All questions (1-50) are each worth 2 points.

1. Which of the following statements best describes the scientific method?
   A. The scientific method is a linear process starting with observation and following several other rigidly defined steps.
   *B. The scientific method is a continuous process by which people learn about the physical universe and share their knowledge with others.
   C. The scientific method allows scientists to report findings in such a way that experiments remain known only to the original experimenters.
   D. The scientific method allows a scientist to ethically discard the results of an experiment and repeat the experiment when the results of an experiment do not fit the hypothesis.
   E. The scientific method has no connection to the way people conduct their lives every day.

2. A scientific theory is best described as being
   A. an educated guess.
   B. a statement that describes how a system will behave.
   C. a precise mathematical equation.
   *D. based on many observations and experiments.
   E. an untested hypothesis.

3. Which measurement of an average classroom door is closest to 2 meters?
   A. Thickness
   B. Width
   *C. Height
   D. Surface area
   E. Volume

4. The magnitude of the force that a baseball player exerts with a 6 kilogram baseball bat on a 0.1 kilogram ball is measured to be 60 Newtons. What is the magnitude of the force that the ball exerts on the bat?
   A. 6 Newtons
   B. 10 Newtons
   C. 50 Newtons
   *D. 60 Newtons
   E. 0.6 Newtons

5. A group of bicycle riders took a 3 hour trip. During the first 2 hours they traveled a total of 40 kilometers. During the last hour they traveled an
additional 10 kilometers. Which of the following values is closest to the group’s average speed for the entire trip?
A. 10 km/hr
*B. 16.67 km/hr
C. 20 km/hr
D. 25 km/hr
E. 40 km/hr

6. Which two terms represent a vector quantity and the scalar quantity of the vector’s magnitude, respectively?
A. acceleration and velocity
B. weight and force
C. speed and time
*D. velocity and speed
E. time and distance

7. In the diagram above, a box is on a frictionless horizontal surface with forces F1 and F2 acting as shown. If the magnitude of F2 is greater than the magnitude of F1, then the box is
A. moving at constant speed in the direction of F1
B. moving at constant speed in the direction of F2
C. accelerating in the direction of F1
*D. accelerating in the direction of F2
E. not moving at all.

8. A 5 kilogram rock and a 2 kilogram stone fall freely from rest from a height of 1000 meters. After they fall for 2 seconds, the ratio of the rock’s speed to the stone’s speed is
*A. 1 to 1
B. 1 to 2
C. 2 to 1
D. 4 to 1
E. 100 to 1

9. When a satellite is a distance R from the center of Earth, the force due to gravity on the satellite is F. What is the force due to gravity on the satellite when its distance from the center of the Earth is 4R?
A. 9 F
B. 4 F
C. F / 4
D. F / 9
*E. F / 16
10. The speed of a car is increased uniformly from 10 meters per second to 50 meters per second in 4 seconds. Which of the following is closest to the magnitude of the car’s acceleration?
   A. 50 m/s²
   B. 12.5 m/s²
   C. 2.5 m/s²
   *D. 10 m/s²
   E. 40 m/s²

11. The metric unit of a Joule (J) is a unit of
   A. potential energy.
   B. work.
   C. kinetic energy.
   *D. All of the above (A, B, and C) are measured in Joules.
   E. None of the above (A, B, and C) are measured in Joules.

12. Which statement is true about the concept of power?
   A. Power is the distance over which work is done.
   B. Power is the time at which energy is expended.
   *C. Power is the work done per unit time.
   D. All of the above (A, B, and C) can be said about power.
   E. None of the above (A, B, and C) is true about power.

13. A kilowatt-hour is a unit of
   A. power.
   *B. work.
   C. time.
   D. area.
   E. volume.

14. Which of the following best describes the law of conservation of energy?
   A. Energy must not be used up faster than it is created or the supply will run out.
   *B. Energy can be neither created nor destroyed.
   C. Energy is conserved because it is easily destroyed.
   D. Conservation is a law describing how to destroy matter.
   E. Energy conservation is a law recently passed by Congress.

15. What is the work done by applying a force of 50 Newtons on a 100 kilogram object over a distance of 10 meters?
   A. 1,000 Joules
   B. 100 Joules
   *C. 500 Joules
   D. 10,000 Joules
   E. 5,000 Joules
16. What is the power consumed by a 100 Joules energy source in 4 seconds?
   A. 400 Watts
   B. 100 Watts
   C. 200 Watts
   D. 50 Watts
   *E. 25 Watts

17. What is the kinetic energy of a ball of mass 200 grams thrown with a velocity of 20 meters per second?
   A. 4,000 Joules
   *B. 40 Joules
   C. 20,000 Joules
   D. 40,000 Joules
   E. 2,000 Joules

18. Absolute zero is best described as the temperature at which
   A. water freezes at standard temperature and pressure.
   B. water boils at standard temperature and pressure.
   C. the molecules of a substance have maximum kinetic energy.
   D. water can be found to be either gas, liquid or solid.
   *E. the molecules of a substance have minimum kinetic energy.

19. Heat will always flow from object B to object A if object B has a higher
   A. mass.
   B. total energy.
   *C. temperature.
   D. weight.
   E. specific heat.

20. The heat transfer that takes place by energy moving directly from molecule to molecule is called
   *A. conduction.
   B. convection.
   C. radiation.
   D. All of the above.
   E. None of the above.

21. As a solid undergoes a phase change to a liquid state, it
   A. releases heat while remaining at a constant temperature.
   *B. absorbs heat while remaining at a constant temperature.
   C. releases heat as the temperature decreases.
   D. absorbs heat as the temperature increases.
   E. always has the same amount of heat.
22. The time required for a vibrating object to complete one full cycle is the
   A. frequency.
   B. amplitude.
   *C. period.
   D. Newton.
   E. Watt.

23. The units of cycles per second is called a
   A. Watt.
   *B. Hertz.
   C. Amp.
   D. volt.
   E. Coulomb.

24. The characteristic of a wave that is responsible for what you interpret as
   pitch is the wave’s
   A. amplitude.
   B. altitude.
   *C. frequency.
   D. height.
   E. None of the above relates to pitch.

25. An astronomer on Earth studying light coming from a star notes that the
   observed light frequencies are higher than the actual emitted frequencies.
   The astronomer concludes that the distance between the star and the
   Earth is
   *A. decreasing.
   B. increasing.
   C. unchanging.
   D. not able to be determined.
   E. imaginary.

26. What is the frequency of a wave if its period is 0.2 second?
   A. 1 Hertz
   B. 2 Hertz
   *C. 5 Hertz
   D. 4 Hertz
   E. 25 Hertz

27. Equal amounts of heat energy are given off by 1 kilogram samples of
   aluminum (c=0.90), iron (c=0.45), platinum (c=0.13) and zinc (c=0.39). All
   are initially at 100°C. Which sample has the smallest decrease in
   temperature?
   *A. aluminum.
   B. iron.
   C. platinum.
   D. zinc.
   E. All of the samples would have the same decrease in temperature.
28. You are a chemist investigating how the chemical “sigma” affects membranes in cells. Of the following, which is the best way to express a hypothesis to serve as a basis for your investigations:
   A. Sigma affects cell membranes under some conditions in nature.
   B. Does Sigma affect cell membranes?
   C. Sigma could affect cell membranes under some conditions in nature.
   *D. Sigma effects changes in cell membranes.
   E. All of the above are equally good hypotheses.

29. Which of the following is commonly associated with pseudoscience?
   A. Astrology
   B. Cosmetics creams
   C. Nutrition supplements
   D. Weight control supplements
   *E. All of the above

30. Which of the following suggests that the acceleration of an object is directly proportional to the force acting upon it?
   A. Newton’s 1st Law of Motion
   *B. Newton’s 2nd Law of Motion
   C. Newton’s 3rd Law of Motion
   D. Coulomb’s Law
   E. Doppler Effect

31. Which of the following describes the apparent bending of waves around a corner, after passing through an opening?
   A. Reflection
   B. Refraction
   *C. Diffraction
   D. Relativity
   E. Snell’s Law

32. Which of the following is a unit of electrical current in charges per second?
   A. Volt
   *B. Amp
   C. Coulumb
   D. Negative
   E. Rate

33. Which of the following describes the apparent shift in the frequency of a wave due to the motion of the source or observer?
   A. Snell’s Law
   B. Charles’ Law
   C. Newton’s Law
   D. Coulomb’s Law
   *E. Doppler Effect
34. Which of the following describes the relationship between charge, distance and the electrical force between two objects?
   A. Snell’s Law
   B. Charles’ Law
   C. Newton’s Law
   *D. Coulomb’s Law
   E. Doppler Effect

35. In order to convert from inches to centimeters, what should you do?
   *A multiply by 2.54
   B divide by 2.54
   C add 2.54
   D subtract 2.54
   E raise the inch value to the 2.54 power

36. In order to convert from kilometers to meters, what should you do?
   A add 1000
   B subtract 1000
   C divide by 1000
   *D multiply by 1000
   E can’t tell from information given

37. How do you write 12,300,000 in scientific notation?
   A $1.23 \times 10^6$
   *B $1.23 \times 10^7$
   C $1.23 \times 10^8$
   D $1.23 \times 10^9$
   E $1.23 \times 10^5$

38. All of the following are moving with a velocity of 10 m/s in the same direction. Which will have the greatest amount of kinetic energy?
   A baseball (~200 g)
   *B bowling ball (~7 kg)
   C pingpong ball (~20g)
   D soccer ball (~200 g)
   E basketball (~400 g)

39. From a physics perspective, which of the following represents work being done?
   A You attempt to open a jar of pickles but do not succeed.
   B You hold an object in one position for three hours.
   C You are sitting, watching a movie for two hours.
   *D You throw a dart at a target.
   E All of the above are examples of work.
40. A non-motorized roller coaster car starts coasting at the top of one hill, rolls down into a valley and then comes to a stop at the top of a neighboring hill. The top of the neighboring hill is at a lower elevation than the starting point. The best picture of the transfer of total energy, in this case, is described as
   A potential to kinetic and back to potential.
   B chemical to kinetic and back to potential.
   *C potential to kinetic and heat, and back to potential and heat.
   D chemical to heat and back to potential.
   E mechanical energy to heat.

41. When a meteor hits the ground it generates a lot of heat. Which of the following statements best describes this process?
   A Elastic potential energy is converted into heat.
   B Magnetic energy is converted into heat.
   C Chemical energy is converted into heat.
   D Electrical potential energy is converted into heat.
   *E Gravitational potential energy is converted into heat.

42. Einstein discovered a formula (E = mc^2) that showed that you could get a great deal of energy from
   A oil heat.
   B the edge of the universe.
   C the Milky Way galaxy.
   *D a small amount of matter.
   E dropping a large weight.

43. A bar magnet cut into half will always make
   A a North pole magnet
   B a South pole magnet
   C two magnetic monopoles
   *D two complete magnets with both a North and South pole
   E a paramagnet

44. What characteristic of a blackbody can you determine from knowing only the spectral peak wavelength?
   *A temperature
   B composition
   C phase
   D energy
   E density
45. Which electromagnetic radiation (of those listed) has more energy per photon than red light?
A  infrared radiation
B  radio waves
C  microwaves
*D  ultraviolet radiation
E  all of the above have the same energy

46. According to Maxwell’s Laws moving electric fields always generate
A  protons
B  neutrons
C  electrons
*D  magnetic fields
E  electrostatic fields

47. An object falls from a building roof and hits the ground 6 seconds later. After release, the only force acting on it is gravity. Which value is closest to the height of the building?
A  600 meters
B  60 meters
C  3600 meters
*D  180 meters
E  350 meters

48. Two resistors are in parallel in a simple DC circuit. One resistor is 10 ohms and the other is 20 ohms. Which value is closest to the effective resistance of the two resistors connected in parallel?
A  15 ohms
*B  6.67 ohms
C  30 ohms
D  10 ohms
E  33.3 ohms

49. A DC circuit has a current of 10 amps and an effective resistance of 20 ohms. What is the voltage of the source supplying the circuit?
A  30 Volts
B  4,000 Volts
C  20 Volts
*D  200 Volts
E  2,000 Volts

50. A DC circuit has a current of 10 amps and an effective resistance of 20 ohms. What is the power consumed by the circuit?
A  300 Watts
B  40,000 Watts
*C  2,000 Watts
D  200 Watts
E  20,000 Watts
MASS CONVERSIONS
one mg (milligram) = 1/1000 g
one g (gram) = 1000 mg, 14.4 gr, .035 oz
one kg (kilogram) = 1000 g, 35 oz, 2.2 lbs
one gr (grain) = 0.65 g
one oz (ounce) = 28.35 g
one lb (pound) = 16 oz, 454 g, .45 kg

LENGTH CONVERSIONS
one μ (micron) = 1/1000 mm
one mm (millimeter) = 1/10 cm, 1000 μ, 1/1000 m
one cm (centimeter) = 10 mm, 0.39 in, 1/100 m
one m (meter) = 1000 mm, 100 cm, 39.37 in
one km (kilometer) = 1000 m, 3280 ft
one in (inch) = 25.4 mm, 2.54 cm
one ft (foot) = 12 in, 0.3048 m, 0.333 yd
one yd (yard) = 3 ft, 0.9144 m, 0.091 m
one mile = 5280 ft, 1760 yd

TIME CONVERSIONS
one millisecond (ms) = 1/1000 sec
one second (sec) = 1000 ms, 1/60 min
one minute (min) = 60 seconds
one hour (hr) = 60 min, 3600 sec
one day = 24 hrs
one year (yr) = 365.25 days

ANGULAR MEASURE CONVERSIONS
one second (") = 1/60', 1/3600 deg
one minute ('') = 60", 1/60 deg
one degree (deg) = 1/360 of a circle
one minute (min) = 60 sec, 1/60 hr
one hour (hr) = 15 deg

Formulas that may be useful:

\[ d = v \cdot t \]
\[ a = \frac{(v_f - v_i)}{t} \]
\[ v_{average} = \frac{(v_f + v_i)}{2} \]
\[ d = 0.5 \cdot a \cdot t^2 \]
\[ F = m \cdot a \]
\[ w = m \cdot g \]
\[ p = m \cdot v \]
\[ a_r = \frac{v^2}{r} \]
\[ F = \frac{(m \cdot v^2)}{r} \]
\[ v_f = (a \cdot t) + v_i \]
\[ F = \frac{(G \cdot m \cdot M)}{d^2} \]
\[ W = F \cdot d \]
\[ KE = 0.5 \cdot m \cdot v^2 \]
\[ PE = m \cdot g \cdot h \]
\[ Q = m \cdot c \cdot \Delta T \]
\[ T = \frac{1}{f} \]
\[ f = \frac{1}{T} \]
\[ v = \lambda \cdot f \]
\[ F = \frac{(k \cdot q_1 \cdot q_2)}{d^2} \]
\[ I = q \cdot t \]
\[ V = I \cdot R \]
\[ P = I \cdot V \]
\[ n = \frac{c}{v} \]
\[ E = h \cdot f \]

\[ R_t = R_1 + R_2 \quad \text{or} \quad \frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2} \]

Acceleration due to gravity is 9.8 m/s²
1 kilocalorie = 4184 Joules