

NUPOC STUDY GUIDE



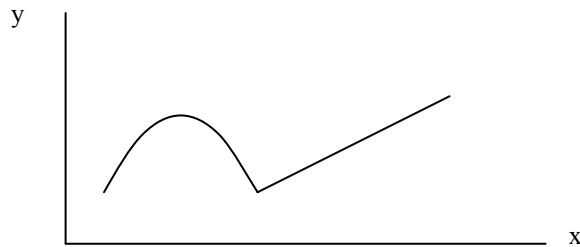
Navy Recruiting Command

Mathematics, Calculus and Differential Equations

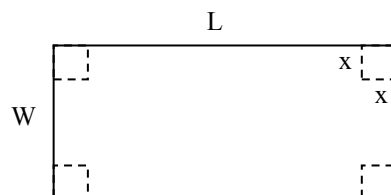
1. What is a solution to the equation $(1-y)^2 + 2xy = 0$
 - A. (1,1)
 - B. (1,i)
 - C. (i,1)
 - D. (1,0)
2. The set of all points P(x,y) in a plane, such that the difference of their distance from two fixed points is a positive constant is called:
 - A. ellipse
 - B. hyperbola
 - C. parabola
 - D. circle
3. A propeller plane and a jet travel 3000 miles. The velocity of the plane is 1/3 the velocity of the jet. It takes the prop plane 10 hours longer to complete the trip. What is the velocity of the jet?
4. What is the center of $x^2 + y^2 - 2x - 4y - 17 = 0$?
5. Rewrite with nothing higher than 2nd order:
$$\frac{a^4 + b^4}{a^2 + b^2}$$
6. Simplify: $\frac{3 + 2i}{3 - 2i}$
7. Solve a system of 3 simultaneous linear equations in three variables.
$$\begin{array}{rcl} 5x - 4y + 2z & = & 0 \\ -3x + 4y & = & 6 \\ x & + & 4z = 6 \end{array}$$
8. What is a logarithm? How is **e**, the natural logarithm base, defined?
9. The number of square feet in a circle is equal to the number in feet of the circle's circumference. What is the circle's radius?
10. Derive the equation of a circle around any point.
11. Given a closed box, where the length is twice the height, the width is 10 meters less than the length, and the surface area is 10 times the width times the height, what are the dimensions?
12. Derive the quadratic equation.
13. What geometric surface encloses the maximum volume with the minimum surface area? How would you prove it?
14. What type of smooth curve would go through these points: (0,4), (2,0) and (-2,0)? What would its equation be?

15. Find the area of A. and B. using Calculus and also derive the formulas for the volumes of C. and D.:
- Triangle
 - Circle
 - Pyramid
 - Cone
16. Draw the following curves and find the area between them:
- $y = x^3$
 $y = x^2$
 - $y = x^2$
 $y = x$
17. Plot $f(x) = x^2 + x - 6$. Find the area between the x-axis in the top and the line $y = -4$ on the bottom and the graph on each side.
18. Rotate $y = 1/x$ about the x-axis and find the volume from 1 to infinity.
19. Determine the area between two concentric circles of radii 1 and 2 respectively, using calculus.
20. Integrate the following:
- $\int (x \sin x) dx$
 - $\int x (x^2 - 4)^{1/2} dx$
 - $\int \frac{e^4 - 3/x}{x^2} dx$
 - $\int (e^{-x} + 3x^2) dx$
 - $\int (x \sin^2 x + x^3) dx$
 - $\int \sec(u)\tan(u) du$
 - $\int xe^x dx$
 - $\int (y + 3)(y + 1) dy$
 - $\int_0^{\pi/2} \int_0^{\pi/2} \int_0^{\pi/2} r \sin(\theta) d\phi d\theta dr$
 - $\int (2x + 1) dx$
21. Take the derivative with respect to x of the following:
- $\cos^4 x \sin x$
 - $\frac{ae^{-bx}}{cx^2}$
 - $5x^4$
 - $x(x^2 - 4)^{1/2}$
 - Each of these: $\sin(x)$, $\cos(x)$, $\tan(x)$, $\cot(x)$, $\sec(x)$, $\csc(x)$
 - $\ln(x)$ and 10^x
 - $x + x^3 + \sin(x)\cos(x) + \sin(x)$
 - $x^5 + (\cos x)(e^x) + \sin(x^2/3)$
 - $x^{1/2} + x^2 \sin^2 x$

22. What is an integral? How is it used? What is the difference between a definite and an indefinite integral?
23. What is a derivative? How is it used? What is a differential? What is the significance of the first and second derivative?
24. Prove that the derivative of x^2 is $2x$.
25. What is $\lim_{x \rightarrow 0} \sin(x)/x$?
26. Be able to integrate or differentiate by using parts, chain rule or quotient rule.
27. Draw the following curves. Plot any maximum, minimum, and points of inflection.
- $f(x) = e^{-x^2}$
 - $f(x) = a \sin x: (0 \leq x \leq 2\pi)$
 - $f(x) = e^{\pi/2}$
 - $f(x) = 3x^2 - 17x - 10$
 - $f(x) = x^3 - x^2$
 - $f(x) = x^2 e^{(-x^2)}$
28. Analyze the curve $y = 1 + e^{-x}$ by finding the first two derivatives, maxima, minima and inflection points.
29. Find the maximum or minimum of a parabola and determine if it is a maximum or minimum.
30. Using Calculus, derive the formula for the exposed surface area of a ball floating in water.
31. Solve the following differential equations:
- $y'' + 6y' + 9 = 5$
 - $\frac{dN}{dt} = -2N$
 - $y' = xy^3$ at $x=0$ and $y=1$
32. For the following curve, plot the first and second derivatives:



33. Given 80 feet of fencing, what is the maximum area that you can enclose along a wall?
34. Given the figure below, determine the value of x so when the corners are removed and flaps folded up, the five-sided box formed will have the maximum volume.



35. Two runners start at a distance of 10 miles from each other. They run towards each other at a constant velocity of 5 mph. A fly takes off from runner one's nose at time zero. The fly has a constant velocity of 20 mph and flies between the runners. Find the total distance that the fly has traveled when the runners collide.

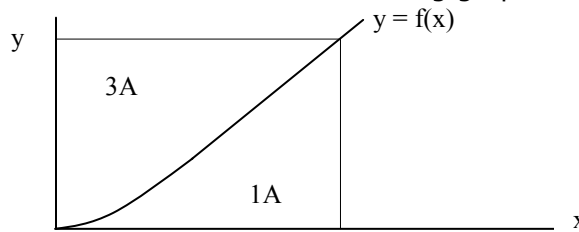
36. What is a Laplace transform, a Fourier transform or a Taylor series? How are each used?

37. When do you use L'Hopital's Rule?

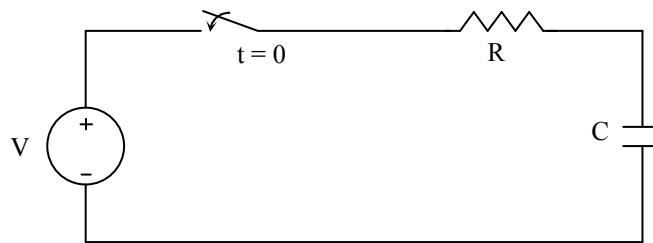
38. What is the probability of throwing one "7" with two dice?

39. If the population doubles in two years, how long does it take to triple?

40. Find $f(x)$ which best describes the following graph. "A" represents area.



41. Use a first order differential equation to find the function to represent current with respect to time and to find the time constant of the circuit.

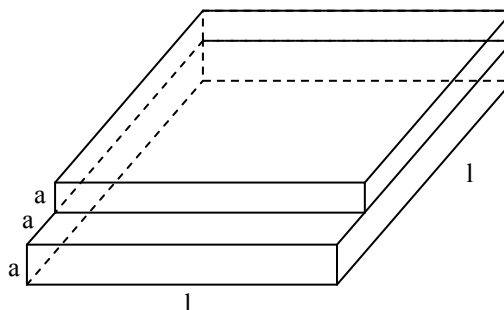


42. Show how to solve a differential equation with matrices.

43. Find the sum of:

$$\sum_{n=1}^{100} n$$

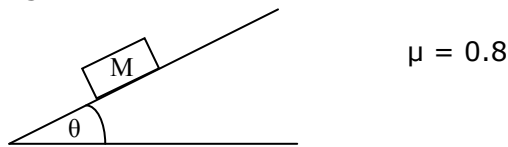
44. Given the figure below with uniform mass, what is the y-coordinate of the center of gravity?



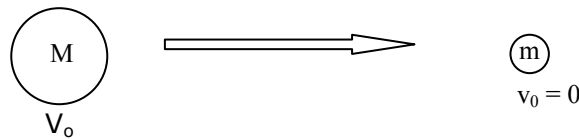
45. Describe how to classify differential equations.
46. Solve: $x'' + 5x' + 6x = e^{-t}$
47. What is the Laplace transform of $f(t) = t$?
48. Solve: $y'' + 4y' + 3y = \sin(x)$
49. Solve: $dx/dt = x/k$
50. Solve the general and specific homogeneous equation with derivatives:
 $dy/dx + Ky = 10$
51. Explain how to solve the following differential equation: $A'' + A' + A = 0$
52. Solve: $y - 3y' = 0$ for $y(0) = 3$

Physics

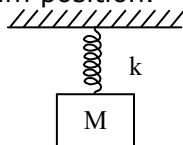
1. What must the angle θ be in order for the block of mass M to start sliding?



2. Find the final velocity of M for both elastic collision and inelastic collision

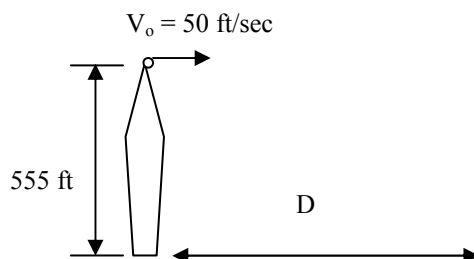


3. Describe the motion of the block-spring assembly when the block is displaced 4 inches from the equilibrium position.

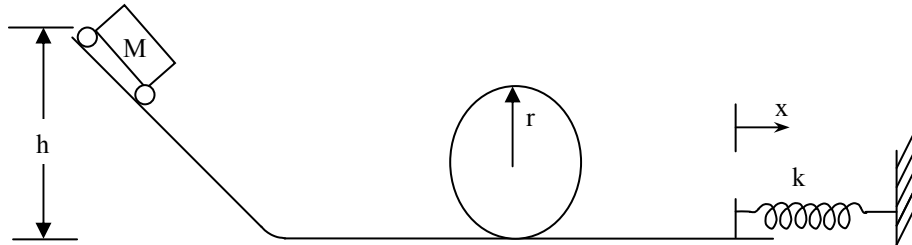


4. How does the gravitational force vary between two masses if distance is doubled?
How does the electrostatic force vary between two charged particles if the distance is doubled?
Explain using both equations and physical applications.

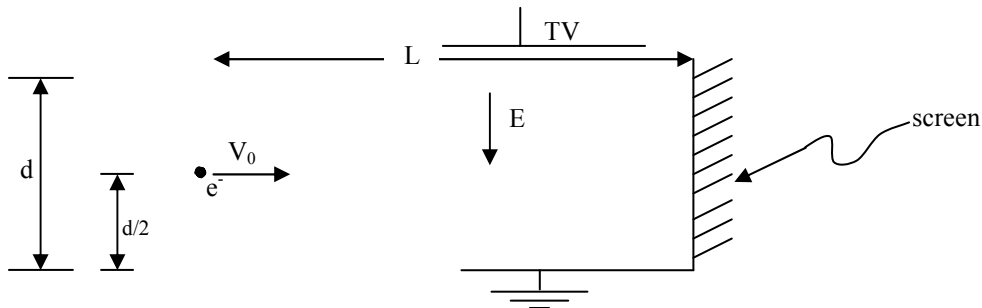
5. Given the following diagram, calculate the distance traveled by the ball being thrown off the monument:



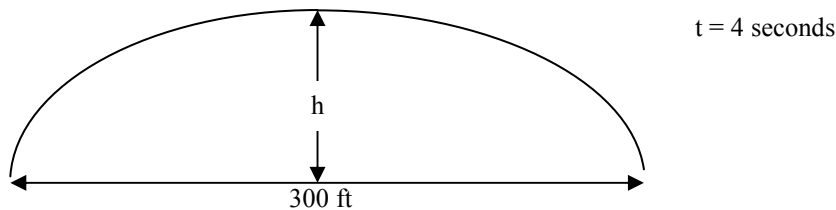
- A spaceship is accelerating at 1000 m/sec^2 . How much force is required from the backthrusters to completely stop the spaceship?
- Find h such that the car will make it around the loop without falling. Find x that occurs when the car impacts the spring.



- What angle will give the maximum range for a projectile neglecting air resistance? What would happen if air resistance occurred?
- If a piece of paper is put on a full glass of water and inverted, what happens? Why?
- Given a hollow and a solid cylinder of equal masses that are placed on an inclined plane. Also, both cylinders have equal radii. Which cylinder will reach the bottom of the plane first?
- In the following diagram, find the position of the electron when it hits the screen. Will it hit the screen? What two variables can you change to determine where the electron will hit? (Assume that d and L are fixed)

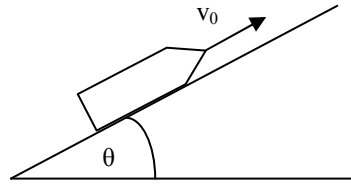


- Given the following data from a projectile, find the height of the parabola.

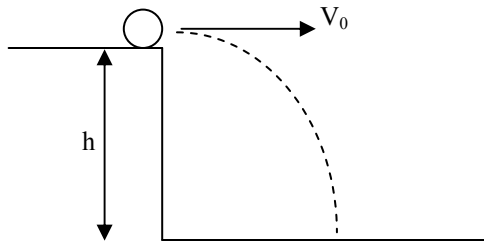


- List and discuss Newton's Laws of Motion.
- A bullet with a mass of 10 grams and a velocity of 1000 m/sec imbeds in a wooden block with a mass of 1000 grams suspended by a rope. How high will the block swing in the vertical direction?

15. Given a rocket sled with initial velocity equal to v_0 , find the total distance the sled travels.

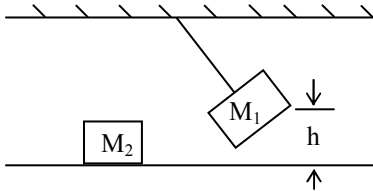


16. Find the time it takes to hit the ground?

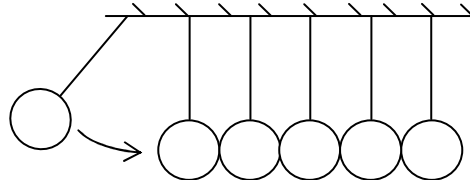


17. A man has $v_0 = 3$ m/s and starts z meters behind a bus with $v = 0$ at time 0. The bus accelerates with $a = 1$ m/s². Does he catch the bus?

18. A block of mass M_1 is attached by string to a support. The block is raised to a height H and released. It then strikes a block of mass M_2 on a frictionless surface. Find the velocity of the block M_2 , assuming a totally elastic collision.



19. Given the following set-up, why will only one of the balls swing out?



20. A 10 gram bullet with a velocity of 1000 m/sec strikes a 100 gram block of wood initially at rest. What is their combined velocity? Can you work the problem using the principle of Conservation of Momentum? Conservation of Energy?

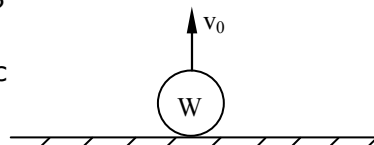


21. What is momentum and how does it relate to Newton's Second Law?

22. What is the maximum altitude reached?

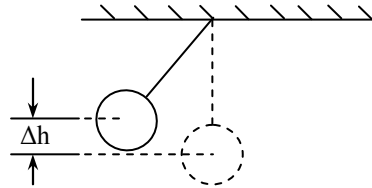
$$W = 100 \text{ lb}$$

$$v_0 = 100 \text{ ft/sec}$$

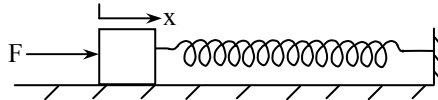


23. A mass is dropped from a height H . What is the velocity of the mass just before it hits the ground?

24. Consider the following pendulum system:
- If the bob is released from rest, what is the maximum velocity attained?
 - What assumptions are made in the answer?
 - What difference does it make if the system is in a vacuum?
 - Suppose a second mass m was suspended at the lowest point, what would be the velocities of both masses after collision?
 - What if the collision was non-elastic?



25. Given a spring with the force displacement relationship $F = e^x$, determine the energy required to move the block 3 units.



26. Define work, energy and power.

Wave Properties & Oscillations

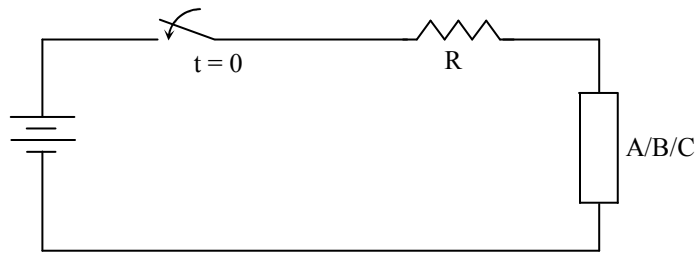
- What is the oscillation period of a simple harmonic oscillator?
- Derive the period of a simple pendulum.
- Explain the difference between light and radio waves.
- What is the relationship between frequency and wavelength?
- What is the frequency of a 5 \AA wavelength emission?
- Contrast light and sound waves. How do they propagate energy? Do they travel at different speeds in different media? Why?
- Define Doppler Shift.
- Arrange the following electro-magnetic radiation in order of increasing frequency: X-rays, gamma rays, infrared radiation, and visible light.
- State Snell's Law.
- Draw a picture of a fish in water and show where you would throw a spear to hit it. Where does the fish appear? Why? How do n and C relate to refraction?
- Draw a concave and convex lens. What effect would each have on paraxial rays? Why?

12. What does a diffraction grating do, and what is it used for? Are there circumstances under which light must be considered a particle? When?

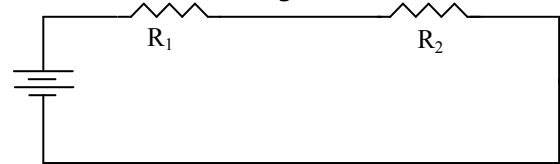
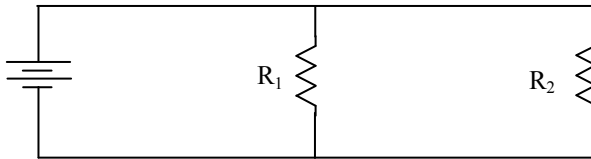
Electrical Engineering / Electromagnetics

1. Plot voltage versus time and current versus time for the circuit with the following substitutions:


- A. Resistor
- B. Capacitor
- C. Inductor

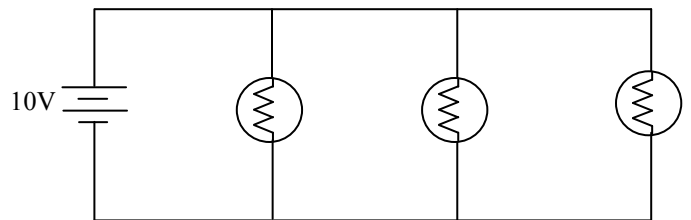
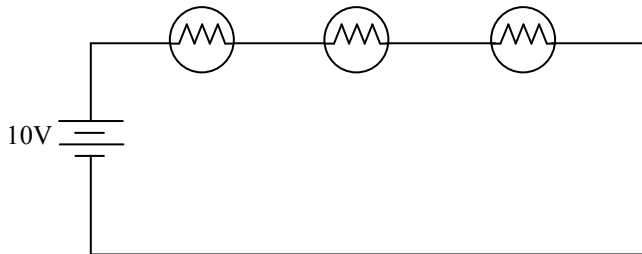


2. Find the total current and voltage drop across R_1 for the following circuits.

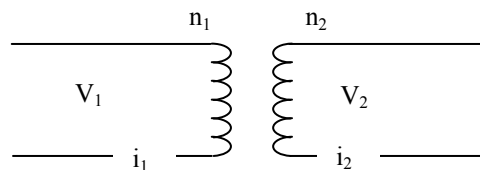


3. Which diagram uses the most power? Discuss advantages and disadvantages for each step.

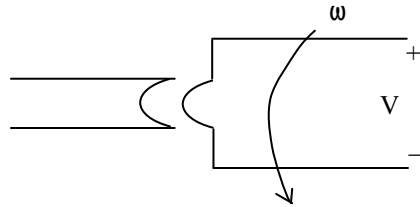
 = 100 Watt Bulb



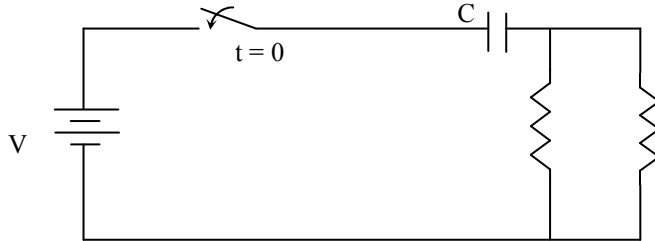
- 4. Explain how a transistor works.
- 5. Explain Kirchoff's Laws. Give applications of Kirchoff's Laws to simple circuits.
- 6. How does an electric motor work?
- 7. Find the relationships between Voltage (V), Current (i), and number of turns (n).



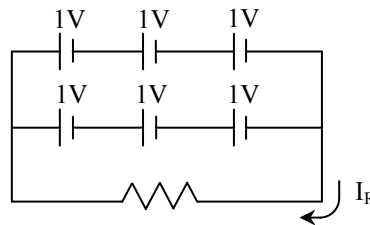
8. Why are electrical transmission lines braided vice solid?
9. Describe the differences between electric and magnetic fields. Show what happens to an electron in each field. Could you derive an experiment to measure the force on the electron in a magnetic field?
10. Using Faraday's Law, state the direction of current in the loop on the left.



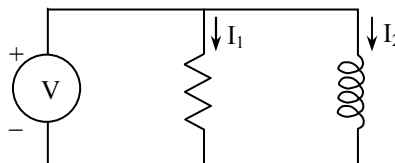
11. There is a light bulb on a circuit. Another bulb is added in series. What is the wattage in the two bulbs? Is this the best way to add a bulb to this circuit? How could you add it differently? Would the bulbs be brighter? Why?
12. Graph voltage and current versus time after the switch is closed in the circuit below.



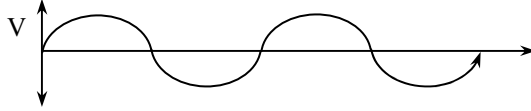
13. Draw a simple RLC circuit and find the voltage.
14. What is capacitance and inductance?
15. How can the current in a wire be determined without touching it?
16. Given a RC circuit, determine the energy stored in the capacitor, the energy dissipated by the resistor, and the total energy contributed from the battery.
17. Find I_R in the circuit shown.



18. Graph I_1 and I_2 vs. time for the circuit below.



19. What is the average of voltage over one and one-half cycles?



20. Discuss the pros and cons of three phase sources.

21. What is the difference between impedance and resistance?

22. What are Maxwell's Equations used for?

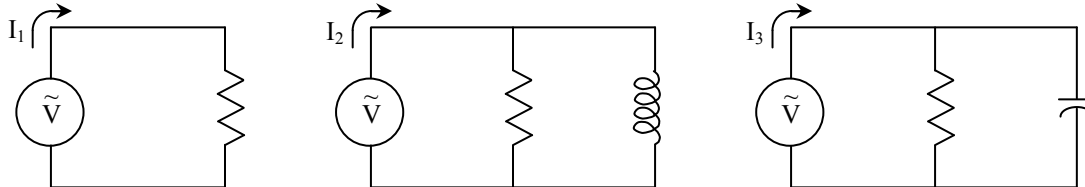
23. What did Faraday do?

24. Given a bar magnet, what does its field look like? Given a wire with electric current flowing in it, simulate the bar magnet's field. Can you, in a laboratory, simulate the earth's magnetic field?

25. Are there places on earth that might affect a ship's transmitters, receivers, etc. more than other places? Where and Why?

26. Given three 1 ohm resistors, how many ways can they be arranged to form different resistances by using any number of the resistors (three max)?

27. Find I_1 , I_2 and I_3 in the circuits below. Is $I_2 >$ or $<$ I_1 ? Compare I_3 and I_1 . What effect would an infinite or zero capacitance have in circuit 3?



28. How would you go about proving that a group of series and/or parallel resistors are equivalent to a single resistor?

29. What are the properties of a diode and how does one work?

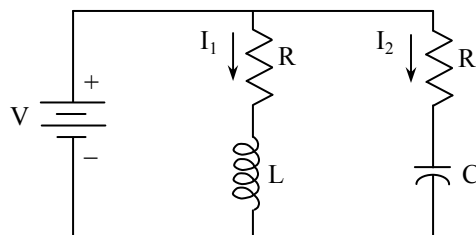
30. Describe in detail how a transistor works. Of what material is it constructed? How are impurity ions diffused into the material? What makes a transistor amplify?

31. Explain digital circuits.

32. How do you find the Thevenin equivalent of a circuit?

33. Find the equation for current in a series RL circuit and find the energy stored in the inductor.

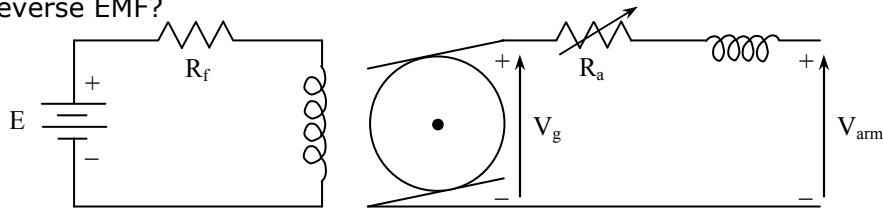
34. Find the current in each branch of the circuit below.



35. Describe the difference between an AC and DC motor.

36. Describe the properties of synchronous and induction motors.

37. Given the separately excited DC motor, how do you increase the speed? What is the reverse EMF?



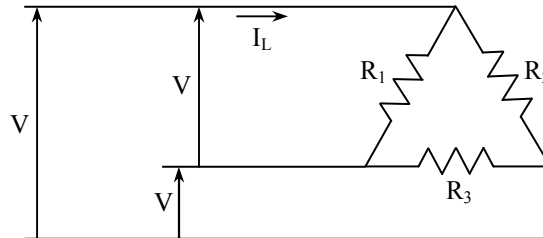
38. How does a transformer work? What sort of losses are involved?

39. Draw a capacitor and resistor in parallel and input a sine wave. What type of current will flow?

40. Explain the operation of and diagram a full wave rectifier. Graph the input and output. How can you filter the output to look more like a DC source? What are the trade-offs involved with this method? Using your method of filtering, do we lose maximum voltage or current?

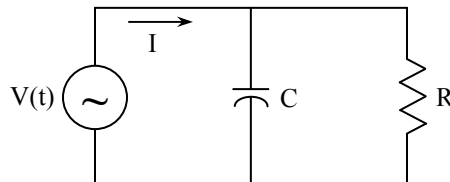
41. Draw a simple oscillating circuit. What type of input would you use? What type of waveform would you get out?

42. Given the following AC delta circuit, what is I_L if $R_1 = .5R_2 = 2R_3$? What is I_L if all resistances are equal?



43. How does an electrical generator work?

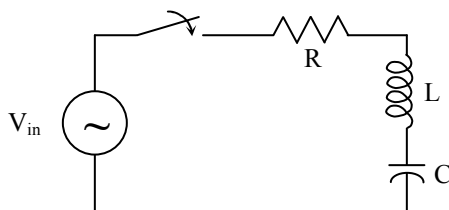
44. How does impedance change with frequency? How does current change with frequency? Graph current vs. frequency. At what frequency is the current a maximum? $R = 1k\Omega$, $C = 1 \mu\text{farad}$



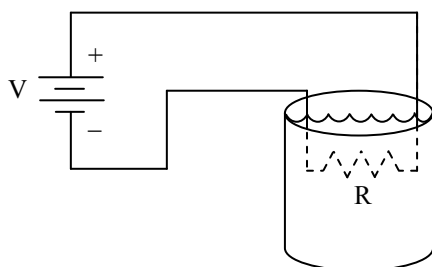
45. Explain what happens to current in a DC motor during startup. What is the role of the armature resistance?

46. Explain the physics of semi-conductors.

47. Draw $V(t)$ and $I(t)$ with respect to time. **Set up** the differential equation to solve for current.



48. The switch closes at $t = 0$ for 20 seconds. Calculate the temperature rise in the 1 kg of water. $V = 12V$, $R = 10\Omega$



Chemistry

1. What is pH?
2. Determine the final pH and temperature when these two solutions are mixed together in a 3-liter container.

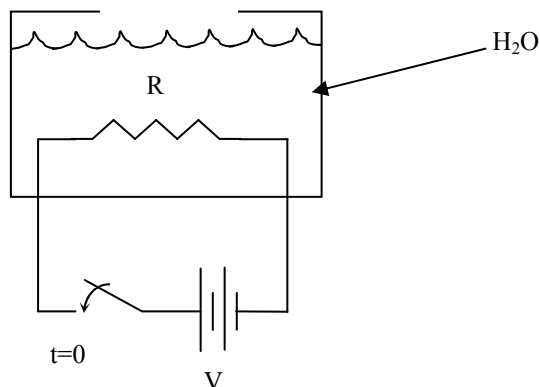
Solution A: 2 liters, pH = 3, Temp = 80°F
Solution B: 1 liter, pH = 5, Temp = 40°F
3. Why is pH important in materials selection?
4. Describe the Bohr model of the atom. Is it realistic?
5. How many grams of oxygen are needed to make Sulfur Trioxide if 500 grams of sulfur is initially used?
6. If NaOH and H_2SO_4 mix, what results?
7. Given thermodynamic data on reactants + products of the reaction in question 6, compute ΔH_{rxn}
8. What is the atomic number of Na? What is the electron structure of Na?
9. You have NaOH and HCl. Will they react? If so what is the outcome?
10. How many moles of CO_2 can be obtained from burning 3 moles of C_3H_8 in an abundance of O_2 ?
11. State the mathematical expression for the pH factor of a solution. What is the pH of pure water? What happens to pH if the hydrogen ion concentration increases?

How is the disassociation constant of water defined? What happens to the pH of water as its temperature increases?

12. Give an example of the use of a differential equation in chemistry. Solve the equation.
13. How do you determine if a reaction is exothermic or endothermic?
14. The half-life of a compound is 40 years. After 60 years, what percentage of the compound has decayed away?
15. Explain ionic bonding.
16. Define corrosion and describe some different forms of corrosion.
17. What is an acid? What is a buffer solution?
18. Draw a H_2 molecule. What types of bonds are involved? Why doesn't it fly apart?
19. How many grams of iron will one liter of a 3 M HCl solution dissolve?

Thermodynamics

1. Draw and explain a typical Carnot cycle.
2. Draw and explain a typical Rankine cycle. Include a discussion of enthalpy and entropy changes.
3. List and discuss the laws of thermodynamics.
4. Given a closed, adiabatic room with an open refrigerator. At time zero, the refrigerator is plugged in. Plot the temperature of the room as a function of time.
5. At time zero, the knife switch of the circuit is shut. The tank of water is insulated and open to the environment at the top. Plot temperature at the bottom of the tank as a function of time.

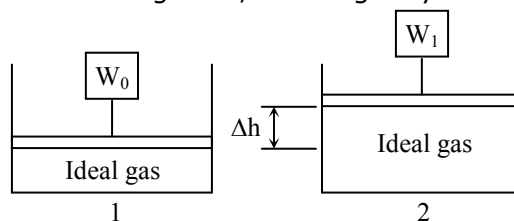


6. Discuss the advantages and disadvantages of using a superheated steam cycle.
7. Discuss various types of heat transfer.

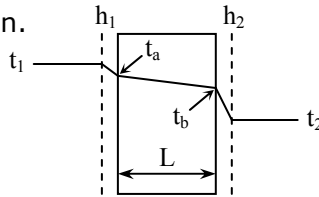
- Discuss heat exchangers for both counter-flow and parallel flow type exchangers. Which is more efficient?
- In the following heat exchanger, all values of temperature can be read from thermometers and \dot{m}_c can be read from a flow meter. List all assumptions and find \dot{m}_h



- A containment building encloses the space around a helium gas reactor. The gas reactor has initial temperature T_i and initial volume V_i . If the reactor cracks and mixes with the air of the containment vessel (volume = V_{cont}), find the resulting temperature of the containment building.
- A tank of N_2 is @ 2000 psig and 70F. If the temperature of the tank rises to 140F, find the pressure in the tank?
- If you know how much heat a bar is putting out, what is the temperature at the center of the bar?
- What is enthalpy? How is it measured? How is it used to calculate entropy?
- What is entropy? How is it used? Machine "A" and machine "B" are performing the same task. Machine "A" is causing twice the entropy change of machine "B". Which would you rather use and why?
- Suppose you have a container full of gas and heat it up. What happens to temperature and pressure? Why?
- Given two boxes of identical volume and temperature and filled with helium, is it possible to have different pressures?
- You have 100 lbs of water with $c_p = \text{constant}$. How much heat would need to be added to raise the temperature by 23 F?
- What is temperature? What is heat content?
- A rigid container is filled with a mixture of three gases: A, B and C. The pressure gage reads P_T . The container is evacuated and filled with an amount of gas A equal to that in the original mixture. The gage now reads P_A . This process is repeated for gases B and C with the pressure gage reading P_B and P_C respectively. How is P_T related to P_A , P_B , and P_C ? What assumptions are made?
- Draw a phase diagram for water. Show where solid, liquid and gas lie. What is the "triple point"? Where is the region of five ices?
- Given the set-up in Figure 1, how much work will be done after part of the weight is removed, as shown in Figure 2, knowing only the height the piston rises?



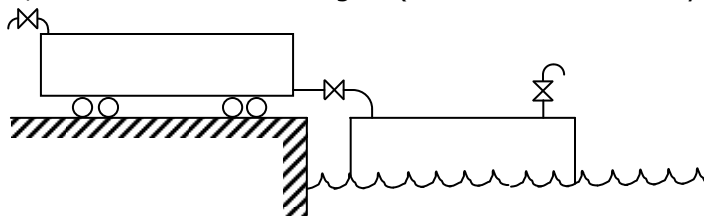
22. a. If $ds = 0$, what can you say about the process?
 b. If $ds < 0$, what can you say about the process?
 c. If $ds_1 < ds_2$, what can you conclude about these processes?
23. Determine the heat transfer and temperature profile across a wall of homogeneous material and thickness L . The fluid film and heat transfer coefficients (h) are known.



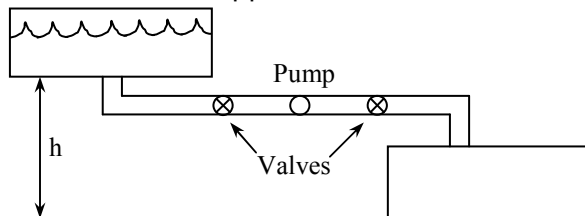
24. Heat is added to a block of ice thermally insulated from its environment. Graph the temperature increase of a unit mass of ice per unit heat added as it changes phase to vapor.
25. Given one pound of ice at 32 F, how much water at 200 F must be added to bring the temperature to 50 F? Assume the specific heat of water to have a constant value of 1 BTU/(lb-F).
26. What is a Mollier diagram?

Mechanical Engineering

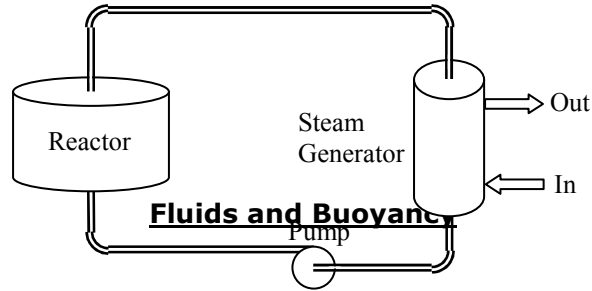
1. Explain how a steam generator operates.
2. Given a full tank car which holds 10000 gallons, an empty barge with a capacity of 30000 gallons, and a pump and hose connecting the two, what should we do to empty the oil from the car to the barge? The hose is attached to the bottom of the tank car, 15 feet above the barge. (Refer to air vents in your answer)



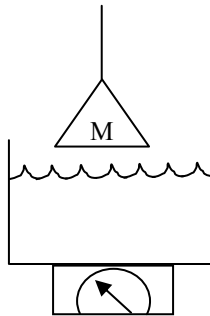
3. Why is there a pump in the basic Rankine Steam cycle?
4. Draw a gas turbine block diagram.
5. In the following diagram, the upper tank is filled with water and the lower tank is empty. Both tanks are sealed, both valves are shut and the pump is off. How would you transfer water from the upper to the lower tank?



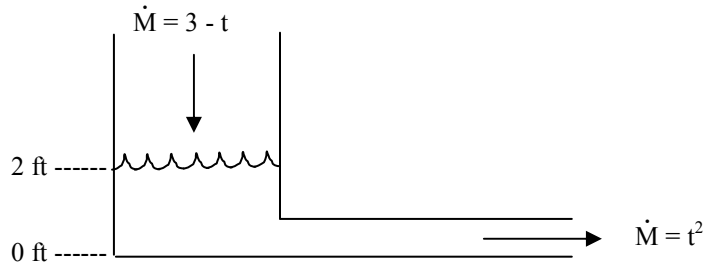
6. Knowing the work done by the steam flow, explain why this is not the power out of the nuclear reactor.



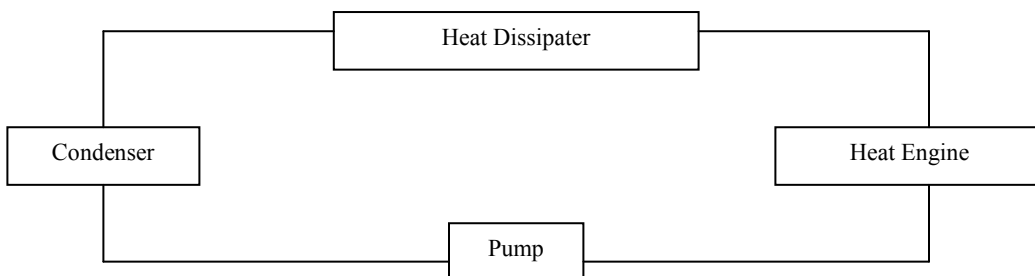
1. What will happen to the scale reading as the mass is lowered?



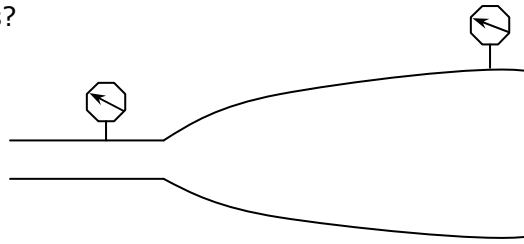
2. Find pressure as a function of time. At time $t = 0$, the water level is 2 feet. Cross-sectional area is 8 ft^2 for the top and 1 ft^2 for the bottom.



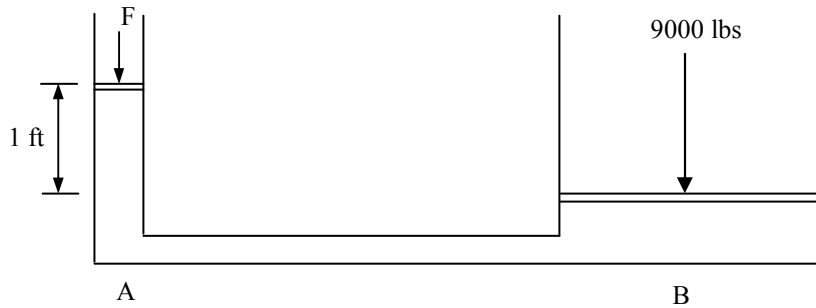
3. For a hydrofoil aircraft, why is turbulent flow preferable?
4. In the following simplified system, where is pressure the greatest?



5. If the flow rate is increased by a factor of three, how does the pressure change at both points?



6. What is force F ?



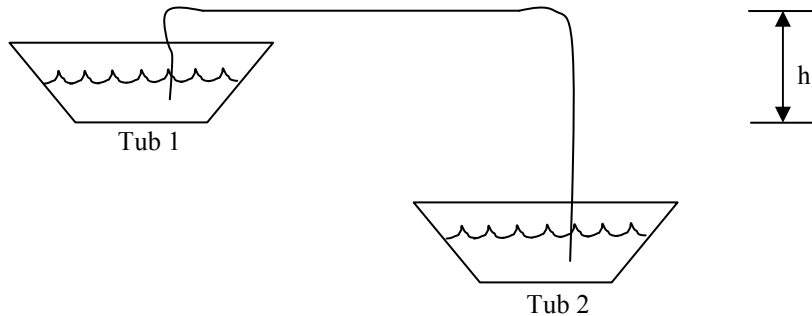
Cross-sectional areas

$$A = 9 \text{ in}^2$$

$$B = 900 \text{ in}^2$$

7. A ball of diameter 10 cm and mass 10 grams is dropped in a container of water. The cross-sectional area of the container is 100 cm^2 . What is the change in the height of the water column?

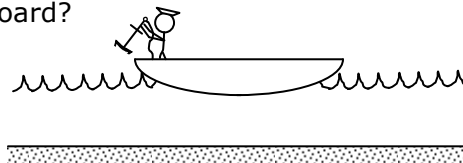
8. The cross-sectional area of the siphon tube is constant. The fluid flows from tub 1 to tub 2. Determine the maximum height h that will still result in fluid flow.



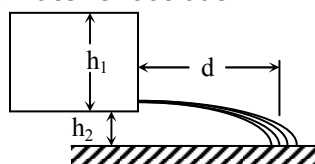
9. The motor on a centrifugal pump is hooked up backwards, causing the impeller to spin the wrong direction. What will happen to the head vs. gpm curve?

10. Describe how a Venturi meter works and show how it can be used to calculate fluid flow (Bernoulli's Eqn. and the Continuity Eqn.)

11. What happens to the water level with respect to the shore when the sailor throws the lead anchor overboard?

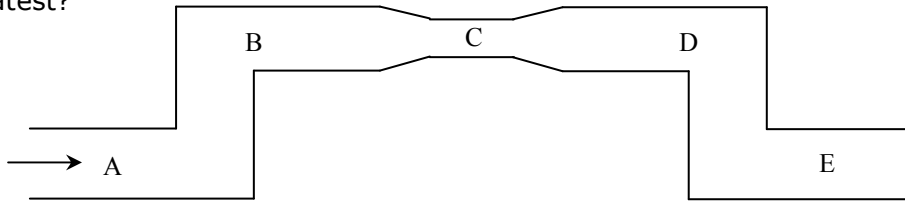


12. How far will the water shoot out?

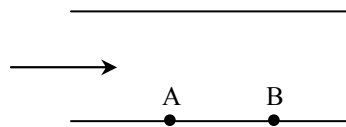


13. Explain how you would estimate the flow rate in a pipe.

14. If the liquid is flowing in the direction indicated, at what point is the pressure greatest?



15. Given a fluid flowing through a pipe in the direction indicated, what difference in parameters exists between points A and B?



16. What is meant by laminar and turbulent flow? If you had a piping system, which type of flow would be better and why?

17. Which will raise the water level in a tank higher when added – a one pound block of iron or a one pound block of wood?

Materials and Civil Engineering

1. Draw and explain a stress-strain curve for steel. Where is the elastic limit? The yield point? What are stress and strain? How would work be defined on the stress-strain curve?

2. Compare and contrast a stress-strain curve for steel with a similar curve of concrete.

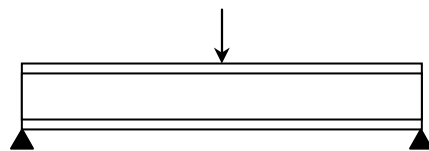
3. What effect does varying pH have on metals?

4. Why is glass more difficult to break when it has been tempered? Describe what occurs within the glass.

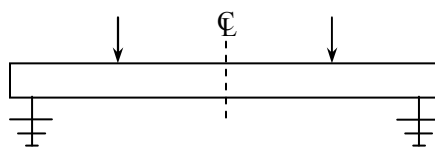
5. What is "Young's Modulus"? What is its approximate value for steel?

6. Describe the pros and cons of castings versus forgings.

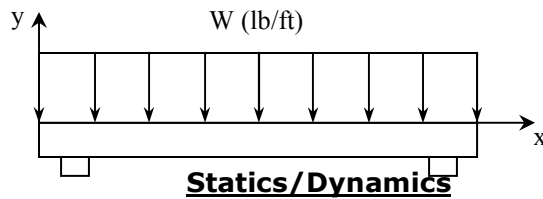
7. Given an I beam, what types of forces are acting at the point of load on this beam? How do you find these forces?



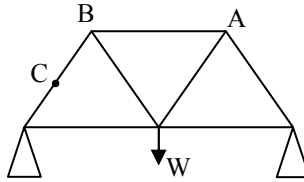
8. Draw the shear and moment diagrams for this beam.



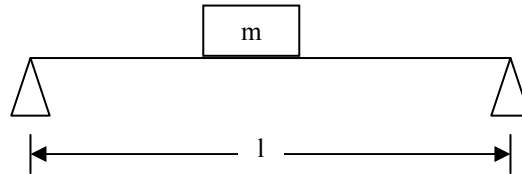
9. Define the following and explain what quantities they compare. (Give units where applicable)
 - a. Hooke's Law
 - b. Poisson's Ratio
10. Define "cold working". What goes on within the material? What happens during "annealing"? Give physical properties.
11. Draw the shear and moment diagrams for this uniformly loaded beam.



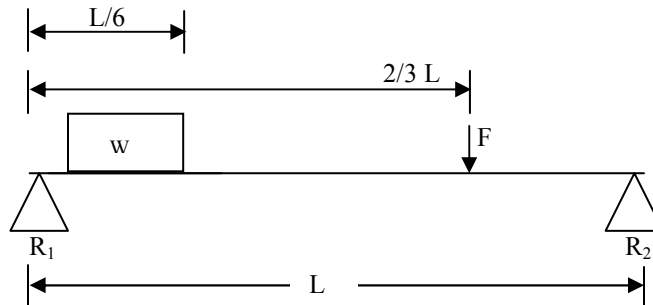
1. Find the forces in the following members of this truss: AB and BC. Dimensions are variable. Discuss tensile or compressive stresses.



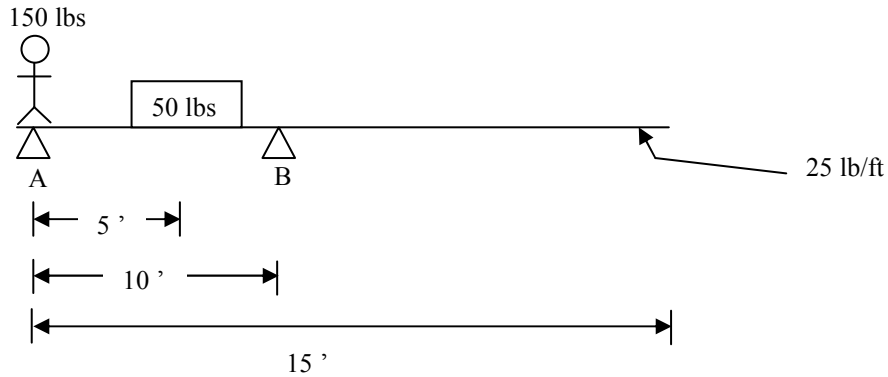
2. What is the largest mass the following beam can hold before it breaks? List any assumptions.



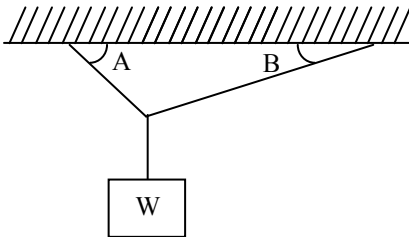
3. Find R_1 and R_2 (Reactions).



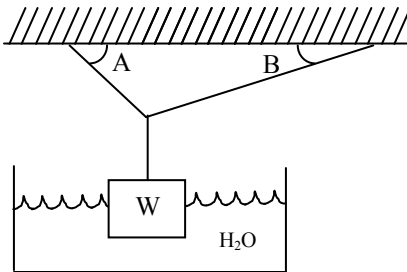
4. How far does the man have to walk down the beam in order to tip the beam off fulcrum A?



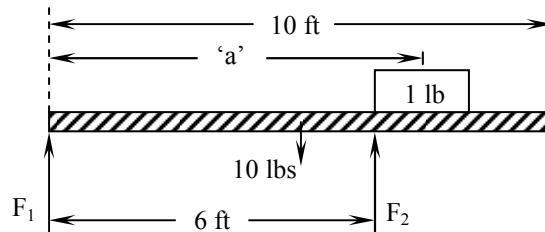
5. a) Find the tensions in the two ropes.



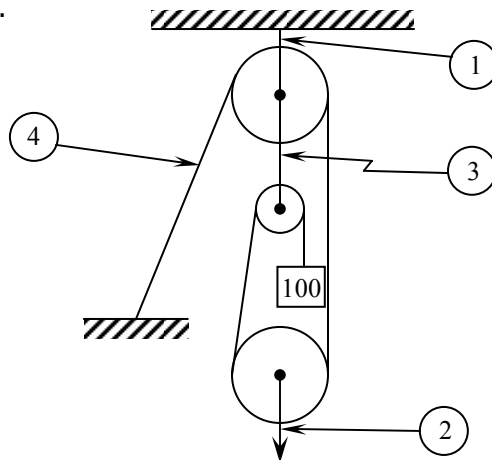
- b) Now describe the forces on the block.



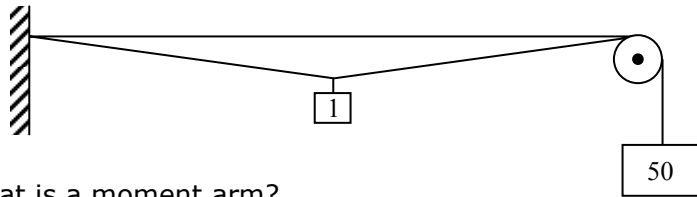
6. Given the figure below what conditions must be fulfilled in order for the system to remain in equilibrium? What is the largest value of 'a' that will still allow the system to remain in equilibrium? State assumptions.



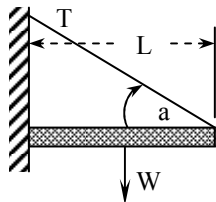
7. Given a block and tackle system and a known weight, give the magnitude of the forces at the numbered points.



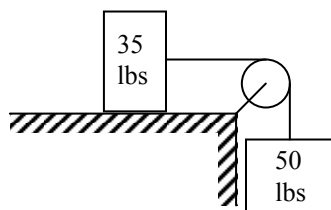
8. How much would the 1 kg mass raise the 50 kg mass in the figure below?



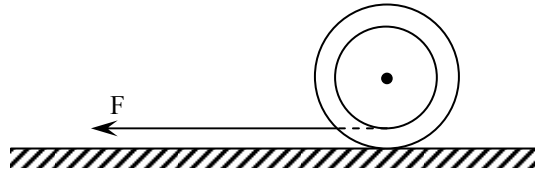
9. What is a moment arm?
 10. Express T in terms of L , W , and a .



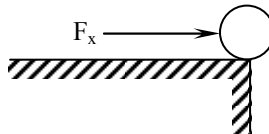
11. A sliding block slows from 16 m/sec to 8 m/sec in two seconds. If it weighs B kg, what is the coefficient of sliding friction?
 12. A car traveling at an initial velocity of v_0 applies its brakes to come to a stop. The coefficient of friction is μ . What distance is required to stop?
 13. A wheel rotating at an initial angular velocity of ω_0 is accelerated to a final velocity of ω_f after 10 revolutions. What is the angular acceleration?
 14. A person is standing on a building of height h . He throws a ball out with velocity v_0 at an angle θ to the horizon. How long will it take to reach the ground?
 15. What is the velocity of the 50 lb block? (Massless, frictionless pulley)



16. If the thread is pulled in the direction shown, which way will the spool roll?

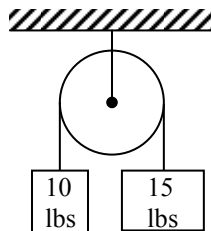


17. Given the diagram below, what are the resultant force, velocity, and acceleration with respect to time?



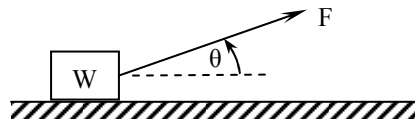
18. What forces act on an object in orbit? Why does the object stay in circular orbit?

19. What is the acceleration of the larger mass? (Pulley and rope are massless)



20. Given a particle in a circular orbit, give the horizontal component of its velocity. Give its position at any time t along the x -axis.

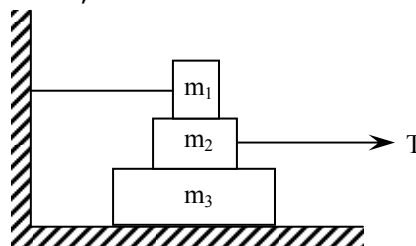
21. Given a coefficient of friction equal to μ , what force must be applied in order to move the block?



22. Derive $F = ma$.

23. Describe inertia.

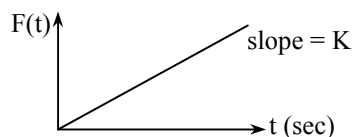
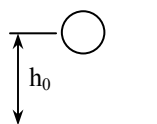
24. Given $\mu = .3$ on all surfaces, what is T in order to move the middle block?



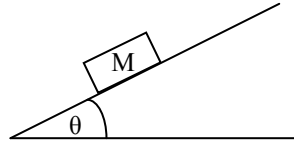
25. A ball is suspended at height h_0 . At $t = 0$, it is released and the following force is applied in the upward direction.

a. Find an expression for $h(t)$.

b. Find a value for K such that the ball just touches the ground.



26. Find the position of the block as a function of time for both cases:
- friction
 - frictionless



27. Find the maximum acceleration of a truck that can occur such that the block remains on the truck bed.

Mass of block = m

$\mu_s = 0.3$

$\mu_k = 0.1$

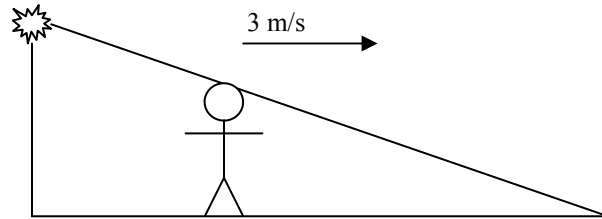
28. A block falls on a conveyer belt with coefficient of friction μ_k . How long until the block gets moving 10 m/s?

Atomic and Nuclear

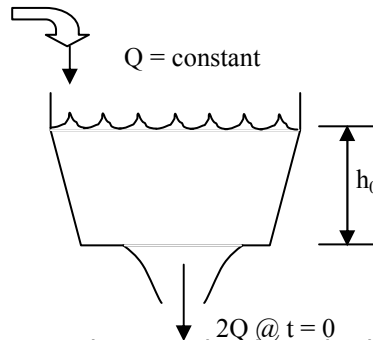
1. Explain the possible energy levels for X-rays (discrete or continuous).
2. What is the Schrodinger wave equation? What is it used for, and what information about the hydrogen atom can it be used to determine?
3. Given a substance (plasma) which must be sustained at a high temperature, how would you do it?
4. What is Buckling?
5. What does a pressurizer do? Why is it important?
6. Draw a block diagram of a nuclear reactor?
7. Define fission and fusion. What are their differences? How does a breeder reactor work?
8. What is criticality? What is the neutron multiplication factor? Write and explain the four factor formula.
9. What is binding energy? How does this relate to nuclear power?
10. What happens to a PWR (pressurized water reactor) as the temperature increases?
11. Explain the difference between a PWR and a BWR (boiling water reactor). Sketch a primary and secondary loop for a PWR.
12. Describe how radiation is stopped by shielding. What types of material are best for various types of radiation and why?

Other Questions

1. What is the ratio of change of the length of the shadow and what is the velocity of the shadow?



2. You have a car and a balloon is tied to the passenger seat. If you go from rest what happens to the balloon?
3. What is a neutron, alpha particle, and beta particle. Draw a He^4_2 nucleus.
4. What are the four forces on an airplane? How is lift generated?
5. Pick a course you liked and show me something?
6. Find at what height the water will go if steady or if it will all draw out?



7. How much force do you need at P to hold up the block?
8. The winch on the 10-ton barge slowly pulls in the line. How far has each barge moved when they are 25 feet apart?

