(Phys. 117 Final EXAM F04, Version A)

Note Error Corrections: #18, #45, #55 & #73 & #106.

MULTIPLE CHOICE: Choose the one most nearly correct answer and insert its letter into your answer sheet.

1. Which version (A or B?) of this exam are you working from? See note after page number in upper left hand corner above, and fill in the correct answer on your NCS sheet.
   a. Version A
   b. Version B

2. If a car requires 30 seconds to accelerate from zero to 90 km per hour, its average acceleration is, most nearly,
   a. 800 m/ sec^2
   b. 80 m/ sec^2
   c. 8 m/sec^2
   d. 0.8 m/sec^2
   e. 0.08 m/sec^2

3. A sheet of paper and a book fell at different rates in the classroom until the paper was wadded up into a ball. We then claimed that if the air resistance could be neglected, all objects would fall at
   a. the same constant speed regardless of the type of material.
   b. the same constant speed regardless of how much they weigh.
   c. different constant speeds depending on the type of material.
   d. the same constant acceleration.
   e. different accelerations proportional to their masses.

4. The motion of a block sliding down a frictionless ramp can be described as motion with
   a. a constant speed, independent of the slope of the ramp.
   b. a constant speed that depends on the slope of the ramp.
   c. an acceleration which increases as the block slides.
   d. a constant acceleration less than 10 m/s/s.
   e. a constant acceleration greater than 10 m/s/s.

5. If a ball is dropped from rest, it will fall 20 m during the first two seconds. How far will it fall during the fourth second?
   a. 15 m
   b. 25 m
   c. 35 m
   d. 45 m
   e. None of the above is within 10% of the correct answer.

6. A ball with a mass of 0.5 kg is thrown vertically upward with a speed of 25 m/s. What are its speed and direction three seconds later?
   a. 10 m/s upward
   b. 5 m/s upward
   c. zero
   d. 5 m/s downward
   e. 10 m/s downward
   f.. None of the above is within 10% of the correct answer.

7. A car initially traveling north at 15 m/s has a constant acceleration of 2 m/s^2 northward. How far does the car travel in the first 10 s?

a. 50 m
b. 100 m
c. 150 m
d. 250 m
e. None of the above is within 10% of the correct answer.

8. You decide to launch a ball vertically so that a friend located 180 m above you can catch it. What is the minimum launch speed you can use?

a. 60 m/s
b. 30 m/s
c. 20 m/s
d. 10 m/s
e None of the above is within 10% of the correct answer.

9. What is the net force on an 800-kg airplane flying with a velocity of 190 km/hour north and a constant acceleration of 2m/s^2 forward?

a. zero
b. 190 N
c. 800 N
d. 1600 N
e. None of the above is within 10% of the correct answer.

10. There are three forces acting on an object: 5 N to the left, 6 N to the right, and 3 N to the left. What is the net force acting on the object?

a. 6 N right
b. 2 N left
c. 4 N right
d. 8 N left
e None of the above.

11. The same net force is applied to object A and object B. The observed accelerations of the two objects are not the same; object A has an acceleration four times that of object B. Which of the following is correct?

a. Object A has three times the mass of object B.
b. Object A has one-third the mass of object B.
c. There may be some other unexpected force accelerating A.
d. There may be some other unexpected force decelerating B.
e. None of the above is consistent with the facts stated.

12. Which of the following is not a vector quantity?

a. force
b. acceleration
c. weight
d. velocity
e. All of the above are vector quantities.

13. A ball with a weight of 20 N is thrown vertically upward. What is the acceleration of the ball just as it reaches the top of its path?
a. 20 m/s^2 downward
b. 10 m/s^2 downward
c. zero
d. 10 m/s^2 upward
e. 20 m/s^2 upward
f. None of the above is correct within 10%.

14. Two steel balls have the same mass, size, shape, and surface, but one is hollow. They are dropped in air and their terminal speeds are measured. Which of the following statements is correct?
a. The hollow ball has a smaller terminal speed because it requires a smaller air resistance to cancel the gravitational force on it.
b. The hollow ball has a larger terminal speed because it requires a smaller air resistance to cancel the gravitational force on it.
c. The terminal speeds are the same.
d. The terminal speeds are different, but it is not possible to say which is greater.
e. None of the above statements is true.

15. A 50-kg crate is being pushed across a horizontal floor by a horizontal force of 375 N. If the coefficient of sliding friction is 0.25, what is the acceleration of the crate?
a. zero
b. 3 m/s^2
c. 5 m/s^2
d. 7 m/s^2
e. 9 m/s^2
f. None of the above is correct within 10%.

16. If the earth exerts a gravitational force of 20,000 N on a satellite of mass 500 kg moving along a synchronous orbit, what force does the satellite exert on the earth?
a. zero
b. a small fraction of 1 N
c. 5000 N
d. 20,000 N
e. None of the above.

17. You leap from a bridge with a bungee cord tied around your ankles. As you approach the river below, the bungee cord begins to stretch and you begin to slow down. The force of the cord on your ankles which slows you must be _____ your weight?
a. less than
b. equal to
c. greater than
d. much greater than
e There is not enough information to be sure of any of the above.

18. Terry and Chris pull hand-over-hand on opposite ends of a rope while standing on a frictionless frozen pond. Terry's mass is 25 kg and Chris's mass is 75 kg. If Chris' acceleration is 12 m/s^2, what is ~~Chris's~~ Terry's acceleration?
a. 36 m/s^2
b. 12 m/s^2
c. 6 m/s^2
d. 4 m/s^2
e. None of the above is within 10% of the correct answer.

19. If a race car is traveling around a circular track at a constant speed of 100 mph, we know that the car experiences
a. a frictional force..
b. a centripetal force.
c. a gravitational force
d. a net force perpendicular to its velocity
e. All of the above.
f. None of the above.

20. In uniform circular motion the
a. acceleration is parallel (or antiparallel) to the velocity.
b. acceleration is perpendicular to the velocity.
c. acceleration is vertical, while the velocity can be in any direction.
d. acceleration is vertical and the velocity is horizontal.
e. none of the above statements is true.

21. A cyclist turns a curve with a radius of 160 m at a speed of 20 m/s. What is the magnitude of the cyclist's acceleration?
a. 0.4 m/s^2
b. 2.5 m/s^2
c. 400 m/s^2
d. 1000 m/s^2
e. None of the above is within 10% of the correct answer.

22. What centripetal acceleration is required to follow a circular path with a radius of 200 m at a speed of 20 m/s?
a. 2 m/s/s
b. 4 m/s/s
c. 6 m/s/s
d. 8 m/s/s
e. None of the above is within 10% of the correct answer.

23. A gun is held horizontally and fired. At the same time the bullet leaves the gun's barrel an identical bullet is dropped from the same height. Neglecting air resistance, which bullet will hit the ground with the greatest kinetic energy?
a. The bullet that was fired, because it feels the force of gravity over a longer distance.
b. The bullet that was dropped, because it falls for a longer time.
c. It will be a tie, because both dropped from the same length of time.
d. The bullet that was fired.
e. The bullet that was dropped.

24. Which of the following statements about projectile motion is true (neglecting air resistance)?
a. The horizontal and vertical motions are independent.
b. The force on the projectile is constant throughout the flight.
c. The acceleration of the projectile is constant throughout the flight.
d. The force on the projectile is always vertically downward
e. All of the above statements are true.

25. Which of the following statements about the moon is most correct?
   a. The moon has a constant velocity.
   b. The net force acting on the moon due to the sun, the earth and the other planets is zero.
   c. The earth exerts a stronger force on the moon than the moon exerts on the earth.
   d. The moon experiences a centripetal acceleration toward the earth.
   e. All of the above statements abut the moon are true.
   f. None of the above statements is true.

26. An astronaut weighs 900 N when measured on the surface of the earth. How large would the force of gravity on him be if he were in an earth satellite at an altitude equal to two earth radii?
   a. 100 N
   b. 225 N
   c. 450 N
   d. 900 N
   e. None of the above is correct within 10%

27. A future space traveler, Skip Parsec, lands on the planet MSU3, which has half the mass of Earth and half its radius. If Skip weighs 400 Newtons on Earth's surface, how much does he weigh on MSU3's surface?
   a. 1600 N
   b. 800 N
   c. 400 N
   d. 200 N
   e. 100 N

28. The precise numerical value of G, the gravitational constant, was determined
   a. from knowledge of the earth's mass density and volume
   b. from the law of universal gravitation and the value of the acceleration due to gravity.
   c. from the value of the moon's acceleration.
   d. from a very precise knowledge of the mass of the earth.
   e. None of the above.

29. Which of the following would <u>not</u> cause the gravitational force on an object near the surface of the earth to change?
   a. an ore deposit just under the surface
   b. a lower elevation
   c. an increase in its mass
   d. an increase in the altitude of the object.
   e. All of the above would cause a change in the gravitational force on the object.

30. In an orbiting satellite such as SkyLab , physical objects
   a. have neither mass nor weight.
   b. have mass but feel no force due to gravity.
   c. have mass but no weight
   d. fall to the floor with an acceleration of 9.5 m/s/s.
   e conform to all of the above statements.

31. How fast would you have to throw a ball of mass $m = 3.6$ kg to give it the same momentum as a 5-g bullet traveling at 800 m/sec, most nearly?
    a. 1.1 m/s
    b. 1.8 m/s
    c. 5.5 m/s
    d. 27.6 m/s
    e. 160 m/s

32. We can explain the recoil that occurs when a rifle is fired by using
    a. The conservation of energy.
    b. The equal and opposite work done by the bullet and the rifle.
    c. equal and opposite changes in momentum.
    d. Newton's second law.
    e. Any or all of the above.
    f. None of the above.

33. What average force is required to stop a 120-kg football player running at 8 m/s in a time of 2.5s?
    a. 6 N
    b. 37.5 N
    c. 384 N
    d. 2400 N
    e. None of the above is within 10% of the correct answer.

34. It takes about 30 s for a jet plane to go from rest to the takeoff speed of 100 mph (44.7 m/s) What is the average forward force that the seat exerts on an 80-kg passenger during takeoff?
    a. 11.9 N
    b. 16.8 N
    c. 53.7 N
    d. 119 N
    e. None of the above is within 10% of the correct answer.

35. If we examine a ball in free fall, we find that the momentum of the ball is not constant. This is not a violation of the law of conservation of momentum because
    a. the force of gravity acts on the ball.
    b. the ball experiences an external force.
    c. the ball is not an isolated system.
    d. All of the above reasons are valid.
    e. None of the above statements is true

36. If rockets are fired in the forward direction from a moving airplane, the momentum of the airplane will
    a. increase just enough to conserve the momentum of the plane plus rocket system
    b. be unchanged, by conservation of momentum.
    c. decrease just enough to conserve the momentum of the plane plus rocket system
    d. decrease, but not by an amount we can specify
    e. Increase, but not by an amount that we can specify.

37. Which of the following properties of a ball is conserved as it falls freely in a vacuum?
    a. kinetic energy
    b. gravitational potential energy
    c. momentum
    d. velocity
    e. None of the above.

38. A ball moving at 4 m/s toward the right has a head-on collision with an identical ball moving at 4m/s to the left. Each of the following final velocity pairs satisfies the law of conservation of linear momentum. Which one also preserves kinetic energy? One ball has a velocity of _____ while the other has a velocity of _____ to the right.
    a. 2 m/s to the left … 2 m/s
    b. zero … zero
    c. 3 m/s to the left … 3 m/s
    d. 4 m/s to the left … 4 m/s
    e. None of the above has a final kinetic energy equal to the initial value.

39. Two objects have different masses but the same kinetic energies. If you stop them with the same constant retarding force, which one will stop in the shorter distance?
    a. The heavier one.
    b. The lighter one.
    c. The one with the larger momentum.
    d. The one with the smaller momentum
    e. Both stop in the same distance.

40. Two objects have different masses but the same momenta. If you stop them with the same constant retarding force, which one will stop in the shorter distance?
    a. the heavier one
    b. the lighter one
    c. The one with the larger kinetic energy
    d. Both stop in the same distance
    e. There is not enough information to say.

41. The kinetic energy of an object moving in a circle at a constant speed
    a. is continually changing as the force changes direction.
    b. is equal to the force times the time for one revolution.
    c. is equal to one-half of the potential energy.
    d. depends upon the radius of the circle..
    e. None of the above statements is true.

42. Which of the following does NOT have the physical dimension of power?
    a. Newton-meter/sec
    b. kilowatt
    c. Joule/sec^2
    d. kg-m^2/sec^3
    e. All of the above have the physical dimension of power.

43. Riding in a glass-walled elevator that goes down the outside of a tall building at a constant speed of 20 meters per second, you drop a ball as you pass a window washer. The window washer will see the ball
   a. fall starting from rest.
   b. fall starting with an upward speed of 20 m/s.
   c. fall starting with a downward speed of 20 m/s.
   d. remain stationary.
   e. None of the above statements is true

44. While you are standing on the ground, your friends pass by in a van traveling at a constant velocity. They drop a ball and you all make measurements of the ball's motion. Which of the following quantities has the same value in both reference systems?
   a. velocities
   b. total mechanical energies
   c. momenta of the individual particles.
   d. total momentum
   e. None of the above

45. Assume that you are riding in a windowless room on a perfectly smooth surface. (You can't feel any motion.) Imagine that you have a collection of objects and measuring devices in the room. Which of the following experiments could you use to prove that the room is accelerating horizontally at a constant ~~velocity~~ rate?
   a. Observing an object on a frictionless surface
   b. Weighing an object and comparing to its known weight.
   c. Dropping an object in vacuum and observing its trajectory.
   d. Measuring the verticality of a hanging object
   e. All of the above.
   f. None of the above.

46. A train is traveling along a straight, horizontal track with a constant acceleration in the forward direction. At the instant the speed is 50 mph, a ball is dropped by an observer in the train. An observer in the train determines that the horizontal speed of the ball during the fall is
   a. decreasing
   b. increasing
   c. zero
   d. equal to 50 mph.
   e. None of the above.

47. An observer drops a ball in a train traveling along a straight, horizontal track with a constant velocity in the forward direction. What would an observer in the train say about the horizontal force acting on the ball?
   a. There is no horizontal force.
   b. A force acts backward.
   c. A force acts forward.
   d. There is a centrifugal force.
   e. None of the above

48. An elevator is moving upward and speeding up with an acceleration equal in magnitude to one-quarter that of gravity. If a person who weighs 800 N when at rest on Earth steps on a bathroom scale in this elevator, what will the scale read?
   a. 200 N
   b. 600 N
   c. 800 N
   d. 1000 N
   e. None of the above.

49.The second postulate of special relativity does NOT require that the speed of light
a. is a constant in a vacuum and equal to c.
b. is independent of the motion of the receiver.
c. is independent of the motion of the source.
d. is independent of the direction of propagation
e. In fact, the second postulate requires all of the above.

50. Superman wants to travel back to his native Krypton for a visit, a distance of $3X10^{13}$ meters. (At nearly the speed of light, it takes light nearly 10^5 seconds to travel this distance.) If Superman is able to hold his breath for 10^3 s and travel at any speed less than that of light, can he make it before he suffocates?
a. Not unless he stops off for a breath on his way.
b. Not unless he goes faster than light.
c. No way.
d. Yes, because for him his biological clock slows down to give him more time
e. Yes because for him, the distance is contracted to a much smaller value.

51. In problem 50.above, Superman wanted to travel back to Krypton, a distance of $3X10^{13}$ meters. (Assume it takes light 10^5 seconds to travel this distance.) If Superman can hold his breath for only 10^3 s, what adjustment factor, γ, must correspond (most nearly) to his speed, v, for him to make it without suffocating?
a. 100
b. 30
c. 10
d. 3
e. 1
f. None of the above, because he can never travel faster than light.

52. In the twin paradox one twin remains on earth while the other makes a trip to a distant location and back at the same constant speed, close top c. Each argues that his brother will have aged less than he. When the twins are reunited on earth, which of their claims will prove to be valid? The valid claim is that of
a. the twin who remained on earth, because he did not undergo any acceleration.
b. the twin who made the trip, because he had to accelerate to turn around.
c. Actually, neither: they are the same age, because the speed was held constant out and back.
d. The answer depends upon the details of the turnaround.
e. None of the above statements is true.

53.An electron is being accelerated by a constant force to nearly the speed of light. Which of the following is NOT true?
a. Its kinetic energy increases steadily.
b. Its momentum increases, but at a diminishing rate
c. It can approach but not exceed the speed of light.
d. Its total energy continually increases.
e. All of the above are true.

54.If inertial mass and gravitational mass were NOT the same,
a. the form of law of universal gravitation would need to be modified.
b. the form of Newton's second law would need to be modified.
c. one could distinguish the pseudo-forces in accelerated frames from gravitational fields.
d. objects falling in a vacuum near the earth's would still all experience the same acceleration.
e. All of the above statements are true.

55. One ammonia molecule consists of 1 ~~mole~~ atom of nitrogen ~~atoms~~ (A=14) and 3 ~~moles~~ atoms of hydrogen ~~atoms~~ (A=1) . If you combine 8 kg of nitrogen with 8 kg of hydrogen to make ammonium, how many moles of ammonia can you make?
   a. 571
   b. 500
   c. 62
   d. 3
   e. None of the above is within 10% of the correct answer.

56. Two gases are kept at the same temperature. If the molecules of gas A have 4 times the mass of those of gas B, what is the ratio of the mean squared speed of the B molecules to that of the A molecules?
   a. 4
   b. 2
   c. 1
   d. 1/2
   e. 1/4

57. Which of the following is NOT assumed in our model of the ideal gas? The gas molecules
   a. rebound elastically when they collide with the container wall.
   b. have no internal structure.
   c. are indestructible.
   d. do not interact except when they collide.
   e. May sometimes break up into their separate atoms
   f. All of the above are properties of our ideal gas.

58. If a liter of gas has a pressure of 0.5 atmosphere, what will the pressure be if the average kinetic energy of the molecules is doubled, while the volume reduced to one fourth of its original value?
   a. 0.5 atm
   b. 1 atm
   c. 2 atm
   d. 4 atm
   e. None of the above is within 10%.

59. What Celsius temperature corresponds most closely to 200 K?
   a. 127° C
   b. 27° C
   c. -73° C
   d. -173° C
   e. None of the above is within 10%.

60. What Celsius temperature corresponds most closely to 77° F?
   a. 25° C
   b. 43° C
   c. 60° C
   d. 81° C
   e. 139° C

61. Joule's experiments with hanging weights turning paddle wheels in water
    a. showed that the same amount of work always generated the same amount of heat.
    b. showed that heat was not a fluid.
    c. were used to define the calorie.
    d. showed that heat could be converted 100% to mechanical energy.
    e. None of the above.

62. Two objects are in thermal equilibrium if
    a. they have the same temperature.
    b. they are each in thermal equilibrium with the same third object.
    c. they are in thermal contact and there is no net flow of thermal energy.
    d. All of the above are true
    e. None of the above is true.

63. The first law of thermodynamics
    a. is a restatement of the law of conservation of energy which includes heat as energy
    b. allows that internal energy can be completely converted into work.
    c. treats mass as another form of energy.
    d. guarantees that the work extracted by a cyclic heat engine can never be less than the heat inserted.
    e. All of the above statements are true of the first law.

64. When an ideal gas was compressed, its internal energy increased by 50 J and it gave off 30 J of heat. How much work was done on the gas?
    a. 30 J
    b. 50 J
    c. 80 J
    d. 110 J
    e. None of the above.

65. The third law of thermodynamics
    a. is a restatement of the law of conservation of energy.
    b. says that heat cannot be completely converted to mechanical energy.
    c. says that we can never reach the absolute zero of temperature.
    d. says that all motion ceases at absolute zero.
    e. guarantees that temperature is useful for predicting heat transfer.

66. Why do winter lakes freeze from the upper surface down?
    a. Because water has a high latent heat of vaporization.
    b. Because lakes have lower elevations, and cool air flows downhill.
    c. Because water has a relatively high specific heat.
    d. Because water becomes less dense as it cools to 0° C.
    e Because water has a high latent heat of fusion

67. It is NOT possible to convert completely
   a. heat into internal energy.
   b. mechanical energy into internal energy.
   c. potential energy into mechanical work.
   d. work into heat.
   e. All of the above transformations are in fact possible.

68. The second law of thermodynamics requires
   a. that a refrigerator can operate only it work is supplied.
   b. that it is impossible to build a heat engine that can do mechanical work by extracting thermal energy that does not also exhaust heat to the surroundings.
   c. that it is impossible to run a heat engine on heat from its own exhaust.
   d. that in each cycle of a heat engine the total entropy of the engine and its surroundings increases.
   e. All of the above.

69. A heat engine takes in 600 J of energy at 1000 K and exhausts 300 J at 400 K. What is the maximum theoretical efficiency (i.e., the Carnot efficiency) for this engine?
   a. 75%
   b. 67%
   c. 60%
   d. 50%
   e. None of the above is correct to ±1%

70. An engineer has designed a machine to produce electricity by using the difference in the temperature of ocean water at depths of 0 and 50 m. If the surface temperature is 20° C and the temperature at 50 m below the surface is 11° C, what is the maximum work this machine can extract per calorie of heat put in at the surface?
   a. 0.12 J
   b. 0.34 J
   c. 0.56 J
   d. 1.26 J
   e. None of the above is within ±10% of the correct answer.

71. How many different outcomes are there for the flipping of four different coins, and what fraction of those yields the most ordered result (i.e., all heads or all tails), respectively?
   a. 4 and 50%, respectively.
   b. 8 and 25%, respectively.
   c. 16 and 12.5%, respectively.
   d. 32 and 6.25%, respectively.
   e. None of the above are correct within ± 1%.

72. A cold piece of metal is dropped into an insulated container of hot water. After the system has reached its equilibrium temperature, the
   a. entropy of the metal has decreased.
   b. entropy of the water has increased.
   c. net change in entropy of the system is negative.
   d. final temperature of the system lies between the initial temperatures of the metal and the initial temperature of the water.
   e. All of the above statements are true.

73. What is the frequency of the minute ~~hour~~ hand on a clock?
    a. 3600 Hz
    b. 60 Hz
    c. 1 Hz
    d. $2 X10^{-2}$ Hz
    e. $3 X 10^{-4}$ Hz

74. Which of the following sets of parameters all affect the period of a pendulum? (M = Mass, L = Length, and g = acceleration due to gravity)
    a. (M, L and g)
    b. (M and L)
    c. (M and g)
    d. (L and g)
    e. L only
    f. None of the above.

75. For small amplitudes the period of a pendulum is _____ the acceleration due to gravity.
    a. proportional to
    b. proportional to the square root of
    c. inversely proportional to the square root of
    d. inversely proportional to
    e. None of the above.

76. Which of the following expressions gives the correct relationship between the wavelength, the period or frequency, and the velocity for a periodic wave?
    a. $v = \lambda T$
    b. $v = \lambda f$
    c. $v = \lambda / f$
    d. $v = fT$
    e. None of the above.

77. The ratio of the speed of a periodic sound wave of frequency of 220 Hz to that of a wave with a frequency of 440 Hz is, most nearly:
    a. 0.5
    b. 0.71
    c. 1.0
    d 1.41
    e. 2.0
    f. None of the above is correct within 10%.

78. A periodic wave on a string has a wavelength of 30 cm and a frequency of 4 Hz. What is the speed of the wave?
    a. 7.5 cm/s
    b. 30 cm/s
    c. 60 cm/s
    d. 120 cm/s
    e None of the above is correct within 10%.

79. The fundamental wavelength for standing waves on a rope fixed at both ends is the length of the rope.
    a. four times
    b. two times
    c. the same as
    d. one-half
    e. one-fourth
    f. None of the above

80. Two point sources produce waves of the same wavelength and are completely in-phase (that is, both sources produce maximal crests at the same time). At a point that is one-half wavelength farther from one source than the other, you would expect to find
    a. an amplitude equal to twice that of one wave alone.
    b. an amplitude equal to that of one wave alone.
    c. approximately zero amplitude.
    d. An intensity equal to four times that of each wave.
    e. None of the above

81. Which of the following are NOT electromagnetic waves?
    a. radio
    b. TV
    c. infrared light
    d. microwaves
    e X-rays
    f. All of the above are electromagnetic waves.

82. What is the wavelength of the carrier wave for an AM radio station located at 1000 kHz on the dial?
    a. 3 cm
    b. 3 m
    c. 30 m
    d. 300 m
    e None of the above is correct within 10%.

83. The periodic table arranges the elements according to
    a. the order in which they were discovered.
    b. their chemical properties.
    c. their relative abundances.
    d. alphabetical order.
    e. None of the above.

84. Which is a correct observation of what happened in our cathode ray tube demonstrations?
    a. The end of the glass tube opposite the cathode glows.
    b. A metal cross casts a shadow by blocking the cathode rays.
    c. The cathode rays are seen only when an accelerating voltage is applied
    d. The cathode ray stream is deflected by an magnetic field.
    e. All of the above.

85. Rutherford's model predicted that atoms should be unstable (the electrons should spiral into the nucleus) over very short time periods. What caused this instability in Rutherford's model?
    a. The positive charge in the nucleus was too far from the electrons to hold them in orbit.
    b. The attractive force between the positive nucleus and the electrons would pull them together.
    c. An accelerating charge must radiate energy.
    d. Nature abhors a vacuum.
    e None of the above.

86. You measure the brightness of two different hot objects; first with a blue filter and then with a red filter. You find that object A has a brightness of 25 in the blue and 20 in the red. Object B has a brightness of 12 in the blue and 3 in the red. The brightness units are arbitrary but the same for all measurements. Object A is _____ object B.
    a. cooler than
    b. the same temperature as
    c. hotter than
    d. hotter than B in the red but cooler in the blue, after normalizing the data.
    e. There is not enough information to say in these two frequency measurements..

87. When light is incident on a metallic surface, the emitted electrons
    a. are called photons.
    b. have arbitrarily high energies.
    c. have a maximum energy that depends on the intensity of the light.
    d. Are referred to as cathode rays.
    e None of the above

88. Einstein was able to account for the experimental observations of the photoelectric effect by assuming that
    a. the metal contained atomic resonators.
    b. light is a wave phenomenon.
    c. light consists of particle-like wave packets.
    d. electrons boil off when they get hot enough.
    e The intensity of the electromagnetic field was the determinant of the elelctrons' energies.
    f. None of the above.

89. A clean surface of potassium metal will emit electrons when exposed to blue light. If the **intensity** of the blue light is increased, the _____ of the ejected electrons will also increase.
    a. maximum kinetic energy
    b. number
    c. average speed
    d. average kinetic energy
    e. All of the above quantities increase with intensity.

90. A clean surface of metal will emit electrons when exposed to light. If the color of the light is changed from red to blue without changing the intensity, the _____ of the ejected electrons will also increase.
    a. mass
    b. number
    c. maximum kinetic energy
    d. charge
    e None of the above will occur with the stated change in color.

91. Which of the following lists photons in order of **increasing** energy?
    a. X ray, radio, infrared, visible, ultraviolet
    b. infrared, visible, ultraviolet, X ray, radio
    c. radio, infrared, X ray, visible, ultraviolet
    d. radio, infrared, visible, ultraviolet, X ray
    e. None of the above.

92. Which of the following is NOT a feature of the Bohr model of the atom?
    a. an quantized electron angular momentum
    b. electrons in planetary-like orbits
    c. quantized energy levels
    d. accelerating electrons that do not radiate
    e. All of the above are features of the Bohr model.

93. Which of the following is NOT considered to be a success of Bohr's theory of the atom?
    a. Obtaining the numerical values for the spectral lines in hydrogen.
    b. Explaining why there are more lines in emission spectra than absorption spectra.
    c. Explaining why the frequency distributions in emission spectra are discrete rather than continuous.
    d. Providing the general features of the periodic table.
    e. All of the above are considered successes of the Bohr theory.

94. In 1923, the French graduate student Louis de Broglie proposed that
    a. photons behave like particles.
    b. electrons behave like waves.
    c. the energy levels in atoms are quantized.
    d. the behavior of electrons must be explained by quantum mechanics.
    e. None of the above.

95. The de Broglie wavelength of a particle with a mass m and a velocity v is given by
    a. mv
    b. λ/mv
    c. mv/h
    d. h/mv
    e. None of the above.

96. Bohr could never really explain why an electron was limited to certain orbits. De Broglie explained this by showing that electrons in Bohr's allowed orbits
    a. form standing-wave patterns about the nucleus.
    b. have elliptical orbits like the planets around the sun.
    c. occupy a continuum of orbits but only radiate from some.
    d. obey Maxwell's equations.
    e. None of the above.

The remaining problems may require some computation. Choose the single best answer and enter your choice into the NCS-Scantron answer sheet.

97. A red ball is thrown straight down from the edge of a tall cliff with a speed of 15 m/s. At the same time a green ball is thrown straight up with the same speed. If the green ball travels up, stops, and then drops to the bottom of the cliff, how many seconds later than the red ball will it land?

a. 3 s
b. 2.45 s
c. 4.9 s
d. 6 s
e. None of the above is within 10% of the correct answer.

98. To determine the height of a steep cliff an experimenter stations his assistant on the top of the cliff and fires a pellet vertically upward with a speed of 40 m/s. His assistant notes that the pellet reaches its maximum height just 3 m above the edge of the cliff. How high is the cliff?

a). 77 m ; b). 237 m; c). 317 m; d). 637 m; e). 797 m.

99. A dirt bike starts up a steep hill with a speed of 5m/s, and speeds up at the rate of $0.2 m/s^2$ as it climbs the hill. It clears the crest of the hill after 15 seconds. How far did the dirt bike travel up the hill?

a). 97.5 m; b). 75 m; c). 52.5 m; d) 15 m; e) none of these is correct within 10%.

100. A rope is used to drag a box across a rough warehouse floor. Its angle is 30 degrees above the horizontal, and the its tension is T. If the box has a mass of 15 kg, feels a frictional drag force of 57.4 N, and is accelerating horizontally at 0.5 m/s^2, what is the value of T, most nearly?
a). 7.5N; b). 37.5 N; c) 75 N; d) 82.5 N; e) 95.3 N.

101. Just after it is launched from the moon rocket feels a gravitational attraction by the moon of about 6000 N. Compute the acceleration of the moon due to the force which Newton's third law guarantees that the satellite exerts on the earth. (Use $M_M = 7 \text{ X } 10^{22}$ kg). The acceleration is most nearly
a) 10^{19} m/s^2; b) 10^{20} m/s^2; c) 10^{-20} m/s^2; d) 10^{-19} m/s^2;
e). None of these is correct within a factor of 10

102. Suppose that the moon travels in a circle about the earth at a distance of $3.84 \text{ X } 10^8$ m once in every 28.3 days, and that has a mass of $7.4 \text{ X}10^{22}$ kg. Then the speed of the moon is most nearly:
a) 10^3 m/s; b) 10^4 m/s; c) 10^8 m/s; d) 10^{12} m/s; e) None of these is correct within a factor of 10.

103. The masses of the Sun and Earth are 2×10^{30} kg and 6×10^{24} kg, respectively. The Earth-Sun distance is 1.5×10^{11} m. What is the size of the gravitational force between Earth and the Moon most nearly ? The gravitational constant is $G = 6.67 \times 10^{-11}$ N-m^2/kg^2.

a. 3.6×10^{11} N
b. 3.6×10^{22} N
c. 3.6×10^{43} N
d. 3.6×10^{54} N
e. None of the above is correct within a factor of 100.

104. A 90-kg satellite orbits a distant planet with a radius of 4000 km and a period of 280 min. From the radius and period, you calculate the satellite's acceleration to be 8 m/s^2. What is the gravitational force on the satellite?

a. 50.4 N
b. 90 N
c. 720 N
d. 12,000 N
e. None of the above is within 10% of the correct value.

105. A 3-kg putty ball traveling to the right with a speed of 5 m/s overtook and collides with a 4-kg putty ball traveling in the same direction with a speed of 1 m/s. If the two ball stick together and move off as a single unit, what is the total kinetic energy after the collision, most nearly ?

a. 7 J
b. 17 J
c. 27 J
d. 37 J
e. 57 J

106. A 1200-kg ~~frictionless~~ roller coaster starts from rest at a height of 24 m. It travels 500 m under a frictional force of 144 N to the crest of a hill that is 12 m high. What is its kinetic energy at the top of the 12 m hill, most nearly?

a. 288,000 J
b. 216,000 J
c. 72,000 J
d. 14,400 J
e 0 J

107. An observer drops a ball in a train traveling along a straight, horizontal track with a constant acceleration of 10 m/sec^2 in the forward direction. The observer is unaware of the acceleration but notices that the ball falls in a straight line that is slanted toward the back of the train. The acceleration of the ball along this line has a magnitude of _____ m/s^2, ,most nearly.

a. 3.1 m/s^2.
b. 10.0 m/s^2.
c. 13.1 m/s^2.
d. 14.1 m/s^2.
e. None of the above is within 10%^ of the correct answer.

108.A cylindrical space habitat with a 1000-m radius is rotating so that a person standing on the inside feels a centripetal acceleration equal to g = 10 m/sec^2. What is the tangential speed of a point just inside the cylinder?

a. 5 m/s
b. 20 m/s
c. 63.2 m/s
d. 100 m/s
e. 200 m/s

____ 109. A train is traveling along a straight, horizontal track at a constant speed of 0.8c. A warning light on the ground flashes once each second. An observer in the train measures the time between flashes to be

a. 0.6 s
b. 0.8 s
c. 1.0 s
d. 1.25
e. 1.67 s

110. If the speed, v, of a particle of rest mass m increases from 0.99999c to 0.9999999c, {so that v/c increases from $(1- 10^{-5})$ to $(1-10^{-6})$}, by what factor does its total energy increase, most nearly ?

a. 1.000 001
b. 1.000 01
c. 3.3
d. 4.67
e. 10

111. A hypothetical balloon filled with an ideal gas has a volume of 10^5 liters at 27°C under one atmosphere of pressure. At what temperature, most nearly, will its volume be 10^4 liters under one atmosphere of pressure?

a. -273°C
b. -243°C
c. -203°C
d. -163°C
e. -123°C

112. If 100 g of water at 100° C and 100 g of ice at 0° C are mixed with 100 g of water at 50° C in a completely insulated container, what is the final equilibrium temperature, most nearly? Recall that the latent heat of fusion of ice is 80 cal/g.

a. 13° C
b. 23° C
c. 33° C
d. 43° C
e. None of the above is within 20% of the correct answer.

113. An ideal heat engine has a theoretical efficiency of 47% and an exhaust temperature of 127° C. What is its input temperature, most nearly ?

a. 230° C
b. 480° C
c. 600° C
d. 750° C
e. None of the above is within 10% of the correct answer

114. An air-conditioner mechanic is testing a unit by running it on the workbench in an isolated room. The unit removes 100 cal/min from the refrigerated chamber, utilizing a work input of 420 J/min. By how much does the internal energy of the room outside the refrigerated chamber change, most nearly, in each minute?

a. It decreases by 100 cal/min.
b It decreases by 200 cal/min
c. It decreases by 520 cal/min.
d. It stays the same.
e. It increases by 520 cal/min
f. It increases by 200 cal/min.
g. It increases by 100 cal /min

115. A certain pendulum with a length of 2.0 m has a period of 2.8 s on earth. If the pendulum is moved to a planet where the gravitational force is twice as great as earth's, and its length is shortened to 1.0 m, what is its new period?
   a. 11.2 s
   b. 5.6 s
   c. 2.8 s
   d. 1.4 s
   e. 0.7 s
   f. None of the above is correct within 10%.

The transverse wave speed along a string of length 0.4m fixed at both ends is 100 m/s. What is the frequency of the third harmonic on this string?
   a. 750 Hz
   b. 375 Hz
   c. 250 Hz
   d. 125 Hz
   e None of the above is correct within 10%.

What is the de Broglie wavelength of a Volkswagen (mass = 1000 kg) traveling at 33.1 m/s (74 mph) most nearly? (Planck's constant is $h = 6.63 \times 10^{-34}$ J·s.)
   a. 1.5×10^{-29} m
   b. 2.2×10^{-39} m
   c. 2.0×10^{-38} m
   d. 3.0×10^{-28} m
   e. None of the above is correct within 10%.

118. A microwave photon has an energy of 6×10^{-23} J. What is its wavelength, most nearly? (Planck's constant is $h = 6.63 \times 10^{-34}$ J·s.)
    a. 1×10^{-56} m
    b. 3×10^{-11} m
    c. 10×10^{-10} m
    d. 3×10^{-3} m
    e. None of the above is correct within a factor of 10.

119. The energy levels of the Hydrogen atom are correctly given by the formula of the Bohr model; as follows, $E_n = -13.6/n^2$ where n = 1, 2, 3,...gives the lowest orbits. (The energy units are electron Volts: $1eV = 1.6 \text{ X } 10^{-19}$ J.) Calculate the energy emitted when an electron jumps from the third Bohr orbit to the first (lowest) orbit.
    a 13.6 eV
    b. 12.1eV
    c. 3.4 eV
    d. 1.5 eV
    e None of the above is correct within 10%.

120. What most nearly is the frequency of the photon of energy 1.5eV which might have been emitted in the electron jump of problem 119, just above? (Planck's constant is $h = 6.63 \times 10^{-34}$ J·s, and $1 \text{ (eV)} = 1.6 \text{ X } 10^{-19}$ J.)
    a. 4×10^{13} Hz
    b. 4×10^{14} Hz
    c. 4×10^{15} Hz
    d. 4×10^{16} Hz
    e. None of the above is correct within a factor of 10.

********end of exam*******