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Physics 117 Exam III, Cover Page

A) GENERAL INSTRUCTIONS

This exam consists of 60 questions worth two points each for a maximum of 120 points.

ALL ANSWERS 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 questions are numbered from 1 to 60: 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.

Exam III: Physics 117 S04 James J. Griffin

Multiple Choice

Identify the letter of the choice that best completes the statement or answers the question, and darken the corresponding letter on your NCS answer sheet.

1. The first postulate of special relativity
   a. says that there is no absolute frame of reference.
   b. is a reaffirmation of the Galilean principle of relativity.
   c. states that the laws of physics are the same in all inertial reference systems.
   d. All of the above three statements are true.
   e. None of the above four statements is true.

2. In the Michelson-Morley experiments two light beams are raced at right angles to each other. Considering the earth's velocity with respect to the sun at the time of the experiment, what were the results?
   a. The beam traveling along the direction of the earth's velocity always won.
   b. The beam traveling along the direction of the earth's velocity always lost.
   c. The beam traveling perpendicular to the earth's velocity always won.
   d. The beam traveling perpendicular to the earth's velocity always lost.
   e. The race between perpendicular beams always ended in a tie, whatever the earth's velocity.

3. 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. is constant in a vacuum, with a different value in each inertial frame.

4. Two rocket ships approach a space station at 80% of the speed of light. Each pilot observes the other ship approaching at _____ of the speed of light.
   a. 20%
   b. 64%
   c. 80%
   d. 98%
   e. 160%

5. Which of the following concepts is NOT a relative one, ? (That is, observers in different inertial systems will agree on which of the following observations?)
   a. simultaneity of events at separated locations
   b. rate at which clocks run
   c. Lengths of measuring rods
   d. simultaneity of events at a single location
   e. synchronization of clocks

6. A train is traveling along a straight, horizontal track at a constant speed that is only slightly less than that of light. An observer on the ground reports that as the midpoint of the train passes an observer on the ground, simultaneous flashes occurred in the engine and caboose. The train observer determines that the flash in the engine occurred _____ the one in the caboose.
   a. before
   b. at the same time as
   c. after
   d. The answer depends on the speed of the train.
   e. None of the above.

7. Peter volunteers to serve on the first mission to visit alpha Centauri. Although he travels at 80% of the speed of light, the round trip takes years. When Peter returns from the trip, he is _____ his twin brother Paul, who remained on earth.
   a. younger than
   b. the same age as
   c. older than
   d. . We can't say, because the answer depends on the details of the trip.
   e. It is impossible to say, because of the first postulate of relativity.

8. An electron is accelerated by a constant force to nearly the speed of light. Which of the following is NOT true?
   a. It experiences a constant acceleration.
   b. Its momentum increases at a constant rate.
   c. It can approach but not exceed the speed of light.
   d. Its total energy continually increases.
   e. Its kinetic energy continually increases.

9. Which of the following expressions gives the relativistic kinetic 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. None of the above expressins gives the relativistic kinetic energy.

10. The implications of the special theory of relativity
   a. are valid only for objects moving at very high speeds.
   b. have not yet been subjected to experimental verification.
   c. apply only to tiny atomic particles, which can travel at very high speeds.
   d. are believed to apply to all motions of all objects.
   e. do not conform to any of the above four statements.

11. The principle of equivalence in the general theory of relativity states that
   a. the laws of physics are the same in all inertial systems.
   b. all clocks are equivalent.
   c. space is warped.
   d. acceleration and gravitation are equivalent.
   e. The speed of light has the same constant value in every accelerating system.

12. The general theory of relativity says that light in a vacuum travels along a path which
   a. is always a straight line.
   b. bends towards a large nearby mass.
   c. bends away from a nearby large mass.
   d. is more complicated than any of the above statements' description.
   e can never be specified by considerations based upon general relativity.

13. Which of the following does NOT conform to the result of relativity that $E = mc^2$?
   a. Energy can be converted to mass.
   b. Mass can be converted to energy.
   c. E is the total energy of the particle.
   d. c is the speed of light.
   e m is the rest mass of the object.

14. Which of the following is NOT necessarily a feature of a good scientific model?

   a. It must account for the known data.
   b. It must be expressible in mathematical form.
   c. It must agree with the way nature behaves.
   d. It must be able to make predictions about new situations.
   e. All of the above are necessary features of a good scientific model.

15. Which of the following is a compound?

   a. hydrogen
   b. oxygen
   c. carbon
   d. sulfur
   e. water

16. The law of definite proportions states that have definite ratios of their constituent elements.

   a. compounds ... mass
   b. compounds ... volume
   c. mixtures ... mass
   d. mixtures ... volume
   e. the law states none of the above.

17. If 16 grams of oxygen combine completely with 12 grams of carbon to form carbon monoxide (1 carbon atom and 1 oxygen atom in each molecule), how many grams of oxygen does it take to combine completely with 3 grams of carbon to form carbon dioxide (1 carbon atom and 2 oxygen atoms)?

   a. 2
   b. 4
   c. 6
   d. 8
   e. 12

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

   a. 1 A and 1 B; i.e., "AB" = AB.
   b. 1 A and 3 B; i.e., "AB" = AB_3.
   c. 2 A and 2 B; i.e., "AB" = A_2B_2.
   d. 2 A and 3 B; i.e., "AB" = A_2B_3.
   e. 2 A and 6 B; i.e., "AB" = A_2B_6.

19. Which of the following is NOT a feature of our ideal gas? The gas particles

a. are massless.
b. have no internal structure.
c. are indestructible.
d. do not interact except when they collide.
e. travel in straight lines until they strike the container wall.

20. The pressure that an ideal gas exerts on the walls of its container is a direct result of the

a. repulsive forces between gas molecules.
b. combined volume of the gas molecules.
c. collisions of the gas molecules with the walls
d. combined mass of the gas molecules.
e. all of the above.

21. The two fixed points used to define the modern Fahrenheit temperature scale are those of

a. boiling water and a mixture of ice and salt.
b. the body and a mixture of ice and salt.
c. the body and freezing water.
d. boiling water and freezing water.
e. None of the above.

22. 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 squared speed of an oxygen molecule to that of a hydrogen molecule?

a. 1/16
b. 1/4
c. 4
d. 16
e. It is not possible to determine with the information given

23. What happens to the temperature of an ideal gas if the volume is reduced to one-half while the pressure is kept 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. temperature in Kelvins is cut to one fourth it original value.

24. Avogadro suggested that each liter of any gas has the same as that of any other gas under identical conditions.

a. mass
b. number of atoms
c. number of molecules
d. density
e. none of the above.

25. Three liters of an ideal gas is cooled from 900 K to 300 K while the pressure is maintained at 1.0 atm. What is the final volume of the gas?

a. 27 liters
b. 9 liters
c. 3 liters
d. 2 liters
e. 1 liter

Heat is
a. the same as temperature.
b. thermal energy that is transferred from one object to another
c. potential energy associated with temperature.
d. massless fluid generated by doing work on the system.
e. equivalent to work.

27. How many calories are required to heat 300 g of water from 3°C to 10°C?
a. 42.8
b. 300
c. 2100
d. 3000
d. 21,000

Joule's experiments in which hanging weights turned paddle wheels in water
a. showed that a specific amount of work always converted into the same amount of heat.
b. showed that 4.2 joules of work are equivalent to 1 calorie of heat.
c. were used to fix the ratio of the unit of heat to the unit of work.
d. showed that mechanical energy could be converted 100% to heat.
e. All of the above statments are true of Joule's experiments.

29. Which of the following statements does NOT corredtly describe what happens when a hot block is placed in contact with a cool block?
a. Heat flows from the hot block to the cool block.
b. The average kinetic energy of the particles decreases in the hot block and increases in the cool block.
c. The temperature of the hot block decreases and that of the cool block increases.
d. Temperature flows from the hot block to the cool block.
e. All of the above statements correctly describe what happens.

30. The first 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. is the basis for the definition of temperature.
d. is the basis for the definition of entropy.
e. includes the second law of thermodynamics as a special case.

31. During a process, 40 joules of heat are transferred into a system, while the system itself does 25 joules of work. The internal energy of the system
a. decreases by 15 joules.
b. decreases by 25 joules.
c. remains the same.
d. increases by 25 joules.
e. increases by 15 joules.

If the internal energy of an ideal gas increases by 80 J when 150 J of work are done to compress it, how much heat is released?
a. 70 J
b. 80 J
c. 150 J
d. 230 J
e. none of the above.

33. Why do climates near the coasts 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.

34. Given that ice has a specific heat that is one-half that of water, when the temperature of 5 grams of water and that of 5 grams of ice both drop by 6°C
a. the water gives off twice as much heat as the ice.
b. the ice gives off twice as much heat as the water.
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.

Why is steam at 100°C more dangerous than water at 100°C?
a. The steam is hotter.
b. The steam has more internal energy per gram.
c. The steam has a higher specific heat.
d. The steam has less viscosity.
e. In fact water is more dangerous than steam at 100°C.

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.

37. In convection, thermal energy is transported by
a. the movement of the fluid under thermal pressure
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 by the propagation of sound waves
e. the movement of the fluid due to work done by gravity.

38. A real cyclic heat engine
a. converts thermal energy into mechanical energy.
b. exhausts heat to its surroundings
c. honors the first law of thermodynamics.
d. can never have 100% efficiency, even in principle
e. conforms to all of the above statements.

39. 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.

40. An engine takes in 6000 cal of heat and exhausts 2000 cal of heat each second it is running. How much work does the engine do each minute?
a. 2000 cal
b. 4000 cal
c. 6000 cal
d. 8000 cal
e. 240,000 cal

41. What input energy is required if an engine performs 50 kJ of work and exhausts 80 kJ of heat?
a. 130 kJ
b. 80 kJ
c. 50 kJ
d. 30 kJ
e. None of the above.

42. Consider the human body to be a heat engine with an efficiency of 20%. This means that
a. only 20% of the food you eat is digested.
b. 80% of the energy you obtain from food is destroyed.
c. you should spend 80% of each day lying quietly without working.
d. only 20% of the energy you obtain from food can be used to do mechanical work.
e. it takes a team of five people to achieve an efficiency of 100%.

43. A heat engine takes in 700 J of energy at 800 K and exhausts 600 J at 400 K. What are the ideal Carnot efficiency and the actual efficiency of this engine respectively?
a. 86% and 14%
b. 50% and 43%
c. 50% and 50%
d. 50% and 14%
e. 14% and 50%

44. When the input to an engine is 1400 W at 600 K and the exhaust temperature is 300 K, the engine performs work at a rate of 200 W. At what rate does the engine exhaust heat?
a. 200 W
b. 300W
c. 600 W
d. 800 W
e. 1200 W

45. 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 increases, because the refrigerator is converting work into heat in each cycle.
b. It decreases, because an operating refrigerator cools its surroundings by more than it increases the ambient temperature
c. It decreases because a refrigerator always diminishes the amount of heat in its immediate neighborhood.
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.

46 How much work per second (power) is required by a refrigerator that takes 900 J of thermal energy from a cold region each second and exhausts 1400 J each second to a hot region?
a. 500 W
b. 900 W
c. 1400 W
d. 2300 W
e. None of the above.

47. 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 as it functions.
d. Perpetual motion machines are not possible.
e. None of the four statements above contradicts the second law.

48. In which of the systems listed below is the entropy decreasing?
a. A deck of playing cards is shuffled after a game has been played.
b. A building is destroyed by demolition.
c. An egg is scrambled.
d. A drop of dye diffuses in a cup of water.
e. Juice is frozen into a popsicle in a freezing compartment.

49. 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 decreased.
b. entropy of the water has increased.
c. net change in entropy of the system is positive.
d. entropy of the system has increased.
e. All of the above.

50. A rocket ship is 80 m long when measured at rest. What is its length as measured by an observer who sees the rocket ship moving past at 99% of the speed of light? The relativistic adjustment factor for 0.99c is 7.09.
a. 11.3 m
b. 68.7 ,
c. 72.9 m
d. 80 m
e. 567 m

51. As a space ship approaches you in outer space at 60% of the speed of light, its rotating beacon sends out a pulse of light. In order to compute time dilation, you calculate the relativistic adjustment factor, γ. That quantity has the value:
a. 0.36
b. 0.6
c. 1.0
d. 1.25
e. 1.67

52. A 4-m long copper wire (coefficient of thermal expansion of $1.7 \times 10^{-5}/°C$) experiences a temperature change of 30°C. What is the change in length of the wire?
a) 0.07 mm; b) 0.51 mm; c) 1.2 mm; d) 2.0 mm; e) 3.5 mm.

53. An ideal gas has the following initial conditions: V_i = 200 cm^3, P_i = 3 atm, and T_i = 27°C. What is its final temperature if the pressure is reduced to 1.0 atm and the volume expands to 1000 cm^3?
a. 16°C
b. 45°C
c. -93°C
d. 27°C
e. 227°C

54. The temperature of an ideal gas is 27 °C. What happens to its volume if the pressure is reduced to one-fourth its original value while the temperature is increased to 77°C? The volume will
a. decrease by a factor of 4.
b. decrease by a factor of 4.67.
c. decrease by a factor of 3.43
d. increease by a factor of 4.
e. increase by a factor of 4.67

55. If Avogadro's number is 6.023 x 10^{23} and it takes 23 grams of sodium to make a gram-mole, what is the mass of one sodium atom?
a. 2.6 X 10^{-24} grams.
b. 3.8 X 10^{-24} grams.
c. 5.2 X 10^{-24} grams.
d. 7.7 X 10^{-24} grams.
e. 3.8 X 10^{-23} grams.

56. Water has a specific heat of 1.0 cal/g·°C. and a latent heat of fusion of 80 cal/gm. How many calories must be removed from 75g of water at 10°C in order to freeze it entirely into ice?
a) 6750 cal.; b) 6075 cal.; c) 5250 cal.;
d) 90 cal.; e) 81 cal.

57. Suppose that the specific heat of copper is 0.20 cal/gm-°C? In an experiment a 200 gm slug of copper at 80°C is inserted into 200 gm bath of water a 20°C. If there is heat lost from the copper/water system to the surroundings as it comes to the final equilibrium temperature, we can be sure that the final temperature is
a) more than 70°C; b) more than 50°C; c) more than 30°C;
d) less than 20°C; e) less than 30°C.

58. A heat engine takes in 900 J of energy at 1000 K and exhausts 600 J at 400 K. What are the maximum theoretical efficiency and the actual efficiency of this heat engine, respectively ?
a) (60%,33%); b) (40%,33%); c) (60%,44%);
d) (70%,44%); e) (70%,33%).

59. Assuming no losses to the environment, what power is used by a refrigerator that takes in 750 J/s of heat from the cold region and exhausts 1250 J/s of heat energy ?
a) 2500 w; b) 2000 w; c) 1250 w; d) 750 w; e) 500 w.

60. What is the probability of getting all heads with 5 tosses of a coin?
a) 0.5; c) 0.25; d) 0.125; e) 0.06; f) 0.03.

****** End of Exam III******