Ex I F05 Solutions

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

1. 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 Definition
   - 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 average speed?
   - a. 15 mph
   - [✓ b] 30 mph
   - c. 45 mph
   - d. 60 mph
   - e. Not enough information is given to be able to say.

$$\bar{v} = d/t = 120/(6-2) = 120/4 = 30 \text{ mi/hr}$$

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 averaged 100 mph for 60 minutes of the trip. true
   - b. The instantaneous speed is not 50 mph, but has a variable value as indicated on the speedometer at any moment during the trip. true
   - c. You can average 50 mph even if the speed is zero for part of the trip. true
   - 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 true
   - [✓ e.] All of the above statements are correct.
   - f. None of the above statements is correct.

4. What average speed, most nearly, is required to run a marathon (26 mi = 41.9 km), in 4 hours?
   - 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

$$\bar{v} = d/t = \frac{41.9 \times 10^3 \text{ m}}{4 \times 60 \times 60 \text{ sec}} = \frac{4.19 \times 10^3}{1.44 \times 10^3} = 2.91 \text{ m/sec}$$

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 maximum and the minimum 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. Definition
   - e. the value of the velocity at the midpoint of the time interval divided by Δt

6. Which of the following quantities could specify a net-force vector?
   - a. 5 kg wrong units
   - b. 5 kg downward " "
   - c. 5 kg-m/s north " "
   - d. 5 kg-m/s^2 ok units, but no direction
   - [✓ e.] 5 kg-m/s^2 east ok units, & direction

7. 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. None of these is an accelerator properly so called
   [✓ e.] All of theses are accelerators properly so called, because they change speed or direction of $\vec{v}$

8. If a go-cart requires 300 seconds to accelerate from zero 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

$$\vec{a} = \frac{v_f - v_i}{t_f - t_i} = \frac{90\times10^3 m/hr}{300 sec} = \frac{90\times10^3 m}{300 sec\text{-}hr} \times \frac{1 hr}{3600 sec} = \frac{9\times10^4 m}{1.08\times10^6 sec}$$

$$= \frac{9}{1.08\times10^2} = 0.0833$$

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

   o o o   o   o   o....

   a. not accelerating.
   [✓ b.] speeding up. because spacing is increasing
   c. slowing down.
   d. moving with a constant speed.
   e. none of the above.

10. Which of the following strobe diagrams corresponds to a situation where the ball has a constant positive acceleration?
   a. o o o o o o o o o o o o o o...
   b. o o o o o o o o o o oo oo o o...
   c. o o o o o o o o ooo o o o o o o o o oo ooooo..
   [✓ d.] oo o o o o o o o o o o o.
   e. none of the above

because spacing is increasing linearly with time

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 claimed that if the air resistance could be neglected, all objects would fall at
   a. the same constant speed regardless of the type of material.
   b. the same constant speed regardless of how much they weigh.
   c. different constant speeds depending on the type of material.
   d. different terminal velocities proportional to the square roots of the masses.
   e. different accelerations proportional to their masses.
   [✓ f.] the same constant acceleration. ... based on Galileo's ramps.
   g. In fact, we claimed none of the above since not enough information is given to support any claim.

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 greater than 10 m/s/s.
   [✓ f.] None of the above. The motion has constant acceleration which is positive $< 10 m/sec^2$

13. If a ball is dropped from rest, it will fall 5 m during the first second. How far will it fall during the second, third and fourth seconds all together, most nearly ?
   - a. 15 m
   - b. 30 m
   - c. 40 m
   - d. 50 m
   - [✓ e.] 75 m

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

$d(1) = 5$ m

$d(4) = \frac{10}{2}\cdot 16 = 80$ m

$d(4) - d(1) = 80 - 5 = 75$ m

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 4.5 seconds later?
   - a. 10 m/s upward
   - b. 5 m/s upward
   - c. zero
   - d. 5 m/s downward
   - [✓ e.] 10 m/s downward

$v(t) = v_0 - |g|t$

$v(4.5) = 35 - (10)(4.5) = 35 - 45 = -10$ m/sec

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 speed up?
   - a. negative velocity and negative acceleration. Speeds up in negative direction
   - b. positive velocity and positive acceleration. " positive "
   - c. zero velocity and positive acceleration. Speeds up " " " from zero
   - d. zero velocity and negative acceleration. " " " negative " " "
   - [✓ e.] In all of the above cases the object speeds up.
   - f. In none of the above cases does the object speed up.

16: QUESTION #16 DOES NOT EXIST: ALL ANSWERS in NCS Row 16 are ok.

17. A car initially traveling north at 2 m/s has a constant acceleration of 5 m/s^2 northward. How far does the car travel in the first 10 s, most nearly?
   - a. 20 m
   - b. 70 m
   - c. 120 m
   - d. 170 m
   - [✓ e.] 270 m
   - f. None of the above is within 10% of the correct answer.

$d = x(t) - x(t=0) = v_0 t + \frac{1}{2}at^2 = 2\cdot 10 + \frac{5}{2}\cdot(10)^2$

$= 20 + \frac{500}{2} = 250 + 20 = 270$ 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. How high 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. 4.5 m
   - b. 15 m
   - c. 30 m
   - [✓ d.] 45 m
   - e 90 m
   - f. None of the above is within 10% of the correct answer.

$v_0 = 30$ m/sec $v_{MAX}(t_{MAX}) = 0$: ball stops at top of trajectory

$v(t) = v_0 - |g|t = 0 \Rightarrow t_{MAX} = v_0/g = \frac{30}{10}$ sec $= 3$ sec

And object has risen $x(t) - x_0 = v_0 t - \frac{g}{2}t^2$ in t seconds

$d(3) = x(3) - x_0 = 3\cdot 30 - \frac{10}{2}(3)^2$

$= 90 - 45 = 45$ m

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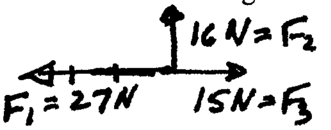
19. What is the net force on an 500-kg hot air balloon rising straight upward with a constant velocity of 4m/s, most nearly?
   - [✓ a. zero] is always the net force on an unaccelerated mass.
   - b. 500 N
   - c. 1000 N
   - d. 2000 N
   - e. 5000 N
   - f. None of the above is within 10% of the correct answer.

20. 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. 4 N
   - c. 11 N
   - d. 12 N
   - [✓ e. 20 N.]
   - f.. None of the above is within 10% of the correct answer.



$F^{NET} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3$

$F_x^{NET} = (-27 + 0 + 15) = -12$

$F_y^{NET} = (+0 + 16 + 0) = +16$

& $|F^{NET}| = \sqrt{12^2 + 16^2}$
$= \sqrt{400} = 20$

21. If the net force on a hot-air balloon is directed straight upward, which way does the 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. None of the above is a correct statement about the acceleration..]

A: upward in direction of F^{NET}, ALWAYS!

22. If you push on a railroad boxcar with a force of 300 N and it doesn't move, you can conclude that
   - a.. Newton's second law is not valid. NO! NET FORCE may be zero.
   - b. This force is canceled by its third law partner force. Never Possible!
   - c. The boxcar has too much mass to accelerate. IMPOSSIBLE: Requires M = infinite
   - d. There must be some object under a wheel which prevents it from rolling, or some other source of another force
   - e. Galileo's Principle of inertia is not relevant: On the Contrary!
   - [✓ f. None of the above conclusions can be validly inferred.] Conclude that outside world has no net effect.

23. The same *known* net force is applied to object A and object B. The observed accelerations of the two objects are *not* the same: object A has an acceleration six times that of object B. Which of the following is correct?
   - [✓ a. Object A has one sixth the mass of object B.]
   - b. Object A has six times the mass of object B.
   - c. There may be some other unexpected force accelerating A.
   - d. There may be some other unexpected force decelerating B.
   - e. None of the above is consistent with the facts stated.

$F_A^{NET} = m_A a_A = F_B^{NET} = m_B a_B$

$\Rightarrow \frac{a_A}{a_B} = \frac{m_B}{m_A} = 6$

24. Which of the following is not a vector quantity?
   - a. force ✓
   - b. acceleration ✓
   - c. weight ✓
   - d. velocity ✓
   - [✓ e. All of the above are vector quantities.]
   - f. Two or more of the items, a through d, are non-vector quantities.

25. The strength of 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
    - c. 240 kg
    - d. 600 kg
    - e None of the above is correct within 10%.

$W = 600 N = mg \Rightarrow m = \frac{600}{10} = 60 kg$

& MASS is same wherever it is

26. A ball with a weight of 20 N is thrown vertically upward. What is the velocity of the ball just as it reaches the top of its path?
    - [✓ a.] zero
    - b. 10 m/s^2 downward
    - c. 10 m/s^2 upward
    - d. 20 m/s^2 downward
    - e. 20 m/s^2 upward

is always the vertical velocity at the top of any trajectory .... as it changes from up (+) to down (-) vertical velocity MUST go through zero ∴ this defines the "top".

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. So that NET FORCE & acceleration 0.
    - e. only when she spreads our her limbs to increase the air resistance.
    - f. None of the above completions yields a correct statement.

28. Two steel 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. } mass is not defined by geometry
    - b. The hollow 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 : invalid!
    - d. The terminal speeds are the same and equal to 10 m/s, but values are not determined
    - [✓ e.] The two balls must have the same mass because terminal speed increases with mass
    - f. None of the above statements is true.

Because terminal speed depends on mass

29. A 50-kg crate is being pushed across a horizontal floor by a horizontal force of 550 N. If the coefficient of sliding friction is 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.

$F^{fr.}_{k} = \mu |\vec{N}| = \mu \cdot Mg = (.2)(50)(10) = 100 N$

$F^{App} = 550 N$

$\frac{F^{NET}}{m} = \frac{F^{App} - F^{fr}}{m} = \frac{550 - 100}{50} = 9 m/sec^2$

30. You must apply a 75-N force to pull a child's wagon across the floor at a constant speed of 0.5 m/s. If you increase your pull to 90 N, the wagon will
    - [✓ a.] continue to speed up as long as you keep pulling, because F^{NET} has increased from zero to 15N
    - b. speed up immediately and then move at the faster constant speed of 0.6 m/s. No .. accelerates steadily
    - c. speed up gradually until it reaches the speed of 0.6 m/s and then move at that constant speed.
    - d. continue to move at 0.5 m/s. : impossible when extra 15N force is being applied
    - e. do none of the above.

31 If the earth exerts a gravitational force of 1000 N on a satellite of mass 500 kg moving in a circular orbit 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.] 1000 N Newton's IIIrd: $|\vec{F}_{ES}| = |-\vec{F}_{SE}|$
f. None of the above is even approximately correct.

32. Which of the following is the third-law partner force to the force that an book exerts on its bookshelf? 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.

33 A book sits at rest on a table. Which force does Newton's third law tell us is equal and opposite to the gravitational force acting on the book? A: The gravitational force of the book upon the earth

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 must be ___________ your weight?

[✓ a.] greater than because the NET FORCE is upward, since it is slowing your fall .... i.e. accelerating you in the upward direction.
b. equal to
c. less than.
d. much less than
e There is not enough information to support of any of the above statements.

35. Terry and Chris pull hand-over-hand on opposite ends of a rope while standing on a frictionless frozen pond. Terry's mass is 90 kg and Chris's mass is 30 kg. If Terry's acceleration is 12 m/s^2, what is Chris's acceleration?

[✓ a.] 36 m/s^2 NIII Forces are EQUAL, & opposite $\Rightarrow m_T a_T = m_C a_C$
b. 12 m/s^2 i.e $a_C = \frac{m_T}{m_C} a_T = \frac{90}{30} \cdot 12 = 36$ m/sec^2
c. 6 m/s^2
d. 4 m/s^2
e. None of the above is within 10% of the correct answer.

36. A child stands on a bathroom scale while riding in an elevator. The child's weight when the elevator is not moving is 100 lbs. What does the scale read when the elevator accelerates upward while traveling downward?

F_{NET} is (+upward) & > ZERO & $F_{NET} = F_{scale} - Mg > 0$

Then $F_{scale} > Mg$ = Weight = 100 lbs

a. Exactly 100 lbs
b. Less than 100 lbs
[✓ c.] Greater than 100 lbs
d. The same as it reads when accelerating downward while traveling upward, by symmetry.
e. None of the above.

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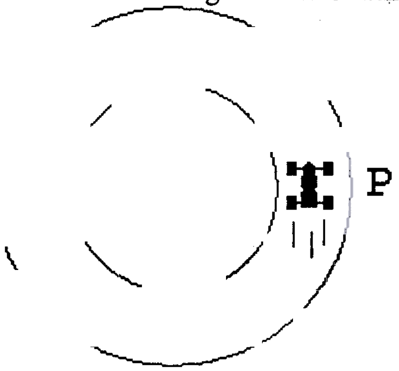
37. If a race car is traveling around a circular track at a constant speed, we know that the car experiences
    - a. no net force.
    - [✓ b.] a centripetal force, to keep it accelerating towards center
    - c. a centrifugal force.
    - d. a net force in the forward direction.
    - e. all of the above.
    - f. none of the above.

Figure 38

A 800 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, 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, because the forward speed is increasing there must be an upward (on the page) component as well as a leftward centripetal force.

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 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.

$$F_{cent} = T = \frac{mv^2}{R} = \frac{8\cancel{00}\cdot(20)^2}{3\cancel{00}} = \frac{3200}{3} = 1.07\times10^3$$

40. Suppose that the track managers decide to bank the frictionless track in question 38 at some angle, a, chosen to make the horizontal component of the force normal to the roadway towards the center equal to 3.6×10^2 N for a situation where the force normal to the (banked) roadway is 4800N. The angle is, most nearly, a =
    - 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 the that angle.
    - f. In fact, it is not possible to obtain the specified force on the car in question by banking.

$N\sin a = 3.6\times10^2$

$\sin a = \frac{3.6\times10^2}{4.8\times10^3} = 0.075$

& $\sin a \approx a$ in Radians if a is small

LOL

Compute: $\sin^{-1}(0.075) =$
4.3°

4 . In uniform circular motion the

- a. acceleration is parallel (or antiparallel) to the velocity: No! these would change speed.
- [✓ b.] acceleration is perpendicular to the velocity: CORRECT THIS FORCE changes only the direction of $\vec{v}$.
- c. acceleration is vertical, while the velocity can be in any direction: NONSENSE
- d. acceleration is vertical and the velocity is horizontal: ALSO "
- e. none of the above statements is true: FALSE ⓑ is true

42. In motion along a straight line the

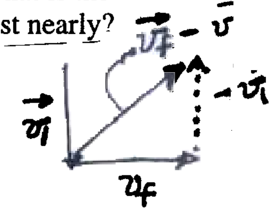
- [✓ a.] acceleration is parallel (or antiparallel) to the velocity. TRUE, since direction of $\vec{v}$ must <u>NOT</u> change.
- b. acceleration is perpendicular to the velocity. FALSE, since " " " " "
- c. acceleration is vertical, while the velocity can be in any direction: NONSENSE
- d. acceleration is vertical and the velocity is horizontal. ALSO: "
- e. none of the above statements is true: FALSE ⓐ is true

43. 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 with the same 6 m/s speed. What is the (approximate) magnitude of the bird's average acceleration during this 2-s interval, most nearly?

- a. 1 m/s^2
- b. 3 m/s^2
- [✓ c.] 4 m/s^2
- d. 5 m/s^2
- e. None of the above is within 10% of the correct answer.

$$|\vec{a}| = \frac{|\vec{v}_f - \vec{v}_i|}{\Delta t} = \frac{\sqrt{(6)^2+(6)^2}}{2} = 4.24 \frac{m}{sec^2}$$

Since $|\vec{v}_f - \vec{v}_i| = \sqrt{6^2+6^2} = 8.48$: See diagram



44. What centripetal acceleration is required to follow a circular path with a radius of 50 m at a speed of 10 m/s?

- [✓ a.] 2 m/s^2
- b. 4 m/s^2
- c. 6 m/s^2
- d. 8 m/s^2
- e. None of the above is within 10% of the correct answer.

$$|\vec{a}_c| = v^2/R = (10)^2/50 = 2 \, m/sec^2$$

45. A 15-kg child on a merry-go-round is traveling in a circle with a radius of 3 m at a speed of 6 m/s. What is the magnitude of the net force experienced by this child?

- a. zero
- b. 60 N
- [✓ c.] 180 N
- d. 600 N
- e. 720 N

$$F_c = ma_c = m\,v^2/R = 15 \cdot 6 \cdot 6/3 = 180 \, N$$

46. A cyclist turns a corner with a radius of 100 m at a speed of 20 m/s. What is the magnitude of the cyclist's acceleration?

- a. 0.4 m/s^2
- b. 2.5 m/s^2
- [✓ c.] 4.0 m/s^2
- d. 5.0 m/s^2
- e. 25 m/s^2
- f. 2000 m/s^2
- g. None of the above is within 10% of the correct answer.

$$a = v^2/R = (20)^2/100 = 4 \, m/sec^2$$

47. A red ball is thrown straight down from the edge of a tall cliff with a speed of 10 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?
    - a. 1 s
    - [✓ b.] 2 s
    - c. 3 s
    - d. 6 s
    - e. None of the above is within 10% of the correct answer.

GREEN ball rises from $v_0 = 10$ m/sec & stops 1 sec later: $0 = 10 - gt \Rightarrow t = 1$ sec.
THEN " " falls with acceleration $g = 10$ for 1 sec, at which time ($t = 2$)
it is at original height & moving downward with speed of 10 m/sec: the
SAME as the RED Ball was 2 seconds earlier.

48. A red ball is thrown straight down from the edge of a tall cliff with a speed of 10 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: because green follows Red's path exactly, only with a 2 second 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 velocity?
    - [✓ a.] The bullet that was fired: because it has a horizontal component v_x, as well as the (same!) vertical component, v_y, as the dropped bullet.
    - b. The bullet that was dropped
    - c. It will be a tie, because the acceleration of gravity is the same for both.
    - d. The bullet that was fired, because it feels the force of gravity over a longer distance: gravity has nothing to do with horizontal component of $\vec{v}$!
    - e. The bullet that was dropped, because it falls for a longer time False
    - f. None of the above assertions is correct

50. 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: gravity $\vec{F} = m\vec{g}$
    - c. The acceleration of the projectile is constant throughout the flight. true $a = -g$
    - d. The force on the projectile is always vertically downward true: gravity force is towards center of earth
    - [✓ e.] All of the above statements are true.
    - f. None of the above answers is correct.

51. In projectile motion the
    - a. acceleration is parallel (or antiparallel) to the velocity. NOT necessarily so
    - b. acceleration is perpendicular to the velocity. NOT "
    - c. acceleration varies with the direction of the velocity. FALSE: always downward
    - d. acceleration is horizontal and the net velocity is horizontal. " : $\vec{a}$ is "
    - e. acceleration varies with the hight of the projectile. FALSE: $\vec{a}$ is independent of height.
    - [✓ f.] None of the above is true of projectile motion

52. 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 what it is on earth, he should obtain a
    a. miss since the monkey's weight is twice as big now. False: acceleration is still same for bullet & monkey
    b. hit only if the bullet's horizontal velocity is increased. False: hit will occur for any horizontal velocity
    c. miss since the monkey's mass is unchanged. False: mass of monkey is irrelevant
    d. hit since the ball and the monkey feel attractive gravitational forces towards one another? False: gravitational attraction of mass to monkey is NEGLIBLE.
    [✓ e.] None of the above statements is valid.

53. Just after being hit into a pop fly, a baseball has a horizontal speed of 20 m/s and a vertical speed of 45 m/s upward. Ignoring air resistance what are these speeds nine seconds later?
    a. 20 m/s horizontal and 45 m/s upward
    b. 20 m/s horizontal and 35 m/s upward
    c. 20 m/s horizontal and 0 m/s upward
    [✓ d.] 20 m/s horizontal and 45 m/s downward
    e. 20 m/s horizontal and 90 m/s downward
    f. None of the above is within 10% of the correct answers.

$v_{hor} = v_x = 20$ m/sec = constant

✓ $v_{vert} = v_y = v_{y0} - gt = 45 - 10 \cdot 9 = -45$ m/sec

54. A golf ball is hit with a vertical speed of 30 m/s upwards and a horizontal speed of 30 m/s. How far will the ball travel horizontally before landing on the flat surface below?
    a. 30 m
    b. 60 m
    c. 90 m
    d. 120 m
    [✓ e.] 180 m

Ball travels up for $30/g = 3$ sec & down for 3 seconds before hitting ground. In these 6 seconds it travels

$d = v_h t = 30 \cdot 6 = 180$ m

The remaining problems may require some 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 with a speed of 70 m/s. His assistant notes that the pellet reaches its maximum height just 9 m above the edge of the cliff. How high is the cliff?

    a). 61m; b). 254m; [✓ c).] 236m; d). 481m; e). 691m; f) None of these answers is correct within 10 %

$v_0 = +70$ m/sec $\quad v(t) = v_0 - |g|t = 0$ at $t = t_{TOP}$.

i.e $\quad t_{TOP} = v_0/g = 70/10 = 7$ sec

Also $y(t) = y_0 + v_{0y} \cdot t - \frac{1}{2} g t^2 = 0 + (70)7 - \frac{10}{2} \cdot 49 = 24$ m

& $H = y(t_{TOP}) - 9\text{m} = 245 - 9 = 236$ m

56. A biker starts up a steep hill with a speed of 5m/s. His speed decreases at the rate of 0.1m/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). 125 m;] b). 75 m;

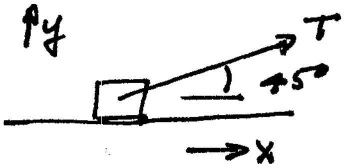
$v(t) =$ $= 0$ at top of hill $\Rightarrow t_{TOP} = 5/0.1 = 50sec$

$$d(t_{TOP}) = x(t_{TOP}) - x_0 = v_0 t_{TOP} - \frac{a}{2}(t_{TOP})^2$$

$$= 5\cdot(50) - \frac{0.1}{2}(50)^2 = 250 - 125 = 125\ m$$

57. A rope is used to drag a box across a rough warehouse floor. Its angle is 45 degrees above the horizontal, and its tension is T. If the box has a mass of 25 kg, feels a frictional drag force of 75 N, and is accelerating horizontally at 0.3 m/s^2, what is the value of T?

a). 7.5N; b). 37.5 N; c) 75 N; d) 82.5 N; [✓ e) 116.7 N.]



$F_x^{NET} = m a_x$ $(25)(0.3) = 7.5$

& F_x^{NET} T_x $- F_{friction}$

$= T\cdot \cos 45° - F_{fr} = m a_x$

& $T = \frac{m a_x + F_{fr}}{\cos 45°} = \frac{7.5 + 75}{0.707} = 116.7\ N$

Ex I F05

58. Just after it is launched a 6000 kg rocket feels a gravitational attraction by the earth of about 60,000 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) 10^{20} m/s^2; b) 10^{21} m/s^2; [✓ c)] 10^{-20} m/s^2; d) 10^{-21} m/s^2; e) None of these is within 10%.

$$|\vec{F}_{E,R}| = |F_{R,E}| = 6 \times 10^4\ N = M_E a_E \quad (\text{by } N\,III)$$

$$a_E = \frac{\cancel{6} \times 10^4\ N}{\cancel{6} \times 10^{24}\ kg} = 10^{-20}\ m/sec^2$$

Scenario 59. Suppose that a moon of Jupiter travels in a circle about the planet at a distance of 1.6×10^{10} meters once in every 11.6 days, and that 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^{10} m/s.

$$v = \frac{2\pi R}{T} = \frac{2\pi \cdot (1.6 \times 10^{10})}{11.6 \times 24 \times 60 \times 60} = \frac{10.0 \times 10^{10}\ m}{1 \times 10^6\ sec} = \frac{10^{11}}{10^6} = 10^5 \frac{m}{s}$$

60. The acceleration of the moon is most nearly:
a) 0.6×10^3 m/s^2; [✓ b)] 0.6 m/s^2; c) 0.6×10^{-3} m/s^2; d) 0.6×10^{-5} m/s^2; e) 0.6×10^{-7} m/s^2.

$$a_M = v^2/R = \frac{(10^5)^2}{1.6 \times 10^{10}} = \frac{10^{10}}{1.6 \times 10^{10}} = 0.625\ m/sec^2$$

END of EXAM I