MULTIPLE CHOICE: Choose the one most nearly correct and complete answer and insert its letter into your answer sheet. (Note that a table of ten matching questions comprises items #46 through #55 of this exam, and you may wish to sequence your work accordingly.)

1. The average 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.

2. A cyclist covers 120 miles between 2 pm and 6 pm. What was his instantaneous speed at the halfway point?
   a. 15 mph
   b. 30 mph
   c. 45 mph
   d. 60 mph
   (e.) Not enough information is given to be able to say.

3. 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. Since it is 100 miles to Helena, your average speed would be 50 mph. Which of the following statements about this trip is correct?
   a. To average 50 mph the car must have exceeded 100 mph for at least 60 minutes of the trip. False
   b. The instantaneous speed was never equal to 50 mph during this trip. FALSE
   c. You can never average 50 mph if the speed is zero for one half of the trip duration. FALSE
   d. Since the car speeds up after each stop and slows down before each stop, it is not possible to determine whether the car traveled faster than 100 mph at some point in the trip FALSE
   e. All of the above statements are correct. FALSE
   (f.) None of the above statements is correct. TRUE

4. What average speed, most nearly, is required to run a four minute mile? (1 mi. = 1.609 km.)
   a. 0.3 m/s
   b. 0.8 m/s
   c. 3.0 m/sec
   (d.) 8.0 m/s
   e. 30.0m/s
   f. 80.0 m/s

$$\frac{1.609 \times 10^3 \text{ m}}{4 \times 60 \text{ sec}} =$$

5. The acceleration of an object at a time, t, during a trip of duration, T, is defined to be :
   a. one half of the sum of the maximum and the minimum velocities divided by T.
   b. the average velocity divided by T.
   c. the total trip distance divided by T^2, on dimensional grounds.
   d. the difference between the final velocity and the initial velocity divided by T.
   e. the value of the velocity at the midpoint of the time interval divided by T
   (f.) None of the above.

6. Which of the following quantities could specify an acceleration vector
   a. 5 m/s^2 X NO DIRECTION
   (b.) 5 m/s^2 downward (OK)
   c. 5 m/s North X WRONG DIMENSION
   d. 5 m^2/s West X " "
   e. 5-m^2/s^2 East X " "
   f. None of the above could possibly specify a physical acceleration.

7. An object is accelerating
   a. only when its speed changes.
   b. only when its direction changes.
   c. when its speed or direction changes.
   d. if its velocity is large.
   e. whenever no net force is acting upon it, by Newton's II Law.
   f. In none of the above cases.

8. If a go-cart requires 30 seconds to accelerate from 0 to 90 km per hour, its average acceleration is, most nearly,
   a. 800 m/ sec^2
   b. 80 m/ sec^2
   c. 8 m/sec^2
   d. 0.8 m/sec^2
   e. 0.08 m/sec^2

$\frac{90 \times 10^3 \text{ m}}{30(60 \times 60)\text{s}^2} = \frac{9 \times 10^4}{1.08 \times 10^5} = 0.83 \text{ m/sec}^2$

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.
   b. speeding up.
   c. slowing down.
   d. moving with a constant speed.
   e. none of the above.

10. A pitcher requires about 0.2 second to throw a baseball. If the ball leaves his hand with a speed of 80 m/s how large is its acceleration?
    a. 40 m/s/s
    b. 40 m/s^2
    c. 400 m/ s^2
    d. 400 m/s
    e. None of the above is dimensionally correct and within 10% of the true answer.

$\frac{80 \text{ m}}{0.2 \text{ sec}^2} = 400 \text{ m/sec}^2$

11. When we say that light objects and heavy objects fall at the same rate, what assumption(s) are we making?
    a. They have the same shape.
    b. They have the same size.
    c. They have surfaces with similar air resistances
    d. They are falling in a vacuum.
    e. They are made of the same material.
    f. All of the above assumptions are required to make them fall at the same rate.
    g. None of the above assumptions (a through e) suffices to yield the same rates

12. The motion of a block sliding down a frictionless ramp can be described as motion with
    a. a constant speed, independent of the slope of the ramp.
    b. a constant speed that depends on the slope of the ramp.
    c. an acceleration which increases as the block continues sliding.
    d. a constant acceleration which is negative (i.e., slows the object down) due to the force of friction.
    e. a constant acceleration less than 10 m/s/s.
    f. None of the above.

$a = g \sin\theta \leq g.$

13. If a ball is dropped from rest, it will fall 5 m during the first second. How far will it fall during the third and fourth seconds, most nearly ?
    a. 15 m
    b. 30 m
    c. 40 m
    (d) 60 m
    e. 75 m

$d(t) = \frac{1}{2} g t^2 = 5t^2$

$d(3) = 5 \cdot 4 = 20$
$d(4) = 5 \cdot 16 = 80$ } $80 - 20 = 60$

14. A ball with a mass of 1.5 kg is thrown vertically upward with a speed of 35 m/s. What are its speed and direction 5 seconds later?
    a. 10 m/s upward
    b. 5 m/s upward
    c. zero
    d. 5 m/s downward
    e. 10 m/s downward
    (f) None of the above is within 10% of the correct answer

$v = v_0 + at = 35 - 10t = 35 - 50 = -15$

$v(t=5) = 15$ m/s downward

15. If we use plus and minus signs to indicate the directions of velocity and acceleration in one dimension, in which of the following situations does the object slow down?
    a. negative velocity and negative acceleration. Speeds up
    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 the object slows down. FALSE
    (f) In none of the above cases does the object slow down.

16. The Center of Mass Point of a solid body
    a. is certain definite fixed point in a coordinate system fixed to the body itself. ✓
    b. moves as though all of the forces applied to the body were applied at its location. ✓
    c. moves as though the entire mass of the body were concentrated at its location. ✓
    d. may be located outside the physical extension of the body. ✓
    (e) All of the above remarks (a through d) are true of the Center of Mass Point.
    f. None of the above answers is true and correct. ✗

17. A car initially traveling north at 2 m/s has a constant acceleration of 0.5 m/s^2 northward. How far does the car travel in the first 10 s, most nearly?
    a. 20 m
    (b) 45 m
    c. 120 m
    d. 170 m
    e. 270 m
    f. None of the above is within 10% of the correct answer.

$x(t) - x_0 = v_0 t + \frac{1}{2} a t^2 = 2 \cdot 10 + \frac{0.5}{2} \cdot (10)^2 = 45$ m

18. A circus clown plans to launch a ball vertically from a gun which gives it an initial upward speed of 30 m/s. His partner is placed so that he can just put his hand out and catch the ball at its maximum height. How many seconds after launch does he catch the ball, most nearly?
    a. 1
    b. 2
    (c) 3
    d. 4
    e 5
    f. None of the above is within 10% of the correct answer.

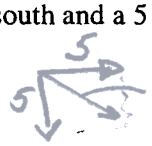
$v = v_0 + at = 30 - 10t = 0$ when $t = 30/10 = 3$

19. If an object moves in a straight line with a constant speed, we can conclude that
    a. the object is unaccelerated. TRUE
    b. there is no net force acting on the object. "
    c. if there is any force acting on the object, there must be two or more forces acting on it. T
    d. there is no unbalanced force acting on the object. T
    e. All of the above conclusions (a through d) are valid.
    f. None of the above answers is correct. F

20. A train is moving with constant velocity along a level section of track. The net force on the first car is _____ the net force on the last car.
    a. equal to because $\vec{v}$ = CONSTANT, $\vec{a}=0$ & $F_{NET}=0$ for both
    b. much greater than
    c. slightly greater than
    d. much less than
    e. slightly less than
    f. None of the above completions yields a correct answer.

21. If there is no net force acting on an object, its motion will be one with acceleration.
    a. zero
    b. a constant, non-zero
    c. an increasing
    d. a decreasing
    e. It is not possible to say from the information given.

22. What is the magnitude, most nearly, of the net force acting on an object which is under the influence of a 5 N force acting south and a 5 N force acting east?
    a. 3 N
    b. 4 N
    c. 5 N
    d. 6 N
    e. 7 N
    f. None of the above is within 10% of the correct answer.



$\sqrt{5^2+5^2} = \sqrt{50} = 7.1$

23. You are applying a 400-newton force to a freezer full of chocolate chip ice cream in an attempt to move it across the basement. It will not budge. The weight of the freezer (including ice cream) is 1000 N. The coefficient of static friction, μ_{Static} is
    a. equal to 0.4, exactly.
    b. greater than 0.4 but less than 0.8.
    c. less than 0.4.
    d. greater than or equal to 0.4
    e. less than 0.4 but greater than0.25
    f. None of the above completions yields a true statement.

24. Which of the following is *not* a vector quantity?
    a. force
    b. acceleration
    c. weight
    d. velocity
    e. displacement
    f. None of the above is a vector quantity
    g. All of these (a through e) are vector quantities.

25. What acceleration, most nearly, is produced by a force of 100 N acting on a mass of 6 kg if its velocity is 20 m/s and the frictional force is 40 N?
    a. 10 m/s/s
    b. 9 m/s^2
    c. 8 m/s^2
    d. 7 m/s^2
    e. 6 m/s^2

$F_{NET} = 100 - 40 = ma = 6a \Rightarrow a = \frac{60}{6} = 10$

26. An astronaut on a strange planet has a mass of 80 kg and a weight of 500 N. What is the value of the acceleration due to gravity on this planet, most nearly ?
    a. 2 m/s^2
    b. 4 m/s^2
    c. 6 m/s^2
    d. 8 m/s^2
    e. 10 m/s^2

$F_G = W = 500N = m\tilde{g} = 80\tilde{g}$

$\tilde{g} = \frac{500}{80}\frac{N}{kg} = 6.25\ m/sec^2$

27. A ball with a weight of 35 N is thrown vertically upward. What is the force on the ball just as it reaches the top of its path, most nearly ?
    a. zero
    b. 10 N upward
    c. 10 N downward
    d. 20 N downward
    e. 20 N upward
    f. None of the above is within 10% of the correct answer, which is 35N downward.

28. A ball falling from a great height will reach terminal speed when its _____ goes to zero.
    a. velocity
    b. gravity force
    c. weight
    d. speed
    e. mass
    f. acceleration
    g. None of the above insertions yields a true statement.

29. You leap from a bridge with a bungee cord tied around your ankles. As you approach the river below, the bungee cord begins to stretch and you begin to slow down. The force of the cord on your ankles slowing you down is _____ your weight?
    a. much less than
    b. slightly less than
    c. just equal to
    d. greater than
    e. There is not enough information to say for sure.

Because the acceleration is upward, the Net Force = $F_{APP} - W$ is upward > 0

$\Rightarrow F_{APP} > W$

30. Terry and Chris pull hand-over-hand on opposite ends of a rope while standing on a frictionless frozen pond. Terry's mass is 75 kg and Chris's mass is 25 kg. If Terry's acceleration is 3 m/s^2, what is Chris's acceleration?
    a. 2 m/s^2
    b. 3 m/s^2
    c. 6 m/s^2
    d. 9 m/s^2
    e. None of the above is within 10% of the correct answer.

$|F_T| = 75 \cdot 3 = F_C = 25 \cdot a_C \Rightarrow a_{CHRIS} = 9$

31. When a snowflake falls, it quickly reaches a constant terminal velocity. This happens because
    b. there is no force acting on it. FALSE : GRAVITY & AIR RESISTANCE
    c. the snowflake has no weight. "
    d. the mass of the snowflake is smaller than its weight. ← MEANINGLESS!
    e. None of the above explanations is sufficient and correct.

32. By what factor does the centripetal acceleration change if a car goes around a corner three times as fast?
    a. 0.33
    b. It stays the same.
    c. 3
    d. 6
    e. 9
    f. None of the above is within 10% of the correct answer.

$a = v^2/R \qquad a' = \frac{(3v)^2}{R} = 9\left(\frac{v^2}{R}\right) = 9a$

33. What net force is influences a 3 kg object following a circular path with a radius of 80 m at a speed of 20 m/s?
    a. 0.75 N
    b. 4 N
    c. 5 N
    d. 12 N
    e. 15 N
    f. None of the above is within 10% of the correct answer.

$F_c = \frac{mv^2}{R} = \frac{(3)(20)^2}{80} = 15N$

34. A 15-kg child on a merry-go-round is traveling in a circle with a radius of 4 m at a speed of 3 m/s. What is the acceleration experienced by this child?
    a. zero
    b. 0.75 m/s^2
    c. 1.33 m/s^2
    d. 2.25 m/s^2
    e. 4.75 m/s^2
    f. 5 m/s^2
    g. None of the above is within 10% of the correct answer.

$a_c = v^2/R = (3)^2/4 = 2.25 \ m/sec^2$

35. A golf ball is hit with an initial vertical speed of 30 m/s and an initial horizontal speed of 20 m/s. How long will the ball remain in the air? (Neglect air resistance.)
    a. 1 s
    b. 2 s
    c. 3 s
    d. 4 s
    e. 6 s
    f. None of the above is within 10% of the correct answer.

$v_{oy} - 10t^{MAX\ HT} = 0 \Rightarrow t^{MAX\ HT} = 3\ sec$

$t^{TOTAL} = 2 \times 3 = 6\ sec$

Scenario 36-37
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.

36. Refer to **Scenario 36-37**. Which bullet will hit the ground with the greatest velocity?
    a. The bullet that was fired. because it has a finite v_x, as well as same v_y as dropped bullet
    b. The bullet that was dropped.
    c. It will be a tie.
    d. The question can't be answered with the information given.

37. Refer to **Scenario 36-37**. If the bullets were not identical, but rather the dropped bullet had twice the mass of the one fired, which bullet would hit the ground first?
    a. The bullet that was fired.
    b. The bullet that was dropped.
    c. It will be a tie.
    d. The question can't be answered with the information given.

(2) ERROR CORRECTION

38. A 1 kg ball is thrown straight down from the edge of a tall cliff with a speed of 20 m/s. At the same time a 2 kg ball is thrown straight up with the same speed. If the 1 kg ball travels up, stops, and then drops to the bottom of the cliff, which ball (if either) will be traveling faster when it reaches the ground below?
    a. the 1kg ball, because its mass is smaller and it moves faster
    b. the 2kg ball, because its mass is larger and it accelerates at a greater rate.
    c. The 1 kg ball, but not for the reason given in (a) above.
    d. The two balls will be traveling at the same speed when they hit.
    e. There is not enough information to say.

39. Which of the following statements about projectile motion is true (neglecting air resistance)?
    a. The horizontal and vertical motions are independent. TRUE
    b. The force on the projectile is constant throughout the flight. TRUE: $F = -mg$
    c. The acceleration of the projectile is constant throughout the flight. T $a = -g$
    d. The path depends upon the initial velocity, but not upon the mass of the projectile. TRUE, because $a = -g$ is independent of mass
    e. All of the above statements are true.
    f. None of the above answers is correct.

40. In projectile motion the
    a. acceleration is parallel (or antiparallel) 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. The acceleration reaches its minimal value of zero at the top of the trajectory.
    f. None of the above.

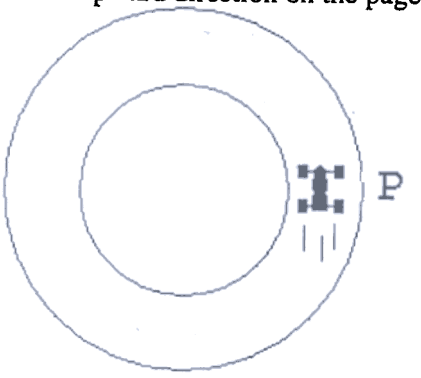
41. A baseball player throws a ball from left field toward home plate. Assume that you can neglect the effects of air resistance. At the instant the ball approaches home plate,the ball's acceleration
    a. reaches its maximal value
    b. reaches its minimal value
    c. retains its constant value, zero.
    d. Has the same magnitude as it had at the highest point of the trajectory.
    e. There is not enough information to say.

42. If a small child stands on a spring scale at home, it reads 100 N, which means his mass is 10 kg. If instead he stands on the scale while accelerating upward in an elevator at 2 m/s^2, how many Newtons would the scale exert?
    a. 120 N
    b. 480 N
    c. 600 N
    d. 720 N
    e. None of the above.

$F_{NET} = F_{scale} - 100N = ma = 10.2$

$F_{scale} = 100 + 10.2 = 120N$

Figure 43-44
A 500 kg race car is moving counterclockwise on a circular path of radius 200 m as shown in the diagram below. Suppose that at this instant, the car is at point P and moving at a constant speed of 30 m/s in the upward direction on the page.



43. Refer to **Figure 43-44.** In what direction, precisely, does the net force point at the instant described?
    a. ↑
    b. ↓
    c. →
    d. ←
    e. None of the above.

44. Suppose that the race track of Fig 43-44 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 above?
    a. 2.2×10^2 N
    b. 3.3×10^2 N
    c. 2.2×10^3 N
    d. 3.3×10^3 N
    e. 2.2×10^4 N
    f. 3.3×10^4 N
    g. None of the above is within 10% of the correct answer.

$T = F_c = M v^2/R = \frac{500\,(30)^2}{200} = (2.5)(900) = 2250\ N = 2.25 \times 10^3 N$

45. A mass, m = 0.900kg, hanging on a spring of spring constant , k= 10N/m, oscillates with a period, T= 1.88 s. If another oscillator has a mass twice as large and a spring constant half as large, Its period will be (most nearly)?
    a. 0.12 s
    b. 0.47 s
    ~~c. 0.94 s~~ e DELETED (ERROR CORRECTION)
    c. 1.88 s
    d. 3.76 s
    e. 7.52 s
    f. None of the above is within 10% of the correct answer.

$T_1 = 2\pi\sqrt{M/k}$

$T_2 = 2\pi\sqrt{\frac{2M}{k/2}} = 2\pi\sqrt{4\frac{M}{k}} = 2\left[2\pi\sqrt{M/k}\right] = 2(1.88) = 3.76\ sec$

Ten Matching Questions, #46 through #55 follow.
For each numbered item, fill in the circle on you NCIS answer sheet which corresponds to the letter of the item on the right which correctly matches it.

	Numbered Items	Lettered Matching Items
I	46.Instantaneous speed	A. Pairs equal and opposite forces.
H	47.Speed with direction	B. Encompasses and Replaces Galileo's Principle of Inertia.
J	48.Acceleration	C. Simultaneous vertical motion with $a_y = -g$ and horizontal motion with $a_x = 0$.
G	49.Free Fall	D. Focusses attention on acceleration rather than velocity.
B	50.Newton's First Law	E. Doubles when speed and radius of trajectory both double.
D	51.Newton's Second Law	F. Is greatest for largest mass among similarly shaped objects.
A	52. Newton's Third Law	G. Constant acceleration independent of mass.
F	53.Terminal Velocity	H. Velocity.
E	54.Centrripetal Acceleration	I. Average speed over a very short time interval.
C	55.Projectile Motion	J. Rate of change of velocity with time.

Note: The following problems may require somewhat more calculation than the average. You may wish to sequence your work accordingly.

56. A 40-kg crate is being pushed across a horizontal floor by a horizontal force of 240 N. If the coefficient of sliding friction is 0.5, what is the acceleration of the crate, most nearly?

a. zero
b. 1 m/s^2
c. 2 m/s^2
d. 3 m/s^2
e. 4 m/s^2
f. 5 m/s^2
g. 6 m/s^2
h. None of the above is within 10 % of the correct answer.

$F_f = \mu \cdot |N| = 0.5(40)(10) = 200$

$F_{NET} = 240 - 200 = 40 = ma = 40a$

$\Rightarrow a = 1\ m/sec^2$

57. Angel Falls in southeastern Venezuela is the highest uninterrupted waterfall in the world. If the water is flowing horizontally at a speed of 3m/s as it passes over the lip of the falls, and hits the pool below at a point 42 m out from the lip, what is the height of the falls above the pool?

a. 140m
b. 420 m
c. 980 m
d. 1400 m
e. 9800 m
f. None of the above is within 10% of the correct answer.

$x - x_0 = v_{0x} t = 3 \cdot t = 42\ m \Rightarrow t = 14\ sec$

$y - y_0 = v_{0y} t - \frac{1}{2} g t^2 = -\frac{10}{2}(14)^2 = 980\ m$

58. A red ball is thrown straight down from the edge of a tall cliff with a speed of 30 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 long after the red ball will the green ball hit the ground?

a. 1 s
b. 2 s
c. 3 s
d. 4 s.
e. 5 s
f. 6 s
g. None of the above is within 10% of the correct answer

At top $v_{MAX} = 0 = v_0 - g t_{MAX} \Rightarrow t_{MAX} = \frac{30}{10} = 3$ sec

Then after 6 seconds, GREEN is falling past edge at 30 m/sec just as RED did, but 3 x 2 = 6 seconds later.

59. A man stands on a large platform merry-go-round which is rotating at a constant angular speed, $\omega = 2.0$ radians/second. The normal force between his shoes and the platform is equal to his weight, 500 N, and the coefficient of static friction is $\mu_{STATIC} = 0.4$. How far from the center can he stand without sliding off the platform, most nearly ?

a. 1 m
b. 2 m
c. 3 m
d. 4 m
e. 5 m
f. 6 m
fg. None of the above is within 10% of the correct answer.

$F_f^{MAX} = \mu \cdot |N| = (0.4)(500) = 200\ N$ is MAX force of static friction

Then static friction can provide force up to 200N, but NO MORE to keep man in circular path

But $F_c = M R \omega^2 = M (R\omega)^2/R = M v^2/R$

is needed. Then if $F_f \geq F_c$ man does NOT slide

$200 \geq M R \omega^2 = 50\ R(2)^2$

i.e. $\frac{200}{50 \cdot 4} \geq R = 1\ m$

MAN must stand within 1 m of center

60. Suppose Newton lived on another planet and thought of launching his apple horizontally at such a speed as to make it travel around that planet (presumed smooth for the present discussion) in a circle at fixed height. What horizontal speed must it have to have to stay at the same small height above the planet's surface? (Take the radius of the planet to be $2X10^6$ m, and the planet's gravitational acceleration to be 8 m/s^2.)

a. $4 X 10^2$ m/s
b. $4 X 10^3$ m/s
c. $4 X 10^4$ m/s
d. $2 X 10^6$ m/s
e. $16 X 10^6$ m/s
f. None of the above is within 10% of the correct answer.

IF $g = 8 = a_c = v^2/R$ then appl travels in circle of Constant R:

i.e $8R = v^2$

$\sqrt{8 \cdot 2X10^6} = v$

$4X10^3 \, m/s =$

END of EXAM