Detailed Solutions for

Fall 2005 Final Exam, Phys 117.

1. When you calculate the speed (in meters per second) in an experiment, your calculator display reads 12.666667. If you are asked to record your result to three significant figures, you should write
   - a. 12.6 m/s
   - [✓ b.] 12.7 m/s
   - c. 12.666 m/s
   - d. 12.667 m/s
   - e. Any one of the aboves choices expresses the result to three significant figures.
   - f. None of the above answers is correct.

2 Given that the circumference of the moon's orbit is 4.0 X 10^4 km, which calculation shows the correct conversion of a speed of 1 orbit per 28.3 days to the same speed in m/s?
   - a. (1orbit/28.3day)(4.0X10^4km/orbit)(1day/24hr)(3600sec/1hr)(10^3m/1km) = $s \cdot m/(hr)^2$ ⊗
   - b. (1orbit/28.3day) (4.0X10^4km/orbit)(24hr/1day)(1hr/3600sec)(1km/10^3m) $(km)^2(hr)^2/(day)^2 \cdot m \cdot s$ ⊗
   - c. (1orbit/28.3day) (1orbit/4.0X10^4km)(1day/24hr)(1hr/3600sec)(10^3m/1km) $(orb)^2 m/km^2 sec$ ⊗
   - [✓ d.] (1orbit/28.3day) (4.0X10^4km/orbit)(1day/24hr)(1hr/3600sec)(10^3m/1km) m/sec (ok) ✓
   - e. (1orbit/28.3day) (4.0X10^4km/orbit)(1day/24hr)(1hr/3600sec)(1km/10^3m) $(km)^2/m \cdot sec$ ⊗
   - f. None of the above: each has at least one factor incorrectly placed.

3. Car A travels from milepost 323 to milepost 333 in 5 minutes. Car B travels from milepost 493 to milepost 512 in 9 minutes. Which car has the greater average speed?
   - a. Car A
   - [✓ b.] Car B
   - c. Their average speeds are the same. ✗
   - d. There is not enough information to be able to say. ✗
   - e. None of the above answers is correct.

$10/5 < 19/9$

4. An object is accelerating
   - a. only when its speed changes. ✗
   - b. only when its direction changes. ✗
   - [✓ c.] whenever its speed or direction changes.
   - d. if its velocity is large. ✗
   - e. even when its velocity is constant. ✗
   - f. None of the above characterizes an accelerating object.

5. If we use plus and minus signs to indicate the directions of velocity and acceleration, in which of the following situations does the object's speed increase?
   - a. positive velocity and negative acceleration ✗
   - b. negative velocity and positive acceleration ✗
   - c. positive velocity and zero acceleration ✗
   - d. negative velocity and negative acceleration ✓
   - e. zero velocity and positive acceleration ✓
   - f. zero velocity and negative acceleration ✓
   - [✓ g.] In fact the speed increases in all of cases d), e), and f) above !
   - h. In none of the above cases does the speed increase. ✗

6 A ping-pong ball and a golf ball have approximately the same size but very different masses. Which hits the ground first if you drop them simultaneously while standing on the moon (which has no atmosphere)?
   - a. the ping-pong ball
   - b. the golf ball
   - [✓ c.] They hit simultaneously.
   - d. We are not able to predict the results.
   - e. None of the above because it depends upon the moon's gravity, not given here.
   - f. Each of the above might occur, given the correct circumstances.

7. A ball is thrown straight up into the air with an unspecified velocity. If we do not ignore air resistance, the magnitude of the acceleration of the ball as it rises is
   - a. 9.8 m/s^2.
   - [✓ b.] greater than 9.8 m/s^2.
   - c. less than 9.8 m/s^2.
   - d. zero.
   - e. None of the above, because the acceleration depends upon the speed.

$\vec{a} = (F_G + F_{drag})/m = \vec{g} + F_{drag}/m$

Since $\vec{F}_{drag}$ is downward, like $\vec{g}$, $|\vec{a}| > |\vec{g}|$

8. A pitcher requires about 0.2 second to throw a baseball. If the ball leaves his hand with a speed of 32m/sec what is its average acceleration, most nearly ?
   - a. 1.6 m/s/s
   - b. 6 m/s/s
   - c. 16 m/s/s
   - d. 60m/s/s
   - [✓ e.] 160 m/s/s
   - f. None of the above is within 10% of the correct answer.

$\vec{a} = \frac{32 m/sec}{0.2 sec} = 160 m/sec^2 = \Delta v/\Delta t$

ERROR CORRECTION

9. A child on a sled is traveling 1 m/s as she passes her younger brother. If her acceleration is 3 m/s^2 and constant, how fast is she traveling when she passes her older brother 2 s later?
   - [✓ a.] 7 m/s
   - b. 10 m/s
   - c. 13 m/s
   - d. 16 m/s
   - e. 24m/s
   - f. None of the above.

$v(t) = v_0 + at = 1 + 3\cdot 2 = 7 m/sec.$

10. Which of the following is **not** a vector quantity?
    - a. force
    - b. acceleration
    - c. weight
    - d. displacement
    - e. velocity
    - [✓ f.] None of the above answers is correct: in fact, all are vector quantities.

11. A subway train is moving with constant velocity along a level section of track. The net force on the first subway car is __________ the net force on the last subway car.
    - a. finite, but equal and opposite to
    - b. much greater than
    - c. slightly greater than
    - d. slightly less than
    - e. much less than
    - [✓ f.] None of the above.

ERROR CORRECTION (f) →

(f) is correct: Net Force is zero, the same, on both cars.

12. A ball with a mass of 2 kg is thrown vertically upward. What are the size and direction of the force on the ball just as it reaches the top of its path?
    - a. zero
    - b. 10 N upward
    - c. 10 N downward
    - d. 20 N upward
    - [✓ e.] 20 N downward
    - f. None of the above.

13. A ball falling from a great height will reach terminal speed when its __________ goes to zero.
    - a. inertia
    - b. gravity force
    - c. weight
    - d. speed
    - [✓ e.] acceleration
    - f. None of the above goes to zero at the terminal velocity

} None of these goes to zero, ever.

14. When a snowflake falls, it quickly reaches a terminal velocity. This happens because
    - a. the mass of the snowflake is too small for gravity to have any effect. ✗
    - b. the snowflake is effectively falling in a vacuum. ✗
    - c. the snowflake has no weight. ✗
    - d. the mass of the snowflake is much smaller than its weight. ✗
    - [✓ e.] the net force acting on the snowflake is zero.
    - f. All of the above completions yield true statements ✗
    - g. None of the above completions yields a true statement ✗

15. 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 is __________ your weight ___________.
    - a. less than……..and is increasing as you fall
    - b. equal to………exactly
    - c. greater than………decreasing as you fall.
    - d. less than……..decreasing as you fall
    - [✓ e.] greater than………increasing as you fall
    - f. None of the above completions yields a true statement.
    - g There is not enough information to say.

"Slowdown" ⇒ $\vec{F}_{cord} > F_g = wt.$

& F_{cord} increases as it stretches

⇒ (e)

16. You are applying a 300-newton force to a freezer full of chocolate chip ice cream in an attempt to move it across the basement, but it will not budge. The weight of the freezer (including ice cream) is 1000 N, and $\mu = 0.5$. The frictional force exerted by the floor on the freezer is
    - [✓ a.] 300 N
    - b 500 N
    - c. 1000 N
    - d. greater than 500 N but less than 1000 N
    - e. greater than 300 N but less than 500 N
    - f. It is not possible to say because the =frictions force varies with the applied force.
    - g. None of the above answers is correct.

$F_{fr} = F_{Applied}$ until F_{App} exceeds STATIC Limit & object begins to move

$= 300\,N$ (a)

17. You are riding an elevator from your tenth-floor apartment to the parking garage in the basement. As you approach the garage, the elevator begins to slow. The net force acting on you is
    - a. equal to your weight ✗
    - [✓ b.] directed upward
    - c. directed downward ✗
    - d. zero ✗
    - e. It is not possible to say from the information given ✗

} since acceleration is upward.

18. In straight line motion the
    - [✓ a.] acceleration is parallel (or antiparallel) to the velocity.
    - b. acceleration is perpendicular to the velocity.
    - c. acceleration is horizontal, while the velocity can be in any direction.
    - d. acceleration is vertical and the velocity is horizontal.
    - e. All of the above are valid statements about straight line motion.
    - f. None of the above statements is valid for straight line motion.

19. In uniform circular motion

a. the acceleration is parallel (or antiparallel) to the velocity.
[✓ b.] the acceleration is perpendicular to the velocity.
c. the acceleration is horizontal, while the velocity can be in any direction.
d. both the acceleration and the velocity are horizontal.
e. All of the above are valid statements about circular motion
E.C. f ~~e.~~ None of the above is valid for uniform circular motion.

20. By what factor does the centripetal acceleration change if a car goes around a corner three times as fast?

a. 0.11
b. 0.33
c. It stays the same.
d. 3
e 6
[✓ f.] 9
g. None of the above is within 10% of the correct answer.

$a_{CENT} = v^2/r$: $v' = 3v \Rightarrow a' = 9a$.

21 . 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. acceleration is zero at the top of the trajectory.
f. None of the above correctly characterizes projectile motion.

$\vec{F}_G$ is vertical & $\vec{a}$

22. A 60-kg person on a merry-go-round is traveling without sliding in a circle with a radius of 4 m at a speed of 6 m/s. What is the magnitude of the net force experienced by this person?

a. zero
b. 2.67 N
c. 9 N
d. 160 N
[✓ e.] 540 N

$F = ma = m v^2/r = 60 \cdot 36/4 = 540 N$

23. The numerical value of G, the gravitational constant, was determined

a. from knowledge of the earth's mass density and volume
b. from the law of universal gravitation and the value of the acceleration due to gravity.
c. from the value of the moon's acceleration.
[✓ d.] by measuring the force between masses in the laboratory.
e. from a very precise knowledge of the mass of the earth.
f. By none of the above means.

24. In an orbiting satellite such as SkyLab , physical objects

[✓ a.] have mass but no weight.
b. have mass but no force due to gravity.
c. have neither mass nor weight.
d. fall to the floor with an acceleration of 9.5 m/s/s.
e conform to all of the above statements.

Since frame is accelerating pseudoforce cancels Force of gravity and Weight = 0.

25. How large, most nearly, is the acceleration of a 30 kg weight due to earth's gravity when the weight is floating freely in an earth satellite at an altitude equal to three earth radii?

a. 10 m/s^2
b. 3.3 m/ s^2
c. 2.5 m/ s^2
d. 1.0 m/ s^2
[✓ e.] 0.6 m/ s^2
f. None of the above is within 10% of the correct answer.

$$a = \frac{GM_E}{(4R_E)^2} = \frac{1}{16}\frac{GM_E}{R_E^2} = \frac{g}{16} = \frac{10}{16} = 0.625 \text{ m/sec}^2$$

26. The law of universal gravitation is written F = GMm/r^2. Why did we use the form F = mg when we studied the motion of projectiles near the surface of the earth?

a. The first form is not valid for projectile motion.
b. The first form does not work because it requires two masses.
c. The first form is not valid near the surface of the earth.
d. The second form is simpler and therefore preferable to the first.
[✓ e.] The first form reduces to the second when the distance to the center of the earth remains nearly constant. $mGM_E/(R_E+x)^2 \approx \text{const} = mg$ if $x \ll R_E$.
f. None of the above is a valid reason for using the second form.

27 .Suppose that the acceleration due to gravity on Titan, Saturn's largest moon, is about 1.5 m/s^2. What would a 30-kg scientific instrument weigh on Titan, most nearly ?

a. 2 N
b. 4.5 N
c. 20 N
[✓ d.] 45 N
e. 200 N
f. 450 N
g. None of the above is within 10% of the correct answer.

$F = 30 g_T = 45 N$

28. An astronaut on a strange planet has a mass of 50 kg and a weight of 1000 N. What is the value of the acceleration due to gravity on this planet?

a. 0.05 m/s^2
b. 0.5 m/s^2
c. 2 m/s^2
d. 5 m/s^2
[✓ e.] 20 m/s^2
f. None of the above is within 10 % of the correct answer.

$50 g_P = 1000 N \Rightarrow g_P = 20 \text{ m/sec}^2$

29. Which of the following statements about the moon is <u>not</u> correct?

a. The acceleration due to gravity on the moon is weaker than on the earth. ✓
b. The earth's gravitational pull on the moon equals the moon's gravitational pull on earth. ✓
c. There is a net force acting on the moon. ✓
[✓ d.] The moon is not accelerating. ✗
e. The moon's rotation about the earth causes high tide to come later on successive days. ✓
f. All of the above statements about the moon are correct. ✗

30. A tennis ball (m = 0.2 kg) is thrown at a brick wall. It is traveling horizontally at 16 m/s just before hitting the wall and rebounds from the wall at 8 m/s, still traveling horizontally. The ball is in contact with the wall ~~wall~~ for 0.0067 s. What is the magnitude of the average force of the wall on the ball, most nearly?
   a. 40 N
   b. 80 N
   c. 120 N
   d. 640 N
   [✓ e.] 720 N
   f. None of the above is within 10 % of the correct answer.

$$\bar{F} = \frac{\Delta p}{\Delta t} = \frac{(0.2)[16 - (-8)]\ m\cdot kg/s}{6.7 \times 10^{-3}\ s} = \frac{(0.2)(24)}{6.7} \times 10^{3}\ \frac{m\cdot kg}{s^2}$$

$$= 7.16 \times 10^{2}\ N$$

31. An astronaut training at the Craters of the Moon in Idaho jumps off a platform in full spacewalk gear and hits the surface at 5 m/s. If later on the moon the astronaut jumps from the LEM and hits the surface at the same speed, the impulse will be ___________ that on earth.
   [✓ a.] the same as ... because momentum change is the same.
   b. larger than
   c. smaller than
   d. greater or less, depending upon the speed
   e. None of the above.

32. Why is skiing into a wall of deep powder less hazardous to your health than skiing into a wall of bricks? Assume in both cases that you have the same initial speed and come to a complete stop.
   a. The change in momentum is less in powder. X
   b. The impulse is less in powder. X
   [✓ c.] The increased stopping time in powder means a smaller stopping force. for same impulse ✓
   d. The decreased stopping time in powder means a larger stopping force. X
   e. None of the above reasons is sufficient.

33. What would an observer measure for the magnitude of the free-fall acceleration in an elevator near the surface of Earth if the elevator accelerates downward at 6 m/s^2?
   [✓ a.] 4 m/s^2
   b. 6 m/s^2
   c. 10 m/s^2
   d. 16 m/s^2
   e. None of the above

$\vec{a} = \vec{g} - \vec{A}$ in frame accelerating at rate $\vec{A}$

Since $\vec{A}$ is downward, $-\vec{A}$ is upward, opposite to g.

Then $a = 9.8 - 6 = 3.8 (\approx 4)$ downward

34. Which of the following properties of a ball is conserved as it falls freely in a vacuum?
   a. kinetic energy increases
   b. gravitational potential energy decreases
   c. momentum increases
   [✓ d.] mechanical energy ✓
   e. None of the above is a conserved quantity in the strict sense of the word.

35. 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.

36. In physics, work is defined as the product of the
    a. net force and the distance traveled. ✗
    [✓ b.] net force parallel to the motion and the distance traveled.
    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 is a valid definition of physical work. ✗

37. Which of the following is NOT a unit of energy?
    a. joule
    b. newton-meter
    c. kilowatt-hour
    d. calorie
    e. kg-m^2/s^2
    [✓ f.] All of the above are units of energy.

38 . Which of the following objects has the largest kinetic energy? A mass of with a speed of
    a. 8 kg ... 1 m/s KE = 4 kg m^2/s^2
    b. 7 kg ... 2 m/s = 14 "
    c. 6 kg ... 3 m/s = 27 "
    d. 5 kg ... 4 m/s = 40 "
    [✓ e.] 4 kg ... 5 m/s = 50 " ← Largest

39. Power is defined to be the energy
    a. which is the useful part of the total energy delivered
    b. lost in a process.
    c. lost in a process divided by the time it takes.
    d. changed to some other form in a process.
    [✓ e.] changed to some other form divided by the time it takes.

40. 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 has the same value in both reference systems?
    a. velocities
    b. total mechanical energies
    [✓ c.] forces
    d. total momentum
    e None of the above quantities is the same in both reference systems.

41. You can throw a ball vertically upward in a car moving with a constant velocity and have it land back in your hand because
    [✓ a.] there is no net horizontal force acting on the ball. ✓
    b. the reference system attached to the car is noninertial. ✗
    c. there is a net force in the forward direction. ✗
    d. the force in the forward direction is canceled by the inertial force. ✗
    e. None of the above. ✗

42. A person drops a ball in train traveling along a straight, horizontal track at a constant velocity of 50 mph. What would the person in the train say about the horizontal forces acting on the ball?

- [✓ a.] There are no horizontal forces acting on the ball.
- b. There is a fictitious (inertial) force acting forward. ✗
- c. There is a fictitious (inertial) force acting backward ✗
- d. There is a centrifugal force. ✗
- e. None of the above.

} No acceleration => No pseudo-forces

43. What would an observer measure for the magnitude of the free-fall acceleration in an elevator near the surface of Earth if the elevator accelerates upward at 4 m/s^2?

- a. 4 m/s^2
- b. 6 m/s^2
- c. 10 m/s^2
- [✓ d.] 14 m/s^2
- e. 16 m/s^2

$\vec{a}' = \vec{g} - \vec{A}$ where $\vec{g} = -10$, where + => up / - => down

$\vec{A} = +4$ ''

$a' = -10 - 4 = -14 \frac{m}{sec^2}$ $-\vec{A} = -4$ ''

44. A train is traveling along a straight, horizontal track with a constant acceleration in the forward direction. At the instant the speed is 50 mph, a ball is dropped by an observer in the train. An observer on the ground determines that the horizontal speed of the ball during the fall is

- a. decreasing
- b. increasing
- c. zero
- [✓ d.] equal to 50 mph, and constant.
- e. None of the above.

45. You and a friend are rolling marbles on a horizontal table in the back of a van traveling straight forward on a level section of interstate highway. You start the marble rolling directly toward the side of the truck and observe that it curves toward the front. You conclude that the truck is

- a. not moving ✗
- b. moving at a constant velocity ✗
- c. speeding up ✗
- [✓ d.] slowing down , since pseudo-force, $= -m\vec{A}$, points forward, $\vec{A}$ must point backward : slowing
- e. None of the above ✗

46. A cylindrical space habitat with a 4000-m radius is rotating so that a person standing on the inside feels a centripetal acceleration equal to g = 10 m/sec^2. What is the tangential speed of a point just inside the cylinder?

$g = v^2/R \Rightarrow \sqrt{v^2} = \sqrt{gR} = v = \sqrt{(10)\, 4\times10^3}$

$= 2\times10^2$

- a. 5 m/s
- b. 20 m/s
- c. 63.2 m/s
- d. 100 m/s
- [✓ e.] 200 m/s

47. According to the special theory of relativity, all laws of nature are the same in reference systems which _________relative to an inertial system.

- a. have a constant acceleration ✗
- [✓ b.] move at a constant velocity ✓
- c. move in ellipses ✗
- d. move in circles at a constant speed ✗
- e. None of the above insertions yields a true statement.