MULTIPLE CHOICE: Choose the one most nearly correct and complete answer and insert its letter into your NCS answer sheet.

1. What average speed, most nearly, is required to run 9 mi in 1 hour, most nearly? (1mi = 1.6 km)
   a. 0.5 m/s
   b. 1.0 m/s
   c. 2.0 m/sec
   (d.) 4.0 m/s
   e. 8.0m/s
   f. 16.0 m/s
   g. None of the above is within 10%.

$$\bar{v} = \frac{9\ mi}{1\ hr} \times \frac{1.6 \times 10^3\ m}{1\ mi} \times \frac{1\ hr}{60 \times 60\ sec} = \frac{1.44 \times 10^4\ m}{3.6 \times 10^3\ sec}$$

$$\bar{v} = 4.0\ m/sec$$

2. The instantaneous speed of an object is defined to be
   a. the distance it travels divided by the time it takes.
   (b.) the distance it travels in a small interval of time divided by the time interval.
   c. the greatest magnitude of its velocity during the trip.
   d. the average magnitude of its velocity during the trip.
   e. none of the above.

3. When you calculate the speed (in meters per second) in an experiment, your calculator display reads 5.6789623. If you are asked to record your result to four significant figures, you should write
   a. 5.678 m/s
   (b.) 5.679 m/s ... after rounding 5.6789 upward to 5.679
   c. 5.6789 m/s
   d. 5.6790 m/s
   e. None of the above, because this result already has eight significant figures.

4. On a trip to Helena, you start your parked car, drive to Three Forks, stop for a one hour coffee break and arrive and park in Helena exactly two hours after leaving Bozeman. Suppose that it is exactly 100 miles from Bozeman to Helena. Which of the following statements about this trip is false?
   a. The speed must have been at least 100 mph sometime during this trip. T
   b. The average speed for this trip was50 mph. T
   c. The instantaneous speed is not 50 mph, but has a variable value as indicated on the speedometer at any moment during the trip. T
   d. Since the car speeds up after each stop and slows down before each stop the car must have traveled faster than 100 mph at some point in the trip T
   (e.) All of the above statements (a through d) are true; none is false. T
   f. None of the above statements (a through d) is true; all are false. F

5. The average acceleration of an object over a finite time interval, Δt, is defined to be
   a. one half of the sum of the initial and final velocities divided by Δt.
   b. the average velocity divided by the time interval of the acceleration.
   c. the distance traveled divided by $(\Delta t)^2$, the time interval squared.
   (d.) the difference between the final velocity and the initial velocity divided by Δt. ✓
   e. the value of the velocity at the midpoint of the time interval divided by Δt.
   f. None of the above yields a correct definition of the average acceleration.

6. If a rocket car requires 3 seconds to accelerate from zero to 900 km per hour, its average acceleration is, most nearly,

$\bar{a} = \frac{(900-0)\times 10^3 m}{(1\,hr)(3\,sec)} \times \frac{1\,hr}{3600\,sec} = \frac{900\times 10^3\,m}{(3)(3.6)\times 10^3\,sec}$

a. 830 m/ sec^2
b. 83 m/ sec^2
c. 8.3 m/sec^2
d. 0.83 m/sec^2
e. 0.083 m/sec^2
f. None of the above is within 10%.

$\bar{a} = 83\ m/sec^2$ (c)

7. Which of the following quantities specifies a net-force vector ?
a. 5 (kg) — MASS, NOT FORCE!
b. 5 (kg) downward — "
c. 5 (kg-m/s) north — M·L/T, NOT F, of dimension ML/T²
d. 5 (kg-m/s^2) ← NOT a vector: No direction given
e. 5(kg-m/s^2)east ✓
f. None of the above could possible specify a net-force vector.

8. Which of the following should be considered to be an "accelerator" in an automobile?
a. gas pedal, because it increases the speed
b. brake pedal, because it decreases the speed
c. steering wheel, because it changes direction.
d. All of the above (a through c) are accelerators properly so called.
e. None of the above is an accelerator properly so called

9. In the strobe diagram below the ball is moving from right to left. Which statement best describes the motion? The ball is

o o o   o   o   o....

(←)

a. not accelerating. F
b. speeding up. F
c. slowing down. T
d. moving with a constant speed. F
e. none of the above. F

10. Which of the following strobe diagrams could (subject to more precise checking) correspond to a situation where the ball moving to the left has a constant negative (with respect to the direction of its velocity) acceleration ? (←)

a. o o o o o o o o o o o o o o... a = 0
b. o o o o o o o o o o oo oo o o... a variable
c. o o o o o o o o oo o o o o o o o o oo ooooo... "
d. o o o o o o o o o o o o.... ← (a < 0 ok)
e. none of the above could have a constant negative acceleration.

11. A sheet of paper and a book fell at different rates in the classroom until the paper was wadded up into a ball. We then considered Galileo's gedanken (thought) experiment and concluded from it that if air resistance could be neglected, all objects would fall at
a. the same constant speed regardless of their masses. NO
b. the same speeds regardless of their masses. T
c. different constant speeds depending on their masses. F
d. different terminal velocities proportional to the square roots of the masses. F
e. different accelerations depending upon their masses. F
f. In fact, we claimed none of the above since no basis was yet available to support any of the claims (a through e). F

12. A ball with a mass of 2.5 kg is thrown vertically upward with a speed of 25 m/s. What are its speed and direction 4.5 seconds later, most nearly?
   a. 20 m/s upward
   b. 10 m/s upward
   c. zero
   d. 10 m/s downward
   (e.) 20 m/s downward
   f. None of the above is correct within 10%.

$v(t) = v_0 - gt = +25 - 10\cdot(4.5)$
$= -20$ m/sec. (e)

13. The motion of a block sliding down a frictionless ramp is typically a motion with
   a. a constant speed, independent of the slope of the ramp. F
   b. a constant speed that increases with the slope of the ramp. F
   c. an acceleration which increases as the block continues sliding. F
   d. a constant acceleration which is negative (i.e., slows the object down) due to friction. F
   (e.) a constant positive acceleration (i.e., which speeds the object up) of less than 10 m/s/s. T
   f. None of the above.

because $F^{NET} = Mg\,\text{final} - F_{friction} \Rightarrow a < g$

14. If a ball is dropped from rest, it will fall 5 m during the first second. How far will it fall during the seventh second, most nearly ?
   a. 15 m
   b. 25 m
   c. 35 m
   d. 45 m
   (e.) 65 m
   f. 75 m
   g. None of the above is within 10% of the correct answer.

IN 7th: $D(7) - D(6) = \frac{1}{2}g(t_f^2 - t_i^2) = \frac{10}{2}(49-36) = 65$
$\simeq 65$ most nearly.

15. If we use positive and negative signs to indicate the directions of velocity and acceleration in one dimension, in which of the following situations is the object speeding up?
   a. negative velocity and negative acceleration. ✓
   b. positive velocity and positive acceleration. ✓
   c. zero velocity and positive acceleration. ✓
   d. zero velocity and negative acceleration. ✓
   (e.) In all of the above cases (a through d) the object is speeding up TRUE
   f. In none of the above cases (a through d) is the object speeding up. F

16. A car initially traveling north at 20 m/s has a constant acceleration of 5 m/s^2 northward. How far does the car travel in the first 6 s, most nearly?
   a. 30 m
   b. 90 m
   c. 100 m
   d. 120 m
   (e.) 210 m
   f. None of the above is within 10% of the correct answer.

$x(t) = x_0 + v_0 t + \frac{1}{2}at^2$ (& take North as +)
$x(6) - x_0 = 20\cdot 6 + \frac{5}{2}\cdot 36 = 120 + 90 = 210$ m

17. If a crate of oranges has several forces acting upon different ones of its 6 corners, then
   a) Its center of mass will accelerate as though the net force of all of those forces were applied at the location of its center of mass. ✓
   b) Under the influence of the applied forces, the crate may rotate, even as its center of mass moves through space. ✓
   c) If an additional force, exactly equal and opposite to the net of the several forces above is applied to one corner of the box, the center of mass will no longer accelerate. ✓
   (d)) All of the above completions (a through c) lead to true statements about the center of mass. T
   e) None of the above completions (a through c) leads to a true statement about the center of mass. F

18. If you push on a railroad boxcar with a force of 3000 N and it doesn't move, you can conclude that
    a.. Newton's second law is not valid. ✗
    b. The force you applied is canceled by its third law partner force. ✗
    c. The boxcar has too much mass to accelerate. ✗
    d. There must be some object under a wheel which prevents it from rolling. ✗
    e. Galileo's Principle of inertia is not relevant ✗
    (f.) The net force acting on it is zero. T
    g. None of the above conclusions can be validly inferred.

19. A circus clown plans to launch a ball vertically from a gun which gives it an initial upward speed of 30 m/s. How high above the gun should his partner be placed so that he can just put his hand out and catch the ball at its maximum height, most nearly?
    a. 15 m
    b. 25 m
    c. 35 m
    (d) 45 m
    e 90 m
    f. None of the above is within 10% of the correct answer.

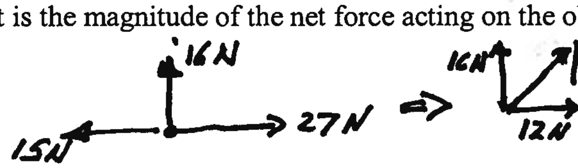
$v(t^{TOP}) = 0 = v_0 - g t^{TOP} = 30 - g t^{TOP} \Rightarrow t^{TOP} = \frac{30}{g} = 3s.$

$y(t^{TOP}) = y_0 + v_0 t - \frac{1}{2} g (t^{TOP})^2 \Rightarrow$

$y^{TOP} - y_0 = 30 \cdot 3 - \frac{10}{2} \cdot 9 = 45 m$

20. What is the net force acting on an 500-kg hot air balloon rising straight upward with a constant velocity of 40 m/s, most nearly?
    (a.) zero ... Since $\vec{v}$ = constant $\Rightarrow \vec{a} \equiv 0$!
    b. 500 N
    c. 2000 N
    d. 5000 N
    e. 20, 000 N
    f. None of the above is within 10% of the correct answer.

21. There are three forces acting on an object: 27 N horizontally to the left, 15 N horizontally to the right, and 16 N upward. What is the magnitude of the net force acting on the object, most nearly?
    a. 1 N
    b. 12 N
    c. 15 N
    d. 16 N
    (e.) 20 N.
    f.. 27 N
    g. None of the above is within 10% of the correct answer.



$|F^{NET}| = \sqrt{(16)^2 + (12)^2} = \sqrt{400} = 20 N$ (e)

22. If the net force on a hot-air balloon is directed straight upward, what is the direction of its acceleration point?
    a. Downward only if the balloon is falling, otherwise upward.
    b. Upward only if the balloon is rising, otherwise downward.
    c. Upward only if the balloon is falling, otherwise downward.
    d. Downward only if the balloon is rising, otherwise upward.
    (e.) Upward, whether the balloon is rising or falling.
    f. None of the above is a correct statement about the acceleration..

$F^{NET} \equiv m\vec{a}$ (!).

23.…The same *known* net force is applied to object A and object B, but the observed accelerations of the two objects are *not* the same: In fact, object A has an acceleration four times that of object B. Which of the following statements is correct?

(a.) Object A has one fourth the mass of object B. T $M_A a_A = F = M_B a_B$
b. Object A has four times the mass of object B.
c. There must be some other unexpected force accelerating A. $\Rightarrow \frac{M_A}{M_B} = \frac{a_B}{a_A} = \frac{1}{4}$
d. There must be some other unexpected force decelerating B.
e. None of the above (a through d) is validated by the facts stated.

24. Which of the following is not a vector quantity?

a. force
b. acceleration
c. weight
d. velocity
e. displacement
(f.) speed … is Magnitude of Velocity … not a Vector.
g. All of the above are vector quantities.
h. Actually, not just one, but two or more of the items (a through f), are non-vector quantities.

25. The acceleration due to gravity on Mars is only 40% of that on earth. If a child has a weight of 600 N on earth, what would the child's mass be on Mars?

a 24 kg
(b) 60 kg $Mg_E = 600N \Rightarrow M = 60\,kg$
c 240 kg … & MASS does not change with location
d 600 kg
e None of the above is correct within 10%.

26. A ball with a weight of 20 N is thrown vertically upward. What is the acceleration of the ball just as it reaches the top of its path?

a. zero
(b.) 10 m/s^2 downward Acceleration is CONSTANT: $g = 10\,m/sec^2$ DOWNWARD
c. 10 m/s^2 upward … always the same
d. 20 m/s^2 downward
e. 20 m/s^2 upward

27. A parachutist reaches terminal speed when

a. her weight goes to zero. ✗
b. the force of air resistance exceeds her weight. ✗
c. the force of air resistance equals her mass. ✗
(d.) the force of air resistance equals her weight. ✓
e. only when she spreads our her limbs to increase the air resistance. ✗
f. None of the above completions yields a correct statement. F

28. Two metal balls have the same size and shape (and therefore feel the same atmospheric drag force at any given speed) but one is hollow. They are dropped in air and their terminal speeds are measured to be exactly the same. Which of the following statements is correct?

a. The hollow ball has a smaller mass because it is hollow.
b. The solid ball has a larger mass because it is solid.
c. The terminal speeds are the same because the acceleration of gravity doesn't depend on mass.
d. The terminal speeds are the same and equal to 10 m/s.
(e.) The two balls must have the same mass
f. None of the above statements (a through e) is true.

29. If the earth exerts a gravitational force of 1000 N on a satellite of mass 500 kg moving in a circular orbit, what force does the satellite exert on the earth?
   a. 10^{-23} N, or, approximately zero
   b. a small, but non-negligible fraction of 1 N
   c. 10,000 N
   d. 5,000 N
   e. 2000 N
   (f.) None of the above is correct within 10%. , because $|\vec{F}_{SE}| = |\vec{F}_{ES}| = 1000$ N

30. A 150-kg crate is being pushed across a horizontal floor by a horizontal force of 1200 N. If the coefficient of sliding friction is $\mu_k = 0.20$, what is the acceleration of the crate?
   a. zero
   b. 1 m/s^2
   c. 3 m/s^2
   (d.) 6 m/s^2
   e. 9 m/s^2
   f. None of the above is within 10% of the correct answer.

$F_f = \mu_k |\vec{N}| = \mu_k Mg = (0.20)(150)(10) = 300N$

$F_{NET} = F_{App} - F_{fr} = 1200 - 300 = 900 N = ma$

Thus $a = \frac{900}{150} = 6$ m/sec^2 (d)

31. You must apply a 75-N force to pull a child's wagon across the floor at a constant speed of 0.6 m/s. If you increase your pull to 100 N, the wagon will
   (a.) continue to speed up as long as you keep pulling.
   b. speed up immediately and then move at the faster constant speed of 0.8 m/s. ✗
   c. speed up gradually until it reaches the speed of 0.8 m/s and then move at that constant speed. ✗
   d. continue to move at 0.6 m/s. ✗
   e. do none of the above.

32. Which of the following is the Newton's third-law partner force to the force that a book exerts on the bookshelf where it rests? It is
   a. the force that the earth exerts on the book. ✗
   b. the force that the book exerts on the earth. ✗
   c. the force that the book exerts on the shelf. ✗
   d. the buoyant force that the air exerts on the book. ✗
   (e) None of the above forces is the required partner force, which is the force of the shelf on the book.

33. A book sits at rest on a table. Which force does Newton's *second* law tell us is equal and opposite to the gravitational force acting on the book?
   (a.) the normal force by the table on the book
   b. the normal force by the book on the table
   c. the gravitational force by the book on the Earth
   d. the net force on the book
   e. None of the above.

34. You leap from a bridge with a bungee cord tied around your ankles. As you approach the river below, the bungee cord stretches and you begin to slow down. Just before you come to a stop the force of the cord on your ankles which is slowing you down must be __________ your weight?
   (a.) greater than ... since F_{NET} is upward.
   b. equal to
   c. less than
   d. much less than
   e Not enough information has been given to support of any of the above statements.

35. If a race car is traveling around a circular track at a constant speed, we know that the car experiences
    - a. no net physical force. F
    - b. a centripetal net physical force. T
    - c. a centrifugal net physical force. F
    - d. a net physical force in the forward direction. F
    - e. all of the above. F
    - f. none of the above. T

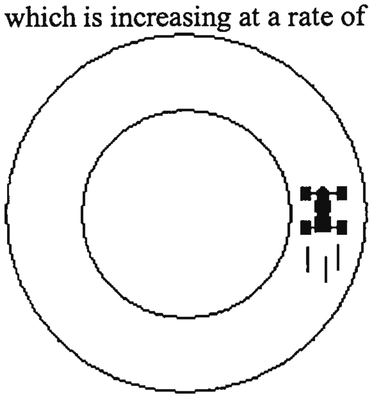
36. Terry and Chris pull hand-over-hand on opposite ends of a rope while standing on a frictionless frozen pond. Terry's mass is 20 kg and Chris's mass is 60 kg. If Terry's acceleration is 36 m/s^2, what is Chris's acceleration?
    - a. 36 m/s^2
    - b. 12 m/s^2
    - c. 6 m/s^2
    - d. 4 m/s^2
    - e. None of the above is within 10% of the correct answer.

$M_T a_T = F = M_C a_C$

$a_C = \frac{M_T}{M_C} a_T = \frac{20}{60} \cdot 36 = 12$ m/sec^2

37. A child stands on a bathroom scale while riding in an elevator. The child's weight on a bathroom scale when the elevator is not moving measures 100 lbs. What must the scale read when the elevator accelerates upward while traveling downward?
    - a. Exactly 100 lbs
    - b. Less than 100 lbs
    - c. Greater than 100 lbs , Since scale FORCE exceeds $W = Mg$ & provides acceleration upward.
    - d. The same as it reads when accelerating downward while traveling upward, by symmetry.
    - e. None of the above.

Figure 38 Caption:
A 2700 kg race car is moving counterclockwise on a circular path of radius 300 m as shown in the diagram below. Imagine that at this instant, the car is at point P and moving at a speed of 20 m/s which is increasing at a rate of 1m/s^2 in the upward direction on the page.



38. Refer to **Figure 38.** In what direction, precisely, does the net force point at the instant described?
    - a. →
    - b. ←
    - c. ↑
    - d. ↓
    - e. None of the above. Since {Speed is increasing / direction is changing} Net Force must have both forward & centripetal components: F_{NET}

39. Suppose that the race track of Fig 38 is covered with a film of oil which reduces the coefficients, (both static and kinetic) of friction on the tires to zero and that the car is kept in its circular paths by cables attached to a post at the center of the track. What, most nearly, is the tension in the cable attached to the car in Fig.38 at the instant described in the Figure 38 caption above?

a. 1.1×10^2 N
b. 3.6×10^2 N
c. 1.1×10^3 N
d. 3.6×10^3 N
e. 1.1×10^4 N
f. 3.6×10^4 N
g. None of the above is within 10% of the correct answer.

$T = F_{cent} = Mv^2/R = 2700 \frac{(20)^2}{300} = 3591\ N \approx 3.6 \times 10^3$ (d)

40. **Suppose that the track architects decide to bank the frictionless track of problem 39 at some angle, θ, chosen to make the component of the gravitational force parallel to the sloped roadway surface equal to 360 N for a situation where the weight of the car is 48,000N. (Recall that for small values of θ in radians, Sin(θ) ≈ θ.) Then the banking angle is, most nearly, θ =**

a. 0.75 radians = 42.9°
b. 0.075 radians = 4.29°
c. 0.0075 radians =0.429°
d. 0.00075 radians = 0.0429°
e. There is a correct banking angle, but none of the above is within 10% of that angle.
f. In fact, it is not possible to obtain the specified force on the car in question by banking.

$Mg \sin\theta = 360\ N$ & since $W = Mg = 48{,}000\ N$,
$\sin\theta \approx \theta = \frac{360}{48{,}000} = 7.5 \times 10^{-3}$ rad. $= 0.0075$ (c)

41. What centripetal acceleration is required to follow a circular path with a radius of 50 m at a speed of 20 m/s?

a. 2 m/s²
b. 4 m/s²
c. 6 m/s²
d. 8 m/s²
e. None of the above is within 10% of the correct answer.

$a_c = v^2/R = (20)^2/50 = 8\ m/sec^2$

42. In uniform circular motion the

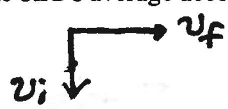
a. acceleration is parallel (or antiparallel) to the velocity. ✗
b. acceleration is horizontal and the velocity is horizontal. ✗
c. acceleration is vertical, while the velocity can be in any direction. ✗
d. acceleration is vertical and the velocity is horizontal. ✗
e. None of the above completions yields a valid statement.

43. In motion along a straight line the

a. acceleration is parallel (or anti-parallel) to the velocity.
b. acceleration is perpendicular to the velocity. ✗
c. acceleration is vertical, while the velocity can be in any direction. ✗
d. acceleration is vertical and the velocity is horizontal ✗
e. acceleration is horizontal and the velocity is horizontal. ✗
f. None of the above completions yields a true statement. F

44. A migrating bird is initially flying south at 6 m/s. To avoid hitting a high-rise building, the bird veers and over a period of 2 s changes its direction to east and increases its speed to 8 m/s speed. What is the (approximate) magnitude of the bird's average acceleration during this 2 s interval, most nearly?

a. 1 m/s²
b. 2 m/s²
c. 3 m/s²
d. 4 m/s²
e. 5 m/s²
f. None of the above is within 10% of the correct answer.



$|\vec{a}|_{AVG} = \frac{|\vec{v}_f - \vec{v}_i|}{\Delta t} = \frac{\sqrt{64+36}}{2} = 5\ m/sec^2$

45. A cyclist turns a corner following a circular arc with a radius of 100 m at a speed of 70 m/s. What is the magnitude of the cyclist's acceleration, most nearly?

a. 0.5 m/s^2
b. 1.4 m/s^2
c. 5.0 m/s^2
d. 14.0 m/s^2
(e.) 50 m/s^2
f. 140 m/s^2
g. None of the above is within 10% of the correct answer.

$a = v^2/R = \frac{(70)^2}{100} = 49\ m/sec^2 \approx 50\ m/sec^2$ (e)

46. A mass of 0.1 kg hangs on a spring whose spring constant is 0.8 N/m^2. If the mass is pulled downward and released, it will oscillate with a period of T_1. If a mass of 1.6 kg is hung on the same spring, its period of oscillation will be T_2 =

a. $0.25T_1$
b. $0.5T_1$
c. $1.0T_1$
d. $2.0T_1$
(e.) $4.0T_1$
f. None of the above is within 10% of the correct answer.

$T = 2\pi\sqrt{M/k}$ for SHO: $\frac{T_2}{T_1} = \frac{2\pi\sqrt{M_2/k}}{2\pi\sqrt{M_1/k}} = \sqrt{\frac{M_2}{M_1}} = \sqrt{16}$

i.e. $T_2 = \sqrt{16}\,T_1 = 4T_1$ (e)

47. A red ball is thrown straight down from the edge of a tall cliff with a speed of 20 m/s. At the same time a green ball is thrown straight up with the same speed. If the green ball travels up, stops, and then drops to the bottom of the cliff, how many seconds later than the red ball will it land? (Neglect air resistance.)

a. 1 s
b. 2 s
c. 3 s
(d.) 4 s
e. None of the above is within 10% of the correct answer.

Compute Time to top, t^{TOP}: $v_y(t^{TOP}) = 0 = v_{0y} - gt^{TOP} \Rightarrow t^{TOP} = 2s$
Then Green Rises for 2 seconds & falls for 2 seconds ... at which time it is at same starting point as Red, but delayed 4s. (d)

48. A red ball is thrown straight down from the edge of a tall cliff with a speed of 20 m/s. At the same time a green ball is thrown straight up with the same speed. If the green ball travels up, stops, and then drops to the bottom of the cliff, which ball (if either) will be traveling fastest when it reaches the ground below? (Neglect air resistance.)

a. The red ball
b. The green ball
(c.) Both balls will be traveling at the same speed. ... See #47 above: ONLY difference is the time delay.
d. Without air resistance there is not enough information to say.
e. None of the above conclusions can be validly inferred.

Scenario 49

A gun is held horizontally and fired. At the same time the bullet leaves the gun's barrel an identical bullet is dropped from the same height. Neglect air resistance.

49. Refer to **Scenario 49**. Which bullet will hit the ground with the greatest speed?

(a.) The bullet that was fired, because it is also moving horizontally. T
b. The bullet that was dropped, because all of its motion is vertical. X
c. It will be a tie, because the acceleration of gravity is the same for both. X
d. The bullet that was fired, because it feels the force of gravity over a longer time. F
e. The bullet that was dropped, because it feels the force of gravity over a longer time. F
f. None of the above assertions is correct F

50. A golf ball is hit with a vertical speed of 60 m/s upwards and a horizontal speed of 10 m/s. How far will the ball travel horizontally before landing on the (flat) fairway again?

a. 30 m
b. 60 m
c. 90 m
d. 120 m
e. 180 m
f. None of the above is within 10% of the correct answer.

$t_{TOP} = 60/10 = 6$ SEC ⇒ TRAVEL TIME $= 2t_{TOP} = 12$ S

$D = 12 \cdot 10 = 120.$ (d)

51. Which of the following statements about projectile motion is true (neglecting air resistance)?

a. The horizontal and vertical motions are independent. T
b. The force on the projectile is constant throughout the flight. T
c. The acceleration of the projectile is constant throughout the flight. T
d. The force on the projectile is always vertically downward T
e. All of the above statements are true. T
f. None of the above answers is correct. F

52. In projectile motion the

a. acceleration is parallel (or antiparallel) to the velocity. F
b. acceleration is perpendicular to the velocity. F
c. acceleration varies with the direction of the velocity. F
d. acceleration is horizontal and the net velocity is horizontal. F
e. acceleration varies with the height of the projectile. F
f. acceleration is vertical, even when the velocity is horizontal. T
g. None of the above is true of projectile motion F

53. A physics student reports that upon arrival on planet X, he promptly sets up the "monkey-shoot" demonstration. If the acceleration due to gravity on planet X is twice that on earth, he should obtain a

a. miss since the monkey's weight is twice as large now. F [So is pellet's!]
b. hit only if the bullet's horizontal velocity is increased. F
c. miss since the monkey's mass is unchanged. F
d. hit, if and only if he aims at the point half as high as the monkey. F
e. None of the above completions leads to a true statement.

54. Just after being hit into a pop fly, a baseball has a horizontal speed of 20 m/s and a vertical speed of 50 m/s upward. Ignoring air resistance what are these speeds 7.5 seconds later?

a. 20 m/s horizontal and 50 m/s upward
b. 20 m/s horizontal and 25 m/s upward
c. 20 m/s horizontal and 0 m/s upward
d. 20 m/s horizontal and 25 m/s downward
e. 20 m/s horizontal and 50 m/s downward
f. None of the above is within 10% of the correct answers.

$\vec{v}(t) = (v_x(t),\ v_y(t))$
$= (v_{0x} + a_x t,\ v_{0y} + a_y t)$
$= (20 + 0,\ 50 - (7.5)(10))$
$= (20, -25)$ (d)
(DOWNWARD!)

The remaining problems may require more than average computation. Choose the single best answer and enter your choice into the NCS-Scantron answer sheet.

55. To determine the height of a steep cliff an experimenter stations his assistant on the top of the cliff and fires a pellet vertically upward from the bottom with a speed of 60 m/s. His assistant notes that the pellet reaches its maximum height just 30 m above the edge of the cliff. How high is the cliff, most nearly?

a). 30m; b). 50m; c).75m; d).125 m; (e) 150m; f) None of these answers is correct within 10 %.

$y^{MAX} = H + 30$ where H is height of cliff

$a_y t^{TOP} = v_{0y} \Rightarrow t^{TOP} = 60/10 = 6$ sec. is time at highest point

Then $y^{MAX} = y(t=6) = v_0 t^{MAX} - \frac{1}{2} g (t^{MAX})^2 = 60(6) - \frac{10}{2} \cdot 36$

$= 360 - 180 = 180$ m

& $H = y^{MAX} - 30 = 150$ m (e)

56. A biker starts up a steep hill with a speed of 6m/s. His speed decreases at the rate of $0.1 m/s^2$ as he climbs the hill. He just reaches the crest of the as his speed falls to zero. How far did the biker travel up the hill?

a). 360 m; b). 240 m; (c) 180 m; d) 120 m; e) 60 m; f) none of these is correct within 10%.

$t^{TOP} = 6/(0.1) = 60$ sec

$D = x(t^{TOP}) - x_0 = v_0 t^{TOP} - \frac{1}{2} a (t^{TOP})^2 = 6 \cdot 60 - \frac{0.1}{2}(60)^2$

$D = 360 - 180 = 180$ m (c)

57. A rope is used to drag a box across a rough warehouse floor. Its angle is 45° (= π/4 radians) above the horizontal, and it exerts a force equal to its tension, T. If the box has a mass of 40 kg, feels a frictional drag force of 80 N, and is accelerating horizontally at $1.5 m/s^2$, what is the value of T?

a). 60 N; b). 80 N; c) 84 N; d)113 N; (e) 200 N; f) None of the preceding is within 10% of the correct answer.

NII $F_x^{NET} = Ma_x = (40)(1.5) = F_x^{Rope} - F_{fr}$

$= T \cos 45° - 80$

Then $T = \frac{60+80}{\cos 45°} = \frac{140}{0.707} = 198 \approx 200$ N (e)

58. Just after it is launched a 300 kg rocket feels a gravitational attraction by the earth of about 3,000 N. Compute the acceleration of the earth due to the force which Newton's third law guarantees that the satellite exerts on the earth. (Use $M_E = 6 \times 10^{24}$ kg). The acceleration is most nearly
a) 0.5×10^{20} m/s^2; b) 0.5×10^{21} m/s^2; c) 0.5×10^{-20} m/s^2; (d) 0.5×10^{-21} m/s^2;
e) None of these is within 10% of the correct answer..

$$\vec{a}_E = \frac{\vec{F}_{E,S}}{M_E} \quad \& \quad \vec{F}_{E,S} = -\vec{F}_{S,E} \text{ by N III}$$

$$|a_E| = \frac{|\vec{F}_{ES}|}{M_E} = \frac{|F_{SE}|}{M_E} = \frac{3000\,N}{6 \times 10^{24}\,kg} = 500 \times 10^{-24}\ m/sec^2 = 5 \times 10^{-22}\ m/sec^2 = 0.5 \times 10^{-21}\ m/sec^2 \quad (d)$$

Scenario 59-60. Suppose that a moon of Jupiter travels in a circle about the planet at a distance of 1.6×10^8 meters once in every 11.6 days, and that it has a mass of 10^{22} kg. Then answer the following two questions.

59. The speed of the moon is most nearly:
a) 10 m/s; (b) 10^3 m/s; c) 10^5 m/s; d) 10^7 m/s; e.) 10^9 m/s.

$$|v| = \frac{2\pi R}{T} = \frac{(2\pi)(1.6) \times 10^8\,m}{11.6\,d} \times \frac{1\,d}{24\,hr} \times \frac{1\,hr}{3600\,sec} =$$

$$= 0.867 \times \frac{10^8}{(24)(3600)} = \frac{0.867 \times 10^8}{8.64 \times 10^4} \approx 0.1 \times 10^4 \approx 10^3\ m/sec \quad (b)$$

60. The acceleration of the moon is most nearly:
a) 6×10^3 m/s^2; b) 6 m/s^2; (c) 6×10^{-3} m/s^2; d) 6×10^{-6} m/s^2; e) 0.6×10^{-9} m/s^2.

$$a_c = v^2/R = \frac{10^6\ m^2}{1.6 \times 10^8\ sec^2 \cdot m} = 0.625 \times 10^{-2} = 6.25 \times 10^{-3}\ \frac{m}{sec^2} \quad (c)$$

END of EXAM I