EX II F08 Solutions

Multiple Choice

Insert the letter of the single choice that best completes the statement or most nearly answers the question into the corresponding line on your NCS answer sheet.

1. At the top left of this page this exam is identified as Exam II F08, VERSION A or VERSION B. (Please identify your exam version by entering either a) or b) in line 1 of your NCS answer sheet.)
   - [✓ a.] Version A
   - [✓ b.] Version B

2. What is the force of earth's gravity upon a 1 kg mass located at a height of 3.00 earth radii above the earth's surface, most nearly?
   - a. 10 N
   - b. 3.3 N
   - c. 2.5 N
   - d. 0.33 N
   - e. 0.25 N
   - [✓ f.] 0.62 N
   - g. None of the above is within 10% of the correct answer.

3. Which of the following statements about Venus is correct?
   - a. Venus has a constant velocity. F
   - b. There is no net force acting on Venus. F
   - c. The sun exerts a stronger force on Venus than Venus exerts on the sun. F
   - d. Venus is driven along its orbit by magnetic forces. F
   - e. Venus has zero acceleration F
   - f. All of the above statements (a through e) are true F
   - [✓ g.] None of the above statements (a through f) is true.

4. Which of the following statements about the moon is most correct?
   - a. The acceleration of the moon due to earth's gravitational attraction is greater than the earth's acceleration due to the moon's attraction. T
   - b. The earth's gravitational pull on the moon equals the moon's gravitational pull on earth. T
   - c. The net force acting on the moon is mainly due to the earth's gravitational attraction. T
   - d. Given that its orbital speed is constant, the moon is accelerating with a constant magnitude. T
   - e. The moon's acceleration due to the earth's gravitational attraction is equal to $g/(60)^2$, because the moon is 60 earth radii away from the earth. ($g = 9.8 m/s^2$.) T
   - [✓ f.] All of the above statements (a through e) are true T
   - g. None of the above statements (a through f) is true. F

5. How large is the acceleration of a 15 kg mass due to earth's gravity when it floating freely in an earth satellite moving in a circular orbit at an distance of 6 earth radii from the center of the earth, most nearly ?
   - a. 10 m/s/s
   - b. 1.7 m/s/s
   - c. 1.4 m/s/s
   - [✓ d.] 0.28 m/s/s
   - e. 0.20 m/s/s
   - f None of the above is correct within 10% of the correct answer.

$$g(6) = g(1)/(6)^2 = 10/36 = 0.278 \ \text{(d)}$$

$$\text{Since } g(r) = G M_E/r^2 = \frac{R_E^2}{r^2} G M_E/R_E^2 = \frac{R_E^2}{r^2} g(r=R_E)$$

6. If you quadruple the length of the edge of a cube, its surface area increases by what factor?
   - a. 1/16
   - b. 1/4
   - c. 1
   - d. 4
   - [✓ e.] 16
   - f. 64
   - g. None of the above.

7. The law of universal gravitation states that $F = GMm/r^2$. We frequently used the shorter form $F = mg$ when we studied projectile motion. Which of the following validates that use?
   - a. The shorter form is simpler and therefore preferable to the first.
   - [✓ b] The shorter form is a good approximation to the first for objects close to the earth's surface.
   - c. The first form does not work for single a projectile because it requires two masses.
   - d. The first form is not valid near the surface of the earth.
   - e The first form is not valid for projectile motion.
   - f. None of the above is a valid and true basis for using the second form.

8. The numerical value of G, the gravitational constant measured by Cavendish could in principle be checked against
   - a. a calculation based upon detailed knowledge of the earth's mass density and volume T
   - b. a calculation based upon the value of the moon's acceleration due to earth's gravity, and independent knowledge of the mass of the earth. T
   - c. the perturbation of some planet's orbital trajectory due to a close passage of another planet, provided one knew their masses independently. T
   - d. the measured gravitational force between masses in the laboratory. T
   - [✓ e.] All of the above checks are possible in principle. T
   - f. None of the above completions (a through e) provides a true statement. F

9. Which of the following would not cause even a slight increase in the gravitational force on an object near the surface of the earth?
   - a. A high density ore deposit just under the surface
   - b. a lower elevation
   - c. an increase in the object's mass
   - d. a downward velocity (as time progresses)
   - [✓ e] An upward velocity (as time progesses) ← Because this motion causes a DECREASE in F_G with time.
   - f. None of the above answers is correct. In fact, all of the above would cause at least a slight increase in the gravitational force on the object.

10. In an orbiting satellite such as SkyLab , a physical object of mass, m
   - a. has mass = m, and weight =mg. ($g = 9.8 m/s^2$.) F
   - b. has mass but feels no force due to gravity. F
   - c. has neither mass nor weight. F
   - d. falls to the floor with an acceleration of 9.8 m/s/s. F
   - [✓ e] feels the force of gravity, but has no weight because its frame is accelerating T
   - f conforms to all of the above statements. F
   - g. conforms to none of the above statements. F

11. Geosynchronous communications satellites orbit the earth once each
   - [✓ a.] day
   - b. month
   - c. lunar month (28.3 days)
   - d. week
   - e year
   - f. In fact they don't orbit the earth at all; they just stay in one place.
   - g. None of the above.

12. Because the moon rotates about the earth (about once every 28.3 days) in the same direction that the earth rotates about its axis, there will occur on earth during some, but not most, 24 hour intervals,
   - a. one high tide and one low tide;
   - [✓ b.] one high tide and two low tides, or two high tides and one low tide;
   - c. two high tides and three low tides, or three high tides and two low tides.
   - d. two high tides and two low tides.
   - e. All of the above combinations occur in some, but not most, 24 hour intervals
   - f. None of the above is a true statement about the occurrence of earth's tides.

{2H & 2L is typical but Moon's motion shifts pattern leading occasionally to 2+1 or 1+2 pattern.

13. Suppose that the acceleration due to gravity on Titan, Saturn's largest moon, is about $3.0 m/s^2$. What would a 20-kg scientific instrument weigh on Titan, most nearly?
   - a. 20 N
   - [✓ b.] 60 N
   - c. 180 N
   - d. 540 N
   - e. 600 N
   - f. None of the above is within 10% of the correct answer.

$W = M\tilde{g} = (20)(3.0) = 60N$

14. An artillery shell has a mass of 10^2 kg. How fast would it have to move to have the same momentum as an 18-wheeler ($m = 3.6\text{x}10^4$ kg) rolling along at 10^3 m/hr?
    - a. 1 m/s
    - b. 10 m/s
    - [✓ c.] 10^2 m/s
    - d. 10^3 m/s
    - e 10^4 m/s
    - f. 10^5 m/s
    - g. None of the above answers is within 10 % of the correct result.

$$m_S v_S = M_{18} v_{18} = (3.6\times10^4\,kg)\left(10^3 \frac{m}{hr}\right)\times\left(\frac{1\,hr}{3600\,s}\right) = 10^4\,kg\,m/sec$$

$$\&\ m_S = 10^2\,kg \qquad v_S = \frac{10^4}{10^2}\,m/sec = 10^2 \quad (c)$$

15. Newton's second law can be rearranged to show that the __________ is equal to the __________.
    - a. net work .... kinetic energy
    - b. change in momentum ... change in impulse
    - c change in net work .... kinetic energy
    - d. momentum ... change in impulse.
    - [✓ e] net work ....change in kinetic energy.
    - f. change in work ... change in kinetic energy.
    - g None of the above

16. Newton's second law can be rearranged to show that the __________ is equal to the __________.
    - a. net work .... kinetic energy
    - [✓ b.] change in momentum ...impulse
    - c change in net work .... kinetic energy
    - d. momentum ... change in impulse.
    - e net work ....kinetic energy.
    - f. change in work ... change in kinetic energy.
    - g None of the above

17. For an acrobatic tumbler, a trampoline reduces the __________ that he feels as his falling velocity is diminished.
    - [✓ a.] force
    - b. work
    - c. impulse
    - d. change in velocity
    - e. change in momentum
    - f. None of the above.

18. A tail gunner jumped from a World War II Lancaster bomber but remained unhurt because he Fell first into the branches of a tree and then into a snow bank. Physics explains this because
    - a. the change in momentum was less than hitting the ground directly. F
    - b. the impulse in less in trees and snow than upon hitting hard ground. F
    - [✓ c.] the increased stopping time in the tree and the snow meant a smaller stopping force. T
    - d. the decreased stopping time in the tree and the snow meant a smaller stopping force. F
    - e. The net work done is still equal to the change in kinetic energy. TRUE but IRRELEVANT - NOT THE CAUSE
    - f The impulse is still due to the change in momentum. "
    - g. None of the above.

19. Which of the following will cause the largest change in the kinetic energy of an object? A force of _________ acting as the object moves a distance of __________.

a. 1 N ... 9 m 9
b. 2 N ... 8 m s 16
c. 3 N ... 7 m 21
d. 4 N ... 6 m 24
[✓ e.] 5 N ... 5 m 25
f. 6 N ... 4 m 24

$W = F_{\parallel} \cdot d$ & ⓔ is largest

20. Approximately what average force is required to stop a 0.25kg baseball moving at 3 m/s in a time of 0.2 sec?

a. 5.6 N
[✓ b.] 3.7 N
c. 1.9 N
d. 0.56 N
e. 0.37 N
f. 0.19 N
g. None of the above is within 10% of the correct answer.

$$\langle F \rangle_{Avg} \Delta t = \Delta m v = -(0.25)(3)$$

$$|\langle F \rangle_{Avg}| = -\frac{0.75}{0.2} = 3.75\,N \quad ⓑ$$

21. A hard rubber ball ($m = 0.4$ kg) is falling vertically at 1.5 m/s just before it bounces off the floor. The ball rebounds back at essentially the same speed. If the collision with the floor lasts $0.006 = 6\text{x}10^{-3}$ s, what is the average force exerted by the floor on the ball?

a. 20 N
b. 40 N
[✓ c.] 200 N
d. 400 N
e. None of the above is within 10% of the correct answer.

$$\Delta p = F_{Avg} \Delta t = 2 m v = 2(0.4)(1.5) = 1.2\ kg\,m/s$$

$$\Rightarrow F_{Avg} = 1.2/.006 = 2 \times 10^{2}\,N \quad ⓒ$$

22. 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. A net work is done on the ball by an outside force as it falls ✓
[✓ e.] All of the above (a through d) are correct answers. ✓
f None of the above answers (a through e) is correct. F

23. When a star undergoes a supernova explosion, the total linear momentum of the star

[✓ a.] Remains constant.
b. increases suddenly in the outward direction.
c. increases slowly.
d. decreases rapidly at first and then more slowly as the star expands.
e. decreases at a nearly uniform rate once the explosion has occurred.
f. There is not enough information to say.
g. None of the above is correct.

24. We can explain the recoil that occurs when a rifle is fired, by using
    a. the Work-Energy Theorem.
    b. conservation of mechanical energy.
    [✓ c] conservation of momentum.
    d. Newton's second law.
    e. Newton's first law.
    f. Any of the above.
    g. None of the above completions yields a correct statement.

25. Larry has a mass of 40 kg and runs across the classroom with a speed of 5 m/s and jumps onto a giant skateboard, initially at rest and with a mass equal to 10kg. If we ignore friction, what is the final speed of Larry and the skateboard, most nearly?
    a. 2 m/s
    [✓ b.] 4 m/s
    c. 8 m/s
    d. 16 m/s
    e. 32 m/s
    f. None of the above is within 10% of the correct answer.

$\vec{P}_{TOT} = const = P_i^{TOT} = 40(5) = P_f^{TOT} = (40+10)v_f$

$\frac{40\cdot 5}{50} = v_f$

4 m/sec =

26. Which of the following properties of a ball is conserved as it falls freely in a vacuum?
    a. kinetic energy F
    b. gravitational potential energy F
    c. momentum F
    [✓ d)] mechanical energy T
    e All of the above quantities (a through d) are conserved. F
    f. None of the quantities (a through d) is conserved. F

27. Under what conditions is the kinetic energy (KE) conserved, in the strict sense of the word, during a collision?
    a. It is always conserved.
    b. When the collision is totally elastic.
    c. When there is no net outside force.
    d. When there is no friction.
    [✓ e.] KE is never conserved during a collision because its value does not remain constant.
    f. None of the above is correct.

28. In physics, **Net Work** is defined as the product of the
    a. net force and the distance traveled.
    [✓ b.] net force , the distance traveled, and the Cosine of angle between the force and the displacement
    c. net force parallel to the motion and the ~~time~~ it is applied.
    d. applied force and the distance traveled.
    e. net force and the ~~time~~ it is applied.
    f. None of the above.

29. A ball moving at 4 m/s toward the right has a head-on collision with an identical ball moving to the left at 1 m/s. Each of the following final velocity pairs satisfies the law of conservation of linear momentum. Which one also preserves kinetic energy? One ball has a velocity of __________ while the other has a velocity of __________ to the right.

a. 2 m/s to the right … 1 m/s
b 1 m/s to the right …2m/s
c. zero … 3 m/s
[✓ d.] 1 m/s to the left…4 m/s
e. 2 m/s to the left … 5 m/s
f. 4 m/s to the left … 7 m/s
g. None of the above has a final kinetic energy equal to the initial value.

$(KE)_i = m/2\,(v_1^2 + v_2^2) = m/2\,(16+1)$ initially

$\leftarrow \frac{m}{2}(1^2 + 4^2) = \frac{17}{2}m = (KE)_i$

30. A 6-kg toy car with a speed of 5 m/s collides head-on with a stationary 4-kg car. After the collision, the cars are locked together and travel with a speed of 3 m/s. How much kinetic energy is lost in the collision, most nearly?

a. 20 J
[✓ b.] 30 J
c. 40 J
d. 50 J
e. 60 J
f. 0 J: (Because kinetic energy is conserved, no kinetic energy is lost in the collision.)
g. None of the above (a through f) is within 10% of the correct value.

$P_i = 6\cdot5 = P_f = (6+4)\cdot3$ ✓

$KE_i = \frac{m}{2}(v_i^2) = \frac{6}{2}\cdot25 = 75\,J$

$(KE)_f = \frac{M}{2}v_f^2 = \frac{10}{2}\cdot9 = 45\,J$

$\Delta(KE) = -30\,J$ (b)

31. Two objects have different masses but the same kinetic energy. If you stop them with the same retarding force, which one will stop in the shorter time?

a. The heavier one.
[✓ b.] The lighter one.
c. The one with the larger momentum.
d. Both stop in the same time.
e. There is not enough information to say
f. There is enough information to say, but none of the above is correct.

WORK ENGY ⇒ SAME STOPPING DISTANCE
So that FASTER ONE (i.e. LIGHTER ONE since KE IS SAME) STOPS in shorter time

32. Two objects have different masses but the same momentum. If you stop them with the same retarding force, which one will stop in the shorter distance?

[✓ a.] The heavier one
b. The lighter one
c. The one with the larger kinetic energy
d. Both stop in the same time
e. There is not enough information to say.
f. There is enough information to say, but none of the above is correct.

IMPULSE/MOMENTUM ⇒ SAME STOPPING TIME
IN SAME STOPPING TIME, SLOWER (i.e HEAVIER, since $\vec{P}$ is same) stops in SHORTER DISTANCE.

33. The kinetic energy of an object moving in a circle at a constant speed
    a. is continually changing as the force changes direction. F
    b. is equal to the force times the time for one revolution. F
    c. is equal to one-half of the potential energy. F
    d. is not constant because the direction of motion is changing. F
    e. depends upon the radius of the circle. F
    [✓ f.] None of the above completions yields a true statement.

34. How much work is performed by the gravitational force F on a geosynchronous satellite during one day?
    a. The work done is F*C, where C is the circumference of the orbit F
    b. The work done is Fr, where r is the radius of the orbit. F
    c. The work done is zero, because the net force vanishes. F
    d. The work done is zero, because the satellite does not move. F
    [✓ e.] The work done is zero, because the force is perpendicular to the displacement. T
    f. None of the above. F

35. If we examine a ball in free fall in a vacuum, we find that the kinetic energy of the ball increases. This does not exemplify a violation of the law of conservation of mechanical energy because the
    a. force of gravity does net work on the ball. T
    b. mechanical energy also involves the potential energy. T
    c. gravitational potential energy decreases exactlty enough to compensate for the increase. T
    d the outside world performs work on the ball during its fall. T
    [✓ e.] All of the above statements (a through d) are correct. T
    f. None of the above completions (a through e) yields a correct statement. F

36. A 13-kg mass is released from rest at the top of a frictionless slide that is 1.5 m high. What is the kinetic energy of the mass when it reaches the bottom?
    a. 390 J
    [✓ b.] 195 J
    c. 39.0 J
    d. 19.5 J
    e. None of the above answers is within 10% of the correct result.

Cons of ME: $ME_i = mgh_i + 0 = ME_f = 0 + (KE)_f$
i.e. $(KE)_f = (PE)_i = 13\cdot(10)(1.5) = 195$ J (b)

37. A 8-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 15 m high?
    a. 4000 J
    b. 12,000 J
    c. 40,000 J
    d 80,000 J
    e. 120,000 J
    [✓ f.] None of the above answers is within 10% of the correct result.

$(ME)_i = CONST = (KE)_i + (PE)_i = (PE)_i + 0 = mgh_i = (8)(10)\cdot(30$
& $ME_f = (KE)_f + (PE)_f = (ME)_i = (PE)_i$
$(KE)_f = (PE)_i - (PE)_f = (8)(10)(30-15)$
1200 J

38. A rubber ball dropped from a height of 8 m bounces back only to a height of 7 m. Which of the following statements is valid for this situation?
    a. Kinetic energy is conserved. F
    b. Mechanical energy is conserved. F
    c. Gravitational potential energy is conserved. F
    [✓ d.] Mechanical energy decreased in the process. T
    e. All of the above. F
    f. None of the above. F

39. How much energy is required to light a 35-W bulb for 2 h?
    a. 5.0×10^5 J
    [✓ b.] 2.5×10^5 J
    c. 8.4×10^3 J
    d. 4.2×10^3 J
    e. None of the above answers is within 10% of the correct result.

$1 W = 1 J/sec$

$$E = 35 W \cdot 2 hr \times \left(\frac{3600 sec}{hr}\right)$$

$$= 252{,}000\ W\cdot sec$$

$$= 2.5 \times 10^5 J$$ (b)

40. Imagine riding in a glass-walled elevator that goes up the outside of a tall building at a constant upward speed of 15 meters per second. Assuming that you release a ball as you pass a window washer, the window washer will see the ball
    a. fall starting with a downward speed of 15 m/s. F
    b. rise, then fall, starting with an upward speed of (15 – g) = 5 m/s. F
    c. fall starting with a downward speed of (15+g) = 25m/s. F
    [✓ d] rise, starting with an upward speed of 15 m/s, then fall. T
    e. fall starting from rest. F
    f. remain stationary. F
    g. None of the above statements is true F

41. While you are standing on the ground, you observe your friends pass by in a van traveling at a constant velocity. They drop a ball and you all make measurements of the ball's motion. Which of the following quantities surely has the same value in both reference systems?
    a. velocities F
    b. kinetic energies F
    c. mechanical energies F
    d. total momenta F
    [✓ e.] Some physical quantities are surely the same in both frames, but none of those mentioned (in a through d) above. T
    f. No physical quantity whatsoever is the same in both reference systems. F
    g All of the lquantities (a through g) in fact have the same values in both frames. F

42. Assume that you are riding in a windowless room on a perfectly smooth surface. (You can't feel any motion.) Imagine that you have a collection of objects and measuring devices in the room. Which of the following experiments could prove that the room is moving horizontally at a constant velocity?
    a. Determining an object's mass by applying a net horizontal force.
    b. Weighing an object and comparing it to its known weight.
    c. Determining the force necessary for an object to move in a circle.
    d. Measuring the verticality of a hanging object
    e. Measuring the range of a projectile to see a deviation from the expected value.
    f. None of the above experiments could prove that the room is in constant-velocity motion, but there exists at leas one other experiment, not listed above, which could prove it. ← { PRIN of GALILEAN RELATIVITY
    [✓ g] No experiment of any kind could prove that the room is in constant-velocity motion.

43. You can throw a ball vertically up in a car moving with a constant velocity and have it drop back into your hand because
    a. there is no net horizontal force acting on the ball. T
    b. the reference system attached to the car is inertial. T
    c. Newton's second law applies in the car's frame of reference. T
    d. the gravity force of earth is the same in the car's frame as it is in the earth's frame. T
    [✓ e] All of the above completions (a through d) yield true statements. T
    f None of the above completions (a through e) yields a true statement. F

44. A person drops a ball in train traveling along a straight, horizontal track accelerating horizontally at a constant rate, equal to $10 m/s^2$ = |g|. Based on the motion of the ball, what would he say about the horizontal forces acting on the ball?
    a. There are no horizontal forces acting on the ball. F
    b. There is a fictitious (inertial) force, equal in magnitude to its weight,acting forward. F
    [✓ c.] There is a fictitious (inertial) force, equal in magnitude to its weight, acting backward.
    d. There is spring-like inertial force, which increases as time progresses, acting backward. F
    e. None of the above completions yield a true statement.. F

45. A rock is thrown horizontally at 30 m/s from the back of a flatbed truck that is moving with a constant velocity of 40 m/s. Relative to an observer on the ground, what is the horizontal speed of the rock when it is thrown in the direction perpendicular to the velocity of the truck?
    a. 10 m/s
    b. 20 m/s
    c. 30 m/s
    d 40 m/s
    [✓ e.] 50 m/s
    f. 70 m/s e
    g. None of the above is withing 10% of the correct speed.

$$v_{\parallel} = v'_{\parallel} + V = 0 + V = 40\ m/s.$$
$$v_{\perp} = v'_{\perp} = 30\ m/se$$
$$|\vec{v}| = \sqrt{v_{\parallel}^2 + v_{\perp}^2} = \sqrt{(40)^2 + (30)^2} = \sqrt{2500} = 50\ m/s\ (e)$$

46. An aircraft carrier is moving to the north at a constant 20 mph on a windless day. A plane requires a speed relative to the air of 170 mph to take off. How fast must the plane be traveling relative to the deck of the aircraft carrier to take off if the plane is headed north?
    - a. 20 mph
    - b. 120 mph
    - [✓ c.] 150 mph
    - d. 170 mph
    - e. 190 mph
    - f. None of the above is correct within 10%.

$v_A = v_D + V_{AC}$

$170 = v_D + 20 \Rightarrow v_D = 170 - 20 = 150$ mph

47. An observer drops a ball in a train traveling along a straight, horizontal track with a constant velocity in the forward direction. What would an observer in the train infer about the force acting on the ball?
    - [✓ a.] The force has no horizontal component. T
    - b. The force has no vertical component. F
    - c. The force has a horizontal component in the forward direction. F
    - d. There is a centrifugal force. F
    - e The force has a horizontal component in the backward direction. F
    - f. None of the above. F

48. An elevator is moving upward and slowing down with an acceleration equal to one-quarter that of gravity. If a person who weighs 800 N when at rest on Earth stands on a bathroom scale in this elevator, what will the scale read, most nearly ? (TAKE up to be +)
    - a. 200 N
    - [✓ b.] 600 N
    - c. 800 N
    - c. 1000 N
    - d. 1250 N
    - e. None of the above is within 10 % of the correct result.

$A = -g/4 \; ; \; F_G = -Mg = -800N$

NII $\underline{\vec{F_S} + \vec{F_G} = M\vec{A}} \Rightarrow F_S = M\vec{A} - \vec{F_G} = -\frac{Mg}{4} + Mg = \frac{3}{4}Mg$

$F = (3/4)(800) = 600N$ (up!) (b)

{OR in ACC FRAME : $\vec{F_S} + \vec{F_G} - \vec{F}_{pseudo} = \vec{F_S} + \vec{F_G} - M\vec{A} = 0$ (unaccelerated)}

49. 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 700 N when he is at rest on earth, how much will he weigh in the room, most nearly ?
    - a. zero
    - b. 350 N
    - c. 700 N
    - [✓ d.] 1050 N
    - e. 1400 N
    - f. None of the above answers is within 10% of the correct result.

IN Acc FRAME: Add $F_{pseudo} = -MA = M \cdot 15 = Mg\left(\frac{15}{g}\right)$

Since $Mg = 700N$, his "weight" in $\vec{A}$ Frame is

$700 \cdot \frac{15}{10} = 1050N$ (d)

50. A person who weighs 800 N when at rest is riding in the rotating cylinder ride. The cylinder rotates fast enough to create an 600-N centrifugal pseudo-force in the rotating frame. What is the magnitude of the apparent force on this person in the rotating reference frame, most nearly? IN ROTATING FRAME

- a. 600 N
- b. 800 N
- [✓ c.] 1000 N
- d. 1200 N
- e. 1400 N
- f. None of the above answers is within 10% of the correct result.

$F_{Apparent} = F_{phys} + F_{pseudo} = M\vec{g} + \vec{F}_{centrifugal}$

$\vec{F}_{APP.} = (F_x, F_y) = (800, 600)$ & $|\vec{F}_{APP}| = \sqrt{(800)^2+(600)^2} = 1000\ N$

51. Which of the following could be cited as evidence that the earth rotates?

- a. The plane of a pendulum rotates in an earthbound lab. ✓
- 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 observations is indicative of a rotating earth. F

52. The center of mass point of an extended rigid object

- a. can not always be defined. F
- b. will be different when the object is near the moon's surface than when it is near the earth's. F
- c. may follow a spiral-helical trajectory if the object rotates while it falls. F
- [✓ d.] behaves like a point mass subject to all of the forces exerted on the body. T
- e. always lies at the focal point of the ellipse if the object has an ellipsoidal shape F
- f. None of the above answers is correct. F

The following problems may require more than average numerical computation. Place the letter of the most nearly correct answer into the corresponding line on your NCS answer sheet.

53. An 600-kg satellite orbits a distant planet with an orbital radius of 3000 km and a period of 300 min. From the radius and period, you calculate the satellite's acceleration to be 0.365 m/s^2. What is the gravitational force on the satellite?

$F_G = ma = (600)(0.365) = 219\,N$ (a)

- [✓ a.] 220 N
- b. 600 N
- c. 658 N
- d 1316 N
- e. 1972 N
- f. 2192 N
- g. None of the above answers is correct within 10 %.

54. Assume that the mass of some distant planet is the same as the earth's mass (6x10^{24} kg), that the mass of its moon is 7x10^{22} kg, and that they are separated by 6.4x10^8 m. Given that G = 6.7x10^{-11} N-m^2/kg^2, and that the radius of the earth is 6.4x10^6 m, the acceleration of the moon towards its planet is, most nearly:

- [✓ a.] 10^{-3} m/s^2.
- b. 10^{-4} m/s^2.
- c. 10^{-5} m/s^2.
- d. 10^{-6} m/s^2.
- e. 10^{-7} m/s^2.
- f. None of the above answers is within 20 % of the correct answer.

(NII) $F_G = M_m a_M = G\frac{M_p M_m}{(R_{pm})^2}$

& use $M_p = M_E$ & $\frac{GM_E}{(R_E)^2} = g = 10\,m/sec^2$ to get

$a_m = \frac{GM_E}{(R_E)^2}\cdot\frac{R_E^2}{(R_{pm})^2} = (10)\left(\frac{6.4\times10^6}{6.4\times10^8}\right)^2$

$a_m = 10\cdot10^{-4} = 10^{-3}\,m/sec^2$

(a)

55. A 0.5-kg air track sled (#1) traveling to the right with a speed of 22 m/s collides inelastically with a similar 1.5-kg sled (#2) traveling to the left with a speed of 2 m/s. The two stick together and move away as a single unit after the collision. Calculate their final velocity.
    - a. 1 m/s to the right
    - b. 1 m/s to the left
    - c. 2 m/s to the right
    - d. 2 m/s to the left
    - [✓ e.] 4 m/s to the right
    - f. 4 m/s to the left
    - g. None of the above answers is within 10% of the correct result.

$$\vec{P}_f = (M_1 + M_2) v_f = \vec{P}_i = M_1 v_1 + M_2 v_2$$

$$v_f = \frac{1}{(0.5+1.5)}\left[(0.5)(22) - (1.5)(2)\right] = \frac{+8}{2} = {}^{+}4 \text{ m/sec} \ (e)$$

(taking + sign towards RIGHT)

56. A 67-kg stunt man falls feet first 45 m from a platform into an airbag. If the maximum force his feet and legs can safely withstand is 4000 N, what is the least value which the airbag must provide for his slowing down time?
    - a. 5 s
    - [✓ b.] 0.5 s
    - c. $0.05 = 5\text{x}10^{-2}$ s
    - d. $0.005 = 5\text{x}10^{-3}$ s
    - e. $5\text{x}10^{-4}$ s
    - f. $5\text{x}10^{-5}$ s
    - g. None of the above answers is within 20% of the correct result.

If $F \cdot \Delta t = \Delta p$ is fixed Minimizing Δt Maximizes F

& $\Delta p = \vec{P}_f = m v_F$ where $(PE)_i = (KE)_F$ yields

$$Mgh_i = (\cancel{67})(10)(45) = \frac{\cancel{67}}{2} v_f^2 = (KE)_F$$

i.e. $v_F = 30$ m/sec

Then $P_F = \Delta p = (30)(67)$

$$\& \ \Delta t = \frac{\Delta p}{F_{max}} = \frac{(30)(67)}{4000} = 0.5 \text{ s } (b)$$

57. A 10 kg block of wood loses 260 J of mechanical energy to friction as it slides down a ramp starting from rest. If it has 40 J of kinetic energy at the bottom of the ramp, we can conclude that it started at a height of

[✓ a.] 3 m
b. 9 m
c. 30 m
d. 90 m
e. 300 m
f. 900 m
g. None of the above answers is within 10% of the correct result.

$$(ME)_f = (ME)_i - W_{friction} = (PE)_i + \cancelto{0}{(KE)_i} - W_{fr}$$

$$(KE)_f + \cancelto{0}{(PE)_f} = mgh_i - W_f = ($$

$$40J = (10)(10)h_i - 260J \Rightarrow h_i = \frac{300}{100} = 3\ m$$

58. A 15-N block impelled straight upward by a steady net force of 8 N has at some instant an initial kinetic energy of 26 J due to its upward motion. If the block is lifted an additional 3 m from that point, what is the block's final kinetic energy, most nearly?

a. 90 J
b. 70 J
[✓ c.] 50 J
d. 30 J
e. 10 J
f None of the above answers is within 10% of the correct result.

$$F \cdot d = \Delta(KE) = (KE)_f - (KE)_i \qquad \text{(WORK/ENERGY Thrm)}$$

$$(8N)(3\ m) + 26J = (KE)_f$$

$$50J = (KE)_f \quad (C)$$

59. An observer drops a ball in a train traveling along a straight, horizontal track under a constant acceleration of 5 m/s^2 in the forward direction. The observer in the train measures that the acceleration of the ball is directed downward at an angle θ from the vertical. The value of θ is, most nearly,

a. 10°
b. 20°
[✓ c.] 30°
d. 40°
e. 50°
f 60°
g. None of the above answers is within 10% of the correct result.

$F_{pseudo} = -M\vec{A}$

θ = deflection from Vertical

$Mg = F_G = M\vec{g}$

$$\sin\theta = \frac{|\vec{F}_{pseudo}|}{|F_{GRAV}|} = \frac{MA}{Mg} = \frac{5}{10} = 1/2$$

$\theta = 30°$ ⓒ

60. A cylindrical space station, far from any large masses, can be made to rotate about its long axis so that people on the inside surface of the station feel "artificial gravity" due to a centrifugal inertial (or pseudo-) force directed outward through the inner surface of the cylinder. If the cylinder has a radius of 100 km, what must its angular velocity be, most nearly, in order to provide an artificial gravity acceleration just equal to g = 10 m/s^2?

[✓ a.] 10^{-2} radians/sec
b. 3.3 x 10^{-2} radians/sec
c. 10^{-1} radians/sec
d. 3.3x10^{-1} radians/sec
e. None of the above answers is within 20% of the correct result.

$$F_{Centrifugal} = \frac{Mv^2}{R} = MR\omega^2$$

$$\text{\& Require } F_{centrif} = Mg = MR\omega 2 \Rightarrow \sqrt{\omega^2} = \sqrt{g/R} = \omega$$

$$\omega = \sqrt{\frac{10}{100km}} = \sqrt{10 \times 10^{-5}} = 10^{-2}\,\frac{rad}{sec}$$

(a)

……..End of Exam