Spring Semester DCA Review

Investigate and calculate quantities using work-energy theorem in various situations.

1. To change the potential energy or kinetic energy of an object, _**WORK**_ must have been done on the object.

2. If 200 J of work is done in lifting a 5 kg object. How high was the object lifted?

$$W = \Delta U_g$$
$$200 = (5)(9.8)h$$
$$h = 4.08m$$

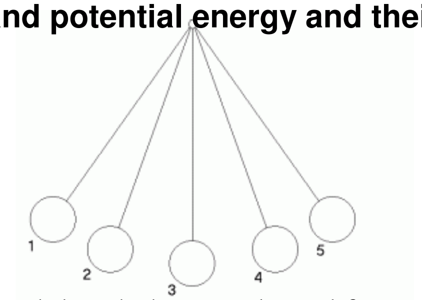
3. A 0. 016 kg baseball is accelerated by a pitcher from 0 to 45 m/s. How much work did the pitcher do in throwing the baseball?

$$W = \Delta K$$
$$W = (0.5)(0.016)(45-0)^2$$
$$W = 16.2J$$

4. The engine of a 900 kg dragster does 350,000 J of work in accelerating from rest to what speed?

$$W = \Delta K$$
$$350000 = (0.5)(900)(v_f - 0)^2$$
$$v_f = 27.9m/s$$

Investigate examples of kinetic and potential energy and their transformations.



5. In the diagram above, the 2 g pendulum bob was released from rest at position 1 and comes to rest again at position 5 before beginning to swing back the other direction. Assume there is no friction acting.
   a. Compare the gravitational potential energy at position 2 to the gravitational potential energy at position 3. **The gravitational potential energy is greater at point 2 than point 3. The loss in gravitational potential energy is about the same from position 1 to position 2 as it is from position 2 to position 3.**

   b. Compare the kinetic energy at position 2 to the kinetic energy at position 3. **The kinetic energy is greater at point 3 than at point 2. The gain in kinetic energy from position 1 to postion 2 is about the same as the gain in kinetic energy from position 2 to position 3.**

   c. Describe the energy transformation that is occurring as the pendulum bob swings from position 5 back to position 4. **Some of the gravitational potential energy that the pendulum bob has at position 5 is changed into kinetic energy as the pendulum bob moves to the lower height.**

   d. How does the total mechanical energy at position 1 compare to the total mechanical energy at each of the other points? **As long as there is not any friction acting, then the total mechanical energy is the same at all points.**

   e. At position 1, the pendulum bob is located 20 cm higher than it is at location 3. How fast is it traveling at position 3?

$$mgh = .5mv^2$$
$$(0.002)(9.8)(0.2) = (0.5)(0.002)v^2$$
$$v = 1.98m/s$$

Calculate the mechanical energy of, impulse applied to, and momentum of a physical system

6. After falling for 2 seconds a 2 kg object is moving at a speed of 19.6 m/s and is at a height of 5 m above the ground. How much kinetic energy does the object have? How much potential energy does the object have? How much total mechanical energy does the object have? What height was it released from?

$$K = (0.5)(2)(19.6)^2$$

$$\underline{K = 384.16J}$$

$$U_g = (2)(9.8)(5)$$

$$\underline{U_g = 98J}$$

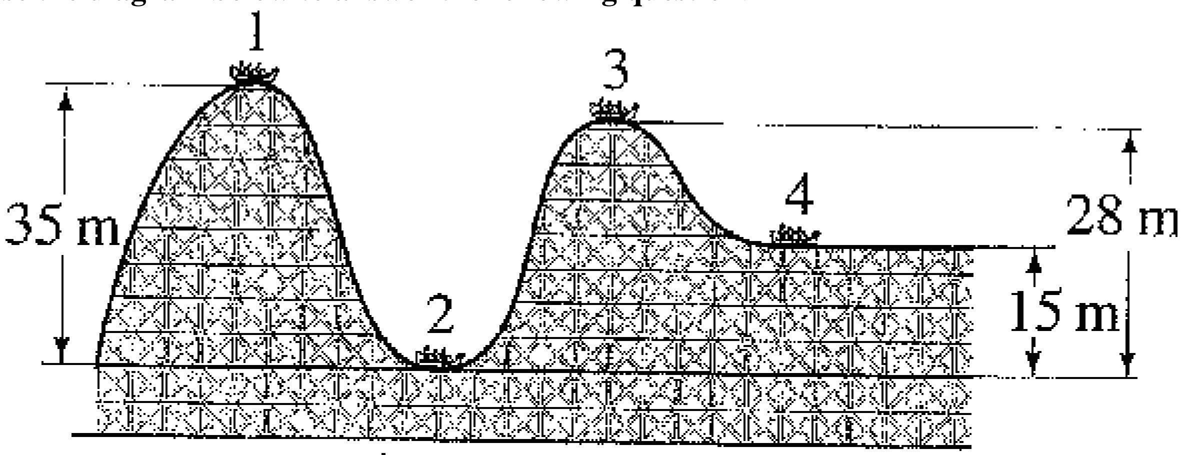
$$TME = 384.16 + 98$$

$$\underline{TME = 482.16J}$$

$$482.16 = (2)(9.8)(h)$$

$$\underline{h = 24.6m}$$

Use the diagram below to answer the following question.



7. The 500 kg rollercoaster in the diagram above is moving at 20 m/s at position 4. How much total mechanical energy does it have at position 4? How fast was it going at position 2? How fast was it moving at position 1?

$$PE_4 = 500kg \times 9.8 m/s^2 \times 15m = 73500J$$

$$KE_4 = \frac{1}{2} \times 500kg \times (20 m/s)^2 = 100000J$$

$$\Delta ME = 73500J + 100000J = 173500J$$

$$v_2 = \sqrt{\frac{2 \times 173500J}{500kg}} = 26.34 \frac{m}{s}$$

$$v_1 = \sqrt{\frac{2 \times 2000J}{500kg}} = 2.83 \frac{m}{s}$$

8. A little boy is standing stationary on the ice when an out of control teenager comes barreling towards him at 5 m/s. In an effort to keep from hurting the little boy, the teenager scoops up the little boy and slides on. What is the speed of the teenager with the little boy in his arms if the teenager has 4 times that mass of the little boy?

$$4m(5) + m(0) = 4m(v) + m(v)$$

$$20m = 5mv$$

$$20 = 5v$$

$$\underline{v = 4m/s}$$

9. In a perfectly (completely) inelastic collision, the objects stick together or one is inside the other,
   a. if their masses are equal then their final velocity will be the _**AVERAGE**_ of their initial velocities.
   b. if their masses are unequal their final velocity will be closer to the initial velocity of the _**HEAVIER**_ mass.

10. A gun with a mass of 2 000 kg fires a 20 kg shell horizontally with a velocity of 300 m/s. What is the velocity of the gun after it is fired? What was the total momentum of the system before the gun was fired? What was the total momentum after the gun was fired?

$$2000(0) + 20(0) = 2000(v) + 20(300)$$
$$0 = 2000v + 6000$$
$$-6000 = 2000v$$
$$v = -3m/s$$

The total momentum before was zero since nothing was moving before the gun was fired. Since the total momentum before the explosion was zero, the total momentum after the explosion has to be zero as well.

11. In an explosion, if you have a closed and isolated system, the total momentum before and the total momentum after are equal to zero. How is that possible since the objects in the system are moving? **After the collision the objects are all moving in different directions. Since momentum is a vector quantity and depends on velocity, another vector quantity (direction matters) it all cancels out.**

12. While in horizontal flight, a 0.1 kg tennis ball is moving toward your racket at 10 m/s, after impacting your racket, it moves in the **opposite direction** at 20 m/s. What is the change of momentum of the tennis ball? What is the impulse that your racket imparts on the tennis ball in the 0.08 sec it is in contact with the ball?

$$J = (0.1)(-20 - 10)$$
$$J = -3kgm/s$$

The impulse is equal to the change in momentum so the impulse that acted was -3 kg m/s or -3 Ns.

13. If a 54 N s impulse is given to a 6.0 kg object, what is the change of momentum for the object? What is the change in speed of the object? **The impulse is equal to the change in momentum so the change in momentum is 54 Ns or 54 kg m/s.**

$$54 = 6(\Delta v)$$
$$\Delta v = 9m/s$$

Describe how the macroscopic properties of a thermodynamic system such as temperature, specific heat, and pressure are related to the molecular level of matter, including kinetic or potential energy of atoms.

14. When energy is added to a liquid substance, the kinetic energy of the molecules of the liquid substance will _**increase**__ and the temperature of the liquid will _**increase**_but when energy is added to a substance while it is changing phase, the kinetic energy of the molecules (**will** / **will not**) change and the temperature will (**increase / decrease** / **remain the same**) because the energy is going into making and breaking chemical _**BONDS**__.

15. As the temperature of a substance decreases, the kinetic energy of the molecules will _**DECREASE**__ because temperature is defined as __**THE AVERAGE KINETIC ENERGY OF THE MOLECULES OF A SUBSTANCE**____

16. Which requires more energy to change its temperature, a substance with a high or a low specific heat? **IT TAKES MORE ENERGY TO CHANGE THE TEMPERATURE OF A SUBSTANCE WITH A HIGH SPECIFIC HEAT. SPECIFIC HEAT CAPACITY IS DEFINED AS THE AMOUNT OF HEAT NEEDED TO CHANGE ONE KILOGRAM OF A SUBSTANCE BY ONE DEGREE CELSIUS.**

17. Water can be boiled at room temperature. How can this be done? **LOWER THE PRESSURE ENOUGH**

Analyze and explain everyday examples that illustrate the laws of thermodynamics, including the law of conservation of energy and the law of entropy.

18. If equal masses of two different substances at different temperatures are mixed together then their final / equilibrium temperature will be ***(closer to / farther from)*** the initial temperature of the substance with the greater specific heat but the amount of heat lost by one substance is _**EQUAL**__ to the amount of heat gained by the other substance.

19. If equal masses of the same substance at different temperatures are mixed together then the final / equilibrium temperature will be the _**AVERAGE**__ of their initial temperatures.

20. An unknown substance is heated from 10 ºC to 30 ºC. If it took 2000 J of thermal energy to raise the temperature of 500 g of the substance by that amount, what is the specific heat of the unknown substance?

$$2000 = (0.5)c(30 - 10)$$

$$c = 200 J/kg ^\circ C$$

21. Water has a specific heat of 4180 J / kg ºC. If 500 grams of an unknown substance at 90 ºC are added to 1500 grams of water at 25 ºC and the resulting temperature was 30 ºC, what is the specific heat of the unknown substance?

$$(0.5)(c)(30 - 90) = -(1.5)(4180)(30 - 25)$$

$$c = 1045 J/kg ^\circ C$$

22. A glass is knocked off of a table and shatters on the floor. Describe the change in entropy.

WHEN THE GLASS BREAKS THERE IS MORE DISORDER TO THE PIECES SO THERE IS AN INCREASE IN ENTROPY.

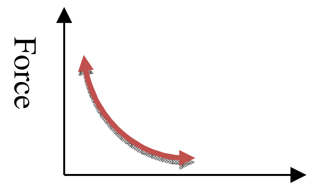
Contrast and give examples of different processes of thermal energy transfer, including conduction, convection, and radiation.

23. Describe the 3 methods of transferring thermal energy and in what types of substances do they occur?
CONDUCTION – TYPICALLY OCCURS IN SOLIDS DUE TO PARTICLES COLLIDING
CONVECTION – TYPICALLY OCCURS IN FLUIDS (LIQUIDS AND GASES) DUE TO THE FLOW OF CURRENTS
RADIATION – CAN OCCUR IN SOLIDS, LIQUIDS, GASES AND IN A VACUUM. DUE TO THE MOVEMENT OF ELECTROMAGNETIC WAVES

24. Which method of transferring thermal energy is occurring in each case primarily?
   a. The entire spoon sitting in a skillet on the stove gets hot. **CONDUCTION**
   b. Sand on the beach is warmed by the sun. **RADIATION**
   c. Air all around the classroom is warmed by the furnace. **CONVECTION**

Describe and calculate how the magnitude of the electrical force between two objects depends on their charges and the distance between them.

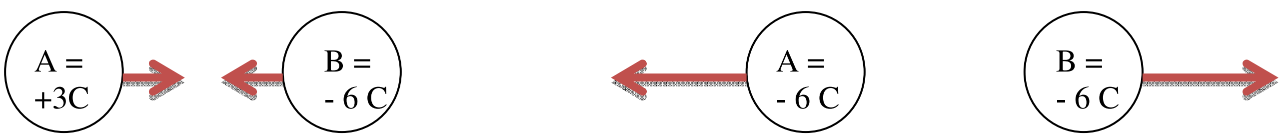
25. Draw a graph demonstrating the relationship between electrostatic force and the distance between the charged particles. What type of relationship exists between the distance and the electrostatic force?



Distance (m)

26. Two charged particles are placed a certain distance apart. If one of the two charged particles is moved to three times the distance away, what happens to the electrostatic force between the two charged particles?
When the distance between the charged particles is tripled, the electrostatic force is 1/9th as much.

27. Draw arrows representing the electrostatic force between particles A and B in the two situations shown below. Remember to indicate the relative magnitude of the electrostatic force by the length of your lines. In both cases particles A and B are the same distance apart.



28. A + 0.03 C charge is placed 2 cm from a - 0.25 C charge. What is the magnitude of the electrostatic force between the two particles? Is this force attractive or repulsive?

$$F = \frac{(9 \times 10^9)(0.03)(-0.25)}{0.02^2}$$

$$F = -1.69 \times 10^{11} N$$

The magnitude of the electrostatic force is 1.69 x 10^{11} N. This is an attractive force as indicated by the negative sign.

Characterize materials as conductors or insulators based on their electrical properties.

29. Define electrical conductor and insulator.
Conductors hold loosely to their electrons and it is easy for the electrons to move from one atom to another so they allow electricity to flow easily.

Insulators hold tightly to their electrons so it is NOT easy for the electrons to move from one atom to another so they do NOT allow electricity to flow easily.

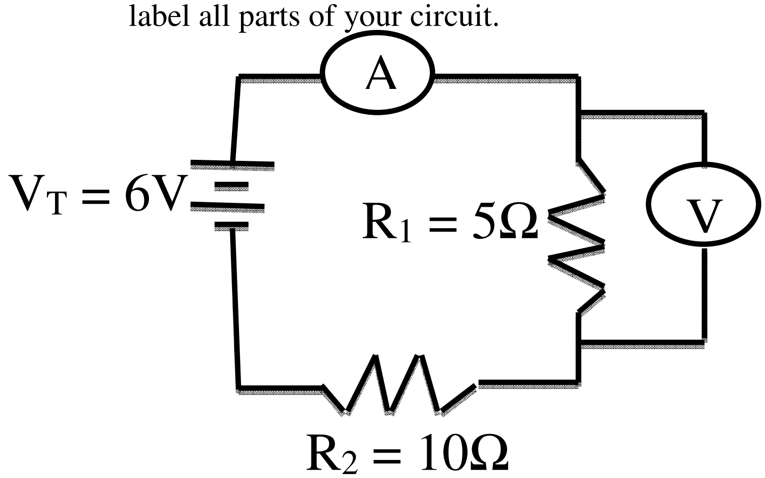
30. Describe a simple experiment using the following equipment which could determine if materials were conductors or insulators: wires with alligator clamps, battery, battery holder, lamp holder, lamp (light), a dime, rubber doorstop, metal spring, wooden popsicle stick, nail, and plastic cup.

One possible solution:
Use wires to connect the positive terminal of the battery in the battery holder to one side of the lamp holder (lamp needs to be in the lamp). Connect another wire to the negative terminal of the battery in the battery holder. You will connect the unattached ends of the wires to opposite ends of the different materials and record whether or not the lamp lights up. You need to test each material.

31. Based upon your past experience, classify each of the materials that were tested in the previous question as being either conductors or insulators. Explain what observational data from the experiment would lead you to this conclusion.
Dime – conductor, rubber doorstop – insulator, metal spring – conductor, wooden popsicle stick – insulator, nail – conductor, plastic cup – insulator. All of the conductors would allow electricity to flow through them and the lamp would light up. The insulators would not allow the electricity to flow through and the lamp would not light up.

Design, construct and calculate in terms of current through, potential differences across, resistance of, and power used by electric circuit elements connected in both series and parallel combinations.

32. Draw the schematic diagram of a circuit containing a 6 V battery in series with a 5 Ohm resistor and a 10 Ohm resistor. Draw an ammeter in the circuit which measures the current leaving the battery. Draw a voltmeter in the circuit which measures the potential difference across the 5 Ohm resistor. Be sure to label all parts of your circuit.



	T	1	2
V	6 V	2 V	4 V
I	0.4 A	0.4 A	0.4 A
R	15 Ω	5 Ω	10 Ω
P	2.4 W	0.8 W	1.6 W

a. How do the individual resistances relate to the equivalent resistance of the circuit?
In series the individual resistances add to give the equivalent resistance of the circuit.

b. How does the current leaving the battery compare to the current going through the 10 Ohm resistor?

In series the current is the same throughout the circuit so the current going through the 10 Ohm resistor is the same as the current leaving the battery.

c. How does the potential difference across the two resistors relate to the potential difference of the battery in this ideal circuit?
In a series circuit the potential differences across the individual resistors add to give the terminal voltage of the battery.

d. What is the equivalent resistance of the circuit? **15 Ω**

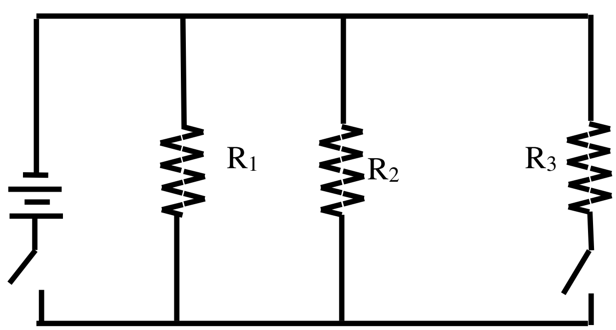
e. What is the potential difference across the 5 Ohm resistor? **2 V**

f. What is the current through the 10 Ohm resistor? **0.4 A**

g. How much power is dissipated by the 5 Ohm resistor? **0.8 W**

h. Can a switch be placed in this circuit which would make current stop flowing through one of the resistors in series but not the others? Why or Why not?
No, there is only one path in a series circuit so if a switch was placed in the circuit and it was open then no current could flow in any part of the circuit.

33. Draw a circuit containing a 12 V battery and three 9 Ohm resistors all connected in parallel to each other. Place one switch so that it can make all of the current stop flowing in the circuit when it is open. Place another switch so that it will make the current only stop flowing through one of resistors.



	T	1	2	3
V	12 V	12 V	12 V	12 V
I	4 A	1.33A	1.33A	1.33 A
R	3 Ω	9 Ω	9 Ω	9 Ω
P	48W	16W	16W	16W

a. How do each of the individual resistances relate to the equivalent resistance of the circuit?
The equivalent resistance of the circuit is less than the smallest individual resistor. The sum of the reciprocals of the individual resistors is equal to the reciprocal of the equivalent resistance of the circuit.

b. How does the current leaving the battery compare to the current going through each of the 9 Ohm resistors?
The current through each of the branches add up to the current leaving the battery. Since in this case, each of the branches has equal resistance, the current splits equally between the three branches so 1/3 of the total current goes through each of the 9 Ohm resistors.

c. How does the potential difference across each of the three resistors relate to the potential difference of the battery in this ideal circuit?
The potential difference on each branch is equal to the potential difference of the battery.

d. What is the total resistance of the circuit? **3 Ohms**

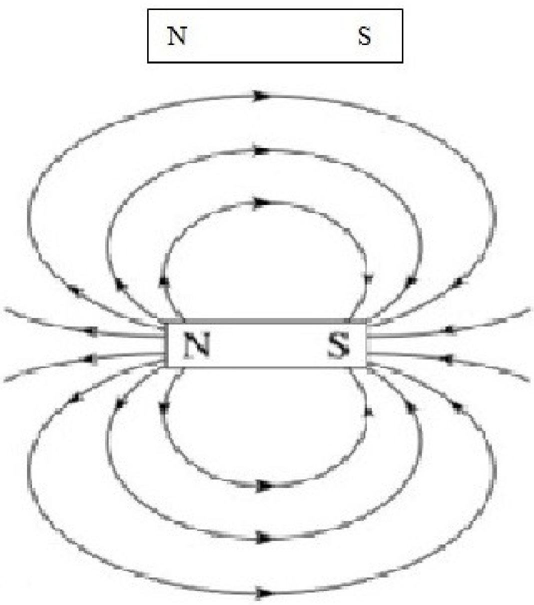
e. What is the potential difference across the first 9 Ohm resistor? **12 V**

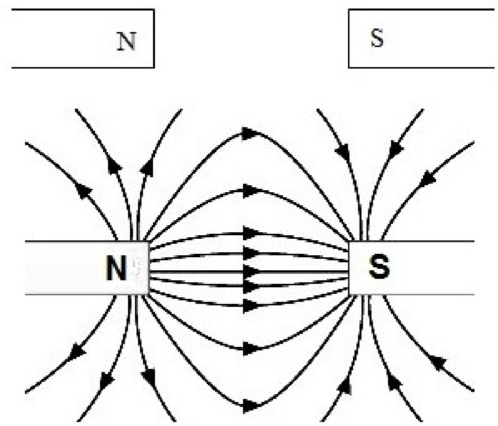
f. What is the current through the second 9 Ohm resistor? **1.33 A**

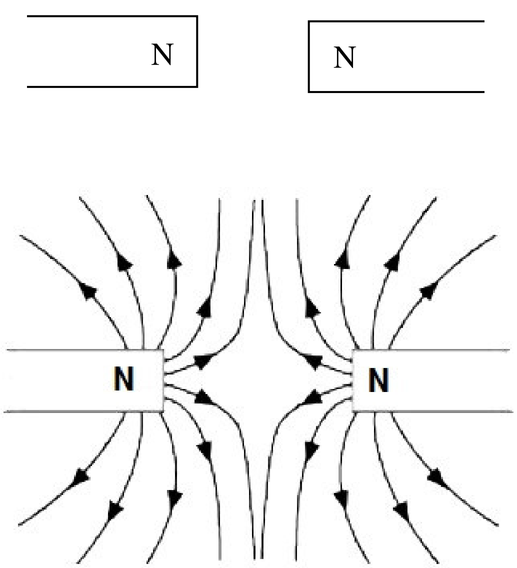
g. How much power is dissipated by the first 9 Ohm resistor? **16 W**

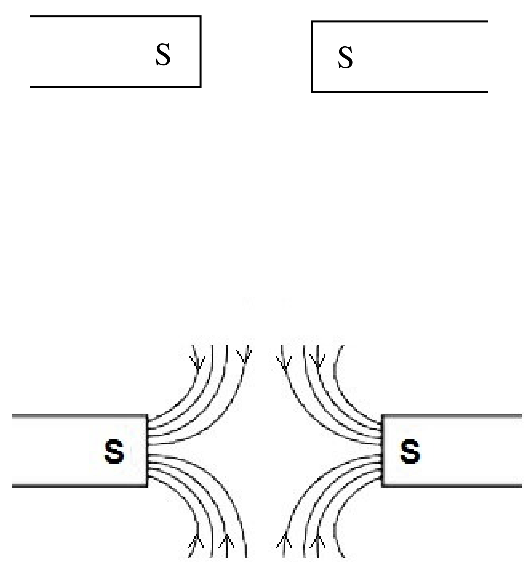
Identify examples of electric and magnetic forces in everyday life.

34. Draw the magnetic field for each of the following situations: a bar magnet, a north and south pole near each other, two north poles near each other, and two south poles near each other.









35. How would placing a piece of iron near but not touching the bar magnet affect the magnetic field? You may draw or use words to answer this question.

A temporary magnetic field would be produced in the iron and the resulting magnetic field would be the vector sum of the two magnetic fields.

36. How would placing a piece of copper (a non-ferromagnetic material) near but not touching the bar magnet affect the magnetic field? You may draw or use words to answer this question.

It would not affect it since copper is not a magnetic material.

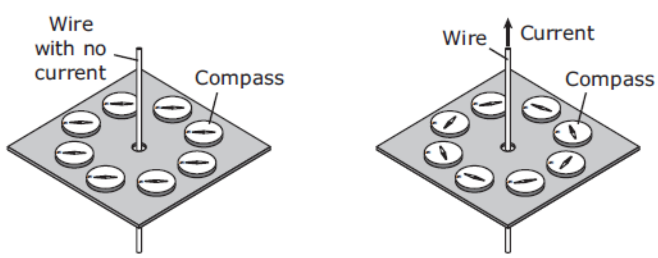
37. Explain why a bar magnet is able to pick up a paperclip off of a desk without ever touching the paperclip.

Magnetic fields are field forces that do not require contact.

38. Briefly describe how a compass is made and how it works.

A compass is made by magnetizing a small needle and placing it on a low-friction mount. It works by aligning itself with the earth's magnetic field.

Use the diagram shown below to answer the following question.



39. In the diagram above, the compasses all initially (diagram on the left) point in the direction of the earth's magnetic field but when current is allowed to flow in the wire (diagram on the right), the compasses point in all different directions. Explain why the compasses no longer point in the direction of the earth's magnetic field.

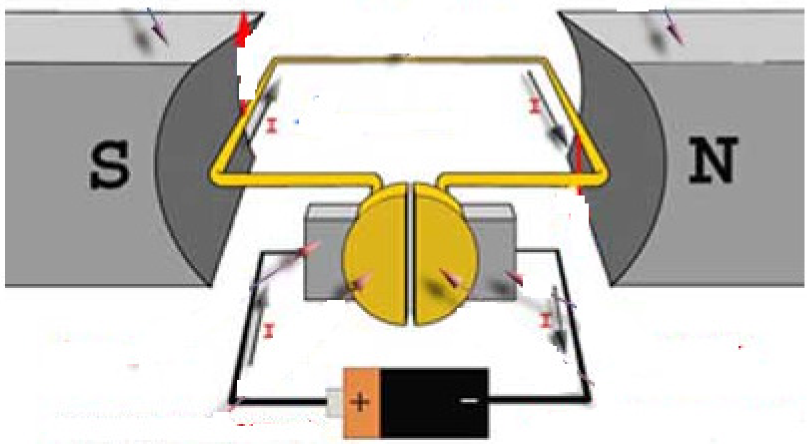
A current in a wire produces an axially symmetric magnetic field that is stronger than the earth's field (at least close to the wire.)

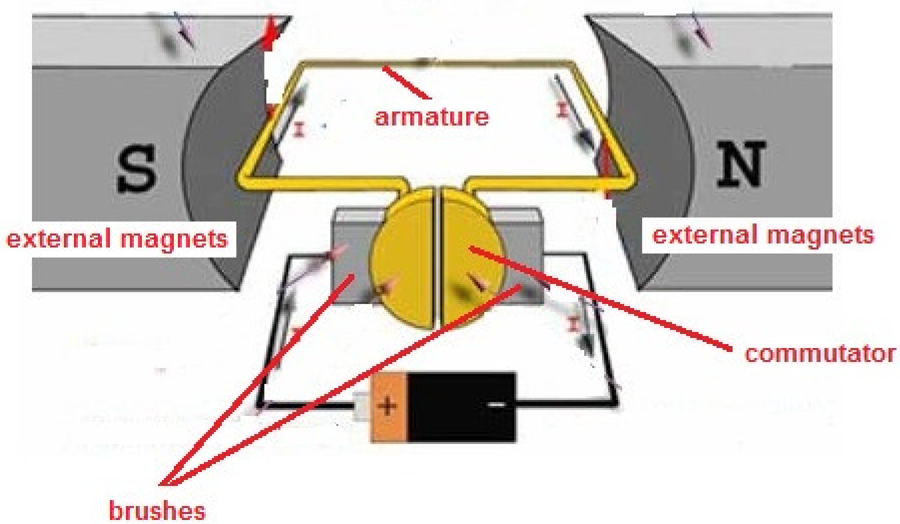
40. While paying for their items at Target, a customer notices a sign which states "do not place purse / wallet on this pad". The pad is used to demagnetize the security devices on some items from the store. Why would this warning label need to be placed there about your purse / wallet? What other everyday items could it affect?

Credit cards, which may be in a purse or wallet, have magnetic strips that could be affected. Any other item that has a magnetic identification strip could be affected.

Investigate and describe the relationship between electric and magnetic fields in applications such as generators, motors, and transformers.

Use the diagram shown below to answer the following questions.





41. Shown above is a simple motor.
    a. Identify the external magnets, commutator, brushes, and armature on the diagram above.
    b. Why does the commutator have to be a split ring?

The "split ring" is to reverse the current flow from the DC source each half cycle to keep the motor running the same direction.

42. Both motors and generators have the same basic parts (commutator, brushes, magnets, and armature) but the energy input and output of each is different. Describe in terms of energy transformations how they differ.

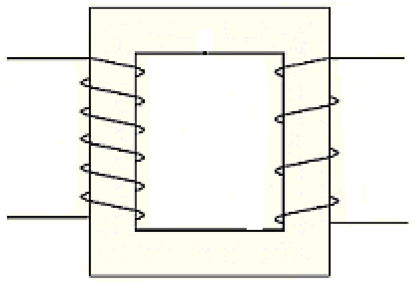
Electric motors transform electrical energy into mechanical energy and vice versa.

43. Complete the following equations relating the number of turns / coils (n), the voltage, and the current in the primary and secondary coils of an ideal transformer by placing the proper subscripts, p for primary and s for secondary.

$$\frac{n\_\_\_\_}{n\_\_\_\_} = \frac{V\_\_\_\_}{V\_\_\_\_} = \frac{I\_\_\_\_}{I\_\_\_\_}$$

$$\frac{n_s}{n_p} = \frac{V_s}{V_p} = \frac{I_p}{I_s}$$

Use the diagram below to answer the following questions.



44. The diagram above shows a transformer that has 6 loops in the primary (on the left) to only 4 loops in the secondary (on the right).

a. What type of transformer is this?
step-down

b. If the voltage in the primary is 20 V, what is the voltage in the secondary?
13.33 V

c. Why does the current in the primary have to be AC (alternating current)? Hint: Faraday's Law
An emf will only be induced if the magnetic flux is changing.

Examine and describe oscillatory motion and wave propagation in various types of media.

45. A sound wave of with a frequency of 200 Hz is traveling through water at a speed of 1482 m/s.

a. What will be the speed of a 400 Hz wave traveling through the same water?
1482 m/s

b. What determines the speed of a wave?
The characteristics of the medium.

c. If the same 200 Hz wave was traveling through 20º C air, would it still be traveling at 1482 m/s? Why or why not?

No. The speed of a wave depends on the characteristics of the medium. They are different for air and water.

Investigate and analyze characteristics of waves, including: velocity, frequency, amplitude, and wavelength, and calculate using the relationship between: wave-speed [including light speed (c)], frequency, and wavelength.

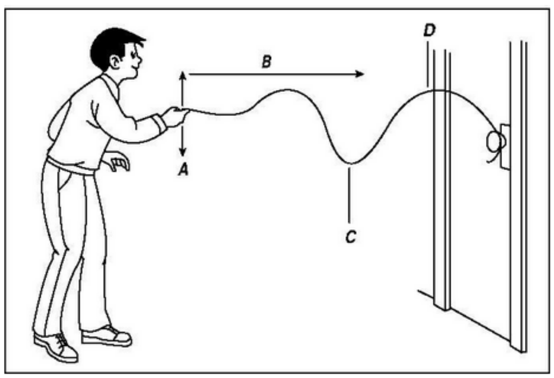
46. Suppose a wave travels from a more dense medium to a less dense medium. How will the frequency and wavelength change?

frequency won't change, wavelength will increase

47. As the frequency of the source of a wave increases, what property of the wave is affected and how?

wavelength, gets shorter

Use the diagram below to answer the following question.



48. In the diagram above, if the person increases the amount of work it takes to set the rope into motion, what characteristic of the wave would also increase?

amplitude

49. As the frequency of a wave increases, how is the wavelength affected? ? Assume the wave speed is constant.

wavelength is shortened

50. The speed of a transverse wave in a string is 12 m/s. If the frequency of the source producing this wave is 3.0 hertz, calculate the wavelength.

4 m

51. A wave has frequency of 50 Hz and a wavelength of 10 m. What is the speed of the wave?

500 m/s

52. A wave has wavelength of 10 m and a speed of 340 m/s. What is the frequency of the wave?

34 Hz

Compare characteristics and behaviors of transverse waves, including the electromagnetic waves and the electromagnetic spectrum, and characteristics and behaviors of longitudinal waves, including sound waves.

53. A cell phone with music playing is placed into a bell jar and a vacuum pump is used to remove all of the air from the bell jar. As the air is being removed, the sound of the music gets quieter and quieter until it can no longer be heard. Once the vacuum pump is turned off and air is allowed back into the bell jar, the music can once again be heard.
    a. Based on this experiment, is sound an electromagnetic wave or a mechanical wave?
    mechanical wave

    b. Why could the music not be heard when there was no air in the bell jar?
    sound is a mechanical wave and requires a medium

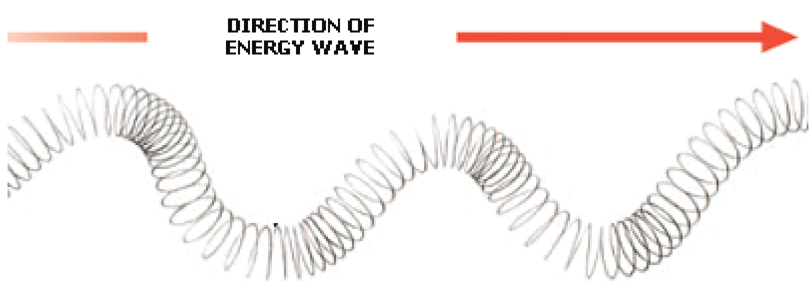
    c. What types of material is this type of wave able to travel through?
    anything but a vacuum

54. In a darkened room, a flashlight is placed in a bell jar and a vacuum pump is used to remove all of the air from the bell jar. Once all of the air is removed, you notice that you are still able to see the flashlight illuminating the area both inside and outside the bell jar.
    a. Based on this experiment, is light an electromagnetic wave or a mechanical wave?
    electromagnetic wave

    b. Why is the light still visible?
    light doesn't need a medium in which to propagate

    c. What types of material is this type of wave able to travel through?
    If it's "visible" light, the medium must be translucent (transparent).

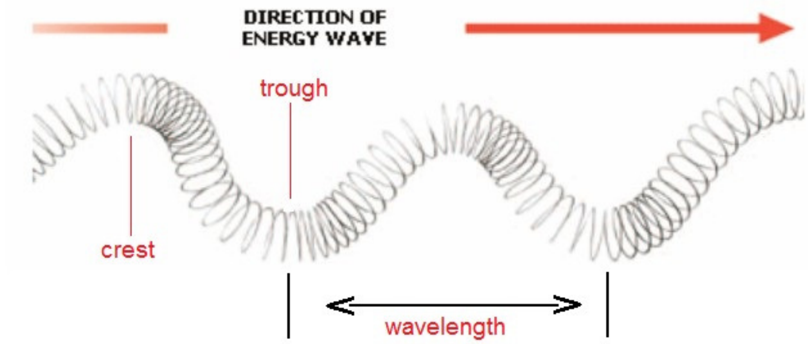
Use the diagram shown below to answer the following questions.



55. The diagram above shows a coiled spring through which a wave is passing.

    a. What kind of mechanical wave is shown above?
    transverse

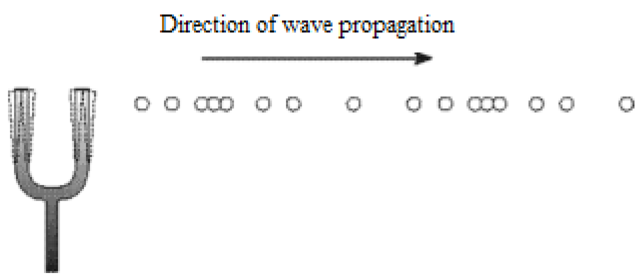
b. In the diagram above, label a crest, trough, and wavelength.



c. Explain the motion of an individual coil in the spring is moving with respect to the direction that the wave's energy is moving.

individual coils are moving "up and down" rather than "right and left"

Use the diagram below to answer the following questions.

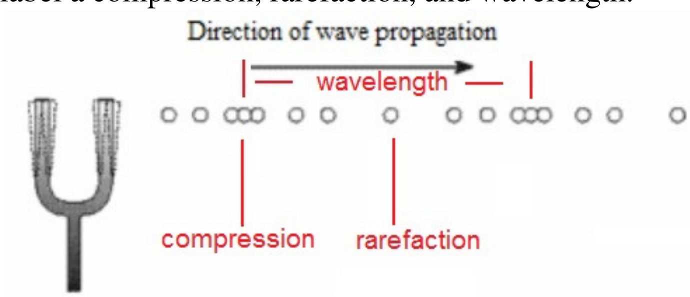


56. The diagram above shows a vibration of a tuning fork producing a sound wave.

a. What kind of mechanical wave is shown above?

mechanical/longitudinal/compressional

b. In the diagram, label a compression, rarefaction, and wavelength.

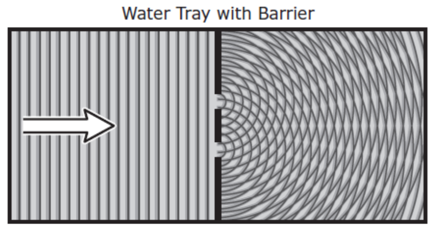


c. Explain how the individual air particles are moving compared to the direction of wave propagation.

they are moving in the same direction as the wave is propagating

Investigate behaviors of waves, including: reflection, refraction, diffraction, interference, resonance, and the Doppler effect.

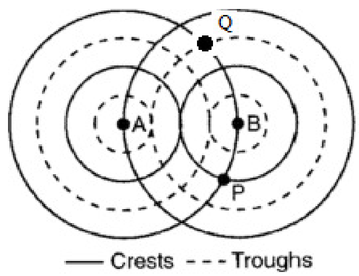
Use the diagram below to answer the following questions.



57. In the diagram above, light is bending around a barrier and passing through very narrow slits.
   a. What phenomena are being depicted the diagram above?
   diffraction and interference

   b. Why do you end up with light and dark regions on the right hand side of the picture?
dark regions result from destructive interference, light regions result from constructive interference

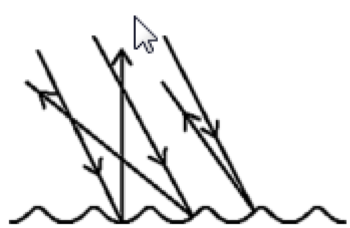
Use the diagram shown below to answer the following questions.



58. In the diagram above, pebbles were dropped into the water at points A and B and the resulting overlapping wave pattern is shown.
   a. What phenomena are occurring in the preceding picture?
interference (constructive and destructive)

   b. Specifically what is happening at points P and Q?
constructive interference at P, destructive interference at Q

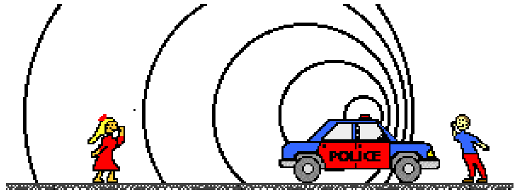
Use the diagram shown below to answer the following questions.



59. In the diagram above, parallel light rays are hitting a rough surface and bouncing off.
   a. What phenomenon is occurring in the preceding picture? Be specific for the type that occurs off rough surfaces. "diffuse" reflection

   b. Why aren't the reflected rays parallel to each other? they are reflected from different surfaces
   Does this mean the law of reflection did not hold true? No.

Use the diagram below to answer the following questions.



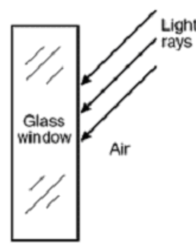
60. In the above diagram, a police car is moving to the right with its siren blaring.

a. What phenomenon is being depicted? the Doppler effect

b. How does the frequency of sound the boy in front of the police car hears compare to the actual frequency being produced by the siren? it's higher

c. How does the frequency of sound the girl behind the police car hears compare to the actual frequency being produced by the siren? it's lower

Use the diagram below to answer the following questions.



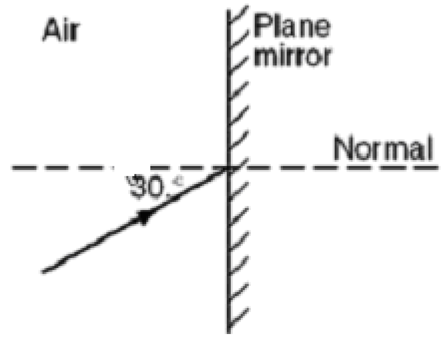
61. In the above diagram, light rays are hitting a piece of glass. At the interface with the glass, some of the light will move into the glass and some will bounce off.

a. What are the names of the two phenomena that will occur when the light strikes the glass?
reflection and refraction

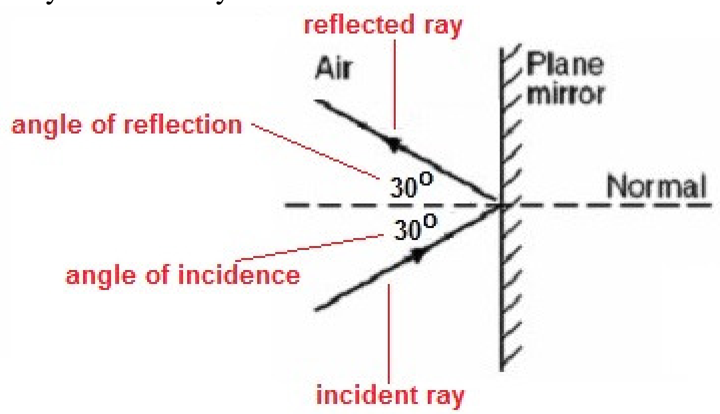
b. Which of those explains what happens to the majority of the light ray?
This question is ambiguous. The answer depends on the angle of incidence and the respective indices of refraction.

c. For the light that moves into the glass, what direction does it bend and why?
The light entering the glass bends "toward" the normal if the medium from which it arrives is less dense.

Use the diagram below to answer the following questions.

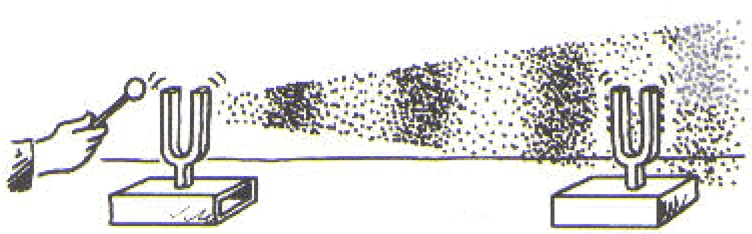


62. Shown above is a light ray striking a plane mirror.
    a. Draw the light ray as it is reflected from the plane mirror in the diagram shown above.
    see part b. below
    b. Label the incident ray, reflected ray, angle of incidence, and angle of reflection. The normal is already labeled for you.



c. Explain the law of reflection.
The angle of incidence equals the angle of reflection.
d. What is the angle measure of the angle of reflection for this situation?
30^o

Use the diagram below to answer the following questions.

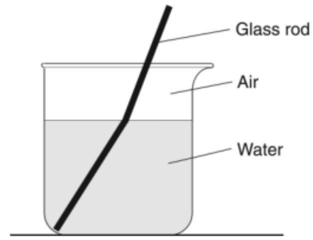


63. Shown above is a tuning fork (left) which has been set into vibration near another tuning fork. The tuning fork on the right begins to vibrate as well.
    a. What phenomenon is occurring?
    sympathetic vibration or "resonance"

    b. Explain **two** other examples of this phenomenon.

classically trained singer able to smash a wine glass, urologist using ultrasound probe to break up a kidney stone

Use the diagram below to answer the following questions.



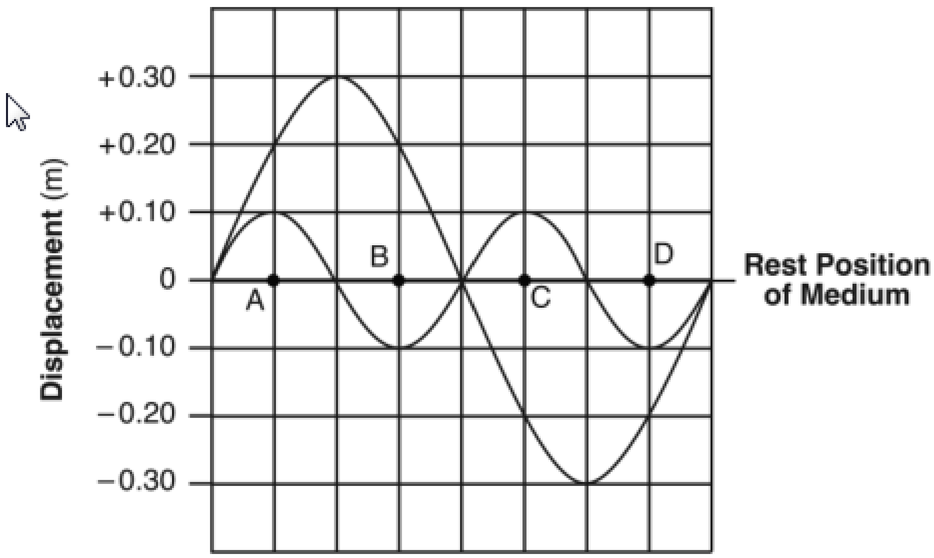
64. Shown above is a glass rod in a beaker of water.
    a. What phenomenon is causing the glass rod to appear broken (bent) at the interface between the air and the water?
    refraction

    b. What is happening to the light waves at the water air interface to cause them to bend?
    the speed of light in the medium is changing

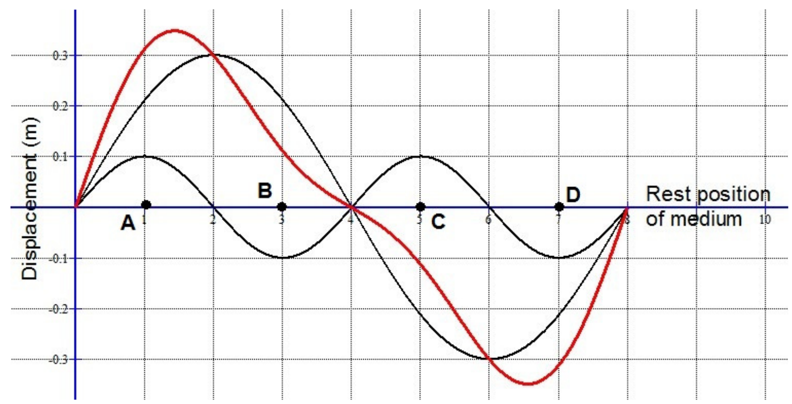
Use the diagram below to answer the following questions.

65. In the diagram above, four test tubes contain varying amounts of water as shown. If all of the air columns are made to vibrate by blowing air across their tops, rank the test tubes from highest frequency to lowest frequency.
    d) c) b) a)

Use the diagram below to answer the following question.

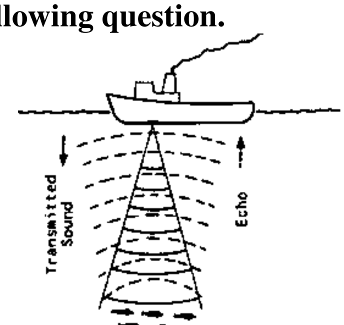


66. In the graph above, two waves are shown passing through a medium. On the graph, sketch the resultant wave.



Describe the role of wave characteristics and behaviors in medical and industrial applications.

Use the diagram below to answer the following question.

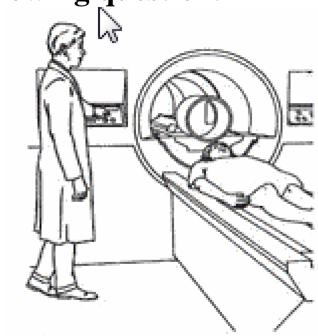


67. In the diagram above, a ship is using sonar to detect objects located under water. Describe the process (including any equations) needed to find out how far below the water the object (in this case, a school of fish) is located. measure the time between the transmitted sound and its echo to determine the depth

68. Define resonance. the phenomenon of introducing energy into a system at a frequency equal to the natural frequency of vibration of the system

69. How is resonance used to break up a kidney stone?
sound energy is introduced to the stone at its natural frequency until the stone breaks up

Use the diagram below to answer the following question.



MRI

70. In the diagram above an MRI is being used as a medical diagnostic tool. When a patient undergoes MRI, he or she is made to lie down inside a large tube-like chamber. A technician then activates a powerful magnetic field that, depending on its position, resonates with the frequencies of specific body tissues. It is thus possible to isolate specific cells and analyze them independently, a process that would be virtually impossible otherwise without employing highly invasive procedures. What does MRI stand for? magnetic resonance imaging

71. Resonance is also used to cook food. The basis for an appliance that does this is the fact that the molecules in all forms of matter are vibrating. By achieving a resonant frequency, this appliance adds energy (heat) to food. This appliance is not equipped to resonate with the natural frequency of all possible substances. Instead, the electromagnetic waves produced by this applicance resonate with the frequency of a single item found in nearly all types of food: water. What appliance is being described?
a microwave oven

72. An ultrasound exam is a procedure that uses high-frequency sound waves to scan a woman's abdomen and pelvic cavity, creating a picture (sonogram) of the baby and placenta. The sound waves bounce off bones and tissue returning back to the transducer to generate black and white images of the fetus. What wave phenomenon is being used to create the "picture" of the baby? reflection

Describe and predict image formation as a consequence of reflection from a plane mirror.

73. Define the following terms.
    a. Real image – an image that can be projected or formed on a screen
    b. Virtual image – an image that can NOT be projected or formed on a screen

74. If you stand 2 m in front of a plane mirror, how far away from the mirror would your image be located?

2 m

75. What type of image does a plane mirror produce?

virtual, upright, same size, left-right reversed

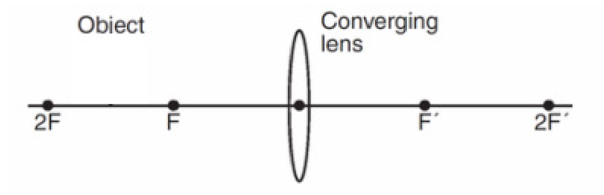
76. Emergency vehicles such as ambulances are often labeled on the front hood with reversed lettering (e.g., ECNALUBMA). Explain why this is so.
so it can be read in a rear-view mirror

Describe and predict image formation as a consequence of refraction through a thin convex lens.

77. What happens at the point on a ray diagram where all the refracted rays cross?

an image forms

78. Use the diagram below to find the image location if the object were at the given location, and complete the following table.



Object Location	Image Description			
	Type of Image	Orientation of Image	Size of Image	Location of Image
Beyond 2F	real	inverted	smaller than object	behind lens
At 2F	real	inverted	same size as object	behind lens
Between F and 2F	real	inverted	larger than object	behind lens
At F	no image			
Between F and the lens	virtual	upright	larger than object	in front of lens

79. A light ray passes through the focal point then hits the lens. In what direction will the refracted ray be moving when it exits the lens?

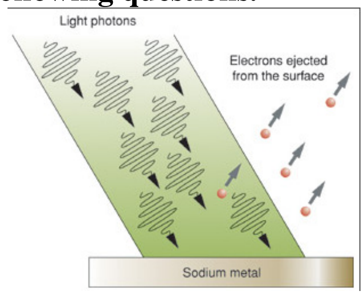
parallel to the principle axis

80. A light ray is moving parallel to the principle axis when it hits a convex lens. In what direction will the refracted light ray be moving when it exits the lens?

toward the focal point

Describe the photoelectric effect and the dual nature of light.

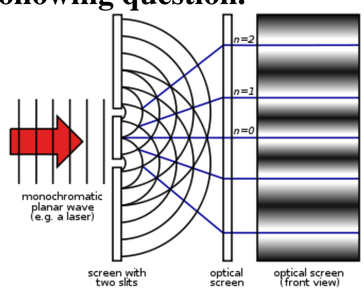
Use the diagram below to answer the following questions.



81. The diagram above shows photons of light hitting a piece of sodium metal and ejecting electrons from the surface of the metal.
    a. What phenomenon is being depicted?
       the photoelectric effect

    b. The electrons that are ejected through this process can create a current. This process takes place within solar cells. Give an example of device that is solar powered.
    an emergency telephone station on the interstate highway system

Use the diagram below to answer the following question.



82. In the diagram shown above a light is shining on two narrow slits and on the screen a series of light and dark bands appear.
    a. Is this experiment evidence for light as a particle or as a wave?
       wave

    b. What phenomenon is causing the light and dark bands?
       interference
    c. Explain how the light bands are formed.
       constructive interference

    d. Explain how the dark bands are formed.
       destructive interference

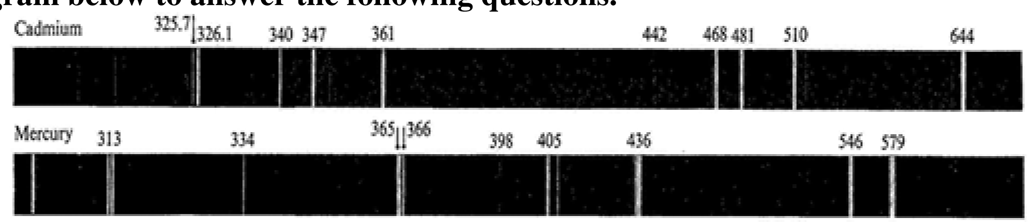
83. Choose whether each of the following light phenomena can be explained by light being a particle or being a wave. It is possible for a phenomenon to be explained by both theories, in which case you should put a check mark in both columns.

Phenomenon	Can be explained by light being a particle	Can be explained by light being a wave
Reflection	X	X
Refraction		X
Diffraction		X
Interference		X
Polarization		X
Photoelectric effect	X	

84. Explain how the answers in the table above illustrate the wave particle duality of light.
light causes the photoelectric effect and cannot be explained by a wave theory of light

Compare and explain the emission spectra produced by various atoms

Use the diagram below to answer the following questions.



85. In the diagram shown above, the bright lines represent light of specific wavelengths emitted by Cadmium and Mercury.

a. To give off this light, what must the electron in the atom be doing?
making a transition from a higher energy state to a lower energy state

b. Will any other element have the same emission spectra as either of the ones shown above? Why or why not?
No, each element has its own unique characteristics.

Describe evidence for and effects of the strong and weak nuclear forces in nature.

86. Where do you find strong and weak nuclear forces in nature?

The "strong" nuclear force holds protons and neutrons together in the nucleus.
The "weak" force is also found in the nucleus and is responsible for "beta-decay".

Describe the significance of mass-energy equivalence and apply it in explanations of phenomena such as: nuclear stability, fission, and fusion.

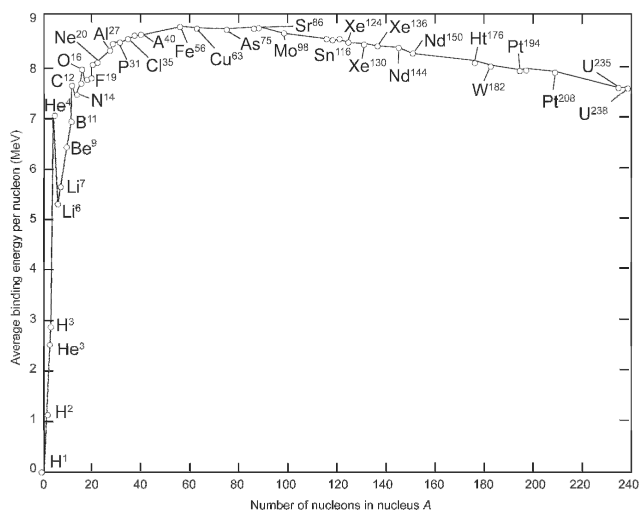
87. What is the total energy released when 5.23×10^{-8} kilograms of mass is converted into energy?
    4.71 GJ

88. How much energy is contained in 10 grams of matter?
    900 TJ

89. Nuclear fusion creates energy in the sun. During this process, hydrogen atoms combine to create helium. The mass of the helium created is less than the mass of the hydrogen from which it was made. The lost mass is converted to radiant energy.

    a. The sun loses 4.3×10^9 kilogram of mass every second. How much energy is released in one second? 3.87×10^{26} J

Use the diagram below to answer the following questions. Binding energy is plotted on the y-axis and number of nucleons in the nucleus is plotted on the x-axis.



90. Use the above diagram to answer the following questions:
    a. Apply what you know about mass-energy equivalence to explain which of these elements has the most stable nucleus: uranium, helium, iron, or sodium.
       of those listed, iron has the highest binding energy per nucleon

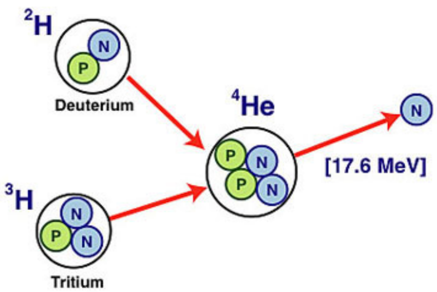
    b. The nuclei to the right would under go _ fission ________________________

    c. The nuclei to the left would under go __ fusion ________________________

    d. Why would the above reactions happen?
       they would tend to a more stable state (a higher binding energy/nucleon)

91. Describe the significance of mass-energy equivalence in terms of nuclear stability. (Hint: What makes the nucleus stable in terms of mass and energy?) A nucleus is less massive than its constituent parts. This difference in mass when converted to energy using the Einstein relation $E = mc^2$ is the "binding energy". The more binding energy a nucleus has, the more stable it is.

Use the diagram below to answer the following question.



92. Use the image above to answer the following questions:

a. What is the process that is occurring?

nuclear fusion

b. What are the reactants?

deuterium and tritium

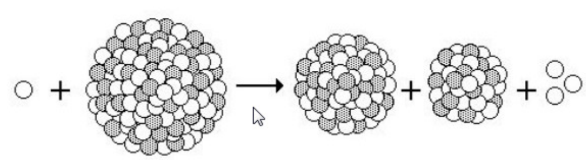
c. What are the products?

helium, a neutron and energy

d. Give an example when this would occur.

in the sun during hydrogen burning

Use the diagram below to answer the following question.



$${}^{1}_{0}\mathbf{n} + {}^{235}_{92}\mathbf{U} \longrightarrow {}^{141}_{56}\mathbf{Ba} + {}^{92}_{36}\mathbf{Kr} + 3\,{}^{1}_{0}\mathbf{n} + \mathbf{Energy}$$

93. Shown above is a neutron colliding with an uranium atom.

a. What phenomenon is shown above?

nuclear fission

b. What are the original reactants?

neutron and uranium

c. What is produced?

barium, krypton, neutrons and energy

d. Give one example where this occurs.

in a nuclear power plant

94. In the reaction X + ${}_{1}^{1}H \rightarrow {}_{3}^{6}Li + {}_{2}^{4}He$, the nucleus represented by X is ____ Be _______

95. In the reaction ${}_{92}^{238}U + {}_{0}^{1}n \rightarrow {}_{93}^{239}Np + X$, the species represented by X is ___beta_______

96. The nuclear equation ${}_{19}^{42}K \rightarrow {}_{20}^{42}Ca + {}_{-1}^{0}e + energy$ is an example of _ beta decay_____

97. The reaction ${}_{1}^{3}H + {}_{1}^{2}H \rightarrow {}_{2}^{4}He + {}_{0}^{1}n + energy$ illustrates the process of __ fusion_______

Give examples of applications of atomic and nuclear phenomena such as: radiation therapy, diagnostic imaging, and nuclear power and examples of applications of quantum phenomena such as digital cameras.

98. In a nuclear-fueled power plant, water is turned into steam, which in turn drives turbine generators to produce electricity. At nuclear power plants, the heat to make the steam is created when uranium atoms split. What is this process of atom splitting called?

fission

99. Radiation therapy uses high-energy radiation to kill cancer cells by damaging their DNA. What parts of the electromagnetic spectrum could be used as these high-energy waves?

gamma-rays