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# Physics 117 Final Exam, Cover Page

## A) GENERAL INSTRUCTIONS

This exam consists of 120 questions worth two points each for a maximum of 240 points. These follow question 1 which inquires which exam you are taking.

ALL ÀNSWERS MUST BE ENTERED INTO THE NCS ANSWER SHEET BY MEANS OF HEAVY BLACK MARKS WITH A NUMBER 2 PENCIL. (Only a pencil mark will work; the optical scanner cannot read inked answers no matter what color or how dark.)

The test questions are numbered from 2 to 121: make sure you enter your single letter answer into the answer line with the same number as the question you are answering.

Only the computer readable NCS answer sheet will be handed in. Keep this exam for you future use.

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## B) PREPARE YOUR ANSWER SHEET IN ADVANCE:

1) SIGN YOUR PERSONAL SIGNATURE INTO THE TOP MARGIN ABOVE THE NAME BOX.
2) PRINT YOUR NAME, **FAMILY NAME FIRST**, INTO THE BOXES PROVIDED AND DARKEN THE CIRCLE FOR THE CORRESPONDING LETTER BELOW EACH BOX
3) INSERT YOUR STUDENT ID NUMBER UNDER "IDENTIFICATION NUMBER" AND DARKEN THE CORRESPONDING CIRCLES BELOW EACH NUMBER.
4) MAKE NO STRAY MARKS ON THE ANSWER SHEET AND ERASE CLEANLY IF NECESSARY.

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## C) GENERAL ADVICE

Many students will not have time to finish this exam if they proceed at a leisurely pace. Therefore it is probably advantageous to earmark time-consuming items for later attention and skip forward to questions that can be answered more easily. No subtractions will be made for wrong answers, so that last minute best guessing is probably an advantageous strategy.

IF YOU NEED HELP, ASK!.....AND ASK EARLY RATHER THAN LATE.

ALSO FOR FAIRNESS' SAKE, PLEASE STOP WRITING WHEN THE EXAM ENDS. A PENALTY OF 8% OF THE RAW SCORE MAY BE IMPOSED UPON STUDENTS WHO TRY TO TAKE UNFAIR ADVANTAGE OF THE COLLECTION PROCESS BY CONTINUING TO WRITE AFTER THE END HAS BEEN ANNOUNCED.

MULTIPLE CHOICE: Choose the single BEST answer and darken the corresponding letter on your NCS Scantron sheet

1. My Final Exam is printed on paper the color of which is
   a. GREEN
   b.
   c.
   d.
   e PINK

2. Which of the following should from the physics point of view be considered to be an "accelerator" in an automobile?

   a. brake pedal
   b. gas pedal
   c. steering wheel
   d. None of the above are accelerators.
   e. All of items a,b, and c above are accelerators.

3. A feather and a ball fell at different rates in the classroom until the tubes in which they fell were evacuated by pumping out all of their air. We then observed that the feather and the ball fell
   a. at different rates which seemed to depend upon their different shapes.
   b. at different constant speeds.
   c. the same constant speed.
   d. the different constant accelerations.
   e. the same constant acceleration.

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

5 An object is dropped off a cliff. During the first second it falls 5 m and reaches a speed of 10 m/s. How far will the object fall during the next two seconds, and what speed will it then have?
   a. 45 m and 25 m/s, respectively.
   b. 40 m and 30 m/s, respectively.
   c. 45 m and 25 m/s, respectively.
   d. 15 m and 30 m/s, respectively.
   e. 15 m and 20 m/s, respectively.

6. If we use plus and minus signs to indicate the directions of velocity and acceleration, in which of the following situations does the object increase its speed?
   a. zero velocity and negative acceleration
   b. negative velocity and positive acceleration
   c. positive velocity and zero acceleration
   d. negative velocity and zero acceleration
   e. none of the above.

7. If there is no net force acting on an object, it must move with _____ acceleration, and _____ velocity, respectively.
   a. zero.....increasing
   b. constant, non-zero.....constant
   c. increasing.....increasing
   d. zero.....constant
   e. decreasing.....decreasing

8. If an object moves in a straight line with a constant speed, we can conclude that
   a. the object has a substantial inertia.
   b. there is no unbalanced net force acting on the object.
   c. there must be at least two forces acting on the object.
   d. there is no force acting on the object.
   e. there must be a force which overcomes the force of friction.

9 If the force of friction on a child's wagon is 25 N, and its mass is 10 kg, how much force must be applied to maintain a constant, non-zero velocity equal 2 m/s?
   a. 25 N
   b. 12.5 N
   c. 10 N
   d. 5.0 N
   e. 2.5 N

10. When the same net force is applied to two blocks, the yellow one has a larger acceleration than the blue one. Which of the following can be inferred?
   a. The yellow block has a larger weight.
   b. The blue block has a smaller weight.
   c. The yellow block has a smaller mass.
   d. The blue block has the smaller mass.
   e. None of the above inferences is valid.

11. When a snowflake falls, it quickly reaches a terminal velocity. This happens because
   a. there is no net force acting on the snowflake.
   b. the mass of the snowflake is too small for gravity to have any effect
   c. the snowflake has no weight.
   d. the mass of the snowflake is smaller than its weight.
   e. it is so light that the drag force is zero.

12. A child stands on a bathroom scale while riding in an elevator. The child's weight when the elevator is not moving is 200 N. What does the scale read when the elevator accelerates downward at 2m/s/s while traveling upward at 3m/s, according to Newton's second law?

   a. 200 N
   b. 210 N
   c. 210 N
   d. 190 N
   e. 210 N

13. If a body is acted on by a force of 10 N and doesn't accelerate, we can conclude
    a. nothing. That's what should happen.
    b. its inertia is too large.
    c. that the total net force acting on the body is zero.
    d. the law of inertia only holds for large forces.
    e None of the above

14. 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

15. A bug rides on a phonograph record. In which direction does the change in the bug's velocity (during a small time interval) point?
    a. away from the center of the record.
    b. along the forward tangent to the circular path
    c. toward the center of the record
    d. along the backward tangent to the circular path.
    e. upward from the record, or downward towards the record, depending upon the direction of motion.

16. By what factor is the centripetal acceleration different for a car of twice the mass which goes around a corner at half the speed of a smaller car just before it?
    a. 0.5
    b. It has the same value for both cars.
    c. 2
    d. 4
    e. 8

17. Which of the following statements about projectile motion is true? Neglect air resistance.
    a. The horizontal and vertical motions are independent.
    b. The acceleration of the projectile is constant throughout the flight.
    c. There is no horizontal force on the projectile.
    d. All of the statements a,b, and c above are true.
    e. None of the statements, a, b, c above is true.

18. A football quarterback throws a long pass toward the end zone. Assume that you can neglect the effects of air resistance. At the instant the ball reaches its highest point, what is the direction of the net force on the ball?
    a. up
    b. down
    c. horizontal
    d. The direction is not defined for a vector of magnitude zero.
    e. None of the above.

19. A bug rides on the edge of a phonograph record turning at constant angular velocity. In which direction does the acceleration of the bug point?
    a. tangent to the circular path
    b. toward the center of the record
    c. away from the center of the record
    d. up
    e The bug's acceleration is zero since the angular velocity is constant.

20. By what factor does the centripetal acceleration change if a car goes around a corner twice as fast?
    a. 0.5
    b. It stays the same.
    c. 2
    d. 4
    e. It depends upon the mass of the car.

21. Which of the following statements about the planet Venus is correct?

    a. Venus has a constant velocity.
    b. There is no net force acting on Venus.
    c. Venus is continually accelerating towards the sun.
    d. The sun exerts a stronger force on Venus than Venus exerts on the sun.
    e. Venus' motion along its orbit is driven by the force of Newtonian gravity

22. What is the acceleration due to earth's gravity at a distance of 3.16 earth radii from the earth's center?

    a. 10 m/s/s
    b. 3.16 m/s/s
    c. 1.0 m/s/s
    d. 0.316 m/s/s
    e. 0.10 m/s/s

23. Al the astronaut has a weight of 600 N when he is standing on the surface of the earth. What is the force of gravity acting on him when he is in a space station orbiting earth at a distance of two earth radii frm the earth's center?

    a. 600 N
    b. 300 N
    c. 200 N
    d. 150 N
    e. 67 N

24. If an astronaut with a weight of 800 N on earth steps on a bathroom scale while he is in earth orbit, the scale will read

    a. 800 N
    b. less than 800 N
    c. zero
    d. more than 800 N
    e. None of the above.

25. A synchronous satellite is one which remains over a given fixed point on the earth as it rotates. Over which of the following locations is it possible to have a synchronous satellite?
a. New York City
b. Los Angeles
c. North Pole
d. A point on the equator
e None of the above

26 In any selected 24 hour interval, there always occur

a. exactly one high tide and one low tide.
b. exactly one high tide and two low tides.
c. exactly two high tides and one low tide.
d. exactly two high tides and two low tides.
e. one of the possibilities (b), (c), or (d) above, but never case (a) above.

27. What is the approximate magnitude of the earth's gravitational field at a distance (above the surface of the earth) equal to twice the earth's radius?

a. 1.1 N/kg
b. 2.5 N/kg
c. 3.3 N/kg
d. 5.0 N/kg
e. 9.8 N/kg

Newton's second law can be rearranged to show that the is equal to the ____

a. momentum ... change in impulse
b. change in momentum ... change in impulse
c. change in momentum ... impulse
d. momentum ... impulse
e. None of the above insertions is correct.

Two air-track gliders are held together with a string. The mass of glider A is four times that of glider B. A spring is tightly compressed between the gliders. The gliders are initially at rest and the spring is released by burning the string. If glider B has a speed of 8 m/s after the release, how fast will glider A be moving?

a. 1 m/s
b. 2 m/s
c. 4 m/s
d. 8 m/s
e. none of the above.

30. Which has the greater momentum, a heavy truck at rest or a moving roller skate?
a. The two momenta are equal.
b. The heavy truck.
c. The roller skate.
d. The one with the greater velocity
e Not enough information is available to know.

31. How fast would you have to throw a baseball ($m$ = 145 g) to give it the same momentum as a 10-g bullet traveling at 800 m/s?
    a. 800 m/s
    b. 80 m/s
    c. 55 m/s
    d. 5.5 m/s
    e 0.55 m/s

32. What average force is required to stop a 120-kg football player running at 8 m/s in a time of 0.4 s?
    a. 3.2 N
    b. 20 N
    c. 48 N
    d. 960 N
    e. 2400 N

33. A very hard rubber ball ($m$ = 0.6 kg) is falling vertically at 6 m/s just before it bounces on the floor. The ball rebounds back at essentially the same speed. If the collision with the floor lasts 0.04 s, what is the average force exerted by the floor on the ball?
    a. 0.144 N
    b. 15 N
    c. 90 N
    d. 150 N
    e 180 N

34. Two objects have different masses but the same momenta. If you stop them with the same retarding force, which one will stop in the shorter distance?

    a. the heavier one
    b. the lighter one
    c. Both stop in the same distance.
    d. it is impossible to say with the information given.
    e. none of the above.

35. Which of the following properties of a ball is conserved as it falls freely in a vacuum?

    a. mechanical energy.
    b. gravitational potential energy.
    c. momentum.
    d. velocity.
    e. kinetic energy.

36. A ball dropped from a height of 10 m only bounces to a height of 5 m. Which of the following statements is valid for this situation?

    a. Kinetic energy is conserved.
    b. Mechanical energy is conserved.
    c. Gravitational potential energy is conserved.
    d. Total energy, including heat, sound, and radiation energy, is conserved.
    e. None of the above.

37. What average power is required to accelerate a 450-kg car from rest to a speed of 10 m/s in 15 s?

a. 30,000 W
b. 15,000 W
c. 3,000 W
d. 1500 W
e. 300 W

38. Two objects have different masses but the same kinetic energies. If you stop them with the same retarding force, which one will stop in the shorter distance?

a. the heavier one, because the work needed to reduce its momentum is larger.
b. the lighter one, because the work needed to reduce its momentm is smaller.
c. the heavier one, because the momentum has nothing to do with stopping distance.
d. the lighter one, because smaller momentum change implies a shorter stopping distance.
e. Both stop in the same distance because the same work effects the same change in kinetic energy.

39. Under what conditions does the total kinetic energy remain constant throughout a collision of a ball with a floor?

a. When the collision is totally elastic
b. When the collision is inelastic.
c. When there is no net external force.
d. When there is no net external torque.
e. Kinetic energy never remains constant throughout such a collision.

40. A ball dropped from a height of 10 m only bounces to a height of 5 m. Which of the following statements is valid for this situation?
a. Kinetic energy is conserved.
b. Mechanical energy is conserved.
c. Gravitational potential energy is conserved.
d. Heat was generated in the bounce.
e. None of the above.

41. While you are standing on the ground, you observe 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. accelerations
c. energies
d. momenta
e. speeds.

42. You can throw a ball vertically upward in a car moving with a constant velocity and have it land back in your hand because
a. the inertial drag on the ball is counteracted by the momentum of the car.
b. the reference system attached to the car is non-inertial.
c. there is no net horizontal force acting on the ball.
d. the force in the forward direction is cancelled by the inertial force.
e. there is a horizontal force acting on the ball which enables it to keep up with the car.

43. 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. The observer in the train determines that the horizontal speed of the ball during the fall is
a. constant
b. increasing
c. decreasing
d. zero.
e. it is not possible to say from the data given.

44. An observer drops a ball in a hypothetical rocket 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 and 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 is approximately
a. less that 6.5 m/sec2
b. 14.1 m/sec$^2$.
c. 10 m/sec$^2$.
d. 7.1 m/sec$^2$.
e. more that 14.6 m/sec$^2$.

45. A large cylindrical space ship is at rest relative to the "fixed" stars, but rotating about the axis of the cylinder. An astronaut standing on the wall of the cylinder releases a ball. Which way will the ball travel as viewed by someone at rest relative to the "fixed" stars?
a. tangent to the cylinder
b. radially inward
c. radially outward
d. along the axis
e. it is not possible to say with the data given.

46. What would an observer measure for the magnitude of the free-fall acceleration in an elevator near the surface of Earth if the elevator accelerates downward at 6 m/s$^2$?
a. 4 m/s$^2$
b. 6 m/s$^2$
c. 10 m/s$^2$
d. 14 m/s$^2$
e. 16 m/s$^2$

47. In his theory of special relativity, Einstein
a. abandoned the Galilean principle of relativity.
b. abandoned Maxwell's equations for electricity and magnetism.
c. reconciled the apparent conflict between the Galilean principle of relativity and Maxwell's equations.
d. postulated the existence of an absolute reference system.

48. The second postulate of special relativity states that the speed of light
a. is a constant in a vacuum.
b. is constant relative to the ether.
c. depends on the motion of the source.
d. depends on the motion of the receiver.
e. depends upon the inertial system of the observer.

49. If you approach a light beacon while traveling at one-fourth the speed of light (0.25c), you will measure the speed of light from the beacon to be
    a. 0.25c
    b. 0.75c
    c. c
    d. 1.25c
    e. 1.75c

50. A train is traveling along a straight, horizontal track at a constant speed that is only slightly less than that of light. An observer in the train determines that firecrackers go off simultaneously in the engine and in the caboose. An observer on the ground determines that the firecracker in the _____ went off first.
    a. engine
    b. caboose
    c. They went off simultaneously for both observers.
    d. The answer depends on the speed of the train.
    e. Not enough information is given to determine the answer.

51. Superman wants to travel back to his native Krypton for a visit, a distance of 3,000,000,000,000 meters. (At nearly the speed of light, it takes light nearly 10,000 seconds to travel this distance.) If Superman can hold his breath for 1000 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.

52. Which of the following expressions gives the total relativistic energy of an object?
    a. $E = mc^2$
    b. $E = \gamma mc^2$
    c. $E = (\gamma-1)mc^2$
    d. $E = 0.5\ mv^2$
    e. $E = 0.5\ \gamma mc^2$

53. Suppose two teams of astronauts who think they are accelerating through space are actually sitting on the surfaces of Earth and Mercury. The gravitational field on Mercury is much smaller than that of Earth. Which team can justify a claim to having the greater speed?
    a. The Mercury team
    b. The Earth team
    c. Neither team can justify the claim
    d. Both teams can justify the claim, as always in relativity.
    e. None of the above

54. If 16 grams of oxygen combine completely with 2 grams of hydrogen to form water (1 oxygen atom and 2 hydrogen atoms in each molecule), how many grams of oxygen does it take to combine completely with 2 grams of hydrogren to form hydrogen peroxide (with 2 oxygen and 2 hydrogen atoms in each molecule)?

    a. 32
    b. 16
    c. 8
    d. 4
    e. 2

55 One liter of element A combines with three liters of element B to form one liter of a gaseous compound, AB. If the molecules of A and B have 2 atoms each how many atoms of A and B are there in 1 molecule of AB?

a. 1 A and 1 B
b. 1 A and 3 B
c. 2 A and 2 B
d. 2 A and 3 B
e. 2 A and 6 B

56 The mass of an oxygen molecule is 16 times that of a hydrogen molecule. If the gases are maintained at the same temperature, what is the ratio of the average kinetic energy of an oxygen molecule to that of a hydrogen molecule?

a. 1/16
b. 1/4
c. 1
d. 4
e. 16

57. What happens to the temperature of an ideal gas if the pressure is reduced to one-half while holding the volume constant? The

a. temperature in °C increases.
b. temperature in °C is cut in half.
c. temperature in Kelvins is doubled.
d. temperature in Kelvins is cut in half
e. none of the above.

58. A ham sandwich consists of one slice of ham (10 g) and two slices of bread (25 g each). You have 1 kg of ham and 1 kg of bread. You make as many sandwiches as you can. What is the mass of the sandwiches?
a. 1.0 kg
b. 1.2 kg
c. 1.4 kg
d. 2.0 kg
e. 3.5 kg

59. Avogadro's hypothesis suggested that each liter of gas under identical conditions has the same
a. mass
b. number of atoms
c. number of molecules
d. density
e. pressure

60. Two liters of an ideal gas is heated from 300 K to 600 K while the pressure is maintained at 1 atmosphere. What is the final volume of the gas?
a. 16 liters
b. 8 liters
c. 4 liters
d. 2 liters
e. 1 liter

61. If 1000 $cm^3$ of a gas with a density of 0.0009 $g/cm^3$ condenses to a liquid with a density of 0.9 $g/cm^3$, what is the volume of the liquid?
   a. 1 $cm^3$
   b. 10 $cm^3$
   c. 100 $cm^3$
   d. 1000 $cm^3$
   e. 10,000 $cm^3$

62. Joule's experiments in which hanging weights turned paddle wheels in water
   a. showed that a specific amount of work converted into various amounts of heat depending upon the circumstances
   b. showed that 1.0 joule of work is equivalent to 4.2 calories of heat.
   c. were used to fix the ratio of the unit of heat energy to the unit of work energy.
   d. showed that heat could be converted 100% to mechanical work.
   e. All of the above statments are true of Joule's experiments.

63. The first law of thermodynamics
   a. guarantees that no temperature can ever be less than 0 K.
   b. says that heat cannot be completely converted to mechanical energy.
   c. is the law of conservation of energy applied to thermodynamical processes.
   d. is the basis for the definition of entropy.
   e. includes the zeroth law of thermodynamics as a special case.

64 Why do climates near the seacoasts tend to be more moderate than near the middle of the continent?
   a. Because water has a relatively high specific heat.
   b. Because water has a high latent heat of vaporization.
   c. Because the coasts have lower elevations.
   d. Because it rains a lot on the coasts.
   e. None of the above.

65. Given that ice has a specific heat that is one-half that of water, when the temperature of 20 grams of water and that of 20 grams of ice both drop by 5°C
   a. the ice gives off twice as much heat as the water.
   b. the water gives off twice as much heat as the ice.
   c. both give off the same amount of heat, but the ice does so quicker.
   d. both give off the same amount of heat, but the water does so quicker.
   e. None of the above.

66. Which type of bench would remain the warmest on a cold winter day?
   a. aluminum
   b. marble
   c. wood
   d. iron
   e. None of the above: all would come to the same temperature.

67. In convection, thermal energy is transported by
a. the movement of the fluid under the influence of gravity.
b. the movement of the fluid under pressure of sound waves.
c. the movement of the fluid by electromagnetic fields.
d. the movement of the fluid the propagation of sound waves.
e. the movement of the fluid due to atmospheric pressure.

68. A real cyclic heat engine can NEVER
a. convert thermal energy into mechanical energy.
b. exhaust heat to its surroundings
c. honor the first law of thermodynamics.
d. have 99.99% efficiency, even in principle.
e. reduce the total entropy of the universe

The second law of thermodynamics says
a. that the entropy of the universe always increases.
b. that a refrigerator must consume mechanical work to move heat from colder to hotter regions.
c. that it is impossible to reduce the entropy in one region of space with no other effects.
d. that it is impossible to build a heat engine that does the same mechanical work as the heat energy it consumes.
e. all of the above.

70. An engine takes in 3000 cal of heat and exhausts 2000 cal of heat each second it is running. How much work does the engine do each second?
a. 1000 cal
b. 4000 cal
c. 5000 cal
d. 6000 cal
e. 60,000 cal

71. A heat engine takes in 900 J of energy at 600 K and exhausts 600 J at 240 K. in each cycle of its operation. What are the ideal Carnot efficiency and the actual efficiency of this engine,
respectively?
a. 67% and 60%
b. 60% and 33%
c. 50% and 50%
d. 60% and 67%
e. None of the above.

When the input to an engine is 1700 W at 600 K and the exhaust temperature is 300 K, the engine performs work at a rate of 1100 W. At what rate does the engine exhaust heat?
a. 200 W
b. 300W
c. 600 W
d. 800 W
e. 1200 W

73. An air-conditioner mechanic is testing a unit by running it on the work bench in an isolated room. What happens to the average temperature of the room, including the refrigerated volume?

a. It decreases, because an operating refrigerator cools its surroundings by more than it increases the ambient temperature
b. It decreases because a refrigerator always diminishes the amount of heat in its immediate neighborhood.
c. It increases because the refrigerator is converting work into heat in every cycle.
d. It stays the same because the heat dumped outside the refrigerator comes from the inside, so that there is no effect on the average temperature.
e. None of the above.

74. Which of the following contradicts the second law of thermodynamics?
a. Heat naturally flows from hot objects to cold objects.
b. No engine can transform all of its heat input into mechanical work.
c. No refrigerator can put out net mechanical work while transferring heat from cold objects to hot.
d. Perpetual motion machines are not possible.
e. None of the four statements above contradicts the second law.

75. A white hot piece of metal is dropped into an insulated container of cool water. After the system has reached an equilibrium temperature, the

a. entropy of the metal has increased.
b. entropy of the water has decreased.
c. net change in entropy of the system is zero.
d. entropy of the system has increased.
e. All of the above.

76. For small amplitudes the vibrational period for an object on a spring is the mass of the object, and _____ the stiffnes of the spring, respectively.

a. proportional to.....proportional to
b. proportional to the square root of.....inversely proportional to the square root of
c. inversely proportional to the square root of.....proportional to the square root of
d. inversely proportional to.....proportional to
e. proportional to the square root of .....proportional to the square root of

77. A mass suspended from a spring is seen to bob up and down over a distance of 24 cm from the top to the bottom of its path every three seconds. What are its amplitude and frequency, respectively?

a. 24 cm, and 3.0/sec
b. 24 cm, and 0.33/sec
c. 12 cm, and 3.0/sec
d. 12 cm, and 0.33/sec
e. 8 cm, and 0.33/sec

78. If a cycle begins at a certain position, it ends when the object
a. next returns to the equilibrium position.
b. next returns to the starting position.
c. next travels in the same direction.
d. next returns to this position while traveling in the same direction
e. passes through the equilibrium position for the second time.

79. What is the frequency of the second hand on a clock?
a. 3600 Hz
b. 60 Hz
c. 1 Hz
d. 1/60 Hz
e. 1/3600 Hz

80. A spring oscillates with a period of 1 s with a mass of 0.25 kg. What would its period be if the mass were increased to 1 kg?
a. 0.25 s
b. 0.5 s
c. 1 s
d. 2 s
e. 4 s

81 Increasing which of the following causes a decrease in the period of a pendulum?
a. mass
b. amplitude
c. length
d. strength of gravity
e. none of the above

82. In the following list of properties of periodic travelling waves, which one is independent of the others?
a. frequency
b. wavelength
c. speed
d. amplitude
e. None of the above is independent of the others.

83. If the frequency of a periodic wave is doubled while the velocity remains the same, the wavelength
a. quadruples
b. doubles.
c. stays the same.
d. is cut in half.
e. is reduced by a factor 1/4.

An anti-node of a standing wave is
a. a point of maximum amplitude.
b. a point of minimum amplitude.
c. a point of destructive interference.
d. a note that's an octave higher than the fundamental.
e. none of the above.

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

Two point sources produce waves of the same wavelength and are completely in-phase (that is, both sources produce 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 an oscillation with
a. an amplitude equal to twice that of one wave alone.
b. an amplitude equal to that of one wave alone.
c. an amplitude equal to one half that of either wave alone.
d. an amplitude approximately equal to zero.
e. an amplitude which varies in time as the two waves pass over the point.

87. Cathode rays are
a. negatively charged.
b. electrons.
c. pieces of atoms.
d. deflected by a magnetic field.
e. All of the above are true for cathode rays

88. The charge-to-mass ratio for cathode rays is
a. 1800 times smaller than that for hydrogen ions.
b. 1800 times smaller than that for electrons.
c. 1800 times larger than that for hydrogen ions.
d. equal to that for hydrogen ions.
e. none of the above.

89 In his famous oil-drop experiment Robert Millikan discovered that
a. not all electrons are the same.
b. cathode rays are electromagnetic waves.
c. electrical charge comes in identical chunks, or quanta.
d. cathode rays are electrons.
e. oil droplets are influenced by the force of gravity.

90. Rutherford's model of an atom as a very tiny, massive nucleus with the electrons orbiting at great distances could NOT explain why
a. most alpha particles pass right through a thin gold foil.
b. some alpha particles are deflected at large angles, even backward.
c. atoms emit a special set of discrete wavelengths.
d. atoms are generally found to have no net electric charge.
e. atoms sometimes have a net positive charge.

91. Planck was able to obtain the correct curve for the spectrum of light emitted by a hot black-body-like object by assuming that the
a. spectrum was continuous.
b. vibrational energies of the atomic resonators were quantized.
c. atoms had only certain allowed orbits.
d. light was mainly ultraviolet.
e. appealing to the Rutherford nuclear picture of the atom.

92. 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. the black body radiation spectrum had to be continuous.
d. light consists of photons which sometimes act like particles
e. electrons boil off when they get hot enough.

93. 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. degree of polarization
b. number
c. mass
d. charge
e. maximum kinetic energy

94. Which of the following is NOT a feature of the Bohr model of the atom?
a. an electron probability cloud
b. electrons in planetary-like orbits
c. quantized energy levels
d. accelerating electrons that do not radiate
e. radiation which occurs only from electron jumps between allowed orbits

95. Bohr gave the following reason for the electron in the hydrogen atom existing only in certain discrete energy levels.
a. This agrees with Newtonian mechanics.
b. This agrees with Maxwell's equations.
c. Both of the above were cited.
d. Bohr simply postulated it, without claiming to know the reason for it
e. Bohr claimed that the underlying reason was irrelevant to atomic structure.

96. If electrons in hydrogen atoms are excited to the fourth Bohr orbit, how many different frequencies of light may be emitted?
a. 1
b. 3
c. 6
d. 8
e. 4! = 24

97. Certain families of elements in the periodic table have very similar properties. This is because in each family
a. the atoms have the same number of electrons.
b. the masses of the atoms are simple multiples of each other.
c. as Z increases, the inner electron orbits are pulled closer to the nucleus.
d. the outermost electrons are in the same configuration.
e. they evolved from the same basic elements.

98. The periodic table arranges the elements in columns according to
a. the order in which they were discovered.
b. their chemical properties.
c. their relative abundances.
d. alphabetical order.
e. their atomic numbers, Z.

99. A gas can be identified by means of its spectral lines because each element
a. can be recognized when magnified greatly.
b. occupies a unique position in the periodic table.
c. emits characteristic wavelengths when electrically excited.
d. has a different atomic mass.
e. corresponds to a different charge on it nucleus.

100. Cathode rays are shown NOT to be electromagnetic radiation by the observation that they
a. travel in straight lines.
b. cast shadows.
c. exist only in a vacuum.
d. are deflected by electric and/or magnetic fields.
e. All of the above properties show that cathode rays are NOT electromagnetic waves.

101. Bohr could never really explain why an electron was limited to certain orbits. De Broglie explained this by showing that electrons
a. form standing-wave patterns about the nucleus, with integer numbers of half wavelengths.
b. form standing-wave pattern about the nucleus with integer numbers of whole wavelengths
c. have elliptical orbits like the planets around the sun.
d. occupy a continuum of orbits but only radiate from some.
e. obey Maxwell's equations.

THE EXAM CONTINUES ON PAGES 20-23

The following PROBLEMS may require some computation. Choose the most nearly correct answer from those offered and darken the coresponding circle on your NCS answer sheet.

A window washer drops a bucket. If the bucket is traveling 7 m/s as it passes a window, how fast will it be falling 3.0 s later ?
a) 7m/s b) 9.5 m/s c) 21 m/s d) 27 m/s e) 37 m/s

An ice skater with a mass of 40 kg moves with an acceleration of 3 m/s/s under an applied force of 150 N. What is the force of friction acting on the skater ?
a) 150n b) 120 N c) 50 N d) 30 N e) 13.3 N

104 If a seismograph has a mass of 30 kg and a weight of 60 N on some distant moon, what is the acceleration due to gravity on the moon ?
a) 2 m/s/s b) 3 m/s/s c) 6 m/s/s d) 20 m/s/s e) 1800 m/s/s

105 A horizontal gun is 12 meters above a flat plain. A bullet is fired at 3000 m/s. How far is the bullet above the ground after 0.5 s ?
a) 12.0 m b) 10.75 m c) 9.5 m d) 7.0 m e) 0.0 m

106. The force on a 5-kg object far above the surface of the earth is 20 N. What is the magnitude of the gravitational field at this location ?
a) 100 N/kg b) 25 N/kg c) 20 N/kg d) 5 N/kg e) 4 N/kg

If the earth expanded to three times its diameter without changing its mass, what would happen to the value of g on its new surface ? g would be multiplied by the factor:
a) 1/9 b) 1/3 c) 1 d) 3 e) 9

A 400-g air cart traveling to the right with a speed of 4 m/s overtook and collided with a 200-g air cart traveling in the same direction with a speed of 2 m/s. What was their common velocity after the collision if they stuck together ?
a) 2 m/s b) 2.6 m/s c) 3.3 m/s d) 3.7 m/s e) 4 m/s

A 20-kg wooden block is lying on a horizontal table. An applied horizontal force, F = 80 N acts on the block while the block moves a distance of 15 m. There is also a frictional force of 20 N acting during this motion. What is the block's kinetic energy if it was initially at rest ?
a) 1200 J b) 900 J c) 600 J d) 300 J e) zero

The temperature of an ideal gas is 20 °C. What happens to this temperature if the volume is reduced to one-fourth its original volume while doubling the pressure ? The approximate final temperature (in °C) is:
a) 40 b) 10 c) -73 d) -126 e) -270.

The temperature of a 500-g block changes from 20°C to 22°C when it absorbs 200 calories. What is the specific heat of the material (in cal/gm-°C) ?
a) 100 b) 10 c) 1 d) 0.5 e) 0.2

112. How much heat is required to completely melt 500 g of ice at a temperature of -10°C ? (The latent heat of fusion and vaporization are 80cal/gm and 540 cal/gm, respectively, and the specific heat of ice is 0.5 cal/gm-°C, while that of water is 1.0 cal/gm-°C.)
a) 42,500 cal b) 42,000 cal c) 4250 cal d) 2500 cal e) 425 cal

113. Assuming no losses to the environment, what power is used by a refrigerator that takes in 8000 J/s from the cold region and exhausts three times that amount of heat energy per second ?
a) 32 kw b) 24 kw c) 16 kw d) 8 kw e) 4 kw

If an engine with a theoretical maximal efficiency of 0.4 and an actual efficiency of 0.20 performs 300 J of work, how much heat does it take in ?
a) 1500 J b) 1000 J c) 750 J d) 500 J e) 300 J

A merry-go-round rotates at 0.3 rev/s. The centrifugal pseudo-force on a 60-kg passenger who is at a point fixed at 4.0 m from the center is, approximately,
a) 850 N b) 450 N c) 225 N d) 110 N e) 50 N.

116 In problem 51.above, Superman wanted to travel back to his native Krypton for a visit, a distance of $9X10^{12}$ meters. (Assume it takes light $3X10^{4}$ seconds to travel this distance.) If Superman can hold his breath for only $10^{3}$ s, what adjustment factor, $\gamma$, must correspond (most nearly) to his speed, v, for him to make it without suffocating?

a. 1
b. 3
c. 9
d. 27
e. 30

117. In problem 116. above, Superman wanted to travel back to his native Krypton for a visit, a distance of $9X10^{12}$ meters. (It takes light $3X10^{4}$ seconds to travel this distance.) Which speed among the following is the lowest speed which would allow him to cover the distance in $10^{3}$ seconds or less?

a. 0.94c
b. 0.994c
c. 0.9994c
d. 0.99994c
e. 0.999994c

118. What is the frequency of the fundamental standing wave on a 4-m long rope that is tied at both ends and has a wave speed of 160 m/s ?
a) 160Hz b) 80 Hz c) 40 Hz d) 20 Hz e) 10 Hz.

119. What is the frequency of a pendulum with a length of 12 m if it is located on a planet where the acceleration due to gravity is only 3 m/s/s ?
a) $1/4\pi$ Hz b) $1/2\pi$ Hz c) $1/\pi$ Hz d) 1 Hz e) $2\pi n$ Hz

120. In the Bohr model the electron travels a distance of about $3.3 \times 10^{-10}$ meter in orbiting the hydrogen atom once and does this in $1.5 \times 10^{-16}$ s. What is the orbital frequency of the electron, approximately ?
a) $4.95X10^{-6}$Hz; b) $3.0X10^{9}$Hz; c) $6.7X10^{15}$Hz; d) $1.5X10^{16}$Hz; e) $3.3X10^{10}$Hz.

121. Assuming that the energy of an electron in the ground state of hydrogen is -13.6 eV, and that that in the n = 3 state is -1.51 eV, what is the frequency of the photon emitted when an electron jumps from the n=3 state to the ground state? (Recall that $h = 6.6 \times 10^{-34}$ J-sec = $4.1 \times 10^{-15}$ eV-sec.)
a) $3.3X10^{15}$Hz; b) $2.9X10^{15}$Hz; c) $1.8X10^{34}$Hz; d) $3.7X10^{14}$Hz; e) $2.3X10^{33}$Hz.

**********END of EXAM**********