DETAILED SOLUTIONS for 2

Multiple Choice: *Insert into your NCS answer sheet the letter of the single choice which best answers the question*

1. Which of the following statements about the moon is most correct?
a. The moon has a non-constant velocity.   TRUE
b. There is a net force acting on the moon due to the sun, the earth and the other planets. T
c. The earth exerts an equally strong force on the moon as the moon exerts on the earth. T
d. The moon experiences a centripetal acceleration toward the earth. T
e. All of the above statements about the moon are true. T
f. None of the above statements is true.   F

2. Which of the following statements about the moon is not correct?
a. The acceleration due to gravity on the moon is weaker than on the earth. true
b. The earth's gravitational pull on the moon equals the moon's gravitational pull on earth. true (N3L)
c. There is a net force acting on the moon.   TRUE
d. The moon is not accelerating. FALSE $a \approx v^2/r$ in circular motion about earth
e. The moon's rotation about the earth causes high tide to come later on successive days. TRUE
f. All of the above statements about the moon are true. No (d) is false

3. 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 twice the earth's radius?
a. 100N
b. 225 N
c. 300 N
d. 450 N
e. 900 N
f. None of the above is correct within 10%.

$$F = \frac{G M_E m}{(R)^2} = mg \quad \text{when } R = R_E = \text{distance to C of Earth}$$
$$= mg \left(\frac{R_E}{3 R_E}\right)^2 = \frac{mg}{9} \quad \text{when } R = 3R_E = \text{distance}$$
$$\qquad\qquad\qquad\qquad\qquad\qquad\qquad\text{to C of Earth}$$
$$= \frac{900}{9} = 100$$

4. If you double the radius of a sphere, its surface area increases by what factor?
a. 1
b. 2
c. 4
d. 8
e. 16
f. None of the above is correct within 10%.

$$A = 4\pi R^2 \quad \text{or} \quad R^2$$
$$\text{doubling } R \text{ yields } A' = (2)^2 \cdot A = 4A$$

5. 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. 100N
f. None of the above is correct within 10%.

$$mg = 400 \qquad \tilde{g}_{MSU3} = G \frac{M_{MSU3}}{(R_{MSU3})^2} = G \frac{M_E/2}{R_E^2/4} = 2G \frac{M_E}{R_E^2} = 2g$$
$$\text{Then } m\tilde{g} = 2mg = 2(400) = 800 N$$

6. What is the magnitude of the earth's gravitational field at a distance from the earth's center
equal to four times the earth's radius?
a. 160 N/kg
b. 90 N/kg
c. 40 N/kg
d. 10 N/kg
e. 3.3 N/kg
f. 2.5 N/kg
g. 0.62 N/kg
h. None of the above is correct within 10%.

$$g \rightarrow g\left(\frac{R_E^2}{R^2}\right) = g\left(\frac{1}{4}\right)^2 = \frac{g}{16} = \frac{10}{16} = \frac{5}{8} = 0.625 \, m/sec^2$$

7. During the Apollo flights to the moon a well-known TV newscaster made the following statement, "The Apollo space craft is now leaving the gravitational force of the earth." This statement is incorrect. He should have said that the space craft
   a. was now being attracted only by the moon. *WRoN* h
   b. was now being attracted only by the sun *WRoNG*
   c. was now attracted more by the sun than by the earth. *WRoNb*
   d. was now in a region of space where there no gravitational forces act upon it. *WRoNG*
   e. was now being attracted more strongly by the moon than by the earth. *RIGHT*
   f. None of the above leads to a correct statement.

8. The 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. by measuring the force between masses in the laboratory. *CAVENDISH EXPERIMENT*
   e. from a very precise knowledge of the mass of the earth.
   f. None of the above completions yields a true statement.

9. Which of the following would <u>not</u> cause the gravitational force on an object near the surface of the earth to be greater than its average value?
   a. A high density ore deposit just under the surface
   b. a lower elevation
   c. an increase in its mass
   d. a horizontal velocity
   e. None of the above would cause an increase in the gravitational force on the object.
   f. All of the circumstances a) through f) above would cause a greater than average gravitational force. *[ERROR Grr: '(d)]*

10. In an orbiting satellite such as SkyLab , physical objects
    a. have mass but no weight.
    b. have weight but no mass. *PHYsicAL OBJECTS MASS does not change w frame of Ry.*
    c. have mass but feel no force due to gravity. *FALSE*
    d. have neither mass nor weight. *MAss is independent of frame of Reference.*
    e. fall to the floor with an acceleration of 9.8 m/s/s. *FALSE*
    f. conform to all of the above statements. *FALSE*

11. Geosynchronous communications satellites orbit the earth, approximately, each
    a. 90 minutes
    b. 24 hours
    c. 28 days
    d. 1 year
    e. They don't orbit the earth; they just stay in one place.
    f. None of the above completions yields a true statement.

12. Because the moon rotates about the earth about once every 28.3 days, there will occur on earth during some, but not most, 24 hour intervals,
    a. one high tide and one low tide; *NEVER occurs*
    b. one high tide and two low tides, or two high tides and one low tide; *← occurs occasionally*
    c. two high tides and three low tides, or three high tides and two low tides. *← NEVER occurs*
    d. two high tides and two low tides. *← occurs MOST of the time: excluded.*
    e. All of the above combinations occur in some, but not most, 24 hour intervals *FALSE*
    f. None of the above completions yields a true statement. *FALSE*

13. Which of the following is true of the momenta of an 18-wheeler parked at the curb and a Volkswagen rolling down a hill?
    a. The 18-wheeler has the greater momentum   *(No: it has zero momentum)*
    b. The Volkswagen has the smaller momentum   *(No: it has finite momentum > zero)*
    c. The two momenta are equal.   *FALSE*
    d. Either could have the greater momentum.   *FALSE, VW has greater.*
    e. The answer depends upon the ratio of the masses.   *FALSE*
    (f.) None of the above   *by default*

14. How fast would you have to throw a baseball ($m = 150$ g) to give it the same momentum as a 5-g pellet traveling at 90 m/sec
    a. 0.10 m/s
    b. 0.67 m/s
    c. 1.0 m/s
    (d.) 3.0 m/s
    e. 18 m/s
    f. 2700 m/s

    $m = 150$

    $m\,v = (5)(90)$

    $v = \dfrac{5}{150} \cdot 90 = \dfrac{45}{15} = 3\ m/sec$

15. 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. All of the above statements can be obtained by suitably rearranging Newton's second law.
    f. None of the results a) through d) can be obtained from Newton's second law.

    $\vec{F} = \Delta\vec{p}/\Delta t \implies$
    $\vec{F}\Delta t = \Delta\vec{p}$

16. The acceleration due to gravity on Titan, Saturn's largest moon, is about 1.4 m/s². What Would a 60-kg scientific instrument weigh on Titan?
    a. 4.28 N
    b. 8.40 N
    c. 42.8 N
    (d.) 84 N
    e. 428 N
    f. 840 N
    g. None of the above is within 10% of the correct answer.

    $m\,g = m\,(1.4) = 60(1.4) = 84\,N$

17. An astronaut training at the Craters of the Moon in Idaho jumps off a platform in full space gear and hits the surface at 5 m/s. If later on the moon the astronaut jumps from the LEM and hits the moon's surface at the same speed, the impulse will be _____ that on earth.
    (a.) the same as   *because $\Delta\vec{p}$ is the same*
    b. larger than
    c. smaller than
    d. larger or smaller depending upon the height of the jump.
    e. It is not possible to compare the impulses.

18. We can explain the recoil that occurs when a rifle is fired by using
    a. conservation of momentum.   *yes*
    b. equal and opposite impulses.   *yes*
    c. equal and opposite changes in momentum.   *yes*
    d. Newton's third law.   *yes*
    (e.) Any or all of the above.
    f. None of the items a) through d) suffices to explain the recoil of a fired rifle.   *FALSE*

19. Which of the following will cause the largest change in the momentum of an object?
    A force of _____ acting for _____.
    a. 4 N ... 10 s
    b. 5 N ... 9 s
    c. 6 N ... 8 s
    d. 7 N ... 7 s ≈ 49 = 7×7 = MAX
    e. 8 N ... 6 s
    f. None of the above.

20. What average net force, most nearly, is required to stop a 120-kg football player running at 8 m/s in a time of 24 s?

    $\overline{F} \Delta t = (120)(8) \Rightarrow \overline{F} = \frac{(120)(8)}{24} = 40\,N$ (= 37.5 most nearly)

    a. 4 N
    b. 37.5 N
    c. 384 N
    d. 2400 N
    e. None of the above is within 10% of the correct answer.

21. If it takes 20 s for a jet plane to go from rest to the takeoff speed of 100 mph (44.7 m/s). What is the average horizontal force that the seat exerts on the back of a 67-kg passenger during takeoff, most nearly ?

    $F \cdot \Delta t = \Delta p = (67)(44.7) \Rightarrow F = \frac{(67)(44.7)}{20} = 149.7\,N$

    a. 50 N
    b. 150 N most nearly
    c. 250 N
    d. 350 N
    e. 450 N
    f. None of the above is within 10% of the correct answer.

22. A very hard rubber ball ($m = 0.3$ kg) is falling vertically at 6 m/s just before it strikes 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?

    $\Delta p = 2(0.3)(6) = 3.6\,kg\,m/s = \overline{F} \Delta t$
    $\frac{3.6}{.04} = 90\,N = \overline{F}$

    a. 45 N
    b. 90 N
    c. 180 N
    d. 360 N
    e. 450 N
    f. None of the above is within 10% of the correct answer.

23. 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. T
    b. the ball experiences an external force. T
    c. the ball is not an isolated system. T
    d. All of the above reasons are valid. T
    e. None of the above statements is true. F

24. If rockets are fired in the forward direction from a moving airplane, the momentum of the airplane will   (isolated)
    a. decrease just enough to conserve the momentum of the plane plus rocket system. ✓
    b. be unchanged, by conservation of momentum. X
    c. increase just enough to conserve the momentum of the plane plus rocket system. wrong, p̄ decreases
    d. decrease, but not by an amount we can specify false
    e. Increase, but not by an amount that we can specify. false
    f. None of the above completions yields a true statement. false

25. Sally is an astronaut who has a mass of 60 kg. Currently she is conducting experiments in a permanent space station that is orbiting the earth at an altitude equal to the earth's radius. What are Sally's mass and weight as measured in the space station?
    a. 0.00 kg and 0 N, respectively.
    b. 60 kg and 600 N, respectively
    c. 60 kg and 0.00 N, respectively
    d. 0.00 kg and 600 N, respectively
    e. 60 kg is her mass, but the weight cannot be specified from the data given.
    f. None of the above.

m = 60 kg = constant
W = 0 in frame accelerating toward earth
In free fall with a = F_G/m

26. Which of the following properties of a ball is conserved as it falls freely in a vacuum?
    a. kinetic energy *(No: KE increases.)*
    b. gravitational potential energy *(No: PE)_G decreases w. height)*
    c. momentum *No: p⃗ increases.*
    d. mechanical energy *yes; KE + PE = ME = constant, because F_GRAV is conservative force*
    e. All of the above are conserved quantities, but only in the absence of non-conservative forces. *FALSE*
    f. None of the above completions yields a correct statement. *FALSE*

27. Under what conditions is the kinetic energy (KE) conserved, in the strict sense of the word, during a collision?
    a. It is always conserved.
    b. When the collision is totally elastic.
    c. When there is no net outside force.
    d. When there is no friction.
    e. When the forces involved are fundamental forces of nature.
    f. KE is never conserved during a collision because its value does not remain constant, *but changes dramatically during collision.*
    g. None of the above.

28. A ball moving at 4 m/s toward the right has a head-on collision with stationary ball of twice the mass. Each of the following final velocity pairs satisfies the law of conservation of linear momentum. Which one also preserves kinetic energy? The lighter ball has a velocity of _____, while the heavier has a velocity of _____ to the right.

$(KE)_i = \frac{m \cdot 4^2}{2} + \frac{(2m)(0)^2}{2} = 8m$

    a. 2 m/s to the right ... 1 m/s $(KE)_f = \frac{1}{2}m(2)^2 + \frac{1}{2}2m(1)^2 = (3m)J$
    b. zero ... 2 m/s $= 0 + \frac{1}{2}(2m)(2^2) = (4m)J$ NONE of these = 8m J
    c. 2 m/s to the left ... 3 m/s $= \frac{1}{2}m(2)^2 + \frac{1}{2}(2m)(3)^2 = (11m)J$
    d. 4 m/s to the left ... 4 m/s $= \frac{1}{2}m(4)^2 + \frac{1}{2}(2m)(4)^2 = (24m)J$
    e. None of the above has a final kinetic energy equal to the initial value.

29. A 4-kg toy car with a speed of 5 m/s collides head-on with a stationary 1-kg car. After the collision, the cars are locked together with a speed of 4 m/s. How much kinetic energy is lost in the collision?
    a. 10 J
    b. 20 J
    c. 30 J
    d. 40 J
    e. None of the above is within 10% of the correct value.

$(m_1 + m_2)v_f = m_1 u_1 + m_2 v_2$ (cons of p tot)
$5v_f = (4\cdot5) + (1\cdot0) \Rightarrow v_f = 4 m/sec$
$(KE)_i = \frac{1}{2}4\cdot5^2 = (50J)$
$(KE)_f = \frac{1}{2}(m_1+m_2)v_f^2 = \frac{1}{2}5(4)^2 (40J)$
$KE_i - KE_f = 50 - 40 = 10J$

30. In physics, **net 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. applied force and the distance traveled ✗
    e. net force and the time it is applied. ✗
    f. None of the above correctly defines a physical work. *FALSE (b) does*

31. Two objects have different masses but equal kinetic energies. If you stop them with the same retarding force, which one will stop in the shorter time?
   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.
   f. It is not possible to say from the data given.

WORK ENERGY THEOREM $\Delta(KE) = F\Delta X$ implies EQUAL (KE)'s are stopped in SAME DISTANCE. THEN FASTER object travels stopping distance in shorter time. $\Rightarrow$ LIGHTER object stops sooner.

32. Two objects have different masses but the equal 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. The one with the larger kinetic energy.
   d. Both stop in the same time.
   e. There is not enough information to say.

IMPULSE MOMENTUM THEOREM, $\Delta\vec{p} = \vec{F}\Delta t$, implies EQUAL MOMENTA are stopped in SAME time. Then slower one stops in SHORTER DISTANCE & HEAVIER IS slower, when momenta are same.

33. The kinetic energy of an object moving in a circle at a constant speed
   a. is continually changing as the force changes direction. *FALSE* $KE = \frac{1}{2}mv^2 = const$
   b. is equal to the force times the time for one revolution. *"*
   c. is equal to one-half of the potential energy. *FALSE*
   d. is constant.
   e. depends upon the radius of the circle. *FALSE*
   f. None of the above completions yields a true statement. *FALSE/ (d) does.*

34. Which of the following has the physical dimension of power?
   a. Newton-meter/sec · *YES*
   b. kilowatt *YES*
   c. Joule/sec *YES*
   d. kg-m^2/sec^3 *YES*
   e. All of the above have the physical dimension of power. *TRUE*
   f. None of the units a) through d) has the dimension of a physical power. *FALSE*

35. How much work is performed by the gravitational force F on a geosynchronous satellite during one day?
   a. Zero, because the satellite does not move. *FALSE*
   b. Zero, because the force is perpendicular to the velocity. *TRUE*
   c. FC, where C is the circumference of the satellite orbit. *FALSE*
   d. Fr, where r is the radius of the orbit. *FALSE*
   e. Zero, because a geosynchronous satellite remains in a stationary position above the earth, and therefore suffers no displacement. *FALSE, in an inertial frame satellite is travelling round the earth.*
   f. None of the above.

36. A bowler lifts a bowling ball from the floor and places it on a rack. If you know the weight of the ball, what else must you know in order to calculate the work she does on the ball?
   a. mass of the ball
   b. the time required
   c. nothing else
   d. height of the rack
   e. acceleration due to gravity
   f. None of the above alone suffices to calculate the work done.

$W = \Delta(PE)_b = \Delta(mgh) = W \cdot h$ *(Weight = W = mg)*
If W is known, only h is needed.

37. How much work does a 50-kg person do against gravity in walking up a trail that gains 700 m in elevation?

$W = \Delta PE_G = mg\Delta h = 50 \cdot 10 \cdot 700 = 350,000 \, J$

a. 500 J
b. 7000 J
c. 3,500 J
d. 35,000 J
(e) 350,000 J
f. There is not enough information to say, because the work depends on the slope of the trail.

38. Imagine riding in a glass-walled elevator that goes up the outside of a tall building at a constant speed of 10 meters per second. Assuming that you drop a ball as you pass a window, a person looking out the window will see the ball

a. fall starting from rest. NO $v_0 = +10 \neq 0$
b. fall starting with an upward speed of 20 m/s. $(NO! +10 \, m/s = v_0)$
c. fall starting with a downward speed of 10 m/s. "
d. accelerate downward at 10 m/s². $TRUE$ $g = -10 \, m/sec^2$
~~d. remain stationary.~~ $\leftarrow$ [deleted in Error Correction]
e. None of the above statements is true $\leftarrow$ $FALSE$ (d) is true

39. While you are standing on the sidewalk, 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 No
b. total mechanical energies No
c. individual momenta No
d. total momentum No
(e.) None of the above physical quantities has the same value in both reference systems.

40. 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. Measuring the verticality of a hanging object
e. None of the above experiments can provide the proof, although it is possible in principle to perform some set of experiments which would do so.
(f.) No experiment of any kind could possibly provide the proof sought. otherwise, one inertial frame (where $v=0$) would be different from all the others.

41. 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.) there is no net horizontal force acting on the ball. So its v_{ix} remains constant, same as car's.
b. the reference system attached to the car is non-inertial. $FALSE (v = const)$
c. there is a net force in the forward direction. $FALSE$
d. the force in the forward direction is canceled by the inertial force. $FALSE$
e. In fact the ball will not actually land in you hand, but will fall behind it, since it is moving. $FALSE$
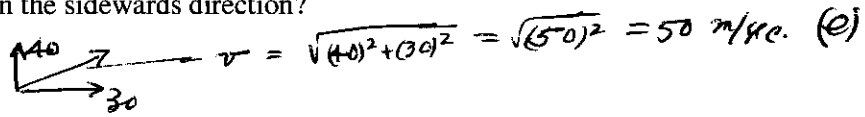f. None of the above. $FALSE$

42. A person drops a ball in train traveling along a straight, horizontal track with a constant acceleration of 5 m/s² in the forward direction. What would the person in the train say about the horizontal forces acting on the ball?

    $-mA = F_{pseudo}$
    $mg = F_G$

a. There are no horizontal forces acting on the ball. *False (Pseudo force acts)*
b. There is a horizontal force acting forward of magnitude g/2
c. There is a horizontal force acting backward of magnitude g/2. $= 10/2 = 5$ ✓
d. There is a horizontal force, but its magnitude cannot be stated in terms of g. *FALSE* $5 = g/2$
e. There is a centrifugal force. *FALSE*
f. The person on the train would offer none of the above statements. *FALSE*
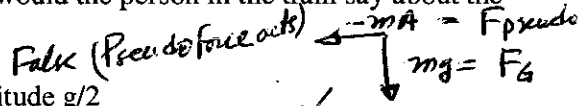
43. A rock is thrown horizontally at 40 m/s from the back of a flatbed truck that is moving with a constant velocity of 30 m/s. Relative to an observer on the ground, what is the horizontal speed of the rock when it is thrown in the sidewards direction?

a. 10 m/s
b. 20 m/s
c. 30 m/s
d. 40 m/s
e. 50 m/s
f. None of the above speeds is within 10 % of the correct answer.

$v = \sqrt{(40)^2 + (30)^2} = \sqrt{(50)^2} = 50 \ m/sec. \ (e)$

44. An aircraft carrier is moving to the north at a constant 20 mph on a windless day. A plane requires a speed relative to the air of 145 mph to take off. How fast must the plane be traveling relative to the deck of the aircraft carrier to take off if the plane is headed north?

a. 20 mph
b. 72.5 mph
c. 105 mph
d. 125 mph
e. 145 mph
f. None of the above answers is within 10% of the correct value.

$145 = v = v' + 20 \Rightarrow v' = 145 - 20 = 125 \ mph \ (d)$

45. 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 on the train determines that the horizontal speed of the ball during the fall is

a. decreasing
b. increasing, *due to acceleration due to horizontal pseudo force,* $-m \cdot 50$,
c. zero
d. constant and equal to 50 mph.
e. None of the above.

46. 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 station say about the horizontal force acting on the ball?

a. There is no horizontal force, *but only the downward gravitational force, since*
b. A force acts backward. *his frame is NOT accelerated, and so*
c. A force acts forward. *he needs to add NO PSEUDO FORCES*
d. There is a centrifugal force. *to the physical forces.*
e. None of the above

47. You and a friend are rolling marbles on a horizontal table in the back of a van traveling straight forward on a level section of interstate highway. You start the marble rolling directly toward the side of the truck and observe that it curves toward the front. You conclude that the truck is
a. not moving
b. moving at a constant velocity
c. speeding up
d. slowing down
e. Turning at constant speed
f. None of the above

$F_{pseudo} = \text{towards front} = -m A_{van}.$
$\Rightarrow A_{VAN} \text{ is towards back}$
$i.e. \text{ Van is slowing down}$

48. An elevator is moving upward and speeding up with an acceleration equal in magnitude to one-quarter that of gravity (about 2.5 m/s^2). If a person who weighs 1000 N when at rest on Earth steps on a bathroom scale in this elevator, what will the scale read?
a. 250 N
b. 500 N
c. 750 N
d. 1000 N
e. 1250 N
f. None of the above.

$a = g + 2.5 \approx 12.5 \, m/sec$
$Weight = ma = 12.5 \times 1000 = 1250 \, N$ (e)

— Corrected in class

49. While driving to the movies you decide to take advantage of a sharp right-hand corner to slide your date over next to you by turning right sharply . (Assume that the seat is frictionless.) From your point of view your date experiences a net force to the left, while a person standing on the roadway says your date experiences
a. a net force to the right.
b. a net force to the left.
c. no net force, since she continues travelling forward at constant speed as the vehicle turns.
d. a net force backward
e. a net force forward.
f. none of the above

50. 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 upward 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
f. None of the above.

$a_{FF} = g + a_E = 10 + 6 = 16 \, m/sec^2$

51. A room is being accelerated through space at 20 m/s^2 relative to the "fixed stars." It is far away from any massive objects. If a man weighs 700 N when he is at rest on earth, how much will he weigh in the room?
a. zero
b 175 N
c. 350 N
d. 700 N
e. 1400 N
f. None of the above is within 10 % of the correct answer.

$\tilde{g} = 20 = 2g$
$700 = mg \Rightarrow m\tilde{g} = 2mg = 2(700) = 1400 N$

52. If you look down on the earth from a satellite, you will see that hurricanes in the Northern Hemisphere rotate in a direction which

a.) is consistently clockwise
b. is consistently counterclockwise
c. is consistently northerly
d. is consistently southerly
e. differs from hurricane to hurricane.
f. is characterized by none of the above completions.

Note that the remaining eight problems (#53 through #60) may require more computation than average. You may wish to allocate your effort accordingly.

53. A solid lead sphere of radius 10 m (about 66 ft across!) has a mass of about 57 million kg. If two of these spheres are floating in deep space with their centers 400 m apart, the gravitational attraction between the spheres is only 130 N. How large, most nearly, would this gravitational force be if the distance between the centers of the two spheres were tripled?

a.) 15 N
b. 30 N
c. 60 N
d. 120 N
e. 240 N

$$130 \, N \times \left[\frac{(400)}{(1200)}\right]^2 = \frac{130}{9} = 14.4 \, N \approx 15N \quad \text{(a)}$$

54. A 800-kg frictionless roller coaster starts from rest at a height of 26 m. It travels 500 m under a frictional force of 224 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? (1 kJ = 10^3 J.)

a.) 0 kJ
b. —
c. 28,800 J
d. 14,400 J
e 208 kJ J

Answer (b) was deleted in ERROR CORRECTION.

$$W^{NET} = W^G + W^F = \Delta KE$$
$$+ mg(h_i - h_f) - F_f \cdot d = \Delta KE$$
$$(800)(10)(26-12) - (224) \, 500 =$$
$$(9000)(14) - 112,000$$
$$112,000 - 112000 = 0 = \Delta(KE)$$

KE at top of 12 m hill is same as at starting point

$\angle = 0$, since car starts from rest. (a)

55. A block weighing 30 N is falling with a kinetic energy of 25 J at time, t = 0, when a constant upward force of 45 N is applied. At a particular later time, t = t₁ the block has been lifted 4 m above the point where it was at t= 0. What is its kinetic energy at time t₁, most nearly?

a. 145 J
b. 115 J
c. 85 J
d. 55 J
e 30 J
f. 25 J
g. 0 J

$$P^{NET} \cdot \Delta y = W^{NET} = \Delta(KE) = (KE)_f - (KE)_i$$

$$(45 - 30)\ 4 = (KE)_f - 25J$$

$$60J + 25J = 85J$$

56. What average power is required to accelerate a 1300-kg car from rest to 15 m/s in 8 s, most nearly? (1 kW = 1000 watts = 1000 J/sec.)

a. 0 kW
b. 12 kW
c. 15 kW
d. 18 kW
e 24 kW

$$Power = \frac{\Delta KE}{\Delta t} = \frac{W^{NET}}{\Delta t} = \frac{\frac{1}{2}(1300)(15)^2}{8} = 18,281.25 \frac{J}{sec}$$

$$\approx 18 \times 10^3\ watts = 18\ kw$$

57. An 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 about 1.1 m/s². What is the gravitational force on the satellite, most nearly?

a. 50 N
b. 100 N
c. 500 N
d. 1,000 N

$F = ma = 90 \cdot (1.1) = 99 \, N \approx 100 N$ (b)

58. A person who weighs 600 N when at rest is riding in the rotating cylinder ride. The cylinder rotates fast enough to create a horizontal centrifugal pseudo-force in the rotating frame of magnitude 600 N. What is the magnitude of the person's weight in the rotating reference frame, most nearly?

a. 450 N
b. 650 N
c. 850 N
d. 1050 N
e. 1250 N
f. 1450 N
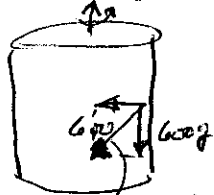
$Weight = \sqrt{(600)^2 + (600)^2} = 600\sqrt{2} = 848.4 \, N \approx 850 \, N$ (c)

59. An observer drops a ball in a train traveling along a straight, horizontal track with a constant acceleration of 5 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 has a magnitude of _____ m/s^2, most nearly.
   a. 5.0 m/s^2.
   b. 10.0 m/s^2.
   c. 11.1 m/s^2.
   d. 14.1 m/s^2.
   e. None of the above.

$$|a| = \sqrt{5^2 + 10^2} = \sqrt{125} = 11.2 \approx 11.1 \; ^{m}/_{sec^2} \;\; (c)$$
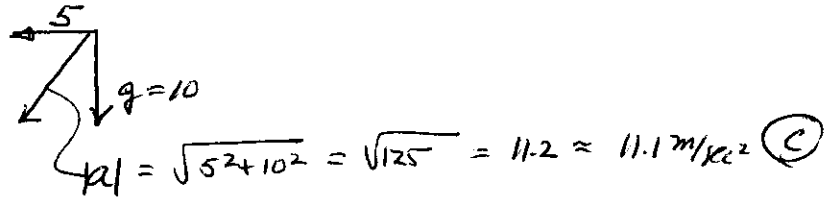
60. A cylindrical space habitat with a 3000-m radius is rotating so that a person standing on the inside surface feels a centripetal acceleration equal to g/2 = 5 m/sec^2. What is the tangential speed of a point just inside the cylinder, most nearly?

   a. 25 m/s
   b. 75m/s
   c. 125 m/s
   d. 175 m/s
   e. 225 m/s

$$\frac{g}{2} = \frac{v^2}{R} \Rightarrow \sqrt{v^2} = \sqrt{\frac{Rg}{2}} = v = \sqrt{\frac{(3000)(10)}{2}} = 122.5 \; ^{m}/_{sec}$$
$$\approx 125 \; ^{m}/_{sec} \;\; (c)$$

........End of Exam ....