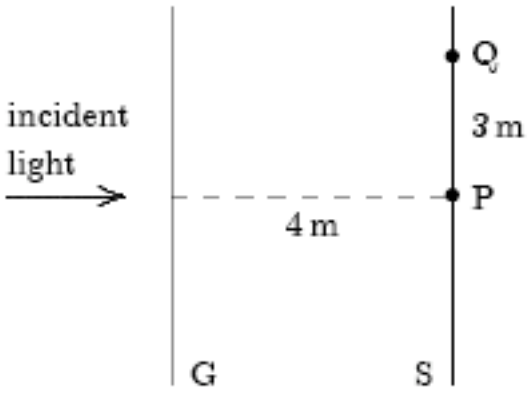
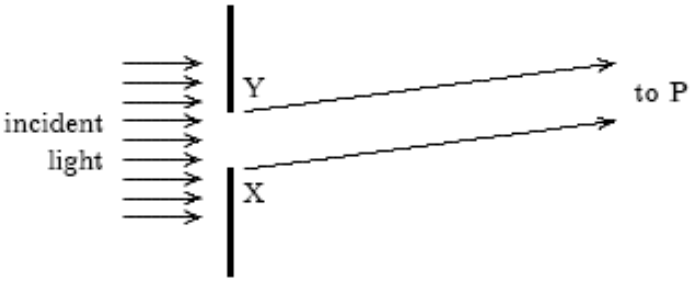
1. (5 points) Light of wavelength λ is normally incident on a diffraction grating, G. On the screen S, the central line is at P and the first order line is at Q, as shown. The distance between adjacent slits in the grating is:



A. 5λ/3
B. 3λ/4
C. 4λ/5
D. 5λ/4
E. 3λ/5

2. (5 points) The diagram shows a single slit with the direction to a point P on a distant screen as shown. At P, the pattern has its maximum nearest the central maximum. IF X and Y are the edges of the slit, what is the path length difference (PX) – (PY)?



A. λ/2
B. λ
C. 3λ/2
D. 2λ
E. 5λ/2

3. (5 points) In a thin film experiment, a wedge of air is used between two glass plates. If the wavelength of the incident light in air is 480 nm, how much thicker (in nm) is the air wedge at the 16^{th} dark fringe than it is at the 6^{th}?

A. 840
B. 1620
C. 2400
D. 3240
E. 4800

4. (5 points) In a cinema, a picture 2.5 cm wide on the film is projected to an image 3.0 m wide on a screen that is 18 m away. The focal length of the lens (in cm) is about:

A. 7.5
B. 10
C. 12.5
D. 15
E. 20

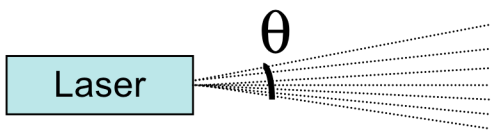
5. (5 points) A concave spherical mirror has a focal length of 12 cm. If an object is placed 6 cm in front of it, the image position is:

A. 4 cm behind the mirror
B. 4 cm in front of the mirror
C. 12 cm behind the mirror
D. 12 cm in front of the mirror
E. at infinity

6. (5 points) A clear sheet of polaroid is placed on top of a similar sheet so that their polarizing axes make an angle of 30^o with each other. The ratio of the intensity of emerging light to the incident unpolarized light is:

A) 1:4
B) 1:3
C) 1:2
D) 3:4
E) 3:8

7. (5 points) A helium-neon laser, radiating at 632.8 nm, has a power output of 3.0 mW. The beam diverges (spreads) at an angle of θ=0.17 mrad. What is the intensity (in W/m^2) of the beam 40 m from the laser?

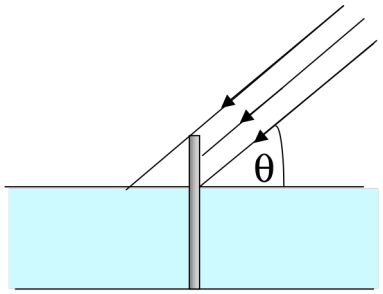


A. 2.4
B. 83
C. 37
D. 590
E. 260

8. (5 points) In a region of space where gravitational forces can be neglected, a sphere is accelerated by a uniform light beam of intensity 6.0 mW/m^2. The sphere is totally absorbing and has a radius of 2.0 microns and a uniform density of 5000.0 kg/m^3. What is the magnitude of the sphere's acceleration (in m/s^2) due to the light?

A. 9.8×10^{-8}
B. 1.5×10^{-9}
C. 4.5×10^{-9}
D. 3.0×10^{-15}
E. 5.0×10^{-26}

9. (5 points) A 2.00 meter long vertical pole extends from the bottom of a swimming pool to a point 50.0 cm above the water. Sunlight is incident at an angle of 55.0°. What is the length (in meters) of the shadow of the pole on the level bottom of the pool? Assume the index of refraction of the pool water is 1.33.



A. 0.61
B. 1.07
C. 2.34
D. 0.35
E. 1.89

10. (5 points) An airplane flying at a distance of 10 km from a radio transmitter receives a signal of intensity 10 μW/m^2. What is the amplitude (in Telsas) of the magnetic component of the signal at the airplane?

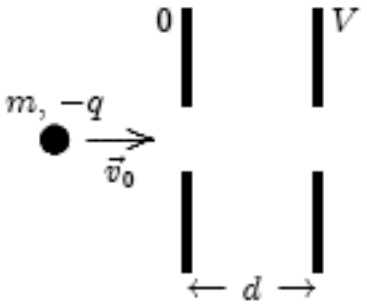
(A) 7.5 x 10^{-3}
(B) 2.0 x 10^{-12}
(C) 7.2 x 10^{-10}
(D) 6.1 x 10^{-4}
(E) 2.9 x 10^{-10}

11. (5 points) A magnetic dipole of moment μ = 13.8 Am^2 points 60^o away from the direction of a 8.1 T uniform magnetic field. What is the torque on this dipole, in Nm units?

A) 75
B) 159
C) 53
D) 106
E) 96

12. (5 points) A matching pair of circular metal sheets of radius 1.1 m are separated in air (face to face) by 0.04 mm and charged to 17 mC. What is the voltage difference (in kV) between the two plates?
A) 20.2
B) 7.68
C) 37.5
D) 2.73
E) 18.1

13. (5 points) A particle with mass m and charge –q is projected with speed v_o into the region between two parallel plates as shown. The potential difference between the two plates is V and their separation is d. The change in kinetic energy of the particle as it traverses this region is



(A) $\frac{-qV}{d}$

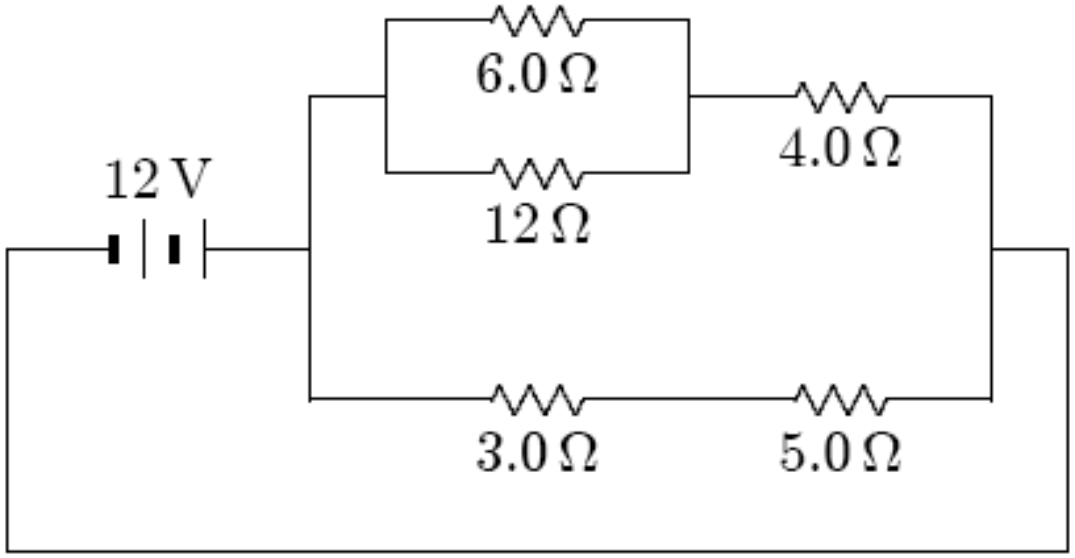
(B) $\frac{2qV}{mv_o^2}$

(C) qV

(D) $\frac{mv_o^2}{2}$

(E) $\frac{1}{V}$

14. (5 points) The current (in Amperes) in the 5.0 ohm resistor in the circuit shown is:



A) 0.42
B) 0.67
C) 1.5
D) 2.4
E) 3.0

15. (5 points) Three +0.12 C charges form an equilateral triangle 1.7 m on a side. Using energy supplied at the rate of 0.83 kW, how many days would be required to move one of the charges to the midpoint of the line joining the other two charges?

A) 0.03
B) 0.4
C) 1.3
D) 2.1
E) 5.6

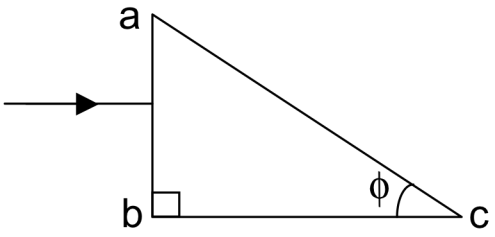
16. (5 points) A solenoid 1.30 m long and 2.60 cm in diameter carries a current of 18.0 A. The magnetic field inside the solenoid is 23.0 mT. Find the length (in meters) of the wire forming the solenoid.

A) 0.5
B) 54
C) 216
D) 12
E) 108

17. (5 points) White light, with a uniform intensity across the visible wavelength range, is perpendicularly incident on a film of water (index of refraction 1.33 and thickness 320 nm) that is suspended in air. At what wavelength (in nm) is the light reflected by the film brightest to an observer?

A) 340
B) 690
C) 567
D) 430
E) 1700

18. (5 points) A ray of light is perpendicular to the face ab of a glass prism (n = 1.52). Find the largest value of the angle ϕ so that the ray is totally reflected at face ac if the prism is immersed in water (n = 1.33).



A) 29.0°
B) 48.9°
C) 0°
D) 12.7°
E) 35.6°

For Questions 19, 20, 21 &22

A peanut is placed 40 cm in front of a two-lens system: lens 1 (nearer the peanut) has a focal length $f_1 = +20$ cm, lens 2 has a focal length $f_2 = -15$ cm, and the lens separation is d= 10 cm. For the image produced by lens 2:

19. (5 points) What is the image distance, i_2 (without the sign) in cm?

A) 10
B) 13
C) 20
D) 30
E) 40

20. (2 points) Is the image orientation:

A) Inverted relative to the peanut
B) Not inverted relative to the peanut

21. (1 points) Is the image:

A) Real
B) Virtual

22. (2 points) What is the absolute value of the net lateral magnification?

A) 0.25
B) 0.5
C) 1.0
D) 2.0
E) 4.0