ISP209 Fall 2012

Exam #2

Name:_____

Student #:_____

Please write down your name and student # on both the exam and the scoring sheet. After you are finished with the exam, please place the scoring sheet inside the exam and turn in at the front of the lecture room.

No form number is necessary. No section # is necessary. Please write last your last name and first names in the locations provided. Mixing last and first names has caused a lot of problems in the past.

Do not begin working on the exam before permission is given. Keep your eyes on your own exam and no conversations. You will be given one verbal warning. The second violation will result in the exam being taken away and a grade of 0 assigned. **No cell phones visible.**

Some useful constants:

k_B(Boltzmann's constant)=1.38×10^{-23} J/$^\circ$K

k(for use in Coulomb's law) = 9×10^9 Nm^2/C^2

e = 1.6×10^{-19} C

c= 3×10^8 m/s

Match the following units with the quantity given in questions 1 through 5

    a) V
    b) V/m
    c) J
    d) A
    e) T

1) Electric current **d**

2) Electric field **b**

3) Electric potential **a**

4) Heat **c**

5) Magnetic field **e**

6) Which of the following statements is true? (only one is)

a) adding heat to a system will in general decrease the amount of entropy in the system

b) whenever energy freely transforms from one form to another, the direction of transformation is toward a state of greater disorder or entropy

c) heat can spontaneously flow from a cold substance to a hot substance

d) all molecules in a gas at a given temperature have the exact same velocity

e) the temperature of a gas is inversely proportional to the average kinetic energy of a molecule in the gas

7) Convert 14º K to ºC

    a) -219ºC
    b) 287ºC
    c) 25ºC
    d) -259ºC
    e) 14ºC

temp (ºC) = temp(ºK)-273º

*   =14-273=-259ºC*

8) If the temperature of a gas is increased from 20ºC to 40ºC, by what factor does the average speed of the molecules increase?

    a)3%
    b)10%
    c)30%
    d)70%
    e)100%

$$KE = \frac{1}{2}mv^2 = \frac{3}{2}k_B T$$

$$KE_{20} = \frac{1}{2}mv_{20}^2 = \frac{3}{2}k_B(273^o K + 20^o K) = \frac{3}{2}k_B(293^o K)$$

$$KE_{40} = \frac{1}{2}mv_{40}^2 = \frac{3}{2}k_B(273^o K + 40^o K) = \frac{3}{2}k_B(313^o K)$$

The kinetic energy is larger by a factor of 313/293=1.068. the speed is larger by the square root of 1.068, or 1.033.

9) The reason ocean temperatures do not vary drastically is that

a) water has a relatively high rate of heat conduction

b) water is a good radiator

c) water has a relatively high specific heat

d) water is a poor heat conductor

e) water is a poor electrical conductor

10) By what primary heat transfer mechanism does the sun warm the earth?

a) convection

b) conduction

c) radiation

d) all of the above

e) none of the above

11) Two charged objects attract each other with a force F. What happens to the force between them if one charge is doubled, the other charged is tripled, and the separation between them is reduced to one-fourth of its original value. The force is now equal to

a) 16F

b) 24 F

c) (3/8/)F

d) 96F

e) 6F

$$F_{original} = k\frac{q_1 q_2}{r^2}$$

$$F_{new} = k\frac{(2q_1)(3q_2)}{(\frac{1}{4}r)^2} = 96F_{original}$$

12) If $3.0X10^{15}$ electrons flow through a section of copper wire of diameter 2.0 mm in 4.0 seconds, what is the current in the wire?

a)0.12 mA

b)0.24 mA

c)$7.5X10^7$ A

d)$7.5X10^{14}$ A

e) 0.48 mA

$3X10^{15}$ electrons/4 seconds = $7.5X10^{14}$ electrons/second X $1.6X10^{-19}$ C/electron = $1.2X10^{-4}$ C/S = $1.2X10^{-4}$ A

13) If a 75-W light bulb operates at a voltage of 120 V, what is the current in the bulb?

a) 0.50 A

b) 0.35 A

c) 50 A

d) 0.25 A

e) 0.63 A

P=IV

I=P/V=75W/120V=0.63A

14) Three identical resistors are connected in parallel to a battery to form a complete electrical circuit. If a current of 12 A flows through the battery, how much current flows through any one of the resistors?

a) 12 A

b) 4 A

c) 36 A

d) zero A

e) 6 A

The current through the battery is divided equally among the three resistors.

15) An AC generator consists of 100 turns of wire in a uniform magnetic field of 1.0 T, where each loop of wire has an area of 0.09 m^2. The loops rotate with an angular frequency ω of 60 radians per second. What is the maximum induced voltage?

a) 100 V

b) 180 V

c) 540 V

d) 60 V

e) 240 V

ε=NBAω=(100)(1.0T)(0.09m²)(60)=540V

16) For all transparent material substances, the index of refracton

a) is less than 1

b) is greater thn 1

c) is equal to 1

d) could be any one of the above depending on the optical density

17) In the video shown in class, what was the gas that Dewar was trying to liquefy before helium

   a) neon

   b) hydrogen

   c) lithium

   d) boron

   e) argon

18) In Faraday's most important experiment, he found that

a) a strong magnetic field created an electric field

b) a strong magnetic field created an electromagnetic wave

c) a changing magnetic field created an electric field

d) a changing electric field created a magnetic field

e) electrical currents are due to the flow of electrons

19) A certain kind of glass has an index of refraction of 1.658 for blue light of wavelength 429 nm and an index of refraction of 1.610 for red light of wavelength 691 nm. If a beam containing these two colors is incident at an angle of 30.4 degrees on a piece of this glass, what is the angle between the two beams inside the glass?

a)   30.4º

b)   1.34º

c)   0.55º

d)   6.47º

e)   0.32º

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$
$$(1)\sin 30.4^o = 0.506$$
$$0.506 = (1.658)\sin\theta_2^{blue}$$
$$\sin\theta_2^{blue} = 0.305$$
$$\theta_2^{blue} = 17.7^o$$
$$\theta_2^{red} = 18.32^o$$

20) Two positive charges of magnitude 1 µC are located 3 cm apart? What is the magnitude of the force between them?

  a) 0 N

  b) 3.6 N

  c) 67 N

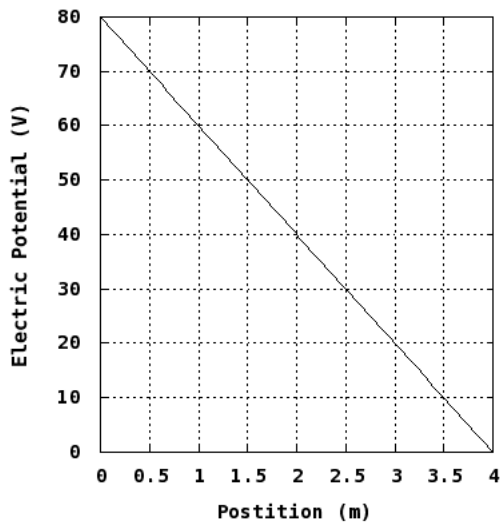 d) 4.3 X 10⁻³ N

  e) 10 N

$$F = k\frac{q_1 q_2}{r^2}$$

$$F = 9X10^9 \, Nm^2/C^2 \frac{(1X10^{-6}C)^2}{(0.03m)^2} = 10N$$

21) If a charge of +0.5 C is moved through a potential increase of 10 V, how much has its electric potential energy changed?

   a) 5 J

   b) 0.5 J

   c) 50 J

   d) 10 J

   e) 0.5 J

$$\Delta PE = q\Delta V = (0.5C)(10V) = 5J$$

22) What is the magnitude of the electric field at a position of 2 m in the figure below?

Postition (m)

   a) 6.7 V/m

   b) 0.0013 V/m

   c) 4.4 V/m

   d) 100 V/m

   e) 20 V/m

$$|E| = \frac{\Delta V}{\Delta x} = \frac{80V}{4m} = 20V/m$$

23) What is the force on a 4.5 μC charge at that position (2m, from the previous problem)?

   a) 9 X 10^{-5} N

   b) 6 X 10^{-15} N

   c) 0 N

   d) 1.98 X 10^{-5} N

   e) 4 X 10^{-3} N

F=qE=(4.5X10^{-6}C)(20V/m)=9X10^{-5}N

24) Of the types of electromagnetic radiation listed below, which has the shortest wavelength?

   a) ultraviolet

   b) radio

   c) X-rays

   d) visible light

   e) infra-red

25) In an electric circuit driven by a battery, which of the following is true?

a) the battery supplies the electrons that make up the electric current

b) the battery supplies the energy necessary for the current of electrons to flow

c) the collisions of the electrons with the atoms in the conductor in the circuit result in a net increase of energy of the electrons

26) A 7.4 μC charge is located far away from any other charges. What electric force does it experience?

   a) 7.4 X 10^{-6} C

   b) 0 N

   c) 7.4 N

   d) 9 X 10^{9} N

   e) 1.6 N

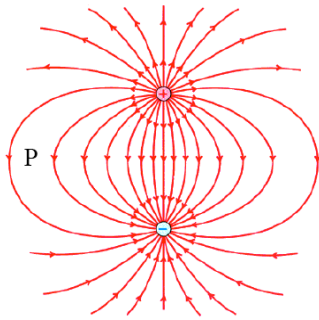27) An electron is moving with a velocity $v=7.16 \times 10^6$ m/s at right angles to a magnetic field of strength 6.35×10^{-2} T. What is the magnitude of the force acting on the electron?

a) 7.27×10^{-14} N

b) 6.26×10^{-11} N

c) 5.56×10^{-15} N

d) 0

e) 1.19×10^{-3} N

$F=qvB=$
$(1.6 \times 10^{-19}C)(7.16 \times 10^6 m/s)(6.35 \times 10^{-2}T)$

$F=7.27 \times 10^{-14}N$

28) If I put an electron at point P in an electric field produced by an electric dipole, which direction will it move?

a) up

b) down

c) left

d) right

e) it remains stationary

29) Which law of nature is employed in an electric generator?

a) Coulomb's law

b) Ampere's law

c) Maxwell's law

d) Faraday's law

e) Herz's law

30) Why is the sky blue?

a) the blue wavelengths coming from the sun are preferentially scattered

b) the red wavelengths coming from the sun are preferentially scattered

c) the nitrogen in the atmosphere has a natural blue color

d) the oxygen in the atmosphere has a natural blue color

e) the dust suspended in the air has a natural blue color

31) In an electromagnetic wave, the electric and magnetic fields are oscillating

a) perpendicular to each other and to the direction of propagation of the wave

b) perpendicular to each other and parallel to the direction of propagation of the wave

c) parallel to each other and parallel to the direction of propagation of the wave

d) parallel to each other and perpendicular to the direction of propagation of the wave

32) The output of electromagnetic radiation from the Sun peaks at a wavelength of (1 nm $= 10^{-9}$ m)

a) 1 nm

b) 100 nm

c) 500 nm

d) 1000 nm

e) 5000 nm

33) The speed of an electromagnetic wave in a vacuum depends on

a) the amplitude of the electric field but not on the magnitude of the magnetic field

b) the amplitude of the magnetic field but not on the magnitude of the electric field

c) the amplitude of both fields
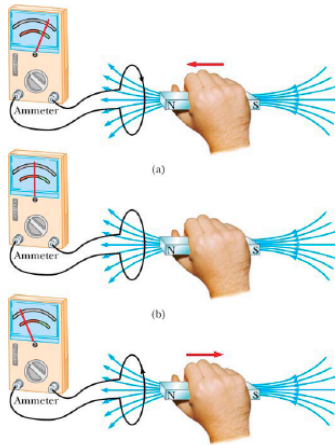
d) the frequency and wavelength

e) none of the above

34) The force on the bar magnet resulting from the current induced in the coil

a) opposes the motion causing the change in flux

b) is in the same direction as the motion causing the change in flux

c) is independent of the motion causing the change in flux

35) What is the speed of light in a diamond with an index of refraction of 1.73?

a) 7.26×10^8 m/s

b) 3.00×10^8 m/s

c) 1.50×10^8 m/s

d) 1.24×10^8 m/s

e) 1.73×10^8 m/s

v=c/n=3X10⁸m/s/1.73=1.73X10⁸m/s

36) A person walking barefoot across a bed of hot coals does not burn his feet because of

a) psychic control

b) the coals are poor conductors of heat

c) the coals are not at a high temperature

d) the feet are at the same temperature as the coals

e) the person is so worried about his vanishing retirement fund that he doesn't notice that he is walking across hot coals

37) When light enters a less optically dense medium, (smaller index of refraction),

a) the wavelength decreases

b) the speed decreases

c) the frequency decreases

d) the frequency increases

e) the speed increases

38) In passing through a narrow slit, a light wave spreads out because of

a) refraction

b) interference

c) dispersion

d) diffraction

e) radiation

39) A flexible wire loop has a radius of r =
28.7 cm and it is inside a uniform magnetic
field of B = 0.303 T, pointing into the plane of
the paper. The loop is grasped at points P and
Q and stretched until its area is zero. It takes
162 ms to close the loop.

What is the magnitude of the average induced
electromotive force (EMF) in the loop during
the stretching process?
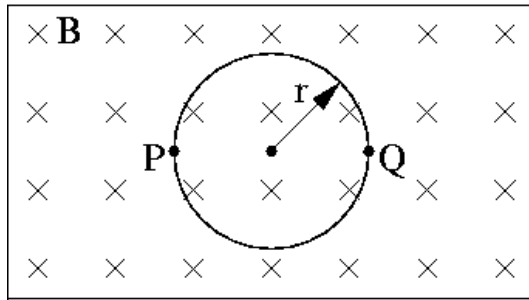
a) 0 V

b) 0 .48 V

c) 0.24 V

d) 1.46V

e) 4.52 V

$$\varepsilon = -\frac{\Delta\varphi}{\Delta t} = -\frac{B\Delta A}{\Delta t} = \frac{(0.303T)(\pi(0.287m)^2 - 0)}{0.162s}$$
$$\varepsilon = 0.48V$$

40) When James Clerk Maxwell met Michael
Faraday in the video shown in class, what
important news did he have for him

a) an electric current produces a magnetic
field

b) accelerated electric charges produce
electromagnetic waves

c) light is an electromagnetic wave

d) a changing magnetic field produces an
electric field

e) a changing electric field produces a
magnetic field