PHYSICS

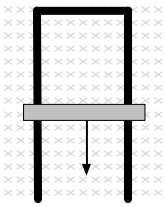
PHY 2054 Final Exam

Name (PRINT, last, first): _____ Signature: _____

On my honor, I have neither given nor received unauthorized aid on this examination.

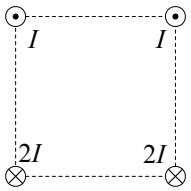
Constants			
$\epsilon_0 = 8.85 \times 10^{-12}$ F/m	$m_e = 9.11 \times 10^{-31}$ kg	$m_p = m_n = 1.67 \times 10^{-27}$ kg	$e = 1.6 \times 10^{-19}$ C
$k = 9 \times 10^9$ N m^2/C^2	$\mu_0 = 12.56 \times 10^{-7}$ H/m	$N_A = 6.02 \times 10^{23}$ atoms/mole	$c = 3 \times 10^8$ m/s
$n_{H_2O} = 1.333$	micro $= 10^{-6}$	nano $= 10^{-9}$	pico $= 10^{-12}$

1. A 14.0 g conducting rod of length 1.30 m and resistance 8.0 Ω slides freely downward between two vertical conducting rails without friction. The entire apparatus is placed in a uniform magnetic field B. Ignore the electrical resistance of the rails. Calculate B if the terminal velocity of the rod is 2.5 m/s. ($g = 9.8$ m/s^2)



(1) 0.51 T
(2) 1.6 T
(3) 0.26 T
(4) 0.73 T
(5) 1.2 T

2. Four long parallel wires pass through the corners of a square with side 15 cm and currents I and $2I$ as shown in the figure. Calculate I if the magnitude of the magnetic field at the center of the square is 40 μT.



(1) 5.0 A (2) 7.5 A (3) 10 A (4) 3.5 A (5) 2.5 A

3. A person takes a picture of the moon using a film camera, using its normal lens of 50 mm focal length. Assuming the moon's diameter to be approximately 3,600 km and its distance from the earth as 384,000 km, what is the *approximate* diameter of the moon's image on the film?

(1) 0.5 mm (2) 50 mm (3) 0.2 mm (4) 25 mm (5) 0.25 mm

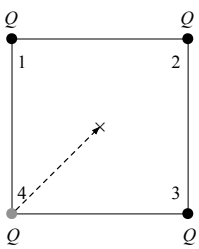
4. An inverted image is formed 50 cm from an object by a thin lens located between the two. The image is 1/2 the height of the object. What is the distance from the object to the lens?

(1) 33 cm (2) 100 cm (3) 50 cm (4) 25 cm (5) 17 cm

5. You are given a microscope with an objective focal length $f_o = 10$ cm and an eyepiece of focal length $f_e = 20$ cm. If you want to focus the microscope on a specimen 16.67 cm away from the objective lens, how far apart must the objective and eyepiece be from each other?

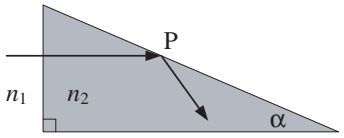
(1) 45 cm (2) 30 cm (3) 15 cm (4) 60 cm (5) None of these

6. Four particles of charge Q are fixed at the corners of a square with sides of length L, as shown in the figure. One particle is moved from its original position to the center of the square by an external force. The work performed by the external force is:



(1) $(5/\sqrt{2} - 2)kQ^2/L$ (2) kQ^2/L (3) $3\sqrt{2}kQ^2/L$ (4) 0 (5) $\sqrt{2}kQ^2/L$

7. As shown in the figure, a light ray is incident normal to one face of a triangular block of material with index of refraction $n_2 = 1.65$ that is immersed in water ($n_1 = 1.333$). What is the maximum angle α for which total internal reflection occurs at P?



(1) 36.1° (2) 53.9° (3) 52.7° (4) 41.4° (5) 37.3°

8. A dental hygienist uses a concave mirror to see the back of her patient's teeth. When the mirror is 1.5 cm from a tooth, the image is upright and 3.0 times as large as the tooth. What is the focal length of the mirror?

(1) 2.25 cm (2) 1.50 cm (3) 2.4 cm (4) 1.13 cm (5) 0.75 cm

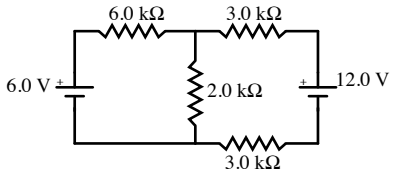
9. Two converging lenses, the first with focal length 25 cm and the second with focal length 20 cm, are separated by 30 cm. A 4.0 cm tall object is placed 50 cm in front of the first lens. Where is the final image?

(1) 10 cm after the second lens
(2) 20 cm after the second lens
(3) 20 cm before the second lens
(4) 10 cm before the second lens
(5) 50 cm after the second lens

10. A flat stack of two materials, the first of index of refraction 1.52 and thickness 2 mm, and the second of index of refraction 1.63 and thickness 3 cm, are setup with the first material on top and a light source at the botttom in the second material. What is the size (radius) of the circle of light that you see at the top of the first material through which you see the light emerge?

(1) 2.5 cm (2) 2.3 cm (3) 0.17 cm (4) 1.4 cm (5) none of these

11. In the multi-loop circuit shown the current through the 6.0 kΩ resistor is



(1) 0.4 mA (2) 1.2 mA (3) 2.4 mA (4) 0.8 mA (5) 1.8 mA

12. A real, erect object is placed in front of a concave spherical mirror of focal length f. Which of the following types of image *cannot* result?

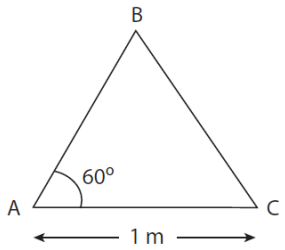
(A) Real, erect, enlarged
(B) Real, inverted, reduced
(C) Virtual, erect, enlarged
(D) Enlarged, inverted and farther away than $2f$
(E) Virtual, inverted, reduced

(1) A, E (2) B, C, D (3) A, C, E (4) B, D (5) A, D, E

13. Two converging lenses, each with a focal length of 30 cm, are separated by distance L. The image of an upright object placed 60 cm in front of the first lens appears 60 cm behind the second lens and is also upright. What is the distance L?

(1) 120 cm (2) 240 cm (3) 60 cm (4) 0 (5) 90 cm

14. Positive charges are arranged at the vertices of an equilateral triangle as shown (all three angles are 60°, all three sides are 1 m in length. At vertex A is 1 C of charge, at vertex B, 3 C, at vertex C, 1 C. Calculate the total of the Coulomb forces on the charge at A from the charges at B and C. What is the ratio of the magnitude of the total force on the charge at A from both charges at B and C in the y-direction to the magnitude of the total force on charge A in the x direction, $|F_y|/|F_x|$?



(1) 1.04 (2) 0.74 (3) 0.96 (4) 0.87 (5) 1.00

15. A thin film of oil ($n = 1.10$) floats on water ($n = 1.33$). When sunlight is incident at right angle to the film, the only colors that are enhanced by reflection are blue (458nm) and red (687nm). Estimate the thickness of the oil film (in nm).

(1) 624 (2) 572 (3) 528 (4) 198 (5) 286