Equation Sheet for Physics 103 Final Exam

Efficiency = Useful Energy Out
Total Energy In

Efficiency \( \text{Eff} = \frac{\text{Work}_{\text{out}}}{\text{Work}_{\text{in}}} \)

\[ F = M a \]

\[ F = M g \]

\[ s = \frac{D}{t} \]

\[ a = \frac{v_f - v_i}{t} \]

\[ F = \frac{k Q_1 Q_2}{D^2} \]

\[ \frac{N_p}{N_s} = \frac{V_p}{V_s} \]

\[ E_{\text{pot}} = Q V \]

\[ E_{\text{cap}} = \frac{1}{2} Q V_{\text{final}} \]

\[ Q = C V \]

\[ I_p V_p = I_s V_s \]

\[ G = 6.67 \times 10^{-11} \text{ N m}^2/\text{kg}^2 \]

1 mile = 5,280 feet = 1.609 kilometers

1 lb = 4.45 N

1 joule = 0.74 foot pounds

1 kilowatt = 1,000 watts

\[ F = \frac{G M_1 M_2}{D^2} \]

\[ W = F D \]

\[ E_{\text{pot}} = M g h \]

\[ E_{\text{kin}} = \frac{1}{2} M v^2 \]

Actual Mechanical Advantage = \( \frac{F_{\text{out}}}{F_{\text{in}}} \)

Theoretical Mechanical Advantage = \( \frac{D_{\text{in}}}{D_{\text{out}}} \)

\[ V = I R \]

\[ I = \frac{Q}{t} \]

\[ P = \frac{E}{t} = \frac{W}{t} \]

\[ P = I V \]

\[ R = \frac{\rho L}{A} \]

\[ P_{\text{joule}} = I^2 R \]

\[ g = 9.8 \text{ m/s}^2 = 32 \text{ ft/s}^2 \]

1 foot = 0.305 meters

1 hour = 3600 seconds

1 horsepower = 746 watts

\[ k = 8.99 \times 10^9 \text{ N m}^2/\text{coulomb}^2 \]
Sample Final Exam A

1. Which of the following statements about a step-down transformer is TRUE?
   a) The current stays the same and the voltage is decreased.
   b) The current is increased and the voltage is decreased.
   c) The current is decreased and the voltage is increased.
   d) The voltage stays the same and the power is increased.
   e) The voltage stays the same and the power stays the same.

2. It is unwise to bring a credit card or bank card near a strong magnet (such as those used in class) because
   a) magnetic domains on the cards may be realigned, changing the stored information.
   b) the cards could become stuck to the magnet.
   c) joule heating of the card could change the stored information.
   d) you might get an electric shock from induced currents.
   e) the magnet could induce currents strong enough to warp the plastic card.

3. \((2 \times 10^4) / (8 \times 10^{-2})\) is between
   a) \(10^1\) and \(10^2\)
   b) \(10^2\) and \(10^3\)
   c) \(10^3\) and \(10^4\)
   d) \(10^5\) and \(10^6\)
   e) \(10^6\) and \(10^7\)

4. Electrical energy is transmitted at high voltage because
   a) it eliminates the use of costly transformers.
   b) it reduces the loss due to joule heating.
   c) it provides tax advantages to the electric company.
   d) it is a much safer way to transmit the electrical energy.
   e) the resistance in the wires is much lower at high voltage.
5. The price of gasoline in 1970 was about $0.20 per gallon. By 1980, the price had risen to $0.40 per gallon. In 1990, gasoline prices had reached about $0.80 per gallon. Based on this information, and assuming that the price of gasoline continued to change in the same manner, what would you expect the price of gasoline to be in the year 2000?

a) $0.80 per gallon
b) $1.20 per gallon
c) $1.40 per gallon
d) $1.60 per gallon
e) $2.00 per gallon

6. Which of the following will **NOT** have a magnetic field?

a) a charge that is not moving
b) a compass needle
c) a wire with a current running through it
d) a stereo speaker
e) All of the above will have a magnetic field.

7. A machine requires 200 joules of energy to raise a 50 N box 3 meters. What is the efficiency of the machine?

a) 50%
b) 67%
c) 75%
d) 82%
e) 87%

8. How much power is lost to joule heating in the transmission of 2,400 watts of power at 120 volts over power lines with a resistance of 1 ohm?

a) 200 watts
b) 400 watts
c) 4,000 watts
d) 16,000 watts
e) To answer the question, you need to know the length of the power lines.
9. Which of the following safety devices serve(s) the same purpose as a circuit breaker?

a) a fuse
b) a ground fault circuit interrupter
c) a double insulated case for power tools
d) a three prong power cord
e) both a) and b)

10. You are given the option of purchasing a 20 watt compact fluorescent light bulb (CF) for $10.00 or a 100 watt incandescent bulb for $1.00. If electricity costs $.075 per kilowatt-hour, what is the total cost of each (initial price and electricity used after 10 months? Assume the bulbs burn 200 hours per month.

a) CF cost=$3.00, incandescent cost=$5.00
b) CF cost=$3.00, incandescent cost=$15.00
c) CF cost=$13.00, incandescent cost=$15.00
d) CF cost=$13.00, incandescent cost=$16.00
e) CF cost=$13.00, incandescent cost=$25.00

11. How many 500 watt floodlights can be connected in parallel to a 120 volt circuit with a 15 amp fuse?

a) 2 are okay but 3 will blow the fuse
b) 3 are okay but 4 will blow the fuse
c) 4 are okay but 5 will blow the fuse
d) even 1 floodlight will blow the fuse
e) as many as you like -- the fuse will never blow

12. If a neutral atom gains an electron, it becomes

a) a proton.
b) a neutron.
c) a positive ion.
d) a negative ion.
e) a molecule.

13. Ramona is designing a transformer that will step down voltage from 2,400 volts to 120 volts. The primary has 500 turns. How many turns should the secondary have?

a) 25 turns
b) 250 turns
c) 500 turns
d) 1,000 turns
14. A lever that allows a force of 12 newtons exerted through a distance of 3 meters to move an object a distance of 2 meters has an actual mechanical advantage of

a) 2/3
b) 3/2
c) 2
d) 4
e) 6

15. The video *A Science Odyssey: Bigger, Better, Faster, Part 1,* did **NOT** discuss the development of

a) the airplane.
b) the automobile.
c) radio.
d) nylon.
e) the steam engine.

16. In class we built either a motor or a buzzer. A necessary component of either a motor or a buzzer is

a) a changing magnetic field.
b) a superconducting magnet.
c) a an electrostatic generator.
d) a capacitor.
e) a generator.

17. According to the video *Lightning,* which of the following statements about lightning is **TRUE**?

a) Lightning bolts are typically 5 to 10 meters in diameter.
b) Lightning is caused by negative charges flowing up from the earth to clouds
c) The leading cause of indoor lightning deaths is lightning strikes to television sets.
d) The safest place outdoors during a lightning storm is under a tree.
e) All of the above statements are true.

18. A box of laundry detergent holds 60 cups of detergent. If a large load of laundry requires 1.5 cups of detergent, how many large loads can you wash per box?

a) 20
b) 40
c) 60
d) 80
19. In class we cooled a superconducting disk with liquid nitrogen and a small magnet floated above the disk. Why did the magnet float?

a) The force from unlike charges repelled the magnet.
b) Liquid nitrogen caused an alternating current in the disk, which created a magnetic field.
c) The magnet induced a current in the disk, which created a magnetic field.
d) The liquid nitrogen magnetized the disk.
e) The force of gravity became much weaker at very low temperatures.

20. A man pushes on a car with a force of 200 N. A frictional force of 50 N acts on the car in the opposite direction. If the car's mass is 750 kg, what will be its acceleration?

a) 0.20 m/s² 
b) 0.27 m/s² 
c) 0.33 m/s² 
d) 3.0 m/s² 
e) 5.0 m/s² 

21. What happened in class when we put a current-carrying wire near a magnet?

a) The magnet became an insulator.
b) The resistance of the current-carrying wire decreased.
c) The poles of the magnet reversed.
d) The current-carrying wire “jumped.”
e) All of the above happened.

22. Which of the following does NOT involve high voltage (over 1000 volts)?

a) Lightning 
b) Sparks from static electricity 
c) The “Jacob’s ladder” device seen in class 
d) Electric power transmission over long distances 
e) All of the above involve high voltages.

23. Amy cranked the starter motor of her motorcycle for 6 seconds. If the motor draws 30 amps of current from a 12 volt battery, how much charge flowed through the starter motor and how much power did the battery supply?

a) 5 coulombs; 15 watts 
b) 72 coulombs; 360 watts 
c) 180 coulombs; 360 watts 
d) 180 coulombs; 2,160 watts
24. Which of the following is an absolutely necessary component of a motor if that motor is to operate on direct current?

a) a resistor
b) a transformer
c) a permanent magnet
d) a capacitor
e) a commutator

25. In pedaling her bicycle, Maria uses 230 watts of power. Only 20% of this power goes into moving the bicycle. How much work does Maria do each minute in moving the bicycle?

a) 23 joules
b) 84 joules
c) 460 joules
d) 2760 joules
e) 165,600 joules

26. Which of the following statements is **TRUE**?

a) The amount of gravitational force that you exert on the Earth is much smaller than the amount of gravitational force the Earth exerts on you.
b) There is no gravitational force between two pages of this test booklet.
c) The amount of gravitational force between two objects does not depend on the distance between them.
d) You would have the same weight on the Moon as you do on the Earth.
e) You would have the same mass on the Moon as you do on the Earth.

27. A negatively charged rod is brought up to but not allowed to touch an uncharged, non-conducting object, shaped like a dog. What will happen?

a) The dog will be repelled by the rod.
b) The dog will be attracted by the rod.
c) Nothing will happen, since a non conducting object cannot be attracted or repelled by a charged rod.
d) The dog will acquire a charge of the same sign as the charge on the rod.
e) The dog will acquire a charge of the opposite sign from the charge on the rod.
28. Which of the following items would **NOT** be present in an induction motor?

a) an electromagnet  
b) a permanent magnet  
c) an alternating current  
d) a conducting wire  
e) All of the above would have to be present in an induction motor.

29. Jano the cat weighs 70 newtons. She jumps off of a tall bookcase and lands on a set of spring scales sitting on the floor. What will be the maximum reading on the spring scales while this is going on?

a) The maximum value the scales will read will be more than 70 newtons.  
b) The maximum value the scales will read will be 70 newtons.  
c) The scales will always read less than 70 newtons.  
d) It is not possible to select a correct answer from the above list, based on the information given.  
e) The answer cannot be found unless the mass of the scales is given.

30. Pearl Jam’s stage crew is setting up the stage for their next concert. The crew has two winches which it can use to raise a spotlight to the top of a scaffold. The first winch requires 30 turns to raise the spotlight and the second winch requires 60 turns. Which of these statements is **TRUE**?

a) The first winch requires half as much force as the second winch.  
b) The first winch requires twice as much force as the second winch.  
c) Each of the winches requires the same force.  
d) The first winch requires less energy than the second winch.  
e) The first winch requires more energy than the second winch.

30. The close relationship between work and energy is reflected in the fact that

a) doing work on an object will give it energy.  
b) stored energy can be used to do work.  
c) both work and energy are measured in units of joules.  
d) power is both the rate of energy transfer and the rate of work done.  
e) All of the above statements are correct.
31. A ground fault circuit interrupter is required by the National Electric Code in electrical receptacles installed outdoors. The purpose of this device is

a) to prevent more than 15 amps of current in the circuit.
b) to provide a ground for any device which is plugged into the receptacle.
c) to reduce the voltage from 120 volts to 30 volts.
d) to convert the electrical current from AC to DC.
e) to shut off the circuit if any current leaks from the circuit.

33. The magnetic field in a solenoid can be increased by (read ALL the answers)

a) decreasing the number of turns in the wire.
b) putting an iron core in the coil.
c) increasing the current in the wire.
d) both b) and c).
e) a), b), and c).

34. A direct current motor (like the St. Louis motor) could be fitted with a hand crank to function as a

a) capacitor
b) electromagnet
c) generator
d) battery
e) transformer

35. You need to transmit a large amount of electrical power, but need to keep the voltage low for safety reasons. You will need to use

a) a small current.
b) a large current.
c) thick wires.
d) both b and c.
e) high voltage after all. It not is possible to transmit large power without using high voltage.
36. Sarah has stored 5 coulombs of charge on a capacitor, using a battery as the energy source. If the final voltage on the capacitor is 6 volts, what is the total energy stored on the capacitor?

a) 5 joules  
b) 6 joules  
c) 15 joules  
d) 30 joules  
e) 180 joules

37. In class we first measured the resistance of a toaster when it was operating, and then we found its resistance when it was turned on but not operating. Which of the following statements about the toaster's resistance is TRUE?

a) The resistance was greater when operating because a series circuit was created.  
b) The resistance was greater when operating because the temperature of the resistor increased.  
c) The resistance was less when operating because a parallel circuit was created.  
d) The resistance was less when operating due to Joule heating.  
e) The resistance was the same because the resistor's length and thickness did not change.

38. A 2 pound rock dropped from a height of 1.0 foot will be traveling at a velocity of 8 feet/second just before it hits the ground. From what height would a 4 pound rock have to be dropped in order for it to be traveling at a velocity of 8 feet/second just before it hits the ground? Neglect air resistance.

a) 0.5 foot  
b) 1.0 foot  
c) 2.0 feet  
d) 4.0 feet  
e) 8.0 feet

39. In a loudspeaker, what device is used in combination with a permanent magnet to produce sound?

a) a coil of wire  
b) a capacitor  
c) a lever  
d) another permanent magnet  
e) Any of the above could be used.
40. Suppose that a neighborhood consists of 200 homes, each requiring 1500 watts of power. If this power is supplied by 2400 volt lines from a power substation, how large is the current supplied by the substation?

a) 0.625 amps  
b) 12 amps  
c) 83 amps  
d) 125 amps  
e) 720,000,000 amps

41. The video Race to Save the Planet: Less is More discussed energy conservation tactics used in Osage, Iowa. Which of the following was NOT a conservation technique discussed in this video?

a) replacing fluorescent lighting fixtures with incandescent lighting fixtures  
b) convincing homeowners that conservation would not mean a lower standard of living  
c) replacement of leaky windows in homes  
d) education programs in the schools  
e) use of infrared cameras to detect heat leaks in homes

42. A 0.5 farad capacitor is attached to a pair of batteries in series so that it is charged to a final voltage of 3.0 volts. How much charge is stored in the capacitor?

a) 0.17 joules  
b) 1.5 joules  
c) 1.5 coulombs  
d) 6.0 joules  
e) 6.0 coulombs

43. How high must the voltage be in order to get the electric potential energy of a charge of 5 coulombs to 15 joules?

a) 1/3 volt  
b) 3 volts  
c) 10 volts  
d) 20 volts  
e) 45 volts
44. If Winston can just barely lift a 1200 pound weight by exerting a force of 80 pounds, what is the mechanical advantage of the machine he is using?

a) 1  
b) 1.5  
c) 15  
d) 80  
e) 160

45. In class, we saw that an audio tape can be quickly erased by

a) a bright light.  
b) humid air.  
c) a capacitor.  
d) a copper disk.  
e) a magnet.