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Physics 2109/Tel.301-405-6118

Physics 117 Exam II, 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.

MULTIPLE CHOICE: Choose the letter of the best answer and enter it into the corresponding numbered line on your NCS answer sheet.

1. Comparison of a "launched apple" and the moon, both imagined to be in in circular motion about the earth, shows that under Newton's gravitational force

   a. the speeds of the apple and moon are fixed by their distances from the earth, independent of their respective masses.
   b. the motion of the moon and apple can be explained by the same laws.
   c. the apple and the moon have the same acceleration when they are at the same distance from the earth.
   d. the periods of both the moon and the apple increase with their distance from the earth.
   e. all of the above are true.

2. 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. The sun exerts a stronger force on Venus than Venus exerts on the sun.
   d. Venus' motion along its orbit is driven by the force of Newtonian gravity.
   e. Venus is continually accelerating toward the sun.

   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

4. 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 above the surface?

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

5. The gravitational force between two metal spheres in outer space is 800 N. How large would the force be if both spheres were twice as massive and twice as far apart?

   a. 12,800 N
   b. 6400 N
   c. 3200 N
   d. 1600 N
   e. 800 N

6. The correct force of universal gravitation is $F = GMm/r^2$ Why did we use the form $F = mg$ when we studied projectile motion?

   a. The first form is not valid for projectile motion.
   b. The first form does not work because it requires two masses.
   c. The first form is not valid near the surface of the earth.
   d. The second form is a good approximation to the first and much simpler to use.
   e. The inverse square denominator makes the force infinite for $r = 0$.

When Cavendish claimed that he "weighed" the earth, he actually calculated the

a. force that the moon exerts on the earth.
b. weight of the earth.
c. the attraction between the fixed and rotatable masses in his experiment.
d. mass of the earth.
e. force that the sun exerts on the earth.

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

9. 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. equator
e. It is not correct to say that a synchronous satellite has a fixed "location".

10. In any selected 24 hour interval, there always occurs

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.

11. According to the Law of Universal Gravitation as proposed by Newton the gravitational field of the earth extends

a. to the sun.
b. to the edge of the solar system.
c. to the edge of the galaxy.
d. to the greatest distances observed by astronomers.
e. throughout the universe.

12. What is the approximate magnitude of the earth's gravitational field at a distance (from the center of the earth) equal to three times 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

13. Which has the greater momentum, a heavy truck or a bullet?

a. The bullet, because it moves faster.
b. The heavy truck, because it is heavier.
c. One momentume is greater than the other, but we cannot say which
d. They are equal.
e. We cannot tell from the information given.

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

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

15. What impulse is needed to stop a 3000-kg car traveling at 10 m/s?

a. 30 N·s
b. 300 N·s
c. 3000 N·s
d. 30,000 N·s
e. none of the above.

16. 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 system is not closed.
d. All of the above.
e. In fact, this situation does violate the law of conservation of momentum.

17. We can explain the recoil that occurs when a rifle is fired by using

a. the conservation of momentum
b. impulse
c. Newton's Third Law
d. action/reaction pairs of forces
e. all of the above.

18. Two air-track gliders are held together with a string. The mass of glider A is three 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 1 m/s after the release, how fast will glider A be moving?

a. 1 m/s
b. 2 m/s
c. 3 m/s
d. 9 m/s
e. none of the above.

19. A 2-kg ball traveling to the right with a speed of 6 m/s collides with a 4-kg ball traveling to the left with a speed of 3 m/s. The total momentum of the two balls after the collision is _____ kg-m/s to the _____.

a. 12 ... left
b. 12 ... right
c. 24 ... right
d. 24 ... left
e. none of the above

20. Why is skiing into a wall of deep powder less hazardous to your health than skiing into a wall of bricks? Assume in both cases that you have the same initial speed and come to a complete stop.
a. The change in momentum is less in powder.
b. The impulse is less in powder.
c. The increased stopping time in powder means a smaller stopping force.
d. The decreased stopping time in powder means a larger stopping force.
e. None of the above reasons is sufficient.

21. An astronaut training at the Craters of the Moon in Idaho jumps off a platform in full spacewalk gear and hits the surface at 5 m/s. If later on the moon the astronaut jumps from the LEM and hits the surface at the same speed, the impulse will be _____ that on earth.
a. the same as
b. larger than
c. smaller than
d. greater or less, depending upon the speed
e. None of the above.

22. A tennis ball (m = 0.2 kg) is thrown at a brick wall. It is traveling horizontally at 16 m/s just before hitting the wall and rebounds from the wall at 8 m/s, still traveling horizontally. The ball is in contact with the wall for 0.0067 s. What is the magnitude of the average force of the wall on the ball?
a. 40 N
b. 80 N
c. 120 N
d. 640 N
e. 720 N

23. What happens to the total momentum of a star that undergoes a supernova explosion?
a. It increases.
b. It remains constant.
c. It decreases.
d. It depends on the color of the star.
e. Since the star is not isolated, we are not able to say.

24. A father (m = 90 kg) and son (m = 45 kg) are standing facing each other on a frozen pond. The son pushes on the father and finds himself moving backward at 4m/s after they have separated. How fast will the father be moving?
a. 1 m/s
b. 1.5 m/s
c. 3 m/s
d. 6 m/s
e. None of the above

25. Which of the following objects has the largest kinetic energy? A mass of ____ with a speed of _____.

a. 10 kg ...1 m/s
b. 9 kg ... 2 m/s
c. 8 kg ... 3 m/s
d. 7 kg ... 4 m/s
e. 6 kg ... 5 m/s

26. Assume that a red car has a mass of 1000 kg and a white car has a mass of 2000 kg. If both cars are traveling at the same velocity,

a. their kinetic energies are in the ratio 2/1, red to white.
b. their momenta are equal.
c. the red car's kinetic energy is half of the white's.
d. all of the above statements are true.
e. none of the aboves statements is true.

27. Under what conditions does the total kinetic energy remain constant throughout a collision?

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 a collision.

28. A ball moving at 9 m/s toward the right has a head-on collision with an identical stationary ball. Each of the following possibile final conditions satisfies the law of conservation of linear momentum. Which one also corresponds to an elastic collision? One ball has a velocity of _____ while the other has a velocity of ___ to the right.

a. 6 m/s to the right ... 3 m/s
b. zero ... 9 m/s
c. 2 m/s to the left ... 11 m/s
d. 3 m/s to the left ... 12 m/s
e. 5 m/s to the left ....14 m/s

29. In physics, work is defined as the product of the

a. net force and the distance traveled.
b. net force parallel to the motion and the distance traveled.
c. net force parallel to the motion and the time it is applied.
d. net force perpendicular to the motion and the distance traveled.
e. none of the above.

30. 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. both stop in the same distance.
d. it is impossible to say with the information given.
e. none of the above.

31. How much work is performed by the gravitational force F on a synchronous satellite during one day?

a. zero, because the satellite does not move.
b. zero, because the force is perpendicular to the velocity.
c. FC, where $C = 2\pi r$ is the circumference of the orbit.
d. Fr, where r is the radius of the orbit.
e. A definite finite amount of work is done, but it depends upon the mass of the satellite so that none if the above can be correct in general.

32. 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. mechanical energy

33. 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.

34. A block of wood loses 300 J of gravitational potential energy as it slides down a ramp. If it has 90 J of kinetic energy at the bottom of the ramp, we can conclude that

a. mechanical energy is conserved.
b. angular momentum energy was conserved.
c. momentum is conserved.
d. All but 90 J of energy was lost.
e. 210 J of energy was transformed to another form.

35. What average power is required to accelerate a 300-kg car from rest to a speed of 20 m/s in 15 s?

a. 400 W
b. 4,000 W
c. 9,000 W
d. 75,000 W
e. 90,000 W

36. 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 needer to reduce its momentum is larger.
b. the lighter one, because the work needed to reduce its momentum 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.

37. Imagine riding in a glass-walled elevator that goes up the outside of a tall building at a constant speed of 20 meters per second. If a window washer drops a ball as you pass by, you, in your own frame of reference will observe the ball to
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. It is not possible to say from the data given.

38. 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. speeds
c. energies
d. momenta
e. accelerations.

39. 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 do to prove that the room is moving horizontally at a constant velocity?
a. Determining an object's mass by applying a net horizontal force.
b. Weighing an object and comparing it to its known weight.
c. Determining the force necessary for an object to move in a circle.
d. Check the angle from the vertical at which a plumb bob hangs.
e. None of the above.

40. 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 a net force in the forward direction which keeps the ball moving with the car.
d. the force in the forward direction is canceled by the inertial force.
e. there is no net horizontal force acting on the ball.

41. A train is traveling along a straight, horizontal track with a constant speed of 70 mph. If the ball is thrown backward with a speed of 40 mph relative to the train, what is its speed relative to the ground?
a. 30 mph
b. 40 mph
c. 70 mph
d. 110 mph
e. none of the above.

42. A ball is thrown horizontally at 50 m/s from a flatcar that is moving in a straight line at 20 m/s. Relative to a person on the ground, what is the horizontal speed of the ball when it is thrown in the forward direction?
a. 20 m/s
b. 30 m/s
c. 50 m/s
d. 70 m/s
e. none of the above.

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. decreasing
    c. increasing
    d. zero.
    e. it is not possible to say from the data given.

44. An observer drops a ball in a train traveling along a straight, horizontal track with a constant acceleration in the forward direction. What would an observer in the train say about the force acting on the ball?
    a. It has a horizontal component in the forward direction
    b. There is no horizontal component of the force.
    c. It has a horizontal component in the backward direction
    d. It has no vertical component.
    e. It is in part a centrifugal force.

45. 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/sec^2
    b. 7.1 m/sec^2.
    c. 10 m/sec^2.
    d. 14.1 m/sec^2.
    e. more that 14.6 m/sec^2.

46. On a day when Larry has a weight of 600N he takes a ride in the elevator that goes up the side of the Space Needle in Seattle. Much to the amusement of the other passengers he stands on a bathroom scale during the ride. During the time that the elevator is accelerating upward at a rate of $3m/sec^2$ the reading on the scale is
    a. 800 N
    b. 780 N
    c. 600N
    d. 420 N
    e. 400 N

47. A woman with an earth weight of 400 N is in a satellite in orbit around the earth. What is the weight of the woman in the ship?
    a. zero
    b. 200 N
    c. 400 N
    d. 800 N
    e. 1000 N

48. 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. radially inward
    b. radially outward
    c. tangent to the cylinder
    d. along the axis
    e. it is not possible to say with the data given.

The following PROBLEMS may require some calculation. Fill in the circle on your NSC answer sheet which corresponds to the most nearly correct of the answers offered.

49. If the radius of the orbit of an earth satellite is increased by a factor of four, then its period
a. increases by a factor of 64.
b. increases by a factor of 16.
c. increases by a factor of 8
d. increases by a factor of 4.
e. actually does not increase at all, but instead decreases, because it travels a much greater distance in each period.

50. If the earth were expanded to twice its diameter without changing its mass, the value of g near the surface would:
a. increase by a factor of 2.
b. increase by a factor of 4.
c. decrease by a factor of 2.
d. decrease by a factor of 4.
e. remain the same, because g is caused by the earth's mass, independent of its radius.

51. Mercury has a radius of about 0.33 Earth radii and a mass of only 0.05 Earth masses. Choose the best estimate of the acceleration due to gravity on the surface of Mercury.
a. 1.5 m/s^2
b. 4.5 m/s^2
c. 21 m/s^2
d. 67 m/s^2
e. 600 m/s^2

52. A 1000-kg car traveling north at 15 m/s is rear-ended by a 2000-kg truck traveling at 25 m/s. If the truck and car lock bumpers and stick together, what is their speed immediately after the collision?
a. 15.0m/s
b. 17.2 m/s
c. 19.5 m/s
d. 21.7 m/s
e. 25.0 m/s

53. A 2000-kg truck moving southward at 15 m/s collides with a 1500-kg car moving eastward moving at 20 m/s. The total momentum of the truck-car system before the crash is
    a. 60,000 N-sec Southeast
    b. 30,000 N-sec Southeast
    c. 60,000 N-sec South
    d. 60,000 N-sec East
    e. none of the above is a good approximation to the correct total momentum.

54. A bullet with a mass of 0.02 kg and a muzzle velocity of 800 m/s takes one millisecond to travel down the barrel. If the rifle has a mass of 5 kg, what is its recoil velocity?
    a. 0.032 m/s
    b. 0.32 m/s
    c. 3.2 m/s
    d. 32 m/s
    e. none of the above.

55. A spring gun fires a 3-kg ball vertically with a velocity of 8.0 m/s. Calculate its gravitational potential energy at the highest point of its path.
    a. 24 J
    b. 72 J
    c. 192 J
    d. 96 J
    e. 36 J

56. When dropped, a 4-kg ball accelerates from a standing start to a speed of 20 m/s in 2 s, what average power is generated?

    a. 80 W
    b. 160 W
    c. 3200 W
    d. 800 W
    e. 400W

57 A 20-kg wooden block is lying on a horizontal table. An applied horizontal force F = 30 N acts on the block while the block moves a distance of 20 m. There is also a frictional force of 20 N acting during this motion. What is the block's final kinetic energy if it was initially at rest?

a. 200 J
b. 600 J
c. 4,000 J
d. 8,000 J
e. 12,000 J

58. Assume that the earth has a radius of 6400 km.and a circumference of 40,200 km. Note also that a day is 8.64×10^4 sec. To correct for the fact that the earth is rotating daily on its axis, what magnitude of inertial psuedoforce has to be added to the physical forces to make a Newton-like law describe the motion of an object of mass, m = 1 kg, at rest on the earth's equator ?

a) 3.4×10^{-5}N ; b) 1.4×10^{-4}N ; c) 1.8×10^{-3}N;
d) 3.4×10^{-2}N ; e) 7.3×10^{-2} N.

59. Imagine yourself looking by remote video into a windowless room where a single lamp hangs not vertically, but a fixed angle of 30° from the vertical. If in fact the room were being accelerated horizontally near the surface of the earth, its horizontal acceleration would have to be

a) 5.8 m/sec^2; b) 7.1 m/sec^2; c) 9.8 m/sec^2;
d) 11.5 m/sec^2; e) 14 m/sec^2.

60. What would a 70-kg observer measure for his weight in an elevator near the surface of the earth that is accelerating upward at 15 m/s/s?

a) 70 N; b) 105 N; c) 175 N; d) 1050 N; e) 1750 N.

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