HOCHIMINH CITY
UNIVERSITY OF TECHNOLOGY AND EDUCATION
FACULTY FOR HIGH QUALITY TRAINING
GROUP OF FUNDAMENTAL SCIENTIFIC KNOWLEDGE

FINAL EXAM
2nd SEMESTER – ACADEMIC YEAR 2018-2019

Subject: Principles of Physics 2
Course Number: PHYS130502E
Test number: 01 (2 pages).
Duration: 90 minutes.

Note:
+ *Students are allowed to use one A4 paper sheet as a memory aid.*
+ *Invigilators are NOT allowed to explain anything related to contents of the test.*
+ *The permeability of free space is* $\mu_0 = 4\pi\times10^{-7}$ T.m/A. *The Coulomb constant is* $k_e = 9.00\times10^9$ N.m²/C².

Question 1: (0.5 marks)
A circular ring with radius a has total charge q uniformly distributed around it. What is the magnitude of the electric potential V at the center of the ring?

a. 0 V b. $k_e \frac{q}{a}$ V c. $k_e \frac{q}{a^2}$ V d. $k_e \frac{q}{2\pi a}$ V

Question 2: (0.5 marks)
A uniform magnetic field is directed along the x-axis. Consider a flat, rectangular coil in this magnetic field. Which of the statements about the flux through the coil is correct?
a. The flux is maximum if the coil is in the xy-plane.
b. The flux is maximum if the coil is xz-plane.
c. The flux is maximum if the coil is yz-plane.
d. The flux has the same nonzero value for all these orientations.

Question 3: (0.5 marks)
Which of the following statements are true regarding electromagnetic waves traveling through a vacuum? More than one statement may be correct.
a. All waves have the same wavelength.
b. All waves have the same frequency.
c. All waves travel at 3.00×10^8 m/s.
d. The electric and magnetic fields associated with the waves are perpendicular to each other and to the direction of wave propagation.
e. The speed of the waves depends on their frequency.

Question 4: (0.5 marks)
Why is it advantageous to use a large-diameter objective lens in a telescope?
a. It diffracts the light more effectively than smaller-diameter objective lenses.
b. It increases its resolution.
c. It enables you to see more objects in the field of view.
d. It reflects unwanted wavelengths.
e. It increases its magnification.

Question 5: (1.0 mark)
The ammeter (shown in Figure 3) reads 2.00 A. Find
a. I_1
b. I_2

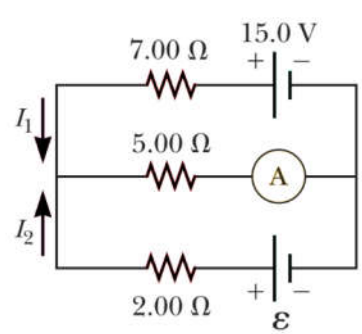


Figure 3.

Question 6: (1.0 mark) A loop of wire is moving near a long, straight wire carrying a constant current I as shown in Figure 4.

a) Determine the direction of the induced current in the loop as it moves away from the wire.

b) What would be the direction of the induced current in the loop if it were moving toward the wire?

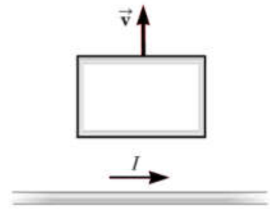


Figure 4.

Question 7: (2.0 marks) A segment of a line of charge lies along the x axis, extending from x_1 = 20.0 cm to x_2 = 50.0 cm (Figure 5.). The segment carries positive charge with a uniform linear charge density $\lambda_0 = 5.00 \times 10^{-7}$ C/m. What are

a. the direction and

b. the magnitude of the electric field at the origin?

Figure 5.

Question 8: (2.0 marks) Two long, parallel wires carry currents of I_1 = 3.00 A and I_2 = 7.00 A in the directions indicated in Figure 6. The distance between the wire is d = 40.0 cm

a. Find the magnitude and direction of the magnetic field at a point M (midway between the wires).

b. Find the magnitude and direction of the magnetic field at point P, located d above the wire carrying the current I_2.

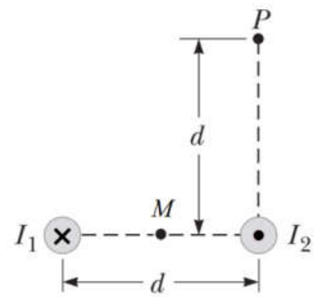


Figure 6.

Question 9: (2.0 marks) A film of MgF_2 having thickness 1.50×10^{-5} cm is used to coat a camera lens made of glass. The indexes of refraction of MgF_2 and glass are n_f = 1.38 and n =1.50 respectively.

a. What are the three longest wavelengths that are strongest reflected?

b. Are any of these wavelengths in the visible spectrum?

The End

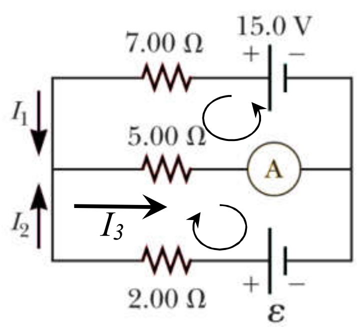
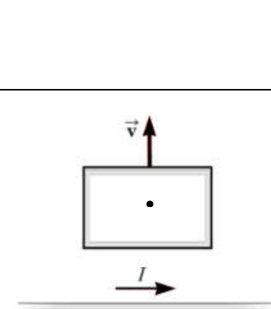
ELO of the subject (knowledge)	Test contents
[ELO 1.1]: Understanding various concepts, and laws related to electric and magnetic fields, and the theorem of electromagnetic field.	Questions: 1, 2, 3, 5, 6,7, 8
[ELO 2.1]: Applying the knowledge of electric and magnetic fields to explain phenomena and to solve the related problems.	Questions: 1, 2, 3, 5, 6,7, 8
[ELO 3.1]: Understanding various concepts, and laws related to ray optics and wave optics	Question: 4, 9
[ELO 3.2]: Applying the knowledge of ray and wave optics to explain phenomena and to solve the related problems.	Question: 4, 9

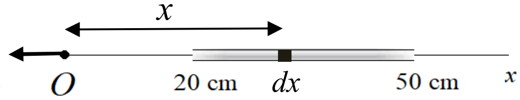
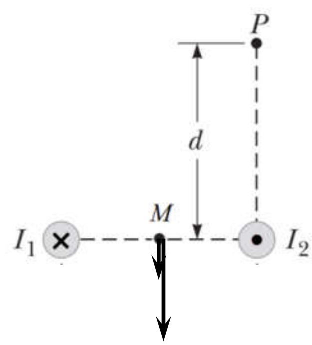
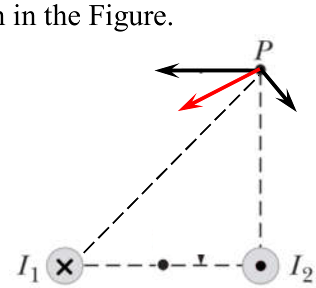
Date: May 20th 2019

Head of Group of Fundamental Scientific Knowledge

(Sign and write full name)

SOLUTIONS, KEYS AND SCORES
For Questions in Final Exam of Principles of Physics 2
Edited by: Phan Gia Anh Vu
Date of Exam: May 24th 2019

Question	Answer	Score
1	According to the definition of electric potential: $V = k_e \dfrac{q}{r}$ the correct answer is **b.**	0.5
2	Definition of flux: $\Phi_B = \vec{B} \times \vec{A}$ If the area of the coil is constant, then the flux will be maximum when the coil is perpendicular to the field. Because the field is along x-axis, the choice **c** is correct. Answer **c.**	0.5
3	Answers **c.** and **d.** These are properties of the electromagnetic waves.	0.5
4	Answer (**b**). Diffraction of light as it passes through, or reflects from, the objective element of a telescope can cause the images of two sources having a small angular separation to overlap and fail to be seen as separate images. According to Rayleigh's criterion, θ_{min} = 1.22λ D, the minimum angular separation θ_{min} two sources must have in order to be seen as separate sources is inversely proportional to the diameter D of the objective element. Thus, using a large-diameter objective element in a telescope increases its resolution.	0.5
5	Lets call the current through the ammeter I_3, directs from left to right.  From Kirchhoff's Laws, we obtain: + For the left conjunction point: $I_1 + I_2 - I_3 = 0$ (1) + For the upper loop: $15 - 7I_1 - 5I_3 = 0$ (2) + For the lower loop: $\varepsilon - 2I_2 - 5I_3 = 0$ (3) + I_3 = 2 A. (4) Rewrite the first two equations considering the 4th equation, we get: $I_1 + I_2 = 2$ $7I_1 = 15 - 10$ Solve for I_1 and I_2: $I_1 = 5/7 = 0.714\,\text{A}$; $I_2 = 9/7 = 1.29$ A	0.5 0.5
6	(a) **Counterclockwise.** With the current in the long wire flowing in the direction shown in the figure, the magnetic flux through the rectangular loop is directed out of the page. As the loop moves away from the wire, the magnetic field through the loop becomes weaker, so the magnetic flux through the loop is decreasing in time, and the change in the flux is directed opposite to the flux itself (or into the page).  The induced current will then flow counterclockwise around the loop, producing a flux directed out of the page through the loop and opposing the change in flux due to the decreasing flux through the loop.	0.5 0.5

	(b) **Clockwise.** In this case, as the loop moves toward from the wire, the magnetic field through the loop becomes stronger, so the magnetic flux through the loop is increasing in time, and the change in the flux has the same direction as the flux itself (or out of the page). The induced current will then flow clockwise around the loop, producing a flux directed into the page through the loop and opposing the change in flux due to the increasing flux through the loop.	
7	a) Because the charge of the rod is positive, the direction of the electric field at O is **to the left**.  b) The magnitude of the electric field is: $E=\int_{x_1}^{x_2} k_e \frac{dq}{x^2}=\int_{x_1}^{x_2} k_e \frac{\lambda_0 dx}{x^2}$ $=\int_{0.200}^{0.500} k_e \frac{\lambda_0 dx}{x^2}=-k_e\lambda_0 \left.\frac{1}{x}\right\|_{0.200}^{0.500}$ $=-\left(9\times10^9\right)\left(5\times10^{-7}\right)\left(\frac{1}{0.5}-\frac{1}{0.2}\right)=13500=13.5\,\text{kV/m}$	0,5 0,5 0,5 0,5
8	Lets number the wire carrying a current of 3.00 A wire 1 and the other wire 2. Also, choose the line running from wire 1 to wire 2 as the positive x direction. a) At the point M (midway between the wires), the field due to each wire is parallel to the y-axis and the net field is:  $B_{net}=B_{1y}+B_{2y}=-\frac{\mu_0}{2\pi\frac{d}{2}}\left(I_1+I_2\right)$ $=-\frac{\mu_0}{\pi d}\left(I_1+I_2\right)=-\frac{4\pi\times10^{-7}}{\pi(0.40)}(3+7)$ $=-1\times10^{-5}\,\text{T}$ $B_{net}=1\times10^{-5}$ T and towards the bottom of the page. b) At the point P, the field due to each wire is shown in the Figure.  $B_{net\,x}=B_{1x}+B_{2x}=\frac{\mu_0}{2\pi}\left(\frac{I_1}{d\sqrt{2}}-\frac{I_2}{d}\right)$ $=\frac{\mu_0}{2\pi d}\left(\frac{I_1}{\sqrt{2}}-I_2\right)=\frac{4\pi\times10^{-7}}{2\pi(0.40)}\left(\frac{3}{\sqrt{2}}-7\right)$ $=-2.44\times10^{-6}\,\text{T}$ $B_{net\,y}=B_{1y}=\frac{\mu_0}{2\pi}\left(-\frac{I_1}{d\sqrt{2}}\right)$ $=\frac{4\pi\times10^{-7}}{2\pi(0.40)}\left(\frac{3}{\sqrt{2}}\right)$ $=-1.06\times10^{-6}\,\text{T}$ $B_{net}=\sqrt{\left(B_{net\,x}\right)^2+\left(B_{net\,y}\right)^2}=\sqrt{2.44^2+1.06^2}\times10^{-6}$ $=2.66\times10^{-6}\,\text{T}$	0,5 0,5 0,5 0,5

	The net field has the magnitude of 2.66 μT, directs to the left and makes an angle of 66.5° below the horizontal.	
9	a) The film thickness is $t = 1.50 \times 10^{-5}$ cm = 150 nm. Since the light undergoes a 180° phase change at each surface of the film, the condition for constructive interference is $2nt = m\lambda$ or $\lambda = \frac{2nt}{m} = \frac{2(1.38)(150)}{m} = \frac{414}{m}$ nm m is an integer. Therefore, the longest wavelengths intensified in the reflected light are, for m = 1, 2, and 3: λ = 414 nm, 207 nm, 138 nm respectely (b) There is one wavelength in the visible spectrum 414 nm.	0,5 0,5 0,5 0,5