FIRST YEAR PHYSICS

MARCH 2002

DIRECTIONS: For each question or statement fill in the appropriate space on the answer sheet. Use the letter preceding the word, phrase, or quantity which best completes or answers the question. Each of the 25 questions is worth 4 points.

CONSTANTS: g (Earth) = 10 m/s^2

$c_{water} = 1\frac{kcal}{kgC^o}$ or $4186\frac{Joules}{kgC^o}$

$c_{ice} = 0.5\frac{kcal}{kgC^o}$ or $2100\frac{Joules}{kgC^o}$

$v_{sound\ in\ air} = 345$ m/s

$I_0 = 10^{-12}$ W/m^2

water's heat of fusion = 80 kcal/kg or $3.35\text{x}10^5$ J/kg

water's heat of vaporization = 540 kcal/kg or $2.26\text{x}10^6$ J/kg

$c_{Aluminum} = 0.22\frac{kcal}{kgC^o}$ or $900\frac{Joules}{kgC^o}$

$c_{steam} = 0.48\frac{kcal}{kgC^o}$ or $2010\frac{Joules}{kgC^o}$

1 In a classroom demonstration, a 73.5-kg physics professor lies on a "bed of nails." The bed consists of a large number of evenly spaced, relatively sharp nails mounted in a board so that the points extend vertically outward from the board. While the professor is lying down, approximately 1900 nails make contact with his body. What is the average force exerted by each nail on the professor's body?

a) 0.0201 N b. 0.387 N c. 1.42 N d. 735 N e. 1.45 x10^5 N

2 If the area of contact at the head of each nail is $1.26\text{x}10^{-6}$ m^2, what is the average pressure at each contact?

a) $1.59\text{x}10^4$ Pa b. $5.71\text{x}10^8$ Pa c. $1.11\text{x}10^{12}$ Pa d. $1.11\text{x}10^6$ Pa e. $3.07\text{x}10^5$ Pa

3 Which one of the following temperatures is approximately equal to "room temperature?"

a) 0 K b. 0 °C c. 100 °C d. 100 K e. 293 K

4 Which one of the following properties could not be used as a temperature sensitive property in the construction of a thermometer?

a) the change in mass of a solid
b) the change in volume of a liquid
c) the change in length of a metal rod
d) the change in electrical resistance of a wire
e) the change in pressure of a gas at constant volume

5 A copper plate has a length of 0.12 m and a width of 0.10 m at 25 °C. The plate is uniformly heated to 175 °C. If the linear expansion coefficient for copper is $1.7\text{x}10^{-5}$/ °C, what is the change in the area of the plate as a result of the increase in temperature?

a) $2.6\text{x}10^{-5}$ m^2 b. $6.1\text{x}10^{-5}$ m^2 c. $3.2\text{x}10^{-6}$ m^2 d. $4.9\text{x}10^{-7}$ m^2 e. $7.8\text{x}10^{-9}$ m^2

6 The units of heat are equivalent to those of which one of the following quantities?

a) force/time b. work c. temperature d. specific heat capacity·time e. power

7 Which one of the following situations is a direct application of the Zeroth Law of Thermodynamics?

a) Block A has twice the temperature of block B before they are brought into contact. Upon contact, heat flows from block A to block B.

b) A sample of gas within a cylinder with a piston is held at constant temperature and pressure while it is allowed to expand. During this process, the gas absorbs heat from its surroundings.

c) The motor of a refrigerator uses electric energy to remove heat from inside the refrigerator and transfer it to the room.

d) A physicist removes energy from a system in her laboratory until she reaches a temperature of $3x10^{-10}$ K, a temperature very close to (but still greater than) absolute zero.

e) A thermometer is calibrated by placing it in an ice water bath within an adiabatic container until the thermometer is in thermal equilibrium with the ice water.

8 Complete the following statement: The first law of thermodynamics states that

a) heat is a form of energy.

b) entropy is a function of state.

c) the entropy of the universe is increasing.

d) the change in the internal energy of a system is given by Q – W.

e) no engine can be more efficient than a Carnot engine operating between the same two temperatures.

9 What are the SI units of the product of pressure and volume, PV?

a) newton b. kg · m/s c. joule d. m^2 e. newton · second

10 A 5.0-g sample of ice at 0.0 °C falls through a distance of 20.0 meters and undergoes a completely inelastic collision with the earth. If all of the lost mechanical energy is absorbed by the ice, how much of it melts?

a) $2.9x10^{-3}$ g b. $4.3x10^{-3}$ g c. $7.6x10^{-3}$ g d. $1.8x10^{-2}$ g e. $2.1x10^{-2}$ g

11 Using the data in the table, determine how many calories are needed to change 100 g of solid X at 10 °C to a vapor at 210 °C.

Thermodynamic Constants for Substance X

heat of fusion	40.0 cal/g
heat of vaporization	150.0 cal/g
melting point	10.0 °C
boiling point	210.0 °C
specific heat capacity (liquid X)	0.500 cal/(g · C°)

a) 4,000 cal b. 10,000 cal c. 15,000 cal d. 29,000 cal e. 39,000 cal

12 A periodic wave is produced on a stretched string. Which one of the following properties is not related to the speed of the wave?

a) frequency b. amplitude c. period d. wavelength e. tension in the string

13 Two canoes are 10 m apart on a lake. Each bobs up and down with a period of 4.0 seconds. When one canoe is at its highest point, the other canoe is at its lowest point. Both canoes are always within a single cycle of the waves. Determine the speed of the waves.

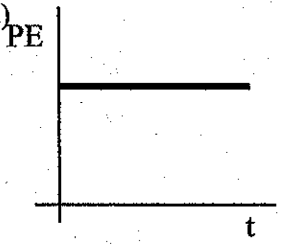
a) 2.5 m/s b. 5.0 m/s c.14 m/s d. 40 m/s e. 80 m/s

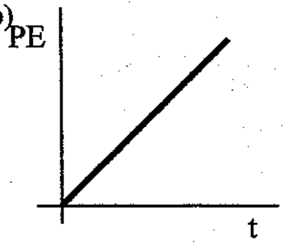
14 Two fans are watching a baseball game from different positions. One fan is located directly behind home plate, 18.3 m from the batter. The other fan is located in the centerfield bleachers, 127 m from the batter. Both fans observe the batter strike the ball at the same time, but the fan behind home plate hears the sound first. What is the time difference between hearing the sound at the two locations? Use 345 m/s as the speed of sound.

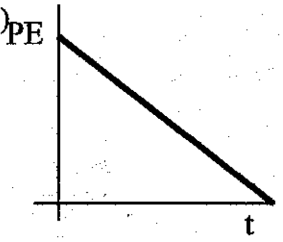
a) 0.315 s b. 0.368 s c. 3.17 s d. 1.89 s e. 0.053 s

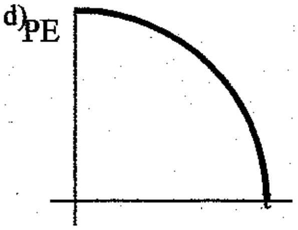
For #24 & 25, use the following information: A 5 kg rock is thrown horizontally with an initial speed of 10 m/s from the top of a 50 m tall cliff

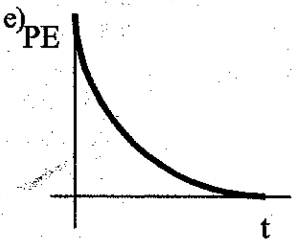
24 Which graph represents the gravitational potential energy of the rock at a function of time?

a)


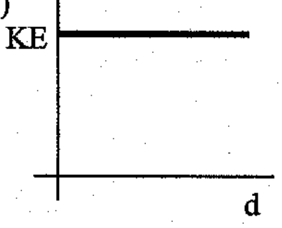
b)


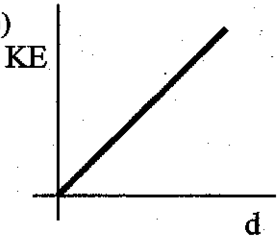
c)


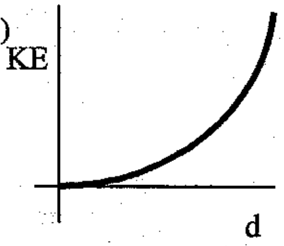
d)


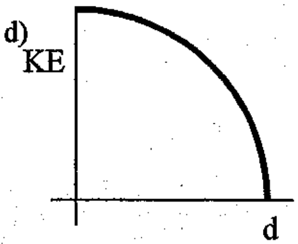
e)


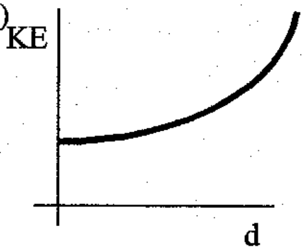
25 Which graph represents the kinetic energy of the rock as a function of distance fallen?

a)


b)


c)


d)


e)


15 The decibel level of a jackhammer is 130 dB relative to the threshold of hearing. Determine the sound intensity produced by the jackhammer.

a) 1.0 W/m^2 b. 10 W/m^2 c. 13 W/m^2 d. 130 W/m^2 e. 1013 W/m^2

16 A pebble is dropped in a lake and produces ripples with a frequency of 0.25 Hz. When should a second pebble be dropped at the same place to produce destructive interference?

a) 0.50 s after the first
b) 0.75 s after the first
c) 1.0 s after the first
d) 1.5 s after the first
e) 2.0 s after the first

17 Pipe A is 0.50 m long and open at both ends. Pipe B is open at one end and closed at the other end. Determine the length of B so that it has the same fundamental frequency as A.

a) 0.25 m b. 0.50 m c. 0.75 m d. 1.0 m e. 2.0 m

18 A car starts from rest and accelerates uniformly at 3 m/s^2. A second car starts from rest 6 seconds later at the same point and accelerates uniformly at 5 m/s^2. How long does it take the second car to catch the first car?

a) 12.2 sec b. 18.9 sec c. 20.6 sec d. 24.0 sec e. 30.0 sec

19 A toolbox of mass M is resting on a flat board. One end of the board is slowly raised until the box just begins to slide. The angle θ that the board makes with the horizontal at that instant depends on the

a) Mass of the box, M.
b) acceleration of gravity, g.
c) normal force, N.
d) coefficient of friction, μ_s.
e) force of gravity, F_g.

20 Action-reaction forces, as stated in Newton's 3rd Law of Motion,

a) Sometimes act on the same object.
b) Always act on the same object.
c) May be at right angles.
d) Always act on different objects.
e) Always result in no motion.

21 The Hubble Satellite moves in an almost circular orbit of radius R. Which expression gives the Hubble's orbital velocity?

a) $v = \dfrac{GM}{R}$ b. $v = \sqrt{\dfrac{GM}{R}}$ c. $v = \dfrac{\sqrt{GM}}{R}$ d. $v = \sqrt{GR}$ e. $v = \sqrt{\dfrac{GR}{M}}$

22 Water runs out of a horizontal drainpipe at a rate of 120 kg per minute. It falls 3.2 m to the ground. Assuming the water doesn't splash up, what average force does it exert on the ground?

a) None b. 6 N c. 12 N d. 16 N e. 20 N

23 A hoop of radius 0.5 m and a mass of 0.2 kg is released from rest and allowed to roll down an inclined plane sitting at an angle of 30° to the horizontal. How fast is it moving linearly after rolling a distance of 6 m down the ramp?

a) 2 m/s b. 4 m/s c. 5.5 m/s d. 7.8 m/s e. 10 m/s

FIRST-YEAR PHYSICS EXAM

MARCH 200~~1~~ 2002

SOLUTIONS

1. B	14. A
2. E	15. B
3. E	16. E
4. A	17. A
5. B	18. C
6. B	19. D
7. E	20. D
8. D	21. B
9. C	22. D
10. A	23. C
11. D	24. D
12. B	25. B
13. B	