PHYSICS

PHY 2054 Final Exam

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

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
$n_{H_2O} = 1.333$	k="kilo"=10^3	M="mega"=10^6	$g = 9.8$ m/s^2
m="milli"=10^{-3}	μ="micro"=10^{-6}	n="nano"=10^{-9}	p="pico"=10^{-12}

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1. An object is 20 cm to the left of a lens of focal length +10 cm. A second lens, of focal length +12.5 cm, is 30 cm to the right of the first lens. The distance between the original object and the final image is:

   (1) 0 (2) 50 cm (3) 100 cm (4) 28 cm (5) infinity

2. An old person sees objects clearly only when they are at distances between 15 cm and 28 cm from his eyes. If he wears contact lenses to correct his nearsightedness, what is the minimum distance in cm that he will be able to see an object clearly?

   (1) 32 (2) 9.7 (3) 13.2 (4) 15 (5) 28

3. Two light waves travel in air with wavelength 520 nm, and they are initially in phase. Each passes through a block of length L before passing back into the air. One travels through glass with index of refraction $n_1 = 1.65$, and the other passes through ice with index of refraction $n_2 = 1.31$. What is the minimum value of L for which the waves will undergo full destructive interference?

   (1) 765 nm (2) 2400 nm (3) 4800 nm (4) 400 nm (5) 1260 nm

4. 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

5. If the two 2nd order maxima ($m = 2$) are separated by 2.0 cm on the screen in a double-slit experiment, what is the separation of the $m = 3$ minima? Assume the angle is very small.

   (1) 3.5 cm (2) 2.0 cm (3) 2.5 cm (4) 3.0 cm (5) 1.5 cm

6. A grating with 8,000 slits space over 2.54 cm is illuminated by light of a wavelength of 546 nm. What is the angle corresponding to the third order maximum?

   (1) 31.1° (2) 15.1° (3) 26.3° (4) 10.5° (5) 21.3°

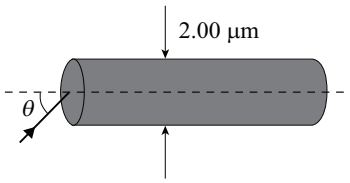
7. A thin film of soapy water, $n = 1.37$, is held vertically. Light of wavelength 600 nm is reflected from the film and horizontal dark lines appear. What is the difference in thickness of the soap film from one band to the next?

(1) 219 nm (2) 300 nm (3) 438 nm (4) 600 nm (5) 900 nm

8. 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

9. Determine the maximum angle (in degrees) for which the light rays incident on the end of the light pipe in Figure are subject to total internal reflection along the walls of the pipe. Assume that the light pipe has an index of refraction of 1.36 and that the outside medium is air.



(1) 67.2 (2) 84.7 (3) 46.7 (4) 32.5 (5) 23.2

10. An elderly sailor is shipwrecked on a desert island, but manages to save his eyeglasses. The lens for one eye has a power of +1.2 diopters, and the other lens has a power of +5 diopters. He makes a telescope from these lenses. What is the angular magnification and the length (in meters) of this telescope?

(1) 4.17, 1.03 (2) 5.8, 0.98 (3) 7.5, 0.94 (4) 7.5, 1.03 (5) none of these

11. 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 (458 nm) and red (687 nm). Estimate the thickness of the oil film.

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

12. Viewed at night from above a lake, the light from an underwater bulb forms a bright, 10-m diameter circle on the surface of the water ($n = 1.33$). How far below the lake's surface is the bulb?

(1) 4.4 m (2) 8.8 m (3) 3.8 m (4) 6.7 m (5) 7.5 m

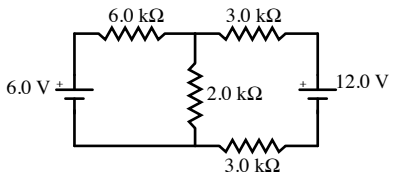
13. A movie theater projector produces a 3.0 m wide image of a 2.5 cm wide picture on a screen that is 18 m distant. The focal length of the projection lens must be about

(1) 15 cm (2) 7.5 cm (3) 10 cm (4) 12.5 cm (5) 20 cm

14. A material shaped as a cylinder has a resistance R measured from one end of the cylinder to the other. If the material is now squeezed to form a cylinder with 1/2 its original length (with the same volume) what is the resistance of the new shape?

(1) $R/4$ (2) $4R$ (3) $2R$ (4) $R/2$ (5) R

15. 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

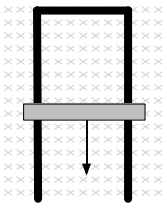
16. A singly charged ^{9}Be ion is accelerated from rest through a potential difference of 32000 V. The ion is then sent into a mass spectrometer where the radius of the path is 24 cm. What is the magnetic field in the spectrometer?

(1) 0.32 T (2) 0.16 T (3) 0.081 T (4) 0.0028 T (5) 0.58 T

17. One wire, lying on the x-axis, carries a current of 4.0 A in the positive x-direction. Another wire, lying on the y-axis, carries a current of 6 A in the positive y-direction. What is the magnitude of the magnetic field at (x, y) = (8.0 cm, 12.0 cm)?

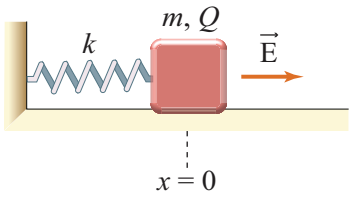
(1) 0.83×10^{-5} T (2) 1.5×10^{-5} T (3) 0.65×10^{-5} T (4) 2.2×10^{-5} T (5) 2.0×10^{-10} T

18. 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

19. A cube with mass $m = 4.00$ kg carrying a charge $Q = 50.0\,\mu$C is attached to a spring with a constant of $k = 100$ N/m. The cube lies on a frictionless horizontal surface, and the system is placed in a uniform electric field with $E = 5.00 \times 10^5$V/m directed (as in Figure) to the right. If the cube is released at rest when the spring is unstretched (at $x = 0$), by what maximum amount does the spring expand (in meters)?



(1) 0.50 (2) 0.25 (3) 0.10 (4) 1.25 (5) zero

20. A parallel plate capacitor has initial capacitance 6.9 μF. The space between the plates is then filled with a slab of glass with dielectric constant 2.6. The capacitor is charged by attaching it to a 1.7-V battery. After the capacitor is disconnected from the battery, the dielectric slab is removed. What is the magnitude of the charge on each plate after the glass is removed?

(1) 30.5μC (2) 11.7μC (3) 4.5μC (4) 12.5μC (5) 9.8μC