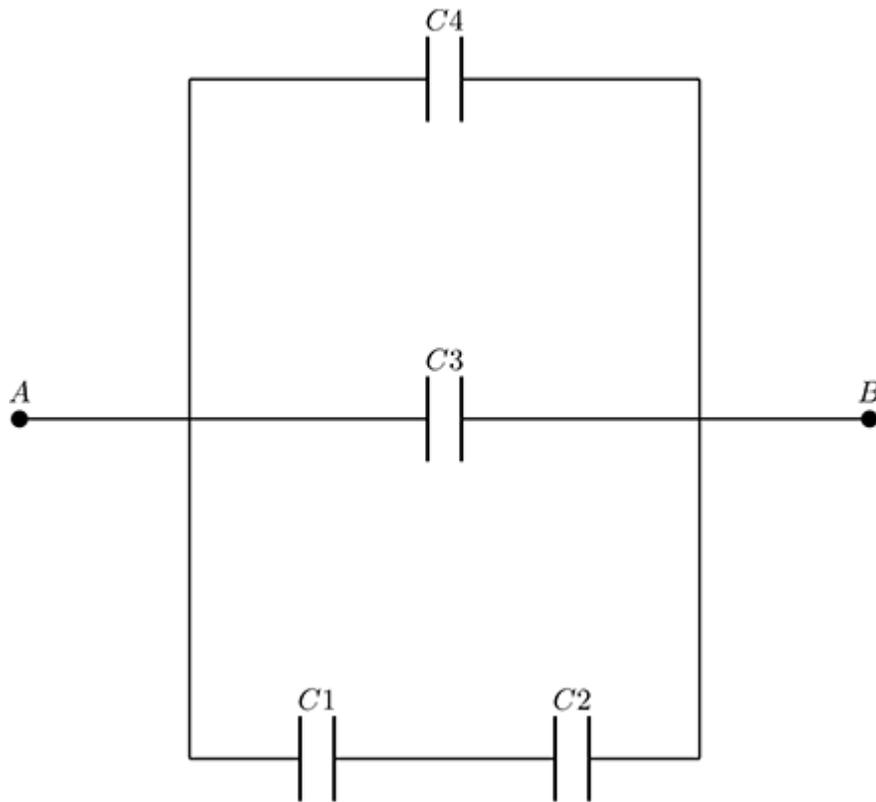
If $R_1 = 81.2 \Omega$, $R_2 = 33.0 \Omega$ and $R_3 = 36.0 \Omega$, what is the total resistance of the circuit between A and B ?

Your Answer: 27.4*ohm

Response-Specific Grading

Comment:	„ Correct value and significant figures 100.0% „
	Dimensions are correct
Total	= 100.0%

Question 4: Score 2/2



If $C1 = 2.27 \times 10^{-7} F$, $C2 = 5.20 \times 10^{-7} F$, $C3 = 2.29 \times 10^{-5} F$
and $C4 = 9.68 \times 10^{-5} F$, what is the total capacitance of the circuit between A and B ?

Your Answer: $1.20 \times 10^{-4} F$

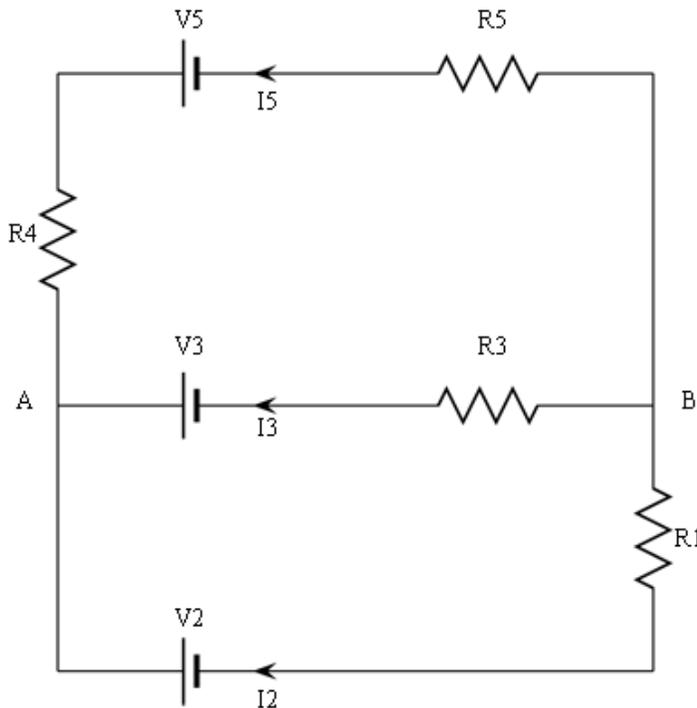
Response-Specific Grading

Comment: „ Correct value and significant figures 100.0% „
Dimensions are correct
Total = 100.0%

Question 5: Score 4/4

Your response

Consider the following circuit where the symbols have their usual meaning. State your answers in terms of the given variables and directions in the diagram.



Correct

(a) Use Kirchhoff's current rule to write an equation for the algebraic sum of the currents flowing into node B.

$$I_5 + I_3 + I_2 = 0 \quad (50\%)$$

(b) Use Kirchhoff's voltage rule to write an equation for the algebraic sum of the potential differences in the top loop of the circuit.

$$-V_5 + I_5 R_5 - R_3 I_3 + V_3 + I_5 R_4 = 0 \quad (50\%)$$

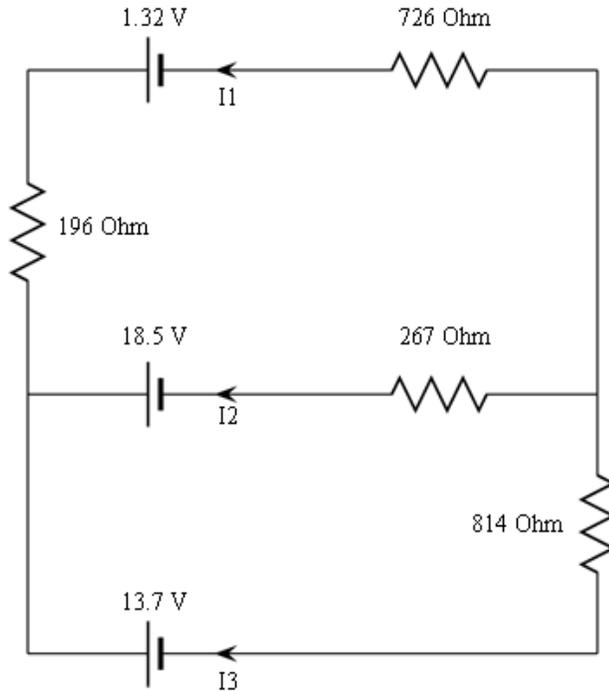
Comment:

1. Kirchhoff's current (or node) law states that the sum of all currents entering a node is equal to the sum of all currents leaving the node.
2. Kirchhoff's voltage (or loop) law states that the sum of all voltage gains and drops around a closed loop is equal to zero.
3. Remember that choosing one direction around a loop is important. It does not matter *which* direction you choose to follow, but you must be consistent.
4. When following a loop: Passing through a battery is a positive if you are going from negative to positive terminal and a negative if going from positive to negative.
5. When following a loop: Passing through a resistor is dependant both on the direction you are following the loop *and the assumed direction of the current passing through the resistor*. If you are following the loop in the same direction as the current through the resistor, the resistor provides a negative term. If you are following the loop against the current, the resistor provides a positive term.

Question 6: Score 4/4

Your response

Given the following circuit, calculate the currents I_1 , I_2 and I_3 , in mA .



- (a) I_1 -14.2 (33%) mA
(b) I_2 15.2 (33%) mA
(c) I_3 -0.923 (33%) mA

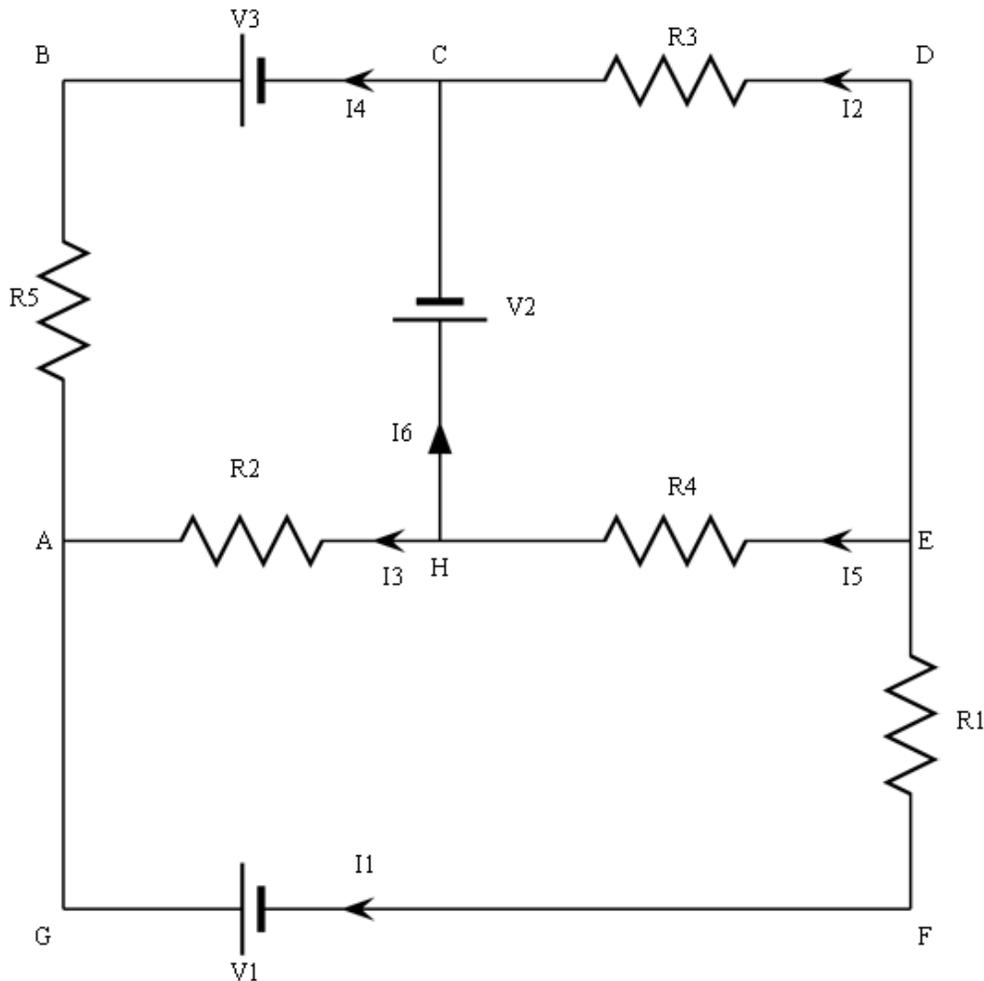
Comment:

1. Kirchhoff's current (or node) law states that the sum of all currents entering a node is equal to the sum of all currents leaving the node.
2. Kirchhoff's voltage (or loop) law states that the sum of all voltage gains and drops around a closed loop is equal to zero.
3. Remember that choosing one direction around a loop is important. It does not matter *which* direction you choose to follow, but you must be consistent.
4. When following a loop: Passing through a battery is a positive if you are going from negative to positive terminal and a negative if going from positive to negative.
5. When following a loop: Passing through a resistor is dependant both on the direction you are following the loop *and the assumed direction of the current passing through the resistor*. If you are following the loop in the same direction as the current through the resistor, the resistor provides a negative term. If you are following the loop against the current, the resistor provides a positive term.

Question 7: Score 4/4

Your response

Consider the following circuit where the symbols have their usual meaning. State your answers in terms of the given variables and directions in the diagram.



Correct

(a) Use Kirchhoff's current rule to write an equation for the algebraic sum of the currents flowing into node A.

$$I1 + I4 + I3 = 0 \quad (50\%)$$

(b) Use Kirchhoff's voltage rule to write an equation for the algebraic sum of the potential differences in the ABCDEFGA loop of the circuit.

$$I4 \cdot R5 - V3 + I2 \cdot R3 - I1 \cdot R1 + V1 = 0 \quad (50\%)$$

Comment:

1. Kirchhoff's current (or node) law states that the sum of all currents entering a node is equal to the sum of all currents leaving the node.
2. Kirchhoff's voltage (or loop) law states that the sum of all voltage gains and drops around a closed loop is equal to zero.
3. Remember that choosing one direction around a loop is important. It does not matter *which* direction you choose to follow, but you must be consistent.
4. When following a loop: Passing through a battery is a positive if you are going from negative to positive terminal and a negative if going from positive to negative.
5. When following a loop: Passing through a resistor is dependant both on the direction you are following the loop *and the assumed direction of the current passing through the resistor*. If you are following the loop in the same direction as the current through the resistor, the resistor provides a negative term. If you are following the loop against the current, the resistor provides a positive term.

Assignment #6 - Cross Products and Magnetic Fields with Point Charges

Question 1: Score 2/2

Calculate $2\hat{k} \times -6\hat{i}$.

Entry Notes:

Vector components can be entered using \hat{i} , \hat{j} and \hat{k} .

Ensure that you explicitly enter the multiplication symbol * between terms.



Correct

Your Answer: -12*jhat

Response-Specific Grading

Component	\hat{j}
Response	-12
Exactly correct value	100.0%
Sub-Total	= 100.0%
Number of Components	X 1

Sub-Total	100.0%
No Rearranging	X 1.0
Total	100.0%

Comment: "

Question 2: Score 1/1

Calculate $-3\hat{i} \times -3\hat{i}$.

Entry Notes:

Vector components can be entered using \hat{i} , \hat{j} and \hat{k} .

Ensure that you explicitly enter the multiplication symbol * between terms.



Correct

Your Answer: 0

Response-Specific Grading

Exactly correct value	100.0%
Total	= 100.0%

Comment: "

Question 3: Score 2/2

Given two vectors $\vec{A} = -1\hat{i} + -1\hat{j}$ and $\vec{B} = -7\hat{i} + -3\hat{j}$ calculate $\vec{A} \times \vec{B}$.

Entry Notes:

Vector components can be entered using *ihat*→ \hat{i} , *jhat*→ \hat{j} and *khat*→ \hat{k} .

Ensure that you explicitly enter the multiplication symbol * between terms.



Correct

Your Answer: -4*khat

Response-Specific Grading

<i>Component</i>	\hat{k}		
<i>Response</i>	-4		
	Exactly correct value		100.0%
	Sub-Total		= 100.0%
Comment:	"	Number of Components X	1"

	Sub-Total		100.0%
		No Rearranging X	1.0
	Total		100.0%

Question 4: Score 2/2

Given two vectors $\vec{A} = 8\hat{i} + -1\hat{j}$ and $\vec{B} = -4\hat{i} + 4\hat{j}$ calculate $\vec{B} \times \vec{A}$.

Entry Notes:

Vector components can be entered using \hat{i} , \hat{j} and \hat{k} .

Ensure that you explicitly enter the multiplication symbol * between terms.



Correct

Your Answer: -28*khat

Response-Specific Grading

<i>Component</i>	\hat{k}		
<i>Response</i>	-28		
	Exactly correct value		100.0%
	Sub-Total		= 100.0%
Comment:	"	Number of Components X	1"

	Sub-Total		100.0%
		No Rearranging X	1.0
	Total		100.0%

Question 5: Score 3/3

Given two vectors $\vec{A} = -1\hat{i} + -6\hat{j} + -5\hat{k}$ and $\vec{B} = 3\hat{i} + 4\hat{j} + 6\hat{k}$ calculate $\vec{A} \times \vec{B}$.

Entry Notes:

Vector components can be entered using *ihat*→ \hat{i} , *jhat*→ \hat{j} and *khat*→ \hat{k} .
Ensure that you explicitly enter the multiplication symbol * between terms.



Correct

Your Answer: -16*ihat-9*jhat+14*khat

Response-Specific Grading

Component	\hat{i}		
Response	-16		
	Exactly correct value		100.0%
	Sub-Total	=	100.0%
	Number of Components	X	1/3

Component	\hat{j}		
Response	-9		
	Exactly correct value		100.0%
	Sub-Total	=	100.0%
	Number of Components	X	1/3

Comment:

Component	\hat{k}		
Response	+14		
	Exactly correct value		100.0%
	Sub-Total	=	100.0%
	Number of Components	X	1/3

Sub-Total			100.0%
	No Rearranging	X	1.0
Total			100.0%

Question 6: Score 3/3

Given two vectors $\vec{A} = 7\hat{i} + -1\hat{j} + -2\hat{k}$ and $\vec{B} = 1\hat{i} + -5\hat{j} + -5\hat{k}$ calculate $\vec{B} \times \vec{A}$.

Entry Notes:

Vector components can be entered using *ihat*→ \hat{i} , *jhat*→ \hat{j} and *khat*→ \hat{k} .

Ensure that you explicitly enter the multiplication symbol * between terms.



Correct

Your Answer: 5*ihat-33*jhat+34*khat

Response-Specific Grading

Component	\hat{i}		
Response	5		
	Exactly correct value		100.0%
	Sub-Total	=	100.0%
	Number of Components	X	1/3

Component	\hat{j}		
Response	-33		
	Exactly correct value		100.0%
	Sub-Total	=	100.0%
	Number of Components	X	1/3

Comment:

Component	\hat{k}		
Response	+34		
	Exactly correct value		100.0%
	Sub-Total	=	100.0%
	Number of Components	X	1/3

Sub-Total			100.0%
	No Rearranging	X	1.0
Total			100.0%

Question 7: Score 2/2

A charge $-1.16 \times 10^{-5} \text{ C}$ is travelling with velocity $\vec{v} = 7.42 \times 10^6 \frac{\text{m}}{\text{s}} \hat{i}$.

What is the magnetic field at a point $\vec{r} = -7.09 \text{ cm } \hat{j}$ from the location of the charge?

Entry Notes:

Vector components can be entered using \hat{i} , \hat{j} and \hat{k} .

Ensure that you explicitly enter the multiplication symbol * between terms.



Correct

Your Answer: $1.71 \times 10^{-3} \text{ N} \hat{k}$

Response-Specific Grading

Component	\hat{k}	
Response	$1.71 \times 10^{-3} \text{ N}$	
	Correct value and significant figures	100.0%
	Dimensions are correct	
Sub-Total		= 100.0%
	Number of Components	X 1

Sub-Total		100.0%
	No Rearranging	X 1.0
Total		100.0%

Comment:

" " = 100.0% "

Question 8: Score 2/2

A charge $9.54 \times 10^{-9} C$ is travelling with velocity $\vec{v} = ((4.99)\hat{i} + (-3.53)\hat{j}) \times 10^4 \frac{m}{s}$.

What is the magnetic field at a point $\vec{r} = ((-8.14)\hat{i} + (-3.17)\hat{j}) cm$ from the location of the charge?

Entry Notes:

Vector components can be entered using \hat{i} , \hat{j} and \hat{k} .

Ensure that you explicitly enter the multiplication symbol * between terms.



Correct

Your Answer: $-6.38 \times 10^{-9} N \hat{k}$

Response-Specific Grading

	Component	\hat{k}	
	Response	$-6.38 \times 10^{-9} N$	
		Correct value and significant figures	100.0%
		Dimensions are correct	
Comment:	Sub-Total		= 100.0%
		Number of Components	X 1

	Sub-Total		100.0%
		No Rearranging	X 1.0
	Total		100.0%

Question 9: Score 3/3

A charge $-7.16 \times 10^{-11} \text{ C}$ is travelling with velocity $\vec{v} = ((-8) \cdot \hat{i} + (4.37) \cdot \hat{j} + (3.65) \cdot \hat{k}) \times 10^5 \frac{\text{m}}{\text{s}}$.

What is the magnetic field at a point $\vec{r} = ((1.7) \cdot \hat{i} + (7.15) \cdot \hat{j} + (7.86) \cdot \hat{k}) \text{ cm}$ from the location of the charge?

Entry Notes:

Vector components can be entered using \hat{i} , \hat{j} and \hat{k} .

Ensure that you explicitly enter the multiplication symbol * between terms.

Your Answer: $-4.74 \times 10^{-11} \text{ N} \cdot \hat{i} - 3.97 \times 10^{-10} \text{ N} \cdot \hat{j} + 3.71 \times 10^{-10} \text{ N} \cdot \hat{k}$



Correct

Response-Specific Grading

Component	\hat{i}		
Response	$-4.74 \times 10^{-11} \text{ N}$		
	Correct value and significant figures		100.0%
	Dimensions are correct		
	Sub-Total	=	100.0%
	Number of Components	X	1/3

Component	\hat{j}		
Response	$-3.97 \times 10^{-10} \text{ N}$		
	Correct value and significant figures		100.0%
	Dimensions are correct		
	Sub-Total	=	100.0%
	Number of Components	X	1/3

Comment:

Component	\hat{k}		
Response	$+3.71 \times 10^{-10} \text{ N}$		
	Correct value and significant figures		100.0%
	Dimensions are correct		
	Sub-Total	=	100.0%
	Number of Components	X	1/3

Sub-Total			100.0%
	No Rearranging	X	1.0
Total			100.0%

Question 10: Score 2/2

A charge of $-5.3 \cdot C$ is moving with velocity $\vec{v} = (5.83 \cdot \hat{i} + -1.97 \cdot \hat{j}) m/s$ through a magnetic field $\vec{B} = (-1.91 T) \cdot \hat{k}$. What is the force acting on the charge due to the magnetic field?

Entry Notes:

Vector components can be entered using \hat{i} , \hat{j} and \hat{k} .
Ensure that you explicitly enter the multiplication symbol * between terms.



Correct

Your Answer: $-1.99 \cdot 10 \cdot N \cdot \hat{i} - 5.90 \cdot 10 \cdot N \cdot \hat{j}$

Response-Specific Grading

Component	\hat{i}		
Response	$-1.99 \cdot 10 \cdot N$		
	Correct value and significant figures		100.0%
	Dimensions are correct		
Sub-Total		=	100.0%
	Number of Components	X	1/2

Comment:

Component	\hat{j}		
Response	$-5.90 \cdot 10 \cdot N$		
	Correct value and significant figures		100.0%
	Dimensions are correct		
Sub-Total		=	100.0%
	Number of Components	X	1/2

Sub-Total			100.0%
	No Rearranging	X	1.0
Total			100.0%

Question 11: Score 3/3

A charge of $-5.79 \cdot C$ is moving with velocity $\vec{v} = (2.8 \cdot \hat{i} + 1.82 \cdot \hat{j} + 5.95 \cdot \hat{k}) \text{ m/s}$ through a magnetic field $\vec{B} = (-6.97 \cdot \hat{i} + -7.92 \cdot \hat{j} - 5.81 \cdot \hat{k}) \cdot T$.



What is the force acting on the charge due to the magnetic field?

Your Answer: $-212 \cdot \hat{i} + 146 \cdot \hat{j} + 55.0 \cdot \hat{k}$

Response-Specific Grading

Component	\hat{i}		
Response	$-212 \cdot \text{N}$		
	Correct value and significant figures		100.0%
	Dimensions are correct		
	Sub-Total	=	100.0%
	Number of Components	X	1/3

Component	\hat{j}		
Response	$+146 \cdot \text{N}$		
	Correct value and significant figures		100.0%
	Dimensions are correct		
	Sub-Total	=	100.0%
	Number of Components	X	1/3

Comment:

Component	\hat{k}		
Response	$+55.0 \cdot \text{N}$		
	Correct value and significant figures		100.0%
	Dimensions are correct		
	Sub-Total	=	100.0%
	Number of Components	X	1/3

Sub-Total			100.0%
	No Rearranging	X	1.0
Total			100.0%

Assignment #7 - Magnetic Fields with Wires, Charges in EM Fields

Question 1: Score 3/3

A charge of $8 \cdot C$ is moving with velocity $\vec{v} = (-6.99 \cdot \hat{i} + -6.52 \cdot \hat{j}) m/s$ through a magnetic field $\vec{B} = (-5.35 T) \cdot \hat{k}$ and an electric field $\vec{E} = \left(\frac{-8.71 \cdot V}{m} \right) \cdot \hat{k}$. What is the force acting on the charge due to the magnetic field?

Entry Notes:

Vector components can be entered using \hat{i} , \hat{j} and \hat{k} .
Ensure that you explicitly enter the multiplication symbol * between terms.



Correct

Your Answer: 279.*N*ihat-299.*N*jhat-69.7*N*khat

Response-Specific Grading

Component	\hat{i}		
Response	279.*N		
	Correct value and significant figures	100.0%	
	Dimensions are correct		
Sub-Total		= 100.0%	
	Number of Components X	1/3	

Component	\hat{j}		
Response	-299.*N		
	Correct value and significant figures	100.0%	
	Dimensions are correct		
Sub-Total		= 100.0%	
	Number of Components X	1/3	

Comment:

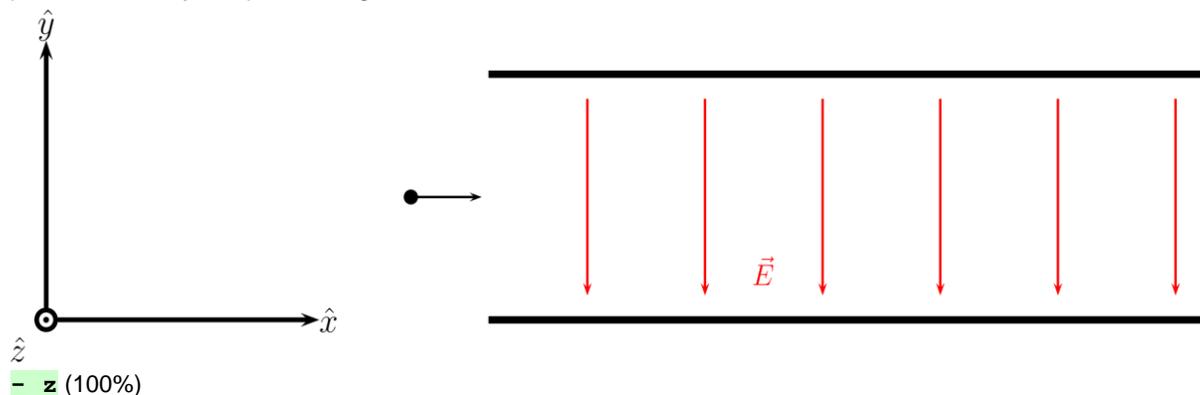
Component	\hat{k}		
Response	-69.7*N		
	Correct value and significant figures	100.0%	
	Dimensions are correct		
Sub-Total		= 100.0%	
	Number of Components X	1/3	

Sub-Total		100.0%	
	No Rearranging X	1.0	
Total		100.0%	

Question 2: Score 2/2

Your response

A velocity selector is set up as in the diagram with uniform electric and magnetic fields. If the magnetic field is directed as shown, in what direction must the electric field point so that a charged particle of a particular velocity can pass through undeflected?



Correct

Comment:

Question 3: Score 3/3

A current of 7.63 mA is travelling through a wire of displacement $\vec{l} = -6.19 \text{ cm } \hat{i}$. If the region has a uniform magnetic field of $\vec{B} = -3.72 \text{ T } \hat{k}$, what is the force on the wire?

Entry Notes:

Vector components can be entered using \hat{i} , \hat{j} and \hat{k} .
Ensure that you explicitly enter the multiplication symbol * between terms.



Correct

Your Answer: $-1.76 \times 10^{-3} \text{ N } \hat{j}$

Response-Specific Grading

Component	\hat{j}
Response	$-1.76 \times 10^{-3} \text{ N}$
	Correct value and significant figures 100.0%
	Dimensions are correct
"	Sub-Total = 100.0%
	Number of Components X 1

Sub-Total	100.0%
	No Rearranging X 1.0
Total	100.0%

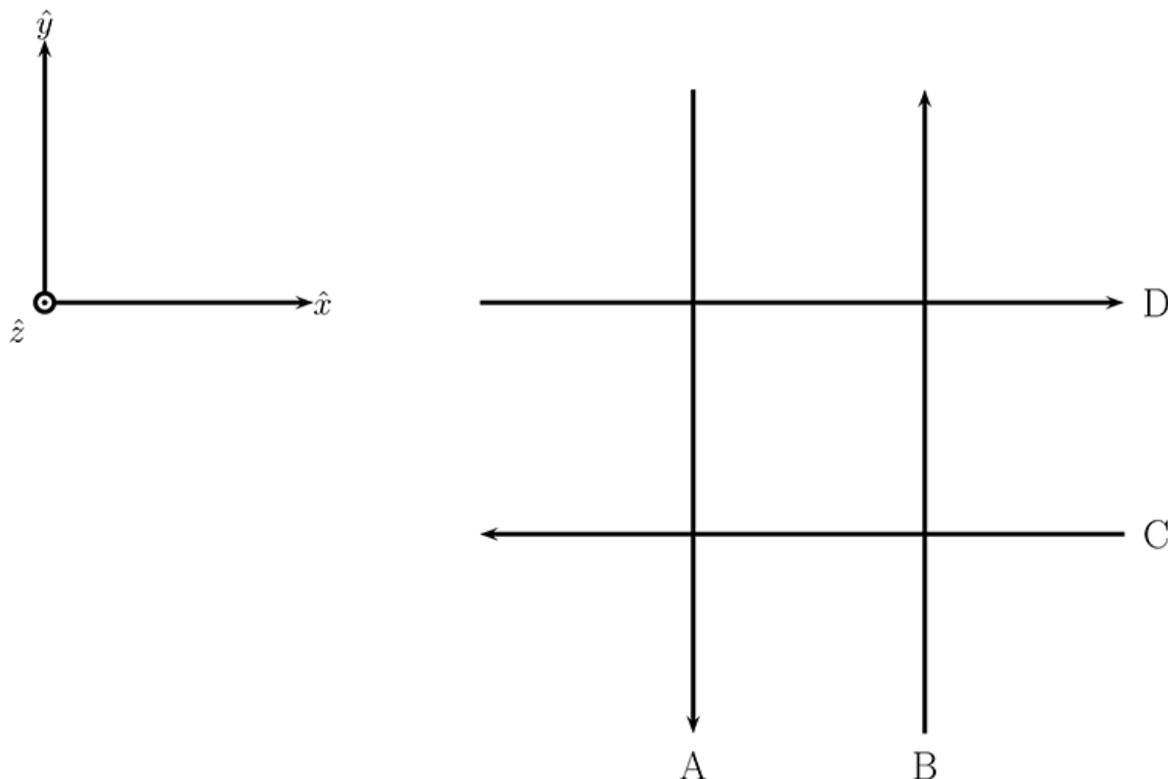
Comment:

Question 4: Score 2/2

Four current carrying wires are arranged as seen in the diagram, where the arrows indicate the direction of current flow.

The wires are each separated by a distance 8.83 mm . Calculate the magnetic field vector at the center point, given the following information:

$$I_A = 6.99 \text{ A}, I_B = 4.16 \text{ A}, I_C = 9.05 \text{ A} \text{ and } I_D = 9.29 \text{ A}.$$



Correct

Entry Notes:

Vector components can be entered using $\hat{x} \rightarrow xhat$, $\hat{y} \rightarrow yhat$ and $\hat{z} \rightarrow zhat$. Ensure that you explicitly enter the multiplication symbol * between terms.

Your Answer: $-3.26 \cdot 10^{-4} \cdot zhat \cdot T$

Response-Specific Grading

Component	\hat{k}
Response	$-3.26 \cdot 10^{-4} \cdot T$
	Correct value and significant figures 100.0%
	Dimensions are correct
"	Sub-Total = 100.0% "
Comment:	Number of Components X 1

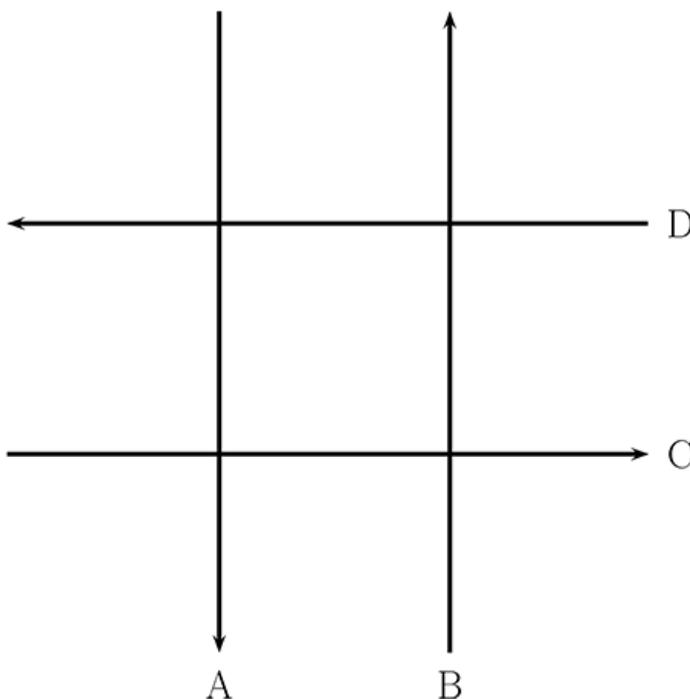
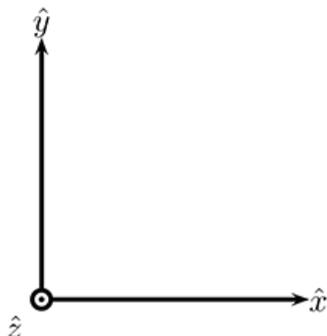
Sub-Total	100.0%
	No Rearranging X 1.0
Total	100.0%

Question 5: Score 2/2

Four current carrying wires are arranged as seen in the diagram, where the arrows indicate the direction of current flow.

The wires are each separated by a distance w . Calculate the magnetic field vector at the center point, given the following information:

$$I_A = 1 I, I_B = 5 I, I_C = 8 I \text{ and } I_D = 3 I.$$



Correct

Entry Notes:

Vector components can be entered using $\hat{x} \rightarrow xhat$, $\hat{y} \rightarrow yhat$ and $\hat{z} \rightarrow zhat$.

Ensure that you explicitly enter the multiplication symbol * between terms.

Enter your response in terms of the given parameters and μ_0 , entering u instead of μ_0 .

Your Answer: $17 * I * u * zhat / \pi / w$

Response-Specific Grading

Component	\hat{k}
Response	$17 * I * u / \pi / w$
Algebraic Term Match	100.0%
Sub-Total	= 100.0%

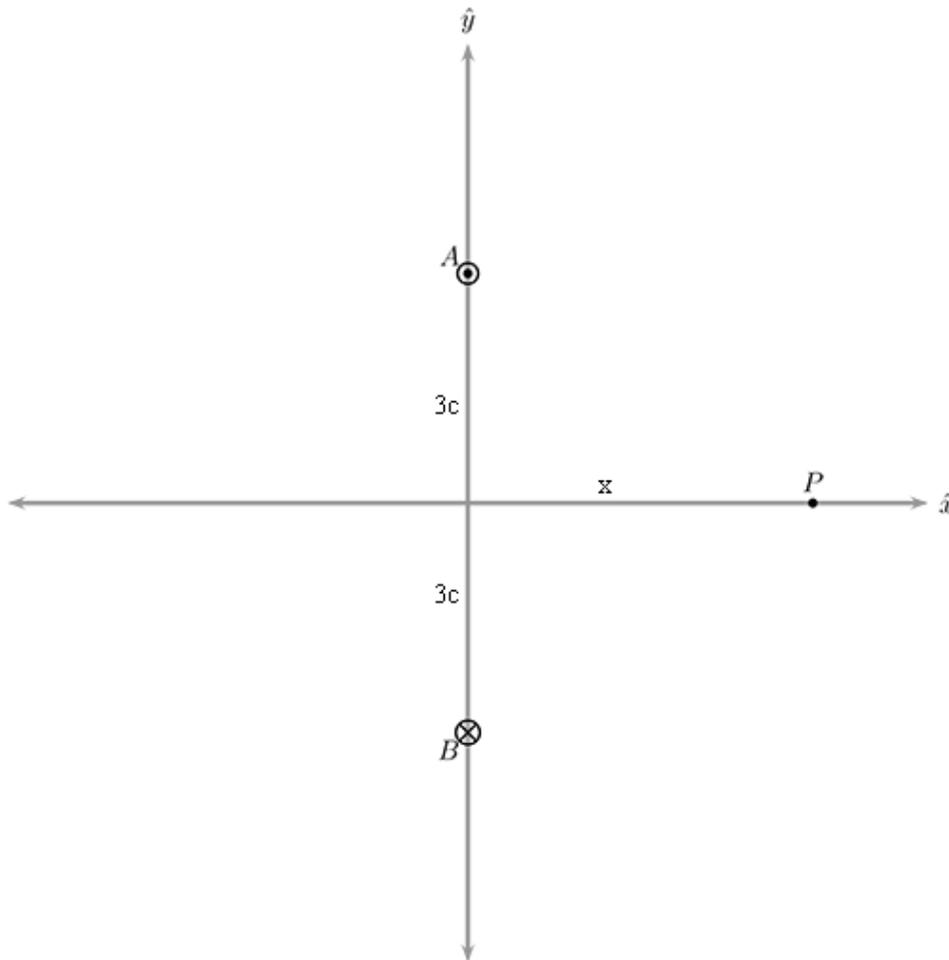
Comment:

Number of Components	X	1

Sub-Total		100.0%
No Rearranging	X	1.0
Total		100.0%

Question 6: Score 3/3

The wires A and B are both carrying a current $3I$ in the directions indicated in the diagram. In terms of the given parameters, provide an equation for the magnetic field at any point on the x — axis.



Correct

Entry Notes:

Vector components can be entered using $\hat{x} \rightarrow xhat$, $\hat{y} \rightarrow yhat$ and $\hat{z} \rightarrow zhat$.

Ensure that you explicitly enter the multiplication symbol * between terms.

Enter your response in terms of the given parameters and μ_0 , entering μ instead of μ_0 .

Your Answer: $9 \cdot I \cdot xhat \cdot \mu / (\pi \cdot (x^2 + 9 \cdot c^2)) \cdot c$

Response-Specific Grading

Component	\hat{i}
Response	$9 \cdot I \cdot \mu / \pi / (x^2 + 9 \cdot c^2) \cdot c$
Algebraic Term Match	100.0%
Sub-Total	= 100.0%

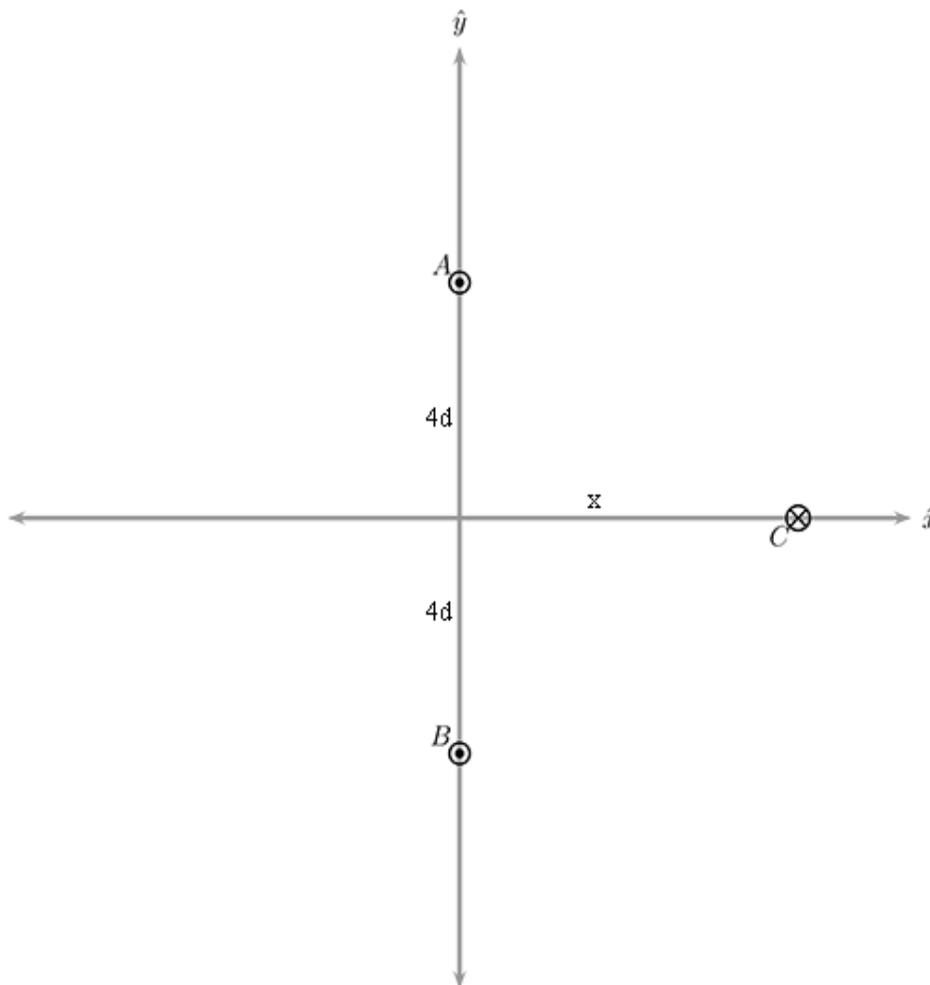
Comment:

Number of Components X 1

Sub-Total	100.0%
No Rearranging X	1.0
Total	100.0%

Question 7: Score 5/5

The wires A , B are carrying a current $3I$ and C is carrying current $5I$, each in the directions indicated in the diagram. In terms of the given parameters, provide a vector expression for the force per unit length exerted by A and B on C , for C placed at any point on the x - axis.



Correct

Entry Notes:

Vector components can be entered using $\hat{x} \rightarrow xhat$, $\hat{y} \rightarrow yhat$ and $\hat{z} \rightarrow zhat$.

Ensure that you explicitly enter the multiplication symbol * between terms.

Enter your response in terms of the given parameters and μ_0 , entering u instead of μ_0 .

Your Answer: $-15 \cdot xhat \cdot u / \text{Pi} / (x^2 + 16 \cdot d^2) \cdot x$

Response-Specific Grading

Component	\hat{i}
Response	$-15 \cdot u / \text{Pi} / (x^2 + 16 \cdot d^2) \cdot x$
Algebraic Term Match	100.0%
Sub-Total	= 100.0%

Comment:

Number of Components	X	1
Sub-Total		100.0%
No Rearranging	X	1.0
Total		100.0%

Assignment #8 - EM Waves, Diffraction and Interference

Question 1: Score 2/2

Your response	Correct response
Consider the following electromagnetic wave, in dimensionless units: $\vec{B}(y, t) = +1 \cdot \cos(9\pi \cdot y - 9\pi \cdot t) \cdot \hat{z}$	Consider the following electromagnetic wave, in dimensionless units: $\vec{B}(y, t) = +1 \cdot \cos(9\pi \cdot y - 9\pi \cdot t) \cdot \hat{z}$
Identify the following:	Identify the following:
Direction of propagation +y (33%)	Direction of propagation +y
Magnetic field direction at $t = 7, y = 7$ -z (33%)	Magnetic field direction at $t = 7, y = 7$ -z
Electric field direction at $t = 7, y = 7$ -x (33%)	Electric field direction at $t = 7, y = 7$ -x



Correct

Comment:

Question 2: Score 2/2

A particular electromagnetic wave has a maximum magnetic field amplitude of $6.93 \times 10^{10} T$, what is the maximum electric field amplitude?



Correct

Your Answer: $2.08 \cdot 10^{19} N/C$

Correct Answer: $.208e20 N/C$

Response-Specific Grading

Correct value and significant figures	100.0%
Dimensions are correct	
Total	= 100.0%

Comment:

Question 3: Score 2/2

Your response	Correct response
Consider the following electromagnetic wave: $\vec{B}(z, t) = (-4.36 \times 10^6 T) \cdot \cos\left(2.715234 \times 10^3 \frac{rad}{m} z - 2.715234 \times 10^3 \frac{rad}{m} t\right)$	Consider the following electromagnetic wave: $\vec{B}(z, t) = (-4.36 \times 10^6 T) \cdot \cos\left(2.715234 \times 10^3 \frac{rad}{m} z - 2.715234 \times 10^3 \frac{rad}{m} t\right)$
Identify the following:	Identify the following:
Direction of propagation -z (33%)	Direction of propagation -z
Magnetic field direction at $t = 0, z = 0$ -x (33%)	Magnetic field direction at $t = 0, z = 0$ -x
Electric field direction at $t = 0, z = 0$ -y (33%)	Electric field direction at $t = 0, z = 0$ -y



Correct

Comment:

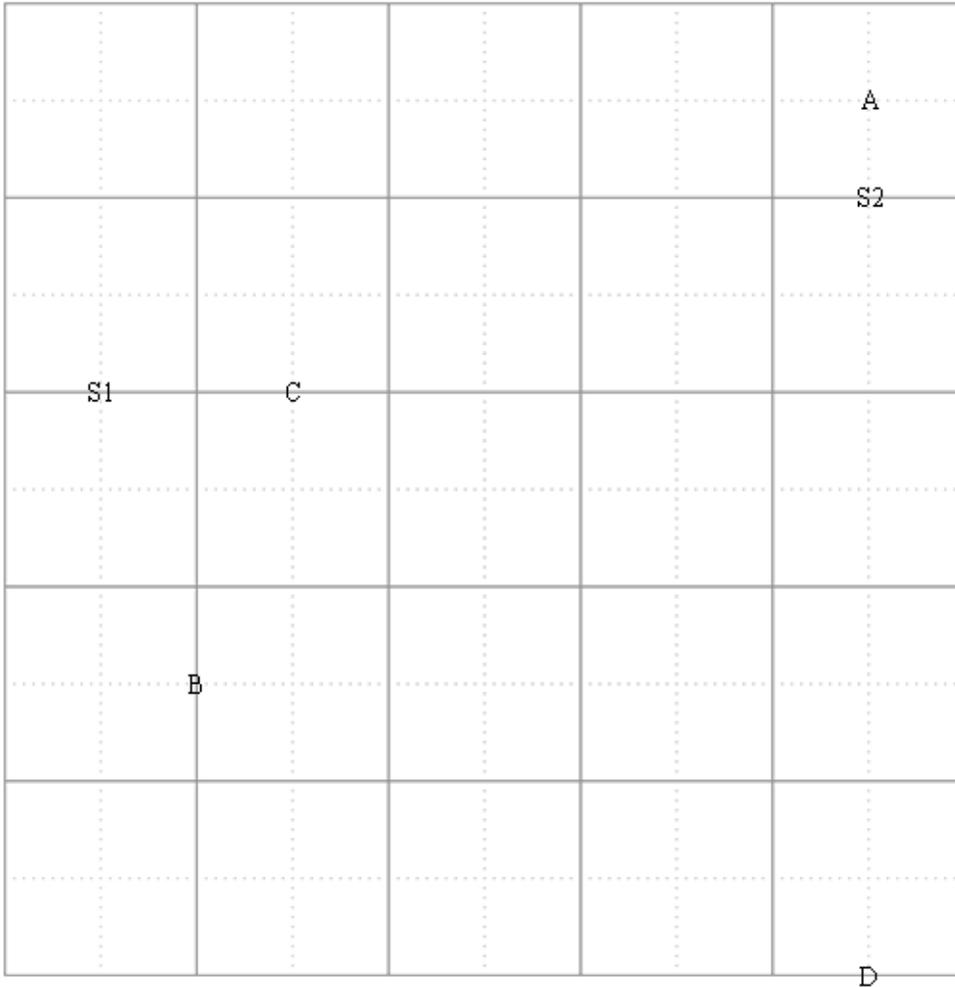
Question 4: Score 2/2

Your response

Correct response

Two sources, S_1 and S_2 output monochromatic electromagnetic waves, in phase, at wavelength 416 cm . If the major grid divisions are 8.32 m apart, at which point will constructive interference be observed?

Two sources, S_1 and S_2 output monochromatic electromagnetic waves, in phase, at wavelength 416 cm . If the major grid divisions are 8.32 m apart, at which point will constructive interference be observed?



D

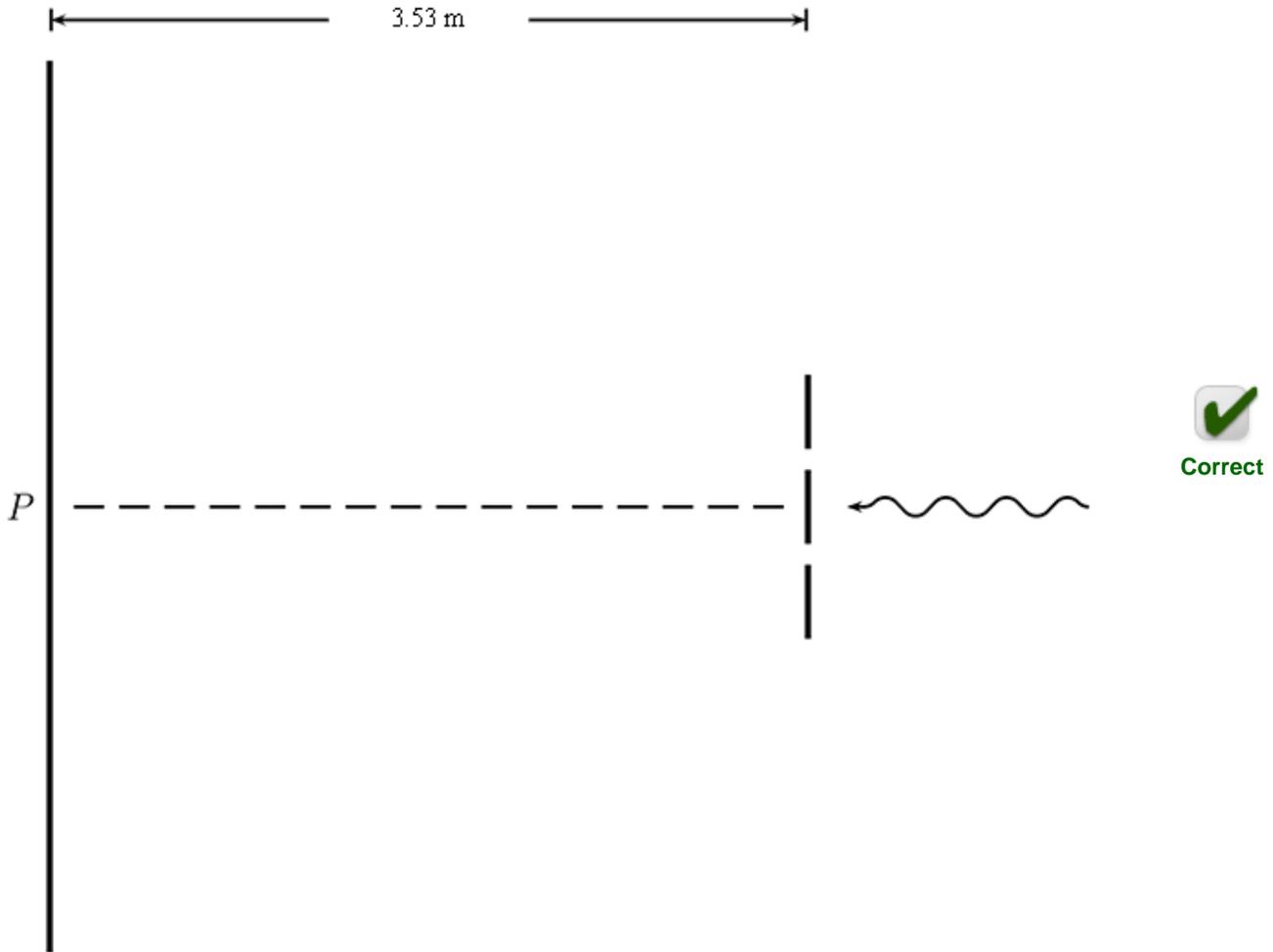


Correct

D (100%)

Question 5: Score 2/2

The centres of the two slits in the diagram are separated by a distance of $d = 0.508 \text{ mm}$. If the coherent light incident on the slits is of wavelength 431 nm , at what distance above and below P would one find the order-1 bright fringes on the screen?



Your Answer: 2.99*mm

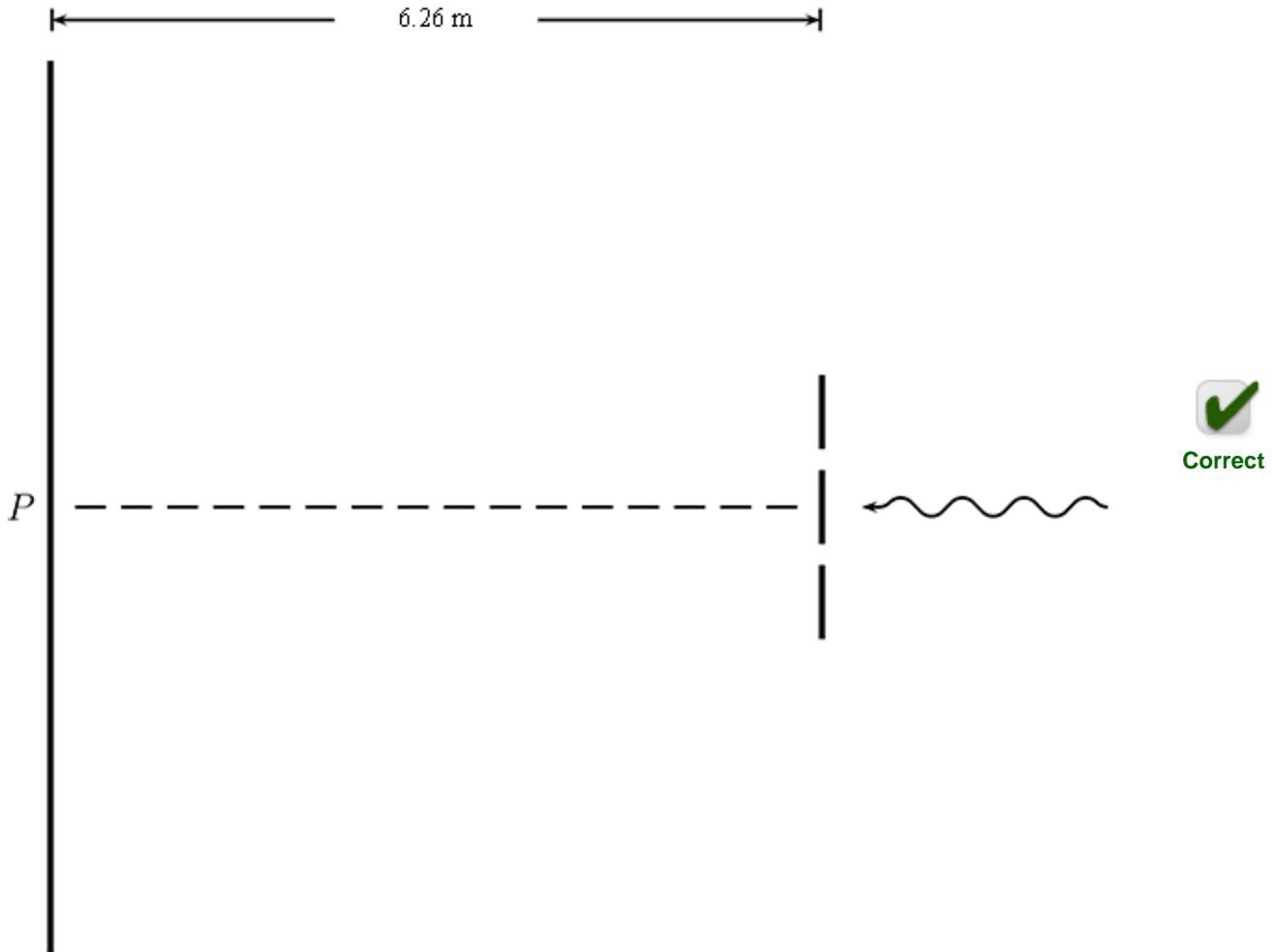
Correct Answer: .299*cm

Response-Specific Grading

Comment: „ Correct value and significant figures 100.0% „
Dimensions are correct
Total = 100.0%

Question 6: Score 2/2

The centres of the two slits in the diagram are separated by a distance of $d = 0.554 \text{ mm}$. If the coherent light incident on the slits is of wavelength 484 nm , at what distance above and below P would one find the order-2 dark fringes on the screen?



Your Answer: 5.47*mm

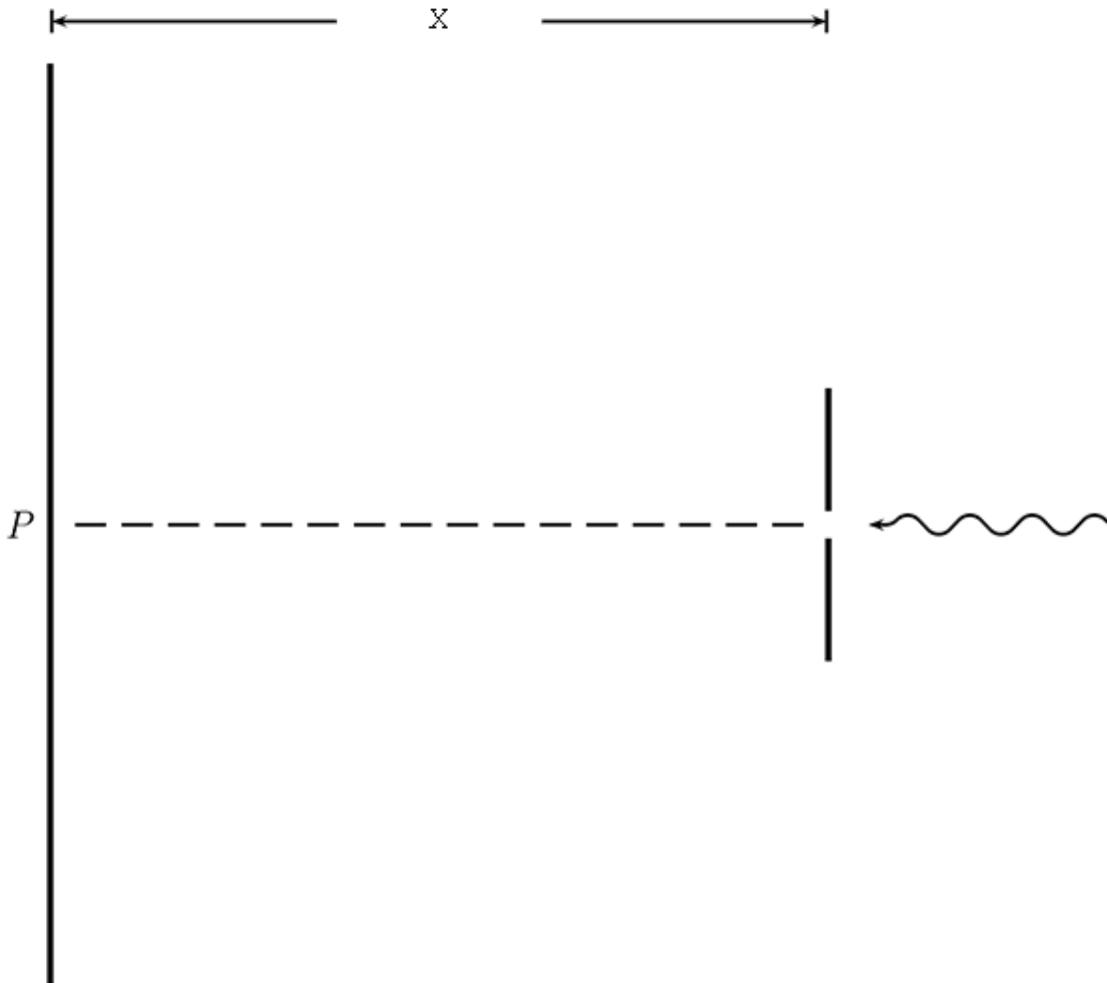
Correct Answer: .547*cm

Response-Specific Grading

Comment: „ Correct value and significant figures 100.0% „
Dimensions are correct
Total = 100.0%

Question 7: Score 2/2

The slit in the diagram is of width $d = 0.646 \mu\text{m}$, with $X \gg d$. A beam of monochromatic light of wavelength 632 nm passes through the slit at normal incidence. What order of bright fringes are observed at an angle 29.3° above and below P ?




Correct

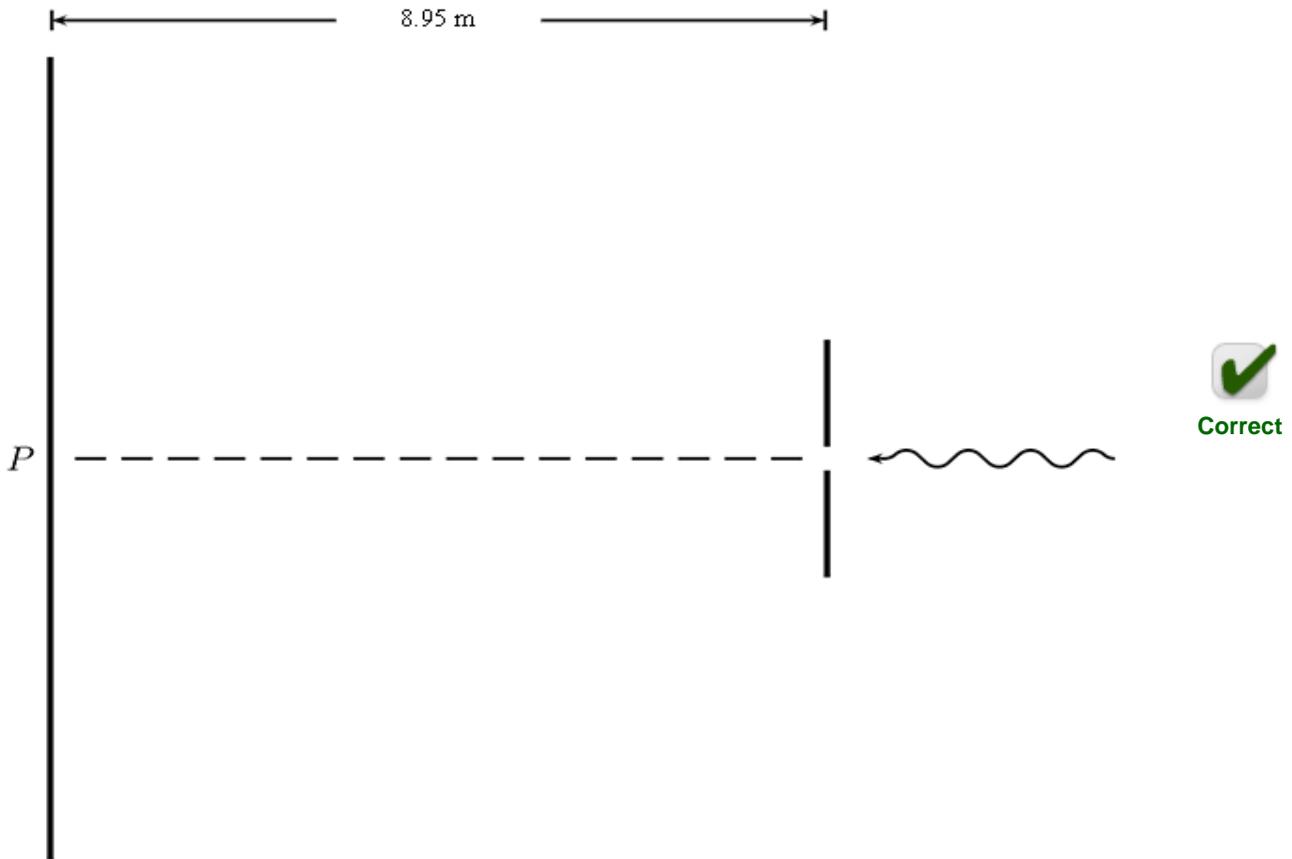
Your Answer: 1
Correct Answer: 1.00

Response-Specific Grading

Comment: " Exactly correct value 100.0% "
Total = 100.0%

Question 8: Score 2/2

The slit in the diagram is of width $d = 0.704 \text{ mm}$. If the light incident on the slit is of wavelength 695 nm , at what distance above and below P would one find the order-2 dark fringes on the screen?



Your Answer: 1.77*cm

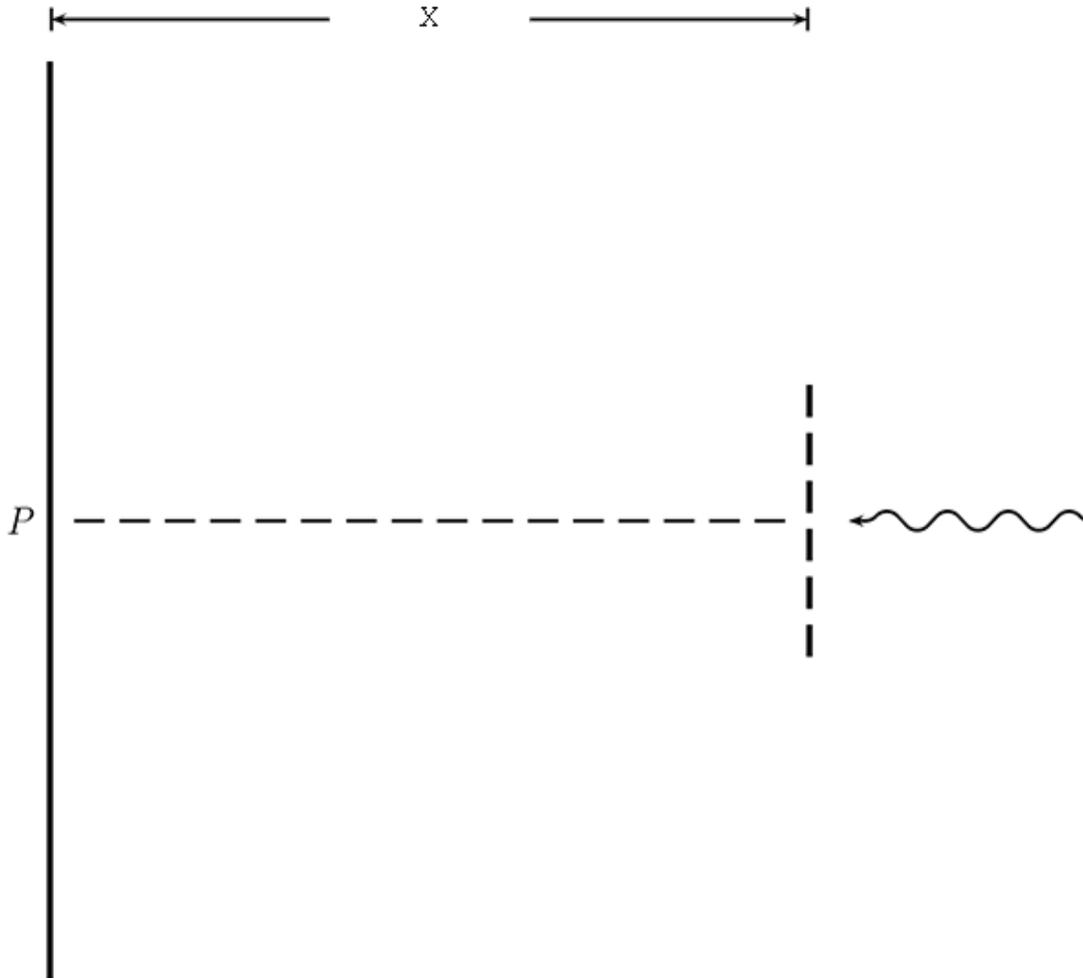
Correct Answer: 1.77*cm

Response-Specific Grading

Comment: „ Correct value and significant figures 100.0% „
Dimensions are correct
Total = 100.0%

Question 9: Score 2/2

The narrow slits of a diffraction grating are separated by a distance of $d = 9.06 \mu\text{m}$, and $X \gg d$. A beam of monochromatic light passes through the grating at normal incidence. If the order-3 bright fringes are visible at 4.52° , what is the wavelength of the light?



Correct

Your Answer: 238*nm

Correct Answer: 238.*nm

Response-Specific Grading

Comment:

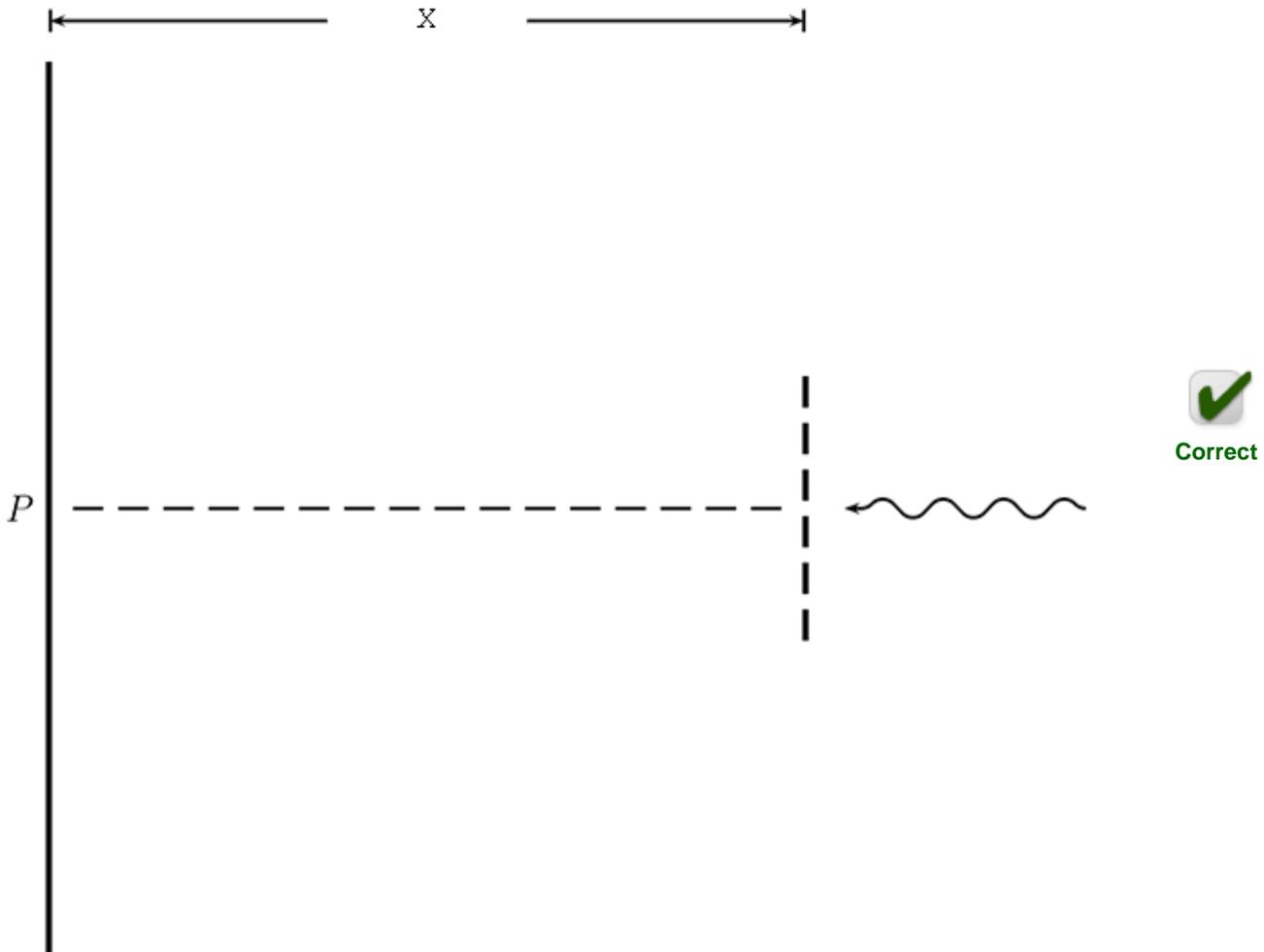
„ Correct value and significant figures 100.0% „

Dimensions are correct

Total = 100.0%

Question 10: Score 2/2

The narrow slits of a diffraction grating are separated by a distance of $d = 3.06 \mu\text{m}$, with $X \gg d$. A beam of monochromatic light of wavelength 413 nm passes through the grating at normal incidence. What order of dark fringes are observed at an angle 19.7° above and below P ?



Your Answer: 5

Correct Answer: 5.00

Response-Specific Grading

Comment: " Exactly correct value 100.0% "

Total = 100.0%