

Final Exam Review:

Representative short answer & problem from each chapter, with answer:

**Chapter 18**

Q) What process can allow heat to be transferred through a vacuum?

P) In a certain solar house, energy from the Sun is stored in barrels filled with water. In a particular winter stretch of five cloudy days,  $1.38 \times 10^6$  kcal is needed to maintain the inside of the house at  $21^\circ\text{C}$ . Assuming that the water in the barrels is at  $52.8^\circ\text{C}$  and that the water has a density of  $1.00 \times 10^3$  kg/m<sup>3</sup>, what volume of water is required? Take the specific heat of water to be 1.00 kcal/kg.

43.4  
m<sup>3</sup>

**Chapter 19**

Q) If an ideal gas expands isothermally, what direction does heat flow?

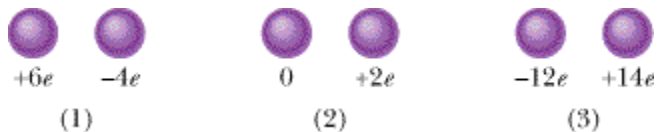
P) An ideal gas undergoes isothermal compression from an initial volume of  $5.32$  m<sup>3</sup> to a final volume of  $2.32$  m<sup>3</sup>. There is  $2.31$  mol of the gas, and its temperature is  $37.0^\circ\text{C}$ . **(a)** How much work is done by the gas? **(b)** How much energy is transferred as heat between the gas and its environment?

**(a)** -4940 J

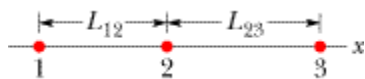
**(b)** 4940 J

**Chapter 21**

Q) Three pairs of identical spheres that are to be touched together and then separated. The initial charges on them are indicated. Rank the pairs according to (a) the magnitude of the charge transferred during touching and (b) the charge left on the positively charged sphere, greatest first.



P) Particles 1 and 2 are fixed in place, but particle 3 is free to move. If the net electrostatic force on particle 3 due to particles 1 and 2 is zero and  $L_{23} = 5.59L_{12}$ , what is the ratio  $q_1/q_2$ ?



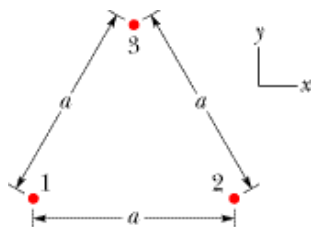
-1.39

**Chapter 22**

Q) Two charged particles fixed in place on an axis. (a) Where on the axis (other than at an infinite distance) is there a point at which their net electric field is zero: between the charges, to their left, or to their right? (b) Is there a point of zero net electric field anywhere *off* the axis (other than at an infinite distance)?



P) Particle 1 (of charge  $+3.65 \text{ mC}$ ), particle 2 (of charge  $+3.65 \text{ mC}$ ), and particle 3 (of charge  $Q$ ) form an equilateral triangle of edge length  $a$ . For what value (in C) of  $Q$  (both sign and magnitude) does the net electric field produced by the particles at the center of the triangle vanish?



0.00365 C

**Chapter 23**

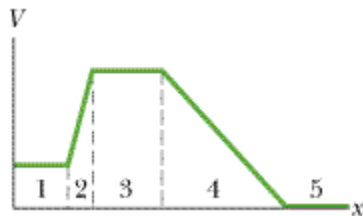
Q) A surface has the area vector  $\vec{A} = (2\hat{i} + 3\hat{j})\text{m}^2$ . What is the flux of a uniform electric field through it if the field is (a) and (b) ?

P) A point charge  $q = 1.0 \times 10^{-7}\text{C}$  is at the center of a spherical cavity of radius 1.9 cm in a chunk of metal. Use Gauss' law to find the magnitude of the electric field (a) 0.79 cm from the cavity center and (b) anyplace in the metal.

- (a)  N/C  
 (b)  N/C

**Chapter 24**

Q) The figure below gives the electric potential  $V$  as a function of  $x$ . (a) Rank the five regions according to the magnitude of the  $x$  component of the electric field within them, greatest first. What is the direction of the field along the  $x$  axis in (b) region 2 and (c) region 4?



P) Point P is at a distance  $d_1 = 2.16\text{m}$  from particle 1 ( $q_1 = -2e$ ) and distance  $d_2 = 0.793\text{m}$  from particle 2 ( $q_2 = +2e$ ), with both particles fixed in place. (a) With  $V = 0$  at infinity, what is  $V$  at P? If we bring a particle of charge  $q_3 = +2e$  from infinity to P, (b) how much work do we do and (c) what is the potential energy of the three-particle system?



- (a)  V  
 (b)  J  
 (c)  J

**Chapter 26**

Q) Three wires, of the same diameter, are connected in turn between two points maintained at a constant potential difference. Their resistivities and lengths are  $r$  and  $L$  (wire A),  $1.2r$  and  $1.2L$  (wire B), and  $0.9r$  and  $L$  (wire C). Rank the wires according to the rate at which energy is transferred to thermal energy, greatest first.

P) A potential difference  $V$  is applied to a wire of cross sectional area  $A$ , length  $L$ , and resistivity  $\rho$ . You want to change the applied potential difference and stretch the wire so that the energy dissipation rate is multiplied by 34.0 and the current is multiplied by 3.55. Assuming the wire's density does not change, what are (a) the ratio of the new length to  $L$  and (b) the ratio of the new cross-sectional area to  $A$ ?

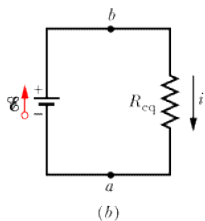
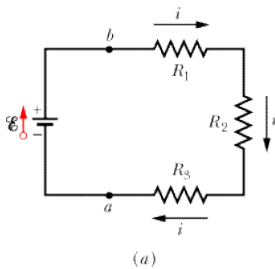
(a) 1.64

(b) 0.609

**Chapter 27**

Q) Initially, a single resistor  $R_1$  is wired to a battery. Then resistor  $R_2$  is added in parallel. Are (a) the potential difference across  $R_1$  and (b) the current  $i_1$  through  $R_1$  now more than, less than, or the same as previously? (c) Is the equivalent resistance  $R_{12}$  of  $R_1$  and  $R_2$  more than, less than, or equal to  $R_1$ ? (d) Is the total current through  $R_1$  and  $R_2$  together more than, less than, or equal to the current through  $R_1$  previously?

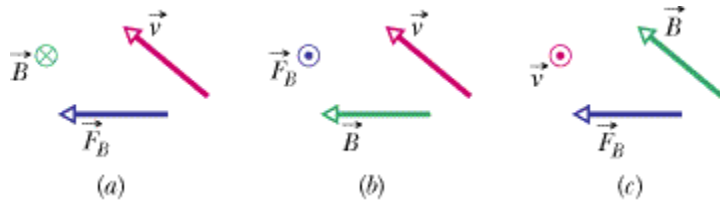
From the figure below, find the potential difference across  $R_2$  if  $\mathcal{E} = 15.8 \text{ V}$ ,  $R_1 = 2.14 \text{ } \Omega$ ,  $R_2 = 4.46 \text{ } \Omega$ , and  $R_3 = 1.64 \text{ } \Omega$ .



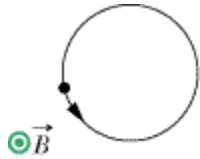
8.55 V

### Chapter 28

Q) Which of the following set of vectors are correct?



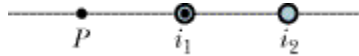
P) A particle moves along a circle in a region of uniform magnetic field of magnitude  $B = 5.68$  mT. The particle is either a proton or an electron (you must decide which). It experiences a magnetic force of magnitude  $1.81 \times 10^{-15}$  N. What are (a) the particle's speed (in m/s), (b) the radius of the circle (in m), and (c) the period of the motion (in s)? The charge of an electron is  $-1.602 \times 10^{-19}$  C and its mass is  $9.109 \times 10^{-31}$  kg. The charge of a proton is  $+1.602 \times 10^{-19}$  C and its mass is  $1.673 \times 10^{-27}$  kg.



- (a)  m/s
- (b)  m
- (c)  s

### Chapter 29

Q) The figure below shows cross sections of two long straight wires; the left-hand wire carries current  $i_1$  directly out of the page. If the net magnetic field due to the two currents is to be zero at point  $P$ , (a) should the direction of current  $i_2$  in the right-hand wire be directly into or out of the page and (b) should  $i_2$  be greater than, less than, or equal to  $i_1$ ?

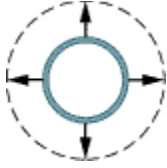


P) A cylindrical cable of radius 7.48 mm carries a current of 23.1 A, uniformly spread over its cross-sectional area. At what distance from the center of the wire is there a point within the wire where the magnetic field is 0.241 mT?

- mm

### Chapter 30

Q) If the circular conductor in the following figure undergoes thermal expansion while it is in a uniform magnetic field, a current is induced clockwise around it. Is the magnetic field directed into or out of the page?

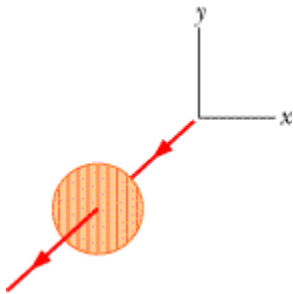


P) A square loop of wire is held in a uniform 0.19 T magnetic field directed perpendicular to the plane of the loop. The length of each side of the square is decreasing at a constant rate of 5.6 cm/s. What emf (in V) is induced in the loop when the length is 14 cm?

0.0030 V

### Chapter 33

Q) (a) The figure below shows light reaching a polarizing sheet whose polarizing direction is parallel to a  $y$  axis. We shall rotate the sheet  $40^\circ$  clockwise about the light's indicated line of travel. During this rotation, does the fraction of the initial light intensity passed by the sheet increase, decrease, or remain the same if the light is (a) initially unpolarized, (b) initially polarized parallel to the  $x$  axis, and (c) initially polarized parallel to the  $y$  axis?

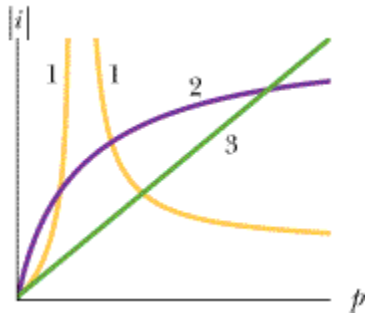


P) Light in vacuum is incident on the surface of a slab of transparent material. In the vacuum the beam makes an angle of  $45.7^\circ$  with the normal to the surface, while in the slab it makes an angle of  $27.9^\circ$  with the normal. What is the index of refraction of the transparent material?

1.53

**Chapter 34**

Q) An object is placed against the center of a converging lens and then moved along the central axis until it is 5.0 m from the lens. During the motion, the distance  $|i|$  between the lens and the image it produces is measured. The procedure is then repeated with a diverging lens. Which of the curves on the plot best gives  $|i|$  versus the object distance  $p$  for these lenses? (Curve 1 consists of two segments. Curve 3 is straight.)

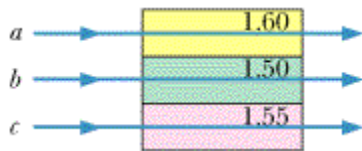


P) A small cup of green tea is positioned on the central axis of a spherical mirror. The lateral magnification of the cup is  $+0.245$ , and the distance between the mirror and its focal point is  $3.15$  cm. What is the distance between the mirror and the image it produces?

2.38 cm

**Chapter 35**

Q) In the figure, three pulses of light— $a$ ,  $b$ , and  $c$ —of the same wavelength are sent through layers of plastic having the given indexes of refraction. Rank the pulses according to their travel time through the plastic, greatest first.



P) A thin film suspended in air is  $0.400 \mu\text{m}$  thick and is illuminated with white light incident perpendicularly on its surface. The index of refraction of the film is  $1.60$ . At what wavelength will visible light that is reflected from the two surfaces of the film undergo fully constructive interference?

512 nm

### *Chapter 36*

Q) Light of frequency  $f$  illuminating a long narrow slit produces a diffraction pattern. (a) If we switch to light of frequency  $1.3f$ , does the pattern expand away from the center or contract toward the center? (b) Does the pattern expand or contract if, instead, we submerge the equipment in clear corn syrup?

P) The pupil of a person's eye has a diameter of 5.00 mm. According to Rayleigh's criterion, what distance apart must two small objects be if their images are just barely resolved when they are 250 mm from the eye? Assume they are illuminated with light of wavelength 500 nm.

30.5  $\mu\text{m}$