SOLUTIONS

Set of Ten Matching Questions #1-#10

Place the letter which best matches the numbered phrase into the corresponding numbered line of your NCS answer sheet.

G	1	Newton's Second Law: Net Force	a	$=\Delta(\text{K.E.})$
I	2	Newton's Law of Universal Gravitation	b	$=h*f$
E	3	Centripetal Force in Uniform Circular Motion	c	$<=> \quad \Delta S \geq 0$
H	4	The Impulse-Momentum Theorem: Impulse	d	$=h/p$
A	5	The Work-Energy Theorem: Work	e	$=mv^2/r$
J	6	First Law of Thermodynamics	f	$=\lambda*f$
C	7	Second Law of Thermodynamics	g	$=\Delta(\gamma mv)/\Delta t$
F	8	Wave velocity of periodic traveling wave	h	$=F*\Delta t$
B	9	Energy of Photon	i	$=GMm/R^2$
D	10	de Broglie Wavelength of particle	j	$Q_{IN}+W_{IN}=\Delta U_{internal}$

The exam is continued on page 3 and following.....

Physics 117 Final Exam Error Corrections

(It is recommended that you enter these corrections into your exam paper immediately after the exam begins.)

a) Page 7: 3rd problem is #37 (NOT #27);
b) Page 8: 2nd problem is #42 (NOT #2);
c) Page 11, problem #62, line 1: replace "pf" by "of"
to make text read "…..form of momentum…..".
d) Page 11, problem #63, line 1: insert "all"
to make text read "states that ALL ________ have…."

ALSO:

(e) Page 14, #79, line f: INSERT ",(b) through (e)," after … restrictions

(f) Page 15, #81, line 2: Delete "the" from ".. vibrating and ~~the~~ comes to rest.

11. 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 → No! must round 3rd figure up.
    - [✓ b.] 12.7 m/s
    - c. 12.666 m/s → No! this is 3 decimal places (6 should be rounded up) to 7
    - d. 12.667 m/s
    - e. Any one of the above choices expresses the result to three significant figures.
    - f. None of the above answers is correct.

12. 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) ✗
    - b. (1orbit/28.3day) (4.0X10^4km/orbit)(24hr/1day)(1hr/3600sec)(1km/10^3m) ✗
    - c. (1orbit/28.3day) (1orbit/4.0X10^4km)(1day/24hr)(1hr/3600sec)(10^3m/1km) ✗
    - [✓ d.] (1orbit/28.3day) (4.0X10^4km/orbit)(1day/24hr)(1hr/3600sec)(10^3m/1km) ok
    - e. (1orbit/28.3day) (4.0X10^4km/orbit)(1day/24hr)(1hr/3600sec)(1km/10^3m) ✗
    - f. None of the above: each has at least one factor incorrectly placed.

13. 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? $\overline{V_A} = \frac{5 mi}{5 min} < \frac{19 mi}{9 min} = \overline{v_B}$
    - 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.

14. 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.

15. If we use plus and minus signs to indicate the directions of velocity and acceleration along some x-axis, 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 yes: Accln is in same direction as velocity
    - e. zero velocity and positive acceleration yes
    - f. zero velocity and negative acceleration yes
    - [✓ g.] In fact the speed increases in three cases, d), e), and f), above
    - h. In none of the above cases does the speed increase.

16 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.

17. 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.

because air drag force is in same direction as $\vec{g}$ during rise

18. A pitcher requires about 0.2 second to throw a baseball. If the ball leaves his hand with a speed of 32m/s, what is its average acceleration, most nearly ?
    a. 1.6 m/s^2
    b. 6 m/ s^2
    c. 16 m/ s^2
    d. 60m/ s^2
    [✓ e.] 160 m/ s^2
    f. None of the above is within 10% of the correct answer.

$$\bar{a} = \frac{32m}{s\,(0.2)s} = 160\ m/sec^2$$

19. 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.

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

20. 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.

(a) through (e)

ok

21. 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.

The net force on any (& EVERY!) object travelling w. constant $\vec{v}$ (i.e zero = $\vec{a}$ccln) is ZERO

22. 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.

$F = mg = 2 \times 9.8 \approx 20N$ downward

23. 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 ✓ zero accln ⇒ constant velocity = terminal velocity here.
    f. None of the above goes to zero at the terminal velocity

24. 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. ✗ $F^{NET} = 0 = ma \Rightarrow a = 0$
    [✓ e] the net force acting on the snowflake is zero. ✓ YES
    f. All of the above completions yield true statements. ✗
    g. None of the above completions yields a true statement . ✗

25. 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………decre✗sing 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. ✗

26. 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 μ_{static} = 0.5. The frictional force exerted by the floor on the freezer is
    [✓ a.] 300 N For static friction $\vec{F}_{fr} = -\vec{F}_{Applied}$
    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.

27. 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 because accln is upward
    c. directed downward
    d. zero
    e. It is not possible to say from the information given.

28. 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. ✗

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

30. 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.

$$a_c = v^2/R \rightarrow (3v)^2/R = 9\left(\frac{v^2}{R}\right)$$

31. In projectile motion the
    - a. acceleration is parallel (or antiparallel) to the velocity. X
    - b. acceleration is perpendicular to the velocity. X
    - [✓ c.] acceleration is vertical, while the velocity can be in any direction. ✓
    - d. acceleration is vertical and the velocity is horizontal. X
    - e. acceleration is zero at the top of the trajectory. X
    - f. None of the above correctly characterizes projectile motion. X

32. 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

$$F = ma = mv^2/R = \frac{60\cdot(6)^2}{4} = 540\,N$$

33. 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.

34. In an orbiting satellite such as SkyLab, physical objects
    - [✓ a.] have mass but no weight. — because pseudo-force in accelerating SKYLAB frame cancels weight due to gravity.
    - b. have mass but no force due to gravity. X
    - c. have neither mass nor weight. X
    - d. fall to the floor with an acceleration of 9.8 m/s^2. X
    - e conform to all of the above statements. X

35. How large, most nearly, is the acceleration of a 30 kg ~~weight~~ object due to earth's gravity when the ~~weight~~ object 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. 1.1m/ s^2
    - [✓ e.] 0.6 m/ s^2
    - f. None of the above is within 10% of the correct answer.

$$a = \frac{F}{m} = \frac{mg}{m}\left(\frac{R_E}{R}\right)^2 \; \& \; R = R_E + 3R_E = 4R_E$$
$$= 10 \cdot \left(\frac{1}{4}\right)^2 = 0.625$$

36. 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. X
    - b. The first form does not work because it requires two masses. X
    - c. The first form is not valid near the surface of the earth. X
    - d. The second form is simpler and therefore preferable to the first. X
    - [✓ e.] The first form reduces to the second when the distance to the center of the earth remains nearly constant. ✓
    - f. None of the above is a valid reason for using the second form.

37 ~~27.~~ Kepler's third law, applied to circular planetary orbits, states the square of the planetary period proportional to the cube of the orbital radius. To prove this law, we needed our knowledge of
- a. uniform circular motion. YES
- b. conservation of momentum. NO
- c. the third law of thermodynamics NO
- d. the law of universal gravitation YES
- e both (b) and (c) above NO
- [✓ f.] both (a) and (d) above. YES
- g. None of (a) through (f) above suffices to prove Kepler's Third Law. X

38. 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.

$$F = m\tilde{g}_s \Rightarrow \tilde{g}_s = \frac{1000}{50} = 20\,m/sec^2$$

39. Which of the following statements (a through e) about the moon is not correct?
    - a. The acceleration due to gravity on the moon is weaker than on the earth. YES
    - b. The earth's gravitational pull on the moon equals the moon's gravitational pull on earth. YES (THIRD LAW)
    - c. There is a net force acting on the moon. YES
    - d. The moon is accelerating towards the earth. YES
    - e. The moon's rotation about the earth causes high tide to come later on successive days. YES
    - [✓ f.] All of the above statements (a through e) about the moon are in fact correct. YES

40. 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 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.

$$F_{AVG} = \frac{\Delta p}{\Delta t} = \frac{m\Delta v}{\Delta t} = m\left[8 - (-16)\right]/(6.7\times10^{-3}) =$$
$$= \frac{24\,(0.2)}{6.7\times10^{-3}} = 0.716\times10^3\,\frac{kg\,m}{sec^2} \approx 720\,N$$

41. 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 his space craft and hits the surface at the same speed, the impulse he feels will be __________ that on earth.

[✓ a.] the same as (because Δp is the same in both cases)
b. larger than
c. smaller than
d. greater or less, depending upon the speed
e. None of the above.

42. 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. F
b. The impulse is less in powder. F
c. The increased stopping time in powder means a larger stopping force. F
d. The decreased stopping time in powder means a smaller stopping force. F
[✓ e.] The increased stopping time in powder means a smaller stopping force. T
f. None of the above reasons is a sufficient answer to the question. F

43. What would an observer in an elevator measure for the magnitude of the free-fall acceleration near the surface of earth if the elevator accelerates downward at 6 m/s^2?

a. 16 m/s^2
b. 10 m/s^2
c. 6 m/s^2
[✓ d.] 4 m/s^2
e. None of the above

44. 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 (ME = PE + KE)
e. None of the above is a conserved quantity in the strict sense of the word. F

45. Under what conditions is the kinetic energy (KE) conserved, in the strict sense of the word, during a collision?

a. It is always strictly conserved. F
b. When the collision is totally elastic. F (because KE changes during collision)
c. When there is no net outside force. F
d. When there is no friction. F
[✓ e.] KE is never conserved during a collision because its value does not remain constant. ✓
f. None of the above (a through e) is a relevant answer to the question. F

46. In physics, net work is defined as the product of the (oh)

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. ✗

47. 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·Dist)
    - [✓ f.] all of the above are units of energy.

48 . Which of the following objects has the largest kinetic energy? A mass of ____ with a speed of _____.
    - a. 8 kg ... 1 m/s $8 \cdot 1^2 = 8$
    - b. 7 kg ... 2 m/s $7 \cdot 4 = 28$
    - c. 6 kg ... 3 m/s $6 \cdot 9 = 54$
    - d. 5 kg ... 4 m/s $5 \cdot 16 = 80$
    - [✓ e.] 4 kg ... 5 m/s $4 \cdot 25 = 100$

49. 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 X ← (per unit time) X
    - [✓ e.] changed to some other form divided by the time it takes.

50. 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 NO
    - b. total mechanical energies NO
    - [✓ c.] forces YES
    - d. total momentum NO
    - e None of the above quantities is the same in both reference systems. FALSE

51. 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. T
    - b. the reference system attached to the car is noninertial. F
    - c. there is a net force in the forward direction. F
    - d. the force in the forward direction is canceled by the inertial force. F
    - e. None of the above. F

52. 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. F
    - c. There is a fictitious (inertial) force acting backward. F
    - d. There is a centrifugal force. F
    - e. None of the above. F

53. 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 , because pseudo force is directed opposite to accl'n.
    - e. None of the above

54. 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?
    - a. 5 m/s
    - b. 20 m/s
    - c. 63.2 m/s
    - d. 100 m/s
    - [✓ e.] 200 m/s

$v^2/R = g \Rightarrow v = \sqrt{Rg} = \sqrt{4\times10^3\times10}$ (m/sec)

$v = 2\times10^2 = 200$ m/sec

55. The second postulate of special relativity does NOT require that the speed of light
    - a. is a constant in a vacuum. REQUIRED
    - [✓ b] is always constant in any medium and equal to c. NOT REQUIRED: velocity of light may be << c in a material medium
    - c. is independent of the motion of the source. REQ'D
    - d. is independent of the motion of the receiver. REQ'D
    - e. In fact the second postulate requires all of the above. FALSE: (b) IS NOT REQUIRED

56. In his theory of special relativity, Einstein
    - a. abandoned the Galilean principle of relativity, that physics is the same in all inertial frames. F
    - b. abandoned Maxwell's equations for electricity and magnetism. F.
    - [✓ c.] reconciled the apparent conflict between the Galilean principle of relativity and Maxwell's equations by making time itself be specific to each inertial frame.. T
    - d. postulated the existence of an absolute reference system. F
    - e. postulated the Principle of Equivalence F

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

58. The first postulate of special relativity
    - a. says that there is no absolute reference frame. T
    - b. is a reaffirmation of the Galilean principle of relativity. T
    - c. states that the laws of physics are the same in all inertial reference systems. T
    - d. applies also to the implication of Maxwell's equations that the speed of light in vacuum is constant. T
    - [✓ e.] All of these statements are true. T

59. A rocket is 8 m long when measured at rest. What is its length as measured by an observer who sees the rocket ship moving past at 99.9% of the speed of light? The relativistic adjustment factor, $\gamma = 1/(1-v^2/c^2)^{1/2}$, for 0.999c is 22.4.
    - a. 179.2 m
    - b. 37.9 m
    - c. 22.4 m
    - d. 1.7 m
    - [✓ e.] None of the above is within 10% of the correct answer.

$8/22.4 = 0.357$ m

60. An electron is being accelerated by a constant force to nearly the speed of light. Which of the following is NOT true?
    a. Its kinetic energy increases steadily. T
    b. Its momentum increases at a constant rate. T
    c. It can approach but not exceed the speed of light. T
    d. Its total energy continually increases. T
    [✓ e.] Its rest energy increases steadily. F Rest Energy = mc^2 = CONSTANT

61. A train is traveling along a straight, horizontal track at a constant speed of 0.9c. A warning light on the ground flashes once each second. An observer in the train measures the time between flashes to be, most nearly,
    a. 0.1 s
    b. 0.9 s
    c. 1.0 s
    d. 1.11 s
    e. 1.67 s
    [✓ f.] 2.3 s
    g. None of the above is within 10% of the correct answer.

$$\gamma = \frac{1}{\sqrt{1-(0.9)^2}} = \frac{1}{\sqrt{0.19}} = 2.29$$

$$\Delta t' = \gamma \Delta t = 2.29 \cdot (1) \text{ sec}$$

62. If we use the classical (i.e. non-relativistic) form pf momentum in Newton's second law, $F^{NET}*\Delta t = \Delta p$, It would require a constant force of 9.5N acting for a year to accelerate a 1 kg mass to a speed of 0.9998c. If we use the relativistic momentum and the same force, how long would it take to reach The speed, v = 0.9998c, most nearly?
    a. $2 X 10^{-4}$ year
    b. $1.4 X 10^{-2}$ year
    c. 1 year
    d. 10 years
    [✓ e.] 50 years
    f. 2,500 years
    g. None of the above is within 10% of the correct answer.

Impulse, $\vec{F}\Delta t = \Delta\vec{p} = \gamma m \vec{v_f} - 0$ is $\gamma = \frac{1}{\sqrt{1-v_f^2/c^2}}$ greater in relativistic case, and so same force takes γ X longer time to get to $v_f = 0.9998c$.

or $\frac{v_f}{c} = 1-\epsilon$ implies $\epsilon = 2X10^{-}$

& $\gamma = \frac{1}{\sqrt{2\epsilon}} = \frac{1}{\sqrt{4x10}} = \frac{10^2}{2} = 5$

63. The law of definite proportions states that all ________ have definite ________ ratios of their constituent elements.
    [✓ a.] compounds … mass T
    b. compounds … volume (… applies only to gases: F)
    c. mixtures … mass F
    d. mixtures … volume F
    e. None of the above, the law of definite proportions is about volumes, not masses. F

64. Two gases are kept at the same temperature. If the molecules of gas A have 4 times the mass of those of gas B, what is the ratio of the average kinetic energy of the A molecules to that of the B molecules?
    a. 4
    b. 2
    [✓ c.] 1
    d. 1/2
    e. 1/4

$\langle KE \rangle = \frac{3}{2} k_B T_A$ is same for both

65. Which of the following is NOT assumed in our model of the ideal gas? The gas particles
    a. rebound elastically when they collide with the container wall. T
    b. have no internal structure. T
    c. are indestructible. T
    d. do not interact except when they collide. T
    [✓ e.] All of the above properties are assumed for our ideal gas. T
    f. None of the above statements is true of our ideal gas. F

66. The pressure that a molecular gas exerts on the walls of its container increases with
    - a. the average magnitude of the momentum of the molecules. T
    - b. the speed with which the molecules travel to their next collision with the wall. T
    - c. the density of gas molecules . T
    - d. the average kinetic energy of the gas molecules. T
    - [✓ e.] All of the above statements are true. T
    - f. None of the above answers is correct. F

67. The two fixed points used to define the modern Celsius temperature scale are those of
    - a. boiling water and a mixture of ice and salt. F
    - b. the human body temperature and a mixture of ice and salt. F
    - c. the human body temperature and freezing water. F
    - [✓ d.] boiling water and freezing water. T
    - e. None of the above F

68. Which of the following doubles with a doubling of the Celsius temperature of an ideal gas?
    - a. average momentum
    - b. average speed
    - c. average kinetic energy
    - d. product of pressure and volume
    - [✓ e.] None of the above

    } The Absolute Temperature (& <u>NOT</u> the Celsius temperature) occurs in ideal gas law.

69. The pressure in a container filled with gas increases when it is heated because
    - a. the walls do work on the gas. F
    - b. the average momentum of a gas particle increases. F (Avg $\vec{p} \equiv 0$!)
    - c. the number of gas particles increases. F
    - d. the volume of the gas decreases. F
    - [✓ e.] The average momentum change in a collision with the wall increases. T
    - f. None of the above. F

70. A hypothetical balloon filled with an ideal gas has a volume of 10^5 liters at 27°C under one atmosphere of pressure. At what temperature, most nearly, will its volume be 10^4 liters under one atmosphere of pressure?
    - a. -273°C
    - [✓ b.] -243°C
    - c. -203°C
    - d. -163°C
    - e. -123°C
    - f. None of the above is within 10% of the correct answer.

    $27°C = 27+273 = 300K = T_A$
    & Volume decreases by 10x if T_A decreases by 10X to $30K = 30-273 = -243°C$ (b)

71. You exert a force of 3 N on the head of a thumbtack.to place it on a board. The tip of the thumbtack has an area less than 10^{-2} mm.^{2}. The pressure on the board at the tip must be greater than: (Recall 1 Pa = $1N/m^2$.)
    - a. $3 X 10^2$ Pa
    - b. $3 X 10^3$Pa
    - c. $3 X 10^4$Pa
    - d. $3 X 10^5$ Pa
    - e. $3 X 10^7$ Pa
    - [✓ f.] $3 X 10^8$ Pa
    - g. None of the above is within 10% of the minimal pressure

    $$\frac{3N}{10^{-2}(10^{-3})^2 m^2} = 3\times10^{8}\ N/m^2 = 3\times10^{8}\ Pa$$

72. In radiative heat transfer, thermal energy is transported by
    - a. the movement of a fluid. F
    - b. the collisions of particles. F
    - [✓ c.] electromagnetic fields. T
    - d. the propagation of sound waves. F
    - e. physical vibrations of the intervening medium. F

73. Joule's experiments with hanging weights turning paddle wheels in water
    - a. showed that heat was not a fluid. F
    - [✓ b.] showed that 4.2 joules of work are equivalent to 1 calorie of heat. T
    - c. were used to define the calorie. F
    - d. showed that heat could be converted 100% to mechanical energy. F
    - e. None of the above. F

74. The first law of thermodynamics
    - a. is a restatement of the law of conservation of energy. T
    - b. allows that work can be completely converted into internal energy. T
    - c. treats heat as another form of energy. T
    - d. guarantees that the work extracted by a cyclic heat engine can never exceed the heat inserted. T
    - [✓ e.] All of the above statements are true of the first law. T

75. Which of the following statements about a cup of water and a gallon of water at the same temperature is correct?
    - a. They will transfer the same heat energy to a third object at lower temperature. F
    - b. They have the same internal energies. F
    - c. The average molecular speed in the gallon is less than that in the cup F
    - d. The average molecular speed in the cup of water is less that that in the gallon. F
    - [✓ e.] None of the above.

76. Aluminum and air have almost the same specific heats. Therefore, 100 calories of heat will raise the temperature of 1 liter of air __________ 1 liter of Aluminum. (Assume T = 20°C, and P = 1 atm.)
    - [✓ a.] much more than
    - b. slightly more than
    - c. about the same as
    - d. slightly less than
    - e. much less than

because 1 l of air has much less mass than 1 l of AL

77. The second law of thermodynamics says
    - a. that the energy of an isolated system is conserved. F
    - b. that the entropy of the earth can never decrease. F
    - c. that it is impossible to reach the absolute zero of temperature. F
    - [✓ d.] that it is impossible to build a heat engine that does ~~more~~ mechanical work equal to the thermal energy it consumes. T
    - e. that two objects which are both in thermal equilibrium with the same third object are also in thermal equilibrium with one another. F
    - f. None of the above.

78. If 200 g of water at 100°C and 100 g of ice at 0°C are mixed with 300 g of water at 50°C in a completely insulated container, what is the final equilibrium temperature, most nearly? Recall that the latent heat of fusion of ice is 80 cal/g. $C_{H_2O} = 1\ cal/gm\ °C \Rightarrow$

    [✓ a.] 45 °C $(1)200(100° - T_f) = 100\cdot(80) + (1)100(T_f - 0) + 300(T_f - 50°)(1)$
    b. 54 °C
    c. 58 °C $20{,}000 - 8000 + 15000 = (200+100+300)T_f$
    d. 70 °C $27000/600 = 45°C = T_f$ (a) oh
    e. None of the above is within 10% of the correct answer.

79. What restrictions does the first law of thermodynamics place on building a perpetual motion machine?
    a. It does not place any restriction on the possibility. F
    b. Some heat energy must be exhausted and wasted. F (II LAW)
    c. Thermal energy cannot be completely converted to mechanical energy. F (II LAW)
    d. The machine must have a very long cyclical period. F
    e. The losses due to friction can not exceed hc (= Planck's constant times the speed of light) in any cycle. F
    [✓ f.] None of the above restrictions is imposed by the first law. T
    b thru e

80. What restrictions does the second law of thermodynamics place on building a perpetual motion machine?
    a. The work extracted must be less than the heat input. T
    b. Some heat energy must be exhausted and wasted T
    c. Thermal energy cannot be completely converted to mechanical energy. T
    d. Its efficiency must not exceed the Carnot efficiency. T
    [✓ e.] All of the above restrictions are imposed by the second law. T
    f. None of the above answers is true and correct. F

81. Consider a certain person's human body to be a heat engine with an efficiency of only 20%. This means that
    a. only 20% of the food he eats is digested. F
    b. 80% of the energy he obtains from food is destroyed. F
    c. he should spend 80% of each day lying quietly. F
    [✓ d.] only 20% of the energy he extracts from food can be used to do physical work. T
    e. None of the above: no quantitative thermodynamic efficiency can be assigned to a human body. F

82. A heat engine takes in 800 J of energy at 1200 K and exhausts 600 J at 400 K. What is the theoretical maximum (i.e.,Carnot) efficiency of this engine?
    a. 25%
    b. 33.3% $\eta_{CARNOT} = 1 - \frac{T_C}{T_H} = 1 - \frac{400}{1200} = 0.67$
    c. 50%
    [✓ d.] 66.7%
    e. 75%
    f. None of the above is within 10% of the correct answer.

83. An engine exhausts 1200 J of energy for every 3600 J of energy it takes in. What is its efficiency?
    a. 25 %
    b. 33 %
    c. 50 % $\eta = \frac{2400}{3600} = \frac{W_{out}}{Q_{in}} = \frac{2}{3} = 67\%$
    [✓ d.] 67 %
    e. 75%
    f. None of the above is within 10% of the correct answer.

84. A heat engine takes in energy at a rate of 1600 W at 1000 K and exhausts heat at a rate of 1200 W at 400 K. What is the actual efficiency of this engine?
   - [✓ a.] 25%
   - b. 40%
   - c. 50%
   - d. 60%
   - e. 75%
   - f. None of the above is within 10% of the correct answer.

$$\eta = \frac{1600-1200}{1600} = \frac{400}{1600} = 25\%$$

85. What is the probability of rolling a total of 10 with two dice?
   - a. 1/36
   - [✓ b.] 3/36
   - c. 5/36
   - d. 6/36
   - e. 10/36
   - f. None of the above.

$1 \times \left(\frac{1}{6} \times \frac{1}{6}\right) = \frac{1}{36}$ prob of (5+5)

$2 \left(\frac{1}{6} * \frac{1}{6}\right) = \frac{2}{36}$ (6+4)

$3/36 = 1/12$ = Total Prob of Rolling 10

86. A ringing bell is inserted into a large glass of water. The bell and the water are initially at the same temperature and are insulated from their surroundings. Eventually the bell stops vibrating and the comes to rest. Which of the following statements (a) through (e) is FALSE?
   - a. The mechanical energy of the bell has been completely converted into internal energy of the combined system. T
   - b. The final temperature of the combined system is greater than the initial temperature. T
   - c. The entropy of the combined system has increased. T
   - d. The water has been warmed in the process T
   - e. The bell performed work on the water. T
   - [✓ f.] All of the above statements ((a) through (e) are true: None is false. T

87. Which of the following statements conflicts with the second law of thermodynamics?
   - a. Heat naturally flows from hot objects to cold objects. No conflict = NC
   - b. No engine can transform all of its heat input into mechanical work. NC
   - c. The entropy of an isolated system can never decrease. NC
   - d. Perpetual motion machines are not possible. NC
   - [✓ e.] No engine can be l~~es~~s efficient than the Carnot engine with the sa~~me maxi~~mum and minimum temperatures Conflict: F NONE can be (MORE) Efficient
   - f. Every heat engine must exhaust heat. NC
   - g. None of the above contradicts the second law. False

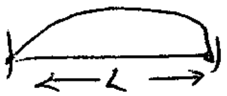
88. A hot piece of metal is dropped into an insulated container of cold water. After the system has reach its equilibrium temperature, the
   - a. entropy of the metal has decreased. T
   - b. entropy of the water has increased. T
   - c. net change in the entropy of the system is positive. T
   - d. entropy of the system has increased. T
   - e. heat energy has been transferred from metal to water T
   - [✓ f.] all of the above statements are true T
   - g. None of the above statements is true. F

89. Which of the following sets of parameters all affect the period of a pendulum? (M = Mass, L = Length, and g = acceleration due to gravity)
   - a. (M, L and g)
   - b. (M and L)
   - c. (M and g)
   - [✓ d.] (L and g) [T does NOT dependupon M.]
   - e. (L only)
   - f. None of the above.

90. Two sinusoidal waves of the same frequency are traveling in opposite directions in a string of length, L, (fixed at its endpoints), so that they form a standing wave pattern. We can state with certainty that
    - a. at certain nodal points the string will not move at all T
    - b. at certain ant-nodal points the string will have a vibrational amplitude larger than its neighboring points. T
    - c. the location of the nodal points will remain fixed as time progresses. T
    - d. The anti-nodal points will remain fixed at time progesses T
    - [✓ e.] All of the assertions (a) through (d) are true. T
    - f. None of the assertions (a) through (e) is true. F

91. The fundamental wavelength for standing waves on a rope fixed at both ends is __________ the length of the rope.
    - a. four times
    - [✓ b.] two times
    - c. the same as
    - d. one-half
    - e. one-fourth
    - f. None of the above

Since 1/2 w.l. fits into L



92. What is the frequency of the earth's rotation abut the sun, most nearly? (1Hz = 1cycle/sec)
    - a. 4×10^{-2} Hz
    - b 8×10^{-2} Hz
    - c. 7×10^{-4} Hz
    - d. 1×10^{-5} Hz
    - e. 2×10^{-6} Hz
    - [✓ f.] 3×10^{-8} Hz
    - g. None of the above is within 10%of the correct answer.

$$\frac{1\,\text{cycle}}{\text{yr}} = \frac{1}{\text{yr}} \times \frac{1\,\text{yr}}{365\,\text{d}} \times \frac{1\,\text{d}}{24\,\text{hr}} \times \frac{1\,\text{hr}}{3600\,\text{sec}} = \frac{1}{3.15 \times 10^{7}}\,\text{cycle/sec}$$

$$= 3.17 \times 10^{-8}\ \text{Hz}$$

MOST NEARLY $= 2 \times 10^{-6}$

93 Which of the following lists correctly orders the various electromagnetic waves in the order of increasing frequency?
    - [✓ a.] radio waves<microwaves<infra-red light<violet light<X-rays<gamma rays ✓
    - b. microwaves<radio waves<red light<ultraviolet light<X-rays<gamma rays X
    - c. infrared light<red light<violet light<ultraviolet light<microwaves<X-rays. X
    - d. gamma rays<X-rays<ultraviolet light<microwaves<radio waves. X
    - e. Ultraviolet light<infrared light<gamma rays<X-rays<microwaves. X
    - f. None of the above orderings is completely correct. F

94. Each column of the periodic table lists elements with similar chemical properties. Mechanistically, These properties are determined by the element's
    - a. atomic mass. F
    - b. atomic number. F
    - c. relative abundances. F
    - d. nuclear charge. F
    - [✓ e] electrons' shell structure T
    - f. None of the above. F

ch

95. Which is a correct observation of what happened in our cathode ray tube demonstrations?
    - a. The end of the glass tube opposite the cathode glowed. T
    - b. A metal cross cast a shadow. T
    - c. The particles were seen only when an accelerating voltage is applied T
    - d. The stream of particles is deflected by an magnetic field. T
    - [✓ e.] All of the above. T
    - f. None of the the above happened during our demonstration. F

96.Thomson's plum pudding model of the atom was abandoned because…

- a. of the cathode ray studies which discovered electrons. F
- b. of the large (compared with the H+ ion) charge to mass ratio of the electron. F
- c. the electron charge was shown to be quantized in integer units of the smallest charge. F
- d. the atom had to be neutrally charged electrically. F
- [✓ e.] alpha particles sometimes back scattered. T
- f. All of the above were reasons for abandoning the Thomson model. F

97. When light is incident on a metallic surface, the emitted electrons

- a. are called photons. F
- b. have arbitrarily high energies. F
- c. have a maximum energy that depends on the intensity of the light. F
- d. Are referred to as cathode rays. F
- e All of the above F
- [✓ f.] None of the above. T

98. Rutherford's model predicted that atoms should be unstable (because the electrons should spiral into the nucleus) in very short time periods. What caused this instability in Rutherford's model?

- a. The positive charge in the nucleus was too strong for the electrons to remain in distant orbits. F (Cf: planets)
- b. The attractive force between the positive nucleus and the negative electrons would pull them together. (F)
- [✓ c.] An accelerating, such as one in uniform circular motion, charge must radiate energy. T
- d. Circular orbits are unstable for an attractive inverse square force. F
- e. All of the above. F
- f. None of the above. F

99 .A clean surface of potassium metal will emit electrons when exposed to blue light. If the intensity of the blue light is increased, the __________ of the ejected electrons will also increase.

- a. maximum kinetic energy F
- [✓ b.] number T
- c. average speed F
- d. average kinetic energy F
- e. All of the above quantities increase with intensity. F
- f. None of the above completions yields a true statement. F

100. Which of the following is NOT a feature of the Bohr model of the atom?

- a. an quantized electron angular momentum T
- b. electrons in planetary-like orbits T
- c. quantized energy levels T
- d. accelerating electrons that do not radiate T
- e. photons emitted when electrons jump from one orbit to another. T
- [✓ f.] All of the above are features of the Bohr model. T
- g. None of the features (a) through (e) is a feature of the Bohr model. F

101. Which of the following is NOT considered to be a success of Bohr's theory of the atom?

- a. Obtaining the numerical values for the spectral lines in hydrogen. Success
- b. Explaining why there the same line frequencies occur in emission spectra as in absorption spectra. Success
- c. Explaining why the frequency distributions in emission spectra are discrete rather than continuous. Success.
- d. Providing the general qualitative features of the periodic table. Success
- [✓ e.] All of the above are considered successes of the Bohr theory. TRUE
- f. None of the items (a) through (d) is considered to be a success of the Bohr model. FALSE

102. A clean surface of metal will emit electrons when exposed to light. If the color of the light is changed from red to blue without changing the intensity, the __________ of the ejected electrons will also increase.

a. mass F
b. number F
[✓ c.] Maximum kinetic energy T
d. charge F
e. All of the quantities listed above will increase with the color change. F
e None of the quantities (a) through (d)above will increase with the change in color. F

103. Bohr gave the following argument why the electron in the hydrogen atom existing only in certain discrete energy levels

a. This agrees with Newtonian mechanics.
b. This agrees with Maxwell's equations.
c. This was implied by the Rutherford atom
d. All of the above were cited.
[✓ e.] None of the above, Bohr simply postulated it, offering no supporting rationale, except that it explained the Hydrogen spectra.

104. Two hydrogen atoms have electrons in the n = 3 energy level. One of the electrons jumps to the n = 2 level, while the other jumps to the n = 1 level. Which property is the same for the two photons that are emitted?

a. momentum No
b. frequency No
c. energy No
d. color No
e. wave length No
f. All of the above properties are the same for the two photons. FALSE
[✓ g.] None of the properties (a) through (e) above is the same for the two photons..

The following 16 questions may typically require more computation than those preceding. Please place the letter for the single most nearly correct answer into the correspondingly numbered line on you r NCS answer sheet.

105 . You throw a ball vertically to a friend on a balcony 20 m above your launch point What is the minimum launch speed which guarantees that the ball will reach him?

- a. 4 m/s
- b. 8 m/s
- [✓ c.] 20 m/s
- d. 40 m/s
- e. None of the above is within 10% of the correct answer.

KE $mgh + \frac{m}{2} v^2 = const \Rightarrow \cancel{m}gh_f = \frac{1}{2}\cancel{m} v_i^2$

$\sqrt{2 \cdot 10 \cdot 20} = v_i$

$20 \, m/sec = v_i$ (c)

106. A baseball is hit with a speed of 20 m/s at an angle 30° upward, and has traveled 34.6 m horizontally when it returns to the (level) ground. If another baseball is hit at the same angle, but with an initial speed of 50 m/s, the second ball will travel, most nearly, ___________m__ before it hits the ground.

- a. 35 m
- b. 87.5 m
- c. 138 m
- [✓ d.] 216m
- e. 432 m
- f. None of the above is within 10% of the correct answer.

If v_{iy} is increased by 2.5X then T_{MAX} (= time to MAX height) increases by 2.5X

& If v_{ix} is increased also by 2X, the $D = v_{xi} \, 2T_{MAX}$

increases by $(2.5)^2 = 6.25$ times

from 34.6 to $(6.25)(34.6) = 2162$ m

ⓓ

107. A 48-kg crate is being pushed across a horizontal floor by a horizontal applied force of 240 N. If the coefficient of sliding friction is 0.5, and the speed is 2m/s at time t = 0, how far does the crate move in the next ten seconds, most nearly ? (Use the approximate value, g = 10 m/s^2 in your calculation.)

[✓ a.] 20 m
b. 50 m
c. 100 m
d. 120 m
e. 620 m

$F_{NET} = F_{App} - F_{friction} = 240 - (0.5)(48)(10) = 0$

Then $a = \frac{F_{NET}}{M} = 0$

& $d = v_0 t + \cancel{\frac{1}{2}a}t^2$

$= 2 \cdot 10 = 20m$

108. Suppose that a satellite is orbiting the earth at a constant distance of 3 earth radii from its center. What is its speed? (Take the radius of the earth to be 6.4X10^6 m)

a. 2.9 X 10^3 m/s
[✓ b.] 4.5 X 10^3 m/s
c. 2.9 X 10^4 m/s
d. 4.5 X 10^4 m/s
e. 2.9 X 10^5 m/s
f 4.5 X 10^5 m/s
g. None of the above is within 10% of the correct answer.

$a = \frac{g}{(3)^2} = \frac{v^2}{R} \Rightarrow v^2 = \frac{g \cdot (\cancel{3}R_E)}{\cancel{9}\,3}$

$v = \sqrt{v^2} = \sqrt{10 \frac{(6.4)}{3} \times 10^6}$

$= \sqrt{2.1 \times 10^7}$

$= 4.5 \times 10^3$ m/sec ⓑ

109. A 160-kg satellite orbits a distant planet at a fixed distance of 4000 km and a period of 280 min. From the radius and period, you calculate the satellite's acceleration to be 0.56 m/s^2. What is the gravitational force on the satellite, most nearly ?

   - [✓ a.] 10^2 N
   - b. 10^3 N
   - c. 10^4 N
   - d. 10^5 N
   - e. 10^6 N
   - f. 10^7 N
   - g. None of the above is within 30% of the correct answer

$F = ma = (160)(0.57) = 89.6 \simeq 10^2 N$ ✓

110. A boxcar traveling at 5 m/s approaches a string of four identical boxcars sitting stationary on the track. The moving boxcar collides and links with the stationary cars, and the five move off together along the track. What is the final speed of the cars immediately after the collision, most nearly ? (You may take the mass of each boxcar to be 20,000 kg.)

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

$P_i = P_f$

$5M + 0\cancel{(4M)} = v_f \cdot 5M \Rightarrow v_f = 1\ m/sec$

111. A block weighing 20 N is lifted straight upward from rest by applying a steady force of 32 N. If the block is lifted 5 m, what is the block's final speed?

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

$\Delta(KE) = F^{NET} \cdot D = (32-20)5 = 60J$

$\frac{1}{2}Mv_f^2 = 60J$

$v_f = \sqrt{\frac{2 \cdot 60}{2}} = 7.74$ m/sec

(f) None is within 10%

$= 10^5 m$

112. A cylindrical space habitat with a 100,000-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?

- a. 10 m/s
- b. 10^2 m/s
- [✓ c.] 10^3 m/s
- d. 10^4 m/s
- e. 10^5 m/s
- f. 10^6 m/s
- g. None of the above is within 10%.

$g = \frac{v^2}{R} \Rightarrow v = \sqrt{gR}$

$= \sqrt{10 \cdot 10^5 (m^2/sec^2)}$

$= 10^3$ m/sec

113. Suppose that the speed, v, of a particle of rest mass m increases so that v/c increases from (1- 10^{-5}) to (1-10^{-7}). By what factor does its total energy increase, most nearly?

a. (1+10^{-7})
b. (1+10^{-6})
c. (1+10^{-5})
d. 4.67
[✓ e. 10]
f. 100
g. None of the above is within 10%.

$$E^{TOT} = \gamma mc^2$$

$$\gamma = \frac{1}{\sqrt{1-v^2/c^2}} = \frac{1}{\sqrt{(1-v/c)(1+v/c)}} \approx \frac{1}{\sqrt{2\epsilon}}$$

where $\begin{cases} \epsilon = 1-v/c \\ 1+v/c \approx 2 \text{ if } v/c \approx 1. \end{cases}$

Then if ϵ decreases by 10^2 from 10^{-5} to 10^{-7} } γ increases by $\sqrt{10^2} = 10X$ (e)

114. A hypothetical balloon filled with an ideal gas has a volume of 10^3 liters at 27°C under one atmosphere of pressure. At what temperature, most nearly, will its volume be 330 liters under one atmosphere of pressure?

a. -273°C
b. -223°C
[✓ c. -173°C]
d. -123°C
e. -73°C

$$\frac{P_i V_i}{P_f V_f} = \frac{cT_i}{cT_f}$$

& $V_i = 10^3 \ell$
$V_f = 330 \ell$
$P_i = P_f = 1atm$
$T_i = 27°C = 300K$

$\Rightarrow 1 \cdot \frac{10^3}{330} = \frac{300K}{T_f}$

i.e $T_f = 99K = 99-273 = -174°C$

115. If 200 g of water at 100°C and 300 g of ice at 0°C are mixed in a completely insulated container, what is the final equilibrium temperature, most nearly ? Recall that the latent heat of fusion of ice is 80 cal/g.

- a. -10°C
- [✓ b.] 0°C
- c. 10°C
- d. 20°C
- e 30 °C
- f. None of the above is within 10% of the correct answer.

$$200(100 - T_f) = (300)(80) + 300(T_f - 0)$$

$$20{,}000 - 24{,}000 = (300 + 200)T_f$$

$$-\frac{4000}{500} = -8^\circ C = T_f$$

But $\boxed{T_f = -8^\circ C \text{ is}}$ → IMPOSSIBLE, because lowest possible Temp is 0° which would be a mixture of Ice & H_2O (b)

116. A heat engine takes in 600 J of energy at 1000 K and exhausts 400 J at 300 K. What is the theoretical maximum efficiency (i.e., the Carnot efficiency) for this engine, and what is its actual efficiency, respectively ?

- a. 30% and 33%, respectively.
- b. 30% and 67%, respectively.
- c. 33% and 33%, respectively.
- d 33% and 67%, respectively
- e. 67% and 30%, respectively.
- f. 67% and 70%, respectively.
- [✓ g.] 70% and 33%, respectively
- h. 70% and ~~67~~%, respectively
- i In none of the above are both answers correct within 10% of the value

$$\eta_{CARNOT} = 1 - \frac{T_C}{T_H} = 1 - \frac{300}{1000} = 0.7 = 70\%$$

$$\eta_{ACTUAL} = \frac{600 - 400}{600} = \frac{200}{600} = \frac{1}{3} = 33.3\%$$

(g)

117\. An engine takes in 12,600 cal of heat and exhausts 4200 cal of heat each minute it is running. How much work does the engine do each minute? (Recall that 4.2 J is equivalent to 1 cal.)

- a. 1000 cal.
- b. 2000 cal.
- c. 3000 cal.
- d. 4200 cal.
- [✓ e.] 8400 cal.
- f. 12,400 cal.
- g. None of the above is within 10% of the correct answer.

$12,600 - 4200 = 8400\ \text{cal}/_{min} = W^{out}$ each minute

✓

118\. The transverse wave speed along a string of length 0.2m fixed at both ends is 100 m/s. What is the frequency of the third standing wave on this string?

- [✓ a)] 750 Hz
- b. 625 Hz
- c. 500 Hz
- d. 375 Hz
- e. 250 Hz
- f None of the above is correct within 10%.

$L = \frac{3\lambda_3}{2}$

$f = v/\lambda_3$

$\& \ \frac{3}{2}\lambda_3 = L$

$f = \frac{3v}{2L} = \frac{1.5(100)}{0.2\ m} = \frac{750}{sec}$

$= 750\ Hz$ (a)

119. The energy levels of the Hydrogen atom are correctly given by the formula of the Bohr model; as follows: $E_n = -13.6/n^2$, where n = 1, 2, 3,…gives the lowest orbits. (The energy units are electron Volts: 1eV = 1.6 X 10^{-19} J.) Calculate the energy emitted when an electron jumps from the third Bohr orbit to the second orbit.

a 13.6 eV
b. 12.8 eV
c. 12.1 eV
d. 10.2 eV
e. 3.4 eV
[✓ f.] 1.9 eV
g. 0.67 eV
h. None of the above is correct within 10%.

$$\Delta E = E_i - E_f = -13.6\left(\frac{1}{(3)^2} - \frac{1}{(2)^2}\right) = 13.6(0.25 - 0.111)$$

$$= 1.918 \text{ eV} \quad \text{(f)}$$

120. The radio emission from WTOP has a carrier frequency of 1500 kilo-Hz. What is the energy of one photon in the emission, most nearly? (Planck's constant is h = 6.63 X 10^{-34} J·s.)

[✓ a.] 10^{-27} J
b. 10^{-28} J
c. 5 X 10^{-29} J
d. 5 X 10^{-30} J
e. None of the above is correct within 10%.

$f \quad 1.5 \times 10^6$ Hz

$$E = hf = 6.63 \times 10^{-34} \text{ J}\cdot\cancel{s} \times \frac{1.5 \times 10^6}{\cancel{sec}} = 9.94 \times 10^{-28} \text{ J}$$

$$\approx 10^{-27} \text{ J}$$

End of exam