SOLUTIONS (w. CORREX #23 & #55)

Multiple Choice: Please select the choice that best answers the question and insert its letter into the corresponding line of your NCS answer sheet.

1. Which of the following statements (a through e) about Venus is false?
   a. Venus has a (nearly)constant speed. T
   b. There is a net force acting on Venus. T
   c. The sun exerts a force on Venus equal in magnitude to that which Venus exerts on the sun. T
   (d.) Venus is driven forward along its orbit by physical forces due to the other masses in the solar system. F
   e. Venus exerts on Mars a force of the same magnitude as Mars exerts on Venus T
   f. All of the above statements (a through e) are true: none is false. F
   g. None of the above statements (a through e) is true: all are false. F

2. Which of the following statements about the moon is most correct?
   a. The acceleration due to gravity on the surface of the moon is smaller than that on the earth T because the effect of the moon's smaller radius is overcome by the moon's smaller mass. T
   b. The earth's gravitational pull on the moon equals the moon's gravitational pull on earth. T
   c. We expect that the moon has zero acceleration in its own (accelerated) rest frame, since T the centrifugal inertial pseudo-force just cancels the centripetal force the earth exerts on it..
   d. The moon is continually accelerating toward the earth at a rate less than $g = 9.8 m/sec^2$. T
   (e.) All of the above statements (a through d) are true.
   f. None of the above statements (a through e) is true. F

3. What is the force of earth's gravity upon a 10 kg mass located 100 earth radii from the earth's center?
   a. 10^{-4} N
   b. 10^{-3} N
   (c.) 10^{-2} N
   d. 10^{-1} N
   e. 1 N
   f. None of the above answers is within 10% of the correct result.

$$F = \frac{10g\,(R_E)^2}{[100\,(R_E)]^2} = \frac{10g}{10^4} = 10^{-3}g = 10^{-2} N$$

where $g = G\frac{M_E}{(R_E)} = 10\ m/sec^2$

4. How large, most nearly, is the acceleration of a 4 kg mass due to earth's gravity when it floating freely in an earth satellite at an altitude equal to three earth radii?
   a. 10 m/s/s
   b. 3.3 m/s/s
   c. 2.5 m/s/s
   d. 1.11 m/s/s
   (e.) 0.625 m/s/s
   f. None of the above answers is within 10% of the correct result.

$$a = g\cdot\frac{R_E^2}{R^2} = g\frac{(R_E)^2}{(R_E+3R_E)^2} = \frac{g}{(4)^2} = \frac{g}{16} = \frac{10}{16} = 0.625\ m/sec^2$$

5. If you triple the radius of a sphere, its surface area increases by what factor?
   a. 1
   b. 27
   c. 3
   d. 6
   e. 18
   (f.) 9
   g. None of the above.

6. A future space traveler, Skip Parsec, lands on the planet, Z, which has half the mass of Earth and twice its radius. If Skip weighs 400 Newtons on Earth's surface, how much does he weigh on Z's surface?
   a. 3200 N
   b. 1600 N
   c. 800 N
   d. 400 N
   e. 200 N
   f. 100N
   (g.) 50 N
   h. None of the above is correct within 10%.

   $mg = 400N \Rightarrow m = 40\ kg$; $g_E = G\frac{M_E}{R_E^2}$

   $g_Z = \frac{M_Z}{M_E} \cdot \frac{R_E^2}{R_Z^2} G\frac{M_E}{R_E^2} = (\frac{1}{2})(\frac{1}{2})^2 \cdot g_E$

   $g_Z = g_E/8 \Rightarrow mg_Z = \frac{40}{8} g_E = 50N$

7. What is the magnitude of the earth's gravitational field, F_G/m, at a height above the earth equal to three times the earth's radius?
   a. 160 N/kg
   b. 90 N/kg
   c. 30 N/kg
   d. 10 N/kg
   e. 3.3 N/kg
   f. 1.1 N/kg
   (g.) 0.62 N/kg
   h. None of the above is correct within 10%.

   $F_G/m = g$ at $r = R_E$

   at $r = 3R_E + R_E = 4R_E$,

   $\frac{F_G}{m} = (\frac{1}{4})^2 g = \frac{g}{16}$

   Replaced

8. The law of universal gravitation states that $F_G = GMm/r^2$. Which of the following reasons, if any, provides a valid and complete justification for using the form $F_G = mg$ when we studied projectile motion?
   a. The first form is not valid for projectile motion. F
   b. The first form does not work for projectile because it requires two masses. F
   c. The first form is not valid near the surface of the earth. F
   d. The second form is simpler and therefore aesthetically preferable to the first. True but insufficient
   (e.) If the distance to the earth's center remains very close to R_E (the radius of the earth), the second form gives the same result as the first, except for a correction of magnitude h/R_E (where h is the height above the earth's surface), which is very small for most projectiles. T
   f. None of the above is a valid and complete justification for using the second form. F

9. In Newton's effort towards constructing his Law of Universal Gravitation, which of the following items was NOT instrumental to his obtaining the correct form of that law?
   a. That a rapid enough horizontal motion can place an object into an orbit around the earth. ✓
   b. That the force should be proportional to the product $M_1 * M_2$ of any two masses it affects. ✓
   c. That the acceleration of the moon is much smaller than g. ✓
   d. That the earth-moon distance is about 60 times larger than the earth's radius ✓
   (e.) All of the above (a through d) were instrumental items.
   f. None of the above items (a through d) was instrumental in Newton's thinking.

10. Al, the astronaut, has a mass of 80 kg and a weight of 800 N when he is standing on the surface of the earth. What is his mass when he is in a space station orbiting earth with a radius of four earth radii?
   a. zero
   b. 5 kg
   c. 10 kg
   d. 20 kg
   e. 40 kg
   f. 80 kg
   g. None of the above completions yields a true statement.

MASS is independent of location

11. Over which of the following locations is it practical to have a geosynchronous satellite?
   a. New York City, because it is a communications center.
   b. Quito, Ecuador, because it lies on the equator.
   c. London, because it is on the prime meridian.
   d. The North Pole, because it does not move as the earth rotates.
   e. A geosynchronous satellite can be placed over any of the above locations.
   f. A geosynchronous satellite can NOT be placed over any of the locations, a through d.

12. To make a satellite geosynchronous in a circular orbit at a height of three earth radii, an engineer is assigned the task of adjusting its speed to make its period exactly equal to 24 hours. To achieve this task:
   a. requires enough energy to speed up or slow down the satellite.
   b. demands engineering ingenuity to make the adjustment sufficiently precise.
   c. needs adequate follow up adjustment to keep the speed correct.
   d. All of the above (a through c), and more, are necessary.
   e. The engineer cannot possibly succeed, because the task is physically impossible.

13. A 300-kg satellite experiences a gravitational force of 1000 N. What is the altitude above the earth's surface of the satellite in orbit, most nearly? (R_E = Earth's Radius.)
   a. 9.0 R_E
   b. 8.0 R_E
   c. 3.0 R_E
   d. 2.0 R_E
   e. 1.7 R_E
   f. 0.7 R_E
   g. None of the above is within 10% of the correct answer.0.7.

$mg = (300)(10) = 3000 N$

$1000\ N = mg\left(\frac{R_E}{R}\right)^2 \Rightarrow \left(\frac{R_E}{R}\right)^2 = \frac{1}{3} \Rightarrow \frac{R_E}{R} = \frac{1}{\sqrt{3}}$

$R = 1.732\ R_E$ & $h = (1.732 - 1.0)\ R_E = 0.732\ R_E$

14. What is the gravitational force between two 10.0-kg iron balls separated by a distance of 10.0 m, most nearly? (The gravitational constant is $G = 6.67 \times 10^{-11}$ N-m^2/kg^2.)
   a. 6.67×10^{-9} N
   b. 3.34×10^{-9} N
   c. 6.67×10^{-10} N
   d. 3.34×10^{-10} N
   e. 6.67×10^{-11} N
   f. None of the above is correct within 10%.

$F = G\frac{(10 \cdot 10)}{(10)^2} = 6.67 \times 10^{-11}\ (1)$

15. Kepler's third Law says that $T^2 = \text{constant}*R^3$ for planetary motion. If planet A has a period, T_A, eight times that of planet B, then A is ____times as far from the sun as B.
   a) 0.125
   b) 0.25
   c) 0.5
   d) 2.0
   e) 4.0
   f) 8.0
   g) 16.0
   h) None of the above is correct within 10%.

$\frac{T_A^2 = k \cdot R_A^3}{T_B^2 = k R_B^3} = \left(\frac{8}{1}\right)^2 = 64$

$R_A^3 = 64 R_B^3 \Rightarrow R_A = 4 R_B$

16. The acceleration due to gravity on Titan, Saturn's largest moon, is about 1.4 m/s^2. What would a 30-kg scientific instrument weigh on Titan, most nearly ?
   a. 4.2 N
   b. 30 N
   c. 42 N
   d. 300 N
   e. 420 N
   f. None of the above is within 10% of the correct answer.

$W_T = 30 \cdot (1.4) = m g_T = 42\ N$

17. Suppose Ted has a mass of 70 kg. How fast (in mph) would he have to run to have the same momentum as an 18-wheeler (m = 20,000 kg) rolling along at 1.0 mph? (1 mi = 1609 m.)
   a. 1.3×10^2 mph
   b. 2.9×10^2 mph
   c. 7.8×10^3 mph
   d. 4.6×10^5 mph
   e. 8.9×10^5 mph
   f. None of the above answers is within 10 % of the correct result.

$P_T = 70(v_T) = (2\times10^4)(1.0)\ kg \cdot \frac{mi}{hr}$

$v_T = \frac{2\times10^4}{70} = 2.86 \times 10^2$ m.p.h (b)

18. 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. Impulse…change in kinetic energy
   d. net work .... change in momentum
   e. net work .... change in kinetic energy
   f. None of the above insertions leads to a true statement.

19. If an air track sled, B, at rest, is struck by an identical moving sled, A, the total final kinetic energy will be
   a. largest when the collision is totally inelastic so that the two sleds stick together, and the moving sled, A, provides the maximum follow-through force F
   b. smallest when the collision is totally elastic so that sled A comes to a halt while sled B moves off with the full initial velocity of sled A. F
   c. smallest for some partially inelastic collision between the above two extreme cases. F
   d. The same for any degree of elasticity in the collision, because of Conservation of Kinetic Energy. F
   e. None of the above completions yields a true statement.

20. Air bags are used by stunt people when they fall off buildings to reduce the __________ which occurs during the stopping of the fall.
   a. change in momentum F
   b. elapsed time F
   c. impulse F
   d. change in velocity F
   e. work F
   (f.) average force T
   g. None of the above insertions yields a true statement.

Since $\langle \vec{F} \rangle_{AVG} \Delta t = \Delta p$, longer Δt means smaller $\langle \vec{F} \rangle_{AVG}$

21. Which of the following will cause the largest change in the momentum of an object? A force of _________acting for __________.
   a. 5 N ... 9 s
   b. 6 N ... 8s
   (c.) 7 N ... 7 s
   d. 8 N ... 6 s
   e. 9 N ... 5 s
   f. Both b and d above cause the same largest change in the momentum.

22. If a 600 kg artillery shell explodes into fragments as it approaches its target with a speed of 600 km/hr, the total momentum of all its fragments just after the explosion will be equal in magnitude to:
   a. $1.0x10^2$ kg-m/s
   b. $3.6 x10^4$ kg-m/s
   (c.) $1.0 x 10^5$ kg-m/s
   d. $3.6 x 10^7$ kg-m/s
   e. None of the above (a through d) has correct units for momentum.
   f. The answer depends upon the energy of the explosion..
   g. None of the answers (a through f) above is either correct or within 10% of the correct answer.

$P_i^{TOT} = P_f^{TOT}$ by conservation of momentum

$= 100\,kg \cdot \frac{6 \times 10^3\,m}{1\,hr} \times \frac{1\,hr}{6 \times 10^3\,sec} = 100 \times 10^3 = 10^5 \frac{kg\,m}{sec}$ (c)

23. What average force is required to stop a 125-kg football player running at 8 m/s in a time of 0.4 s, most nearly?
   a. 16 N
   b. 25 N
   c. 31 N
   d. 250 N
   e. 1000 N
   (f.) 2500 N
   g. None of the above is within 10% of the correct answer.

Impulse - Momentum Theorem: $F_{AVG} \Delta t = \Delta P$

$F_{AVG} = \frac{\Delta \vec{P}}{\Delta t} = \frac{125 \cdot (8)}{0.4} = 250 \frac{kg\,m}{sec^2} = 250\,N$ (d) ← ERROR

$= \frac{1000}{0.4} = 2500\,N =$ (f)

CORRECT ANSWER IS (f) NOT (d)

24. A very hard rubber ball ($m = 0.6$ kg) is falling vertically at 10 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 0.006 s, what is the average force exerted by the floor on the ball?
    a. 1000 N
    b. 200 N
    c. 100 N
    d. 20 N
    (e.) None of the above is within 10% of the correct answer.

$\Delta P/\Delta t = F_{AVG}$ (from $F_{AVG} \cdot \Delta t = \Delta p$: IMPULSE-MOMENTUM Theory)

$\frac{P_f - P_i}{\Delta t} = \frac{[(10)(0.6) - (0.6)(-10)]}{6\times10^{-3}} = \frac{6+6}{6\times10^{-3}} = 2\times10^3$ N

25. If we examine a ball in free fall, we find that the momentum of the ball is not constant. This is not a violation of the law of conservation of momentum because
    a. The force of gravity acts on the ball.
    b. The ball experiences an external force.
    c. The ball is not an isolated system.
    d. Net work is done on the ball as it falls.
    (e.) All of the above answers are correct.

26. As a supernova star explodes, the total linear momentum of the star
    a. increases slowly
    b. increases suddenly in the outward direction
    c. decreases rapidly at first and then more slowly as the star expands.
    d. decreases at a nearly uniform rate once the explosion has occurred.
    e. There is not enough information given to define the behaviour of the total momentum.
    (f.) None of the above statements (a through e) is true.

27. We can explain the recoil that occurs when a rifle is fired by using
    a. conservation of momentum.
    b. Newton's second and third laws.
    c. equal and opposite impulses.
    d. equal and opposite changes in momentum
    (e.) Any of the above.

28. Larry has a mass of 60 kg and runs across the classroom with a speed of 15 m/s and jumps onto a giant skateboard, initially at rest and with a mass equal to half of Larry's. If we ignore friction, what is the final speed of Larry and the skateboard, most nearly?
    a. 4 m/s
    (b.) 10 m/s
    c. 15 m/s
    d. 20 m/s
    e. 30 m/s
    f. None of the above is within 10% of the correct answer.

$P_i = 60(15) = P_f$ (Conservation of MOMENTUM)

$= (60+30)v_f$

$\frac{60\cdot15}{90} = v_f = 10$ m/sec

29. 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 A has a speed of 3 m/s after the release, how fast will glider B be moving?
   a. 0.75 m/s
   b. 1.0 m/s
   c. 3 m/s
   (d.) 9 m/s
   e. 12 m/s
   f. None of the above is within 10% of the correct answer.

$P^{TOT} = 0 = m_A v_A - m_B v_B$, $m_A = 3m_B$ ⇒ $3 m_B v_A = m_B v_B$; $9\,\frac{m}{sec} = v_B$

30. A father (m = 80 kg) and son (m = 30 kg) are standing facing each other on a frozen pond. The son pushes on the father and finds himself moving backward at 4 m/s after they have separated. How fast will the father be moving?
   a. 1.1 m/s
   (b.) 1.5 m/s
   c. 3.0 m/s
   d. 4.0 m/s
   e. 10.6 m/s
   f. None of the above is within 10% of the correct answer.

$|\vec{P}| = 0 = m_F v_F - m_S v_S \Rightarrow v_F = \frac{m_S v_S}{m_F} = \frac{30}{80} \cdot 4 = 1.5$ m/sec

31. Assume that a red car has a mass of 1000 kg and a white car has a mass of 3000 kg., and both have the same momentum. Then
   a. the white car's kinetic energy is one-third as big T
   b. their kinetic energies are not equal. T
   c. the red car's kinetic energy is three times as big T
   (d.) All of the statements, a, b, & c, above are true.
   e. None of the completions yields a true statement.

$KE = \frac{1}{2} M v^2 = \frac{1}{2}\frac{(Mv)^2}{M} = \frac{p^2}{2M}$

$\frac{(KE)_{RED}}{(KE)_{WHITE}} = \frac{P^2_{RED}}{M_{RED}} \cdot \frac{M_{WHITE}}{P^2_{WHITE}} = \frac{M_{WHITE}}{M_{RED}} = 3$ & $P_{RED} = P_{WHITE}$

Then (c) is true, (a) is true, (b) is true & (d) is correct

32. Under what conditions is the kinetic energy (K.E.) conserved (in the strict sense) in a collision?
   a. K.E. is always conserved.
   b. K.E. is only conserved when the collision is totally elastic.
   c. K.E. is conserved when there is no net outside force.
   d. K.E. is conserved when there is no friction.
   (e.) Kinetic energy is never "conserved" in a collision because it does not remain constant.
   f. None of the above answers is correct.

33. In physics, the **net work** is defined as the product of the
   a. net force and the distance traveled.
   b. net force and the time it is applied.
   (c.) net force parallel to the motion and the distance traveled.
   d. net force parallel to the motion and the time it is applied.
   e. applied force and the distance traveled.
   f. None of the above.

34. Two objects have different masses but the same momentum. If you stop them with the same constant retarding force, which one will stop in the shorter distance, and why?
    a. Both stop in the same distance, because both require the same impulse to stop. X
    b. The lighter one, because it travels a shorter distance in the same time. X
    c. The heavier one, because it travels a shorter distance in the same time. ✓
    d. Both stop in the same distance, because both require the same net work to stop. X
    e. None of the above statements is correct. X

$\frac{\Delta P}{F_{AVG}} = \Delta t$ (Same for both)
& $M_L v_L = M_H v_H = \Delta P$
$v_L = \frac{M_H}{M_L} v_H > v_H$
THUS IN SAME TIME LIGHTER (& FASTER) TRAVELS FURTHER

35. Regardng the amount of work is performed by the gravitational force F on a synchronous satellite during one day, and the reason why:
    a. The work done is zero, because the force is always perpendicular to the velocity. T
    b. The work done is F*C, where C is the circumference of the orbit F
    c. The work done is zero, because the net force on the satellite vanishes. F
    d. The work done is zero, because a synchronous satellite does not move. F
    e. The work done is F*D, where D is the diameter of the orbit. F
    f. The work done is Fr, where r is the radius of the orbit. F
    g. None of the above statements (a through f) is true.. F

36. Which of the following properties of a ball is conserved as it falls freely in a vacuum?
    a. kinetic energy F
    b. mechanical energy T
    c. momentum F
    d. gravitational potential energy. F
    e. No conservation law applies because gravity does work on the ball as it falls. F
    f. None of the above is a true answer to the question. F

37. Because the earth rotates once daily under the tidal bulges generated by the moon's gravitational attraction, and because the moon orbits the earth in about 28 days,
    a. we always have 2 high and 2 low tides in every 24 hour interval. F
    b. we sometimes have 2 low tides and 1 high tide in a 24 hour interval. T
    c. we sometimes have an extra high tide or low tide, in addition to the usual 2 high and 2 low tides. F
    d. we always have exactly 1 high tide and 1 low tide every 24 hours. F
    e. All of the above responses are flawed: none is correct. F

38. A man with a mass of 90 kg falls 800 m. How much kinetic energy does he gain?
    a. 7.2 J
    b. 72 J
    c. 720 J
    d. 7200 J
    e. 72000 J
    f. None of the above statements is within 10% of the correct answer.

CONS of ME: $(ME)_i = (ME)_f$
$(PE)_i + (KE)_i = (PE)_f + (KE)_f$
$0 + mgh = 90 \cdot 10 \cdot 800 = 0 + (KE)_f = 72 \times 10^4 J = 720,000$

39. An 800-kg frictionless roller coaster starts from rest at a height of 30 m. What is its kinetic energy when it goes over the top of a hill that is 10 m high?
   a. 8,000 J
   b. 16,000 J
   c. 24,000 J
   d. 80,000 J
   (e.) 160,000 J
   f. 240,000J
   g. None of the above answers is within 10% of the correct result.

$(ME)_i = (PE)_i + (KE)_i = (800)(30)(10) + 0 = (ME)_f$
by CONSERVATION of M.E. for CONSERVATIVE FORCES
$2.4\times10^5 = (PE)_f + (KE)_f = (800)(10)(10) + (KE)_f$
So that $(2.4 - 0.8)\times10^5 = (KE)_f = 1.6\times10^5\,J$ (e)

40. A 1.5 kg. pendulum has a kinetic energy of 45 Joule at the lowest point in its swing. How high does it travel to its stopping point?
   a) 0.1m
   b) 0.3 m
   c) 1.0 m
   (d) 3.0 m
   e) None of the above is correct within 10%.

$(ME) = const = (PE)_i + (KE)_i = (PE)_f + (KE)_f$
$0 + 45J = mgh + 0$
$\frac{45}{(10)(1.5)} = h = 3\,m$

41. If a spring, extended by 5 cm from its natural length, is relaxed to a smaller extension of 4 cm, its potential energy (P.E.) change by a factor, most nearly, of
   a) 0.35
   (b) 0.65
   c) 0.85
   d) 2.85
   e) None of the above is within 10%.

$(PE) = \frac{1}{2}kx^2 \Rightarrow \frac{(PE)_{x=4}}{(PE)_{x=5}} = \frac{16}{25} = 0.64$

42. A ball dropped from a height of 8 m bounces back to a height of 7 m before coming to rest. Which of the following statements is valid for this process?
   a. Kinetic energy is conserved. F
   b. Mechanical energy is conserved. F
   c. Gravitational potential energy is conserved. F
   d. The net work done by gravity was zero. F
   e. All of the above. F
   (f.) None of the above.

43. How much energy is required to light a 10-watt bulb for 278 h?
   (a.) 1.0×10^7 J
   b. 1.7×10^5 J
   c. 2.8×10^3 J
   d. 280 J
   e. None of the above answers is within 10% of the correct result.

$10\,watts = \frac{10\,J}{sec}$: $E = \frac{10\,J}{sec} \times 278\,hr \times \frac{3600\,sec}{1\,hr} = 10\times10^6$

44. 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 you drop a ball, an observer in the building will observe that initially the ball
    a. falls starting from rest.
    (b.) rises starting with an upward speed of 20 m/s.
    c. falls starting with a downward speed of 20 m/s.
    d. remains stationary.
    e. None of the above.

45. While you are standing on the sidewalk, you observe your friends pass by in a van traveling horizontally at a constant velocity. They and you make various physical measurements in your own frames of reference. Which of the following quantities has the same value in both reference systems?
    a. horizontal velocity components F
    b. kinetic energies F
    c. momenta F
    (d.) work done by vertical forces. T
    e. work done by horizontal forces. F
    f. None of the above quantities is the same in both frames F

46. You can throw a ball vertically up 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.
    b. the reference system attached to the car is non-inertial.
    c. there is a net force in the forward direction.
    d. the pseudo-force in the backward direction is canceled by the inertial force.
    e None of the above completions yields a true statement
    f. All of the above completions yield valid statements.

47. A ball is thrown horizontally at 30 m/s from a flatcar that is moving in a straight line at 40 m/s. Relative to a person on the ground beside the track, what is the horizontal speed of the ball when it is thrown directly backward?
    a. 70 m/s
    b. 50 m/s
    c. 40 m/s
    d. 30 m/s
    (e.) 10 m/s
    f. None of the above.

48. A person 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 based on the trajectory he observes?
   a. The force has no horizontal component.
   b. The force has no vertical component.
   c. The force has a horizontal component in the forward direction.
   d. There is a centrifugal force.
   e. The force has a horizontal component in the backward direction.
   f. None of the above.

49. You and a friend are rolling marbles on a horizontal table in the back of a moving van on a straight, 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 of the van. You conclude that the truck is
   a. not moving
   b. moving at a constant velocity
   c. speeding up
   d. slowing down
   e. None of the above conclusions can be validly drawn from the information given.

50. Which of the following could reasonably be cited as valid evidence that the earth rotates?
   a. The plane of a pendulum rotates as time passes.
   b. The sun rises and sets each day.
   c. Hurricane winds rotate counterclockwise in the Northern Hemisphere; clockwise in the Southern.
   d. A high precision measurement of the weight of a standard mass yields a slightly smaller value at sea level on the equator than at the north pole.
   e. All of the above.
   f. None of the above would indicate a rotation of the earth..

51. An elevator passenger's vertical acceleration, A, in an inertial frame, his mass, M, and the forces acting upon him due to gravity, F_{Grav}, and due to the floor, F_{floor}, are related (by NII) as follows: $MA = F_{Grav} + F_{floor}$. If we re-write this equation as: $0 = F_{Grav} + F_{floor} - MA$,
   a. We have added new physical content to the statement.
   b. We have placed the outside world's forces on the same side of the equation as their effect, and have thus altered their physical implications.
   c. We can re-interpret the result as the computation of observer, O_A, in a frame accelerating at a rate, A, which calculation uses a pseudo-force, and informs him that this person has an acceleration equal to 0 in O_A's accelerating frame.
   d. All of the above are true and valid completions.
   e. None of the above is true.

The following questions many require more computation that those preceding. Please Select the choice that best answers the question and insert its letter into the corresponding line of your NCS answer sheet.

52. A cylindrical space station, far from any large masses, can be spun so that people on the inside surface of the station feel the effects of an "artificial gravity" force directed outward from the axis of the cylinder. If the cylinder has a radius of 400 km, what must its angular velocity be in order to provide an artificial gravity just equal to g = 10 m/s/s.
   a. 0.5×10^{-2} radians/sec
   b. 0.5×10^{2} radians/sec
   c. 2.5×10^{-3} radians/sec
   d. 2.5×10^{3} radians/sec
   e. None of the above answers is within 10% of the correct result.

$$m\frac{v^2}{R} = mR\omega^2 = mg$$
$$\omega = \sqrt{g/R} = (10/400\times10^3)^{1/2} = \sqrt{2.5\times10^{-5}} = 5\times10^{-3}$$
$$\omega = 0.5\times10^{-2}$$

53. A 900-kg satellite orbits a distant planet in a circle of radius of 4000 km with a period of 280 min. From the radius and period, you calculate the satellite's acceleration to be 11 m/s^2. What is the gravitational force on the satellite, most nearly?
   a. 10 N
   b. 10^2 N
   c. 10^3 N
   d. 10^4 N
   e. None of the above answers is within 10% of the correct result

$$F_G = ma = 900 \cdot 11 \frac{kg\,m}{sec^2} = 9900\,N \sim 10^4 N$$

54. A solid lead sphere of radius 10 m (about 66 ft across!) has a mass of about 5.7 x 10^6 kg. If two of these spheres are floating in deep space with their centers 15 m apart, compute the gravitational force of attraction between them, and select the best answer from those listed below.
(G = = 6.67 × 10^{-11} N-m²/kg².)
   a. 1 N
   (b.) 10 N
   c. 100 N
   d. 1000 N
   e. 10,000 N
   f. None of the above answers is within 10% of the correct result.

$F_G = G \frac{M_1 M_2}{(R_{12})^2} = \frac{(6.67\times10^{-11})(5.7\times10^6)^2}{225} \frac{N\text{-}m^2}{kg^2} \frac{kg^2}{m^2}$
$= \left(\frac{216.7}{225}\right) 10^{-11+6+6} = (0.96)\times 10$
$F_G \approx 10$ N (b)

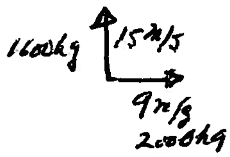
55. A 60 kg fighter pilot's ejection seat accelerates him upward at a rate of 4 times g, the near earth acceleration due to gravity ("4 g's"). If his seat had a built in weight scale, what would it read during his ejection?
   a. 600 N
   b. 2400 N
   (c.) 3000 N
   d. 3600 N
   e. None of the above is within 10% of the correct answer..

~~W~~ $= ma = 60\cdot 4\cdot g = 2400$ N (b) ← ERROR
$F_{NET} = ma = F_{SEAT} - F_G = m\cdot 4g$
$F_{SEAT} = 4mg + F_G$ = WEIGHT
$= 4mg + 1mg$
$= 5mg = 5\cdot 60\cdot 10$ (c)
= WEIGHT

CORRECT ANSWER IS (c) NOT (b)

56. A 1600-kg car traveling north at 15 m/s is struck by a 2000-kg truck traveling east at 9 m/s. If the truck and car crunch and move off locked together as a single unit, what is their speed immediately after the collision, most nearly?

a. 8.0 m/s
b. 10.0 m/s
c. 12.0 m/s
d. 14.0 m/s
e. 16.0 m/s
f. None of the above answers is within 6% of the correct result.



$\vec{P}_i^{TOT} = (P_x^{TOT}, P_y^{TOT})$ $((9)2000, (15)\cdot 1600) = (M_1 v_x, M_2 v_y)$

$|\vec{P}_i^{TOT}| = \sqrt{(P_x^{TOT})^2 + (P_y^{TOT})^2} = 1000\sqrt{(18)^2+(24)^2} = 30{,}000$

& $P_i^{TOT} = P_f^{TOT} = (M_1+M_2)v_f$

yields $v_f = |P_i^{TOT}|/(1600+2000)$

$= \frac{30{,}000}{3600} = 8.3$ m/sec (a)

57. A 20 kg block of wood loses 100 J of mechanical energy to friction as it slides down a ramp after starting at rest. If it started at a height of 15 m, we can conclude that its kinetic energy at the bottom of the ramp (where the height is zero) is, most nearly,

a. 15 J
b. 20 J
c. 200 J
d. 300 J
e. 2900 J
f. 3000 J
g. None of the above answers is within 10% of the correct result.

$(\Delta KE) = (KE)_f = W^{NET} = -\Delta(PE)_G - W_{frict} = mgh - 100$

$= 20\cdot 15\cdot 10 - 100 = 2900$ J (e)

58. A block which weighs 16 N is moving upward with an initial kinetic energy of 34 J and is being accelerated by an applied upward force of 32N. If the block is lifted 6 m , what is the block's final kinetic energy, most nearly?
   a. 226 J
   b. 192 J
   c. 158 J
   d. 130 J
   e. 96 J
   f None of the above answers is within 10% of the correct result

$F_{NET} = F_{APP} - F_G = 32 - 16 = 16\,N$

$W_{NET} = \Delta(KE) = (KE)_f - (KE)_i = F_{NET} \cdot \Delta y = 16 \cdot 6 = 96\,J$

$(KE)_f = 96\,J + (KE)_i = 96 + 34 = 130\,J$ (d)

59. A room is being accelerated through space at 15 m/s^2 relative to the "fixed stars." It is far away from any massive objects. If a man weighs 1000 N when he is at rest on earth, how much will he weigh in the room, most nearly ?
   a. zero
   b. 500 N
   c. 670 N
   d. 1000 N
   e. 1500 N
   f. None of the above answers is within 10% of the correct result.

$|\vec{W}| = |m\vec{A}| = (100\,kg)(15\,m/sec^2) = 1500\,N$

60. Assuming that the earth is a perfect sphere and that the force of gravity is constant over the surface, your weight (as determined by a bathroom scale) at the equator would be less that at the North Pole. by a small fraction due to the centrifugal force arising from the rotation of the earth about its axis. That fraction of your weight is equal to ________(Use $R_E = 6.4 \times 10^6$ m)

a. 3.4×10^{-2}
(b.) 3.4×10^{-3}
c. 3.4×10^{-4}
d 3.4×10^{-5}
e. 3.4×10^{-6}
f. None of the above is within 10 % of the correct answer.

$F_{centrifugal} = \frac{m v^2}{R_E} = m R_E \omega^2$ outward from axis of rotation

$\omega = \frac{2\pi}{1 day} = \frac{2\pi}{day} \times \frac{1 day}{24 h} \times \frac{1 h}{3600 sec} = 7.3 \times 10^{-5}$

Fractional change $= \frac{F_{cent}}{mg} = \frac{R_E \omega^2}{g} = \frac{(6.4 \times 10^6)(7.3 \times 10^{-5})^2}{10} = 34.1 \times 10^{6-10} = 3.4 \times 10^{-3}$ (b)

End of exam..........Phys 117-ExII-S08.........End of exam