

Physics 103 Final Exam

Name _____ ID# _____

Section # _____ TA Name _____

Fill in your name, student ID# (not your social security #) and section # (under ABC of special codes) on the Scantron sheet. Fill in the letters given for the first 5 questions on the Scantron sheet. These letters determine which version of the test you took, and it is *very* important to get this right. Make sure your exam has questions 6 to 40.

1. A
2. D
3. C
4. E
5. B

USEFUL NUMBERS:

Gas constant 8.31 J/K-mole
1 atm = 10^5 Pa
 $N_A = 6.03 \times 10^{23}$ molecules/mole
 $g = 9.8$ m/s²
 $\sigma = 5.67 \times 10^{-8}$ W/m²-K⁴
atomic weight of nitrogen N = 14
atomic weight of oxygen O = 16
atomic weight of Hydrogen = 1
atomic weight of helium = 4
mass density of water 1000 kg/m³
mass density of ice 917 kg/m³
mass density of aluminum 2700 kg/m³
mass density of sea water 1035 kg/m³
mass density of iron 7860 kg/m³
specific heat of water 4183 J/kg-C
specific heat of copper 387 J/kg-C
specific heat of ice 2090 J/kg-C
specific heat of iron 448 J/kg-C
linear thermal expansivity of copper = 17×10^{-6} °C⁻¹
linear thermal expansivity of aluminum = 24×10^{-6} °C⁻¹
linear thermal expansivity of steel = 11×10^{-6} °C⁻¹
latent heat of fusion of water is 3.33×10^5 J/kg
latent heat of vaporization of water is 2.26×10^6 J/kg

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6) A train whistle is measured to have a loudness of 100 db at a distance of 10m from the train. Assuming that the sound energy spreads out spherically, the loudness measured 40 meters from the train is

- a) 88 db
- b) 125 db
- c) 94 db
- d) 106 db
- e) 97 db

7) Ten moles of a monatomic He gas is at an initial temperature of 300K. If the gas absorbs 150,000 J of heat energy while the volume is kept constant, the final temperature of the gas is:

- (a) 1503 K
- (b) 701 K
- (c) 816 K
- (d) 1022 K
- (e) none of the above

8) A hollow cubic box of wood, 1 m on each side, weighs 980 N in air. It is placed in fresh water lake tied to an anchor made of solid iron (1m x 1m x 10cm) with a massless cord of such length that exactly half of the wooden box is submerged. The tension in the cord is:

- (a) 8829 N
- (b) 3920 N
- (c) 4900 N
- (d) 7644 N
- (e) 0 N

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9) Indicate which of the following processes of heat transfer requires a fluid to be involved;

- (a) Change of phase
- (b) Convection
- (c) Radiation
- (d) Conduction
- (e) None of the above choices is valid

10) A 100 m long high voltage cable is suspended between two towers. The mass of the 100 m cable is 150 kg. If the tension in the cable is 30,000 N, the lowest frequency at which this cable can oscillate is:

- (a) 2.0 Hz
- (b) 1.0 Hz
- (c) 1.4 Hz
- (d) 0.71 Hz
- (e) 0.50 Hz

11) If two adjacent frequencies of an organ pipe closed at one end are 550 Hz and 650 Hz, the length of the pipe is: (*velocity of sound is 340 m/s*)

- (a) 0.85 m
- (b) 1.25 m
- (c) 1.50 m
- (d) 1.70 m
- (e) 3.40 m

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12) A trumpeter in the UW band is proud that he can blow with an intensity measured to be 60 db. What is the intensity level that a group of 40 equally capable trumpeters can reach?

- (a) 63 db
- (b) 66 db
- (c) 100 db
- (d) 76 db
- (e) 240 db

13) A sound wave traveling in air has velocity v_0 ; frequency f_0 and wavelength λ_0 , when it encounters a balloon filled with a gas of much greater density than air. Inside the balloon the wave has velocity v_1 ; frequency f_1 and wavelength λ_1 . Indicate the true situation:

- (a) The velocity is unchanged $v_1 = v_0$; but the wavelength increases $\lambda_1 > \lambda_0$,
- (b) The frequency is unchanged $f_1 = f_0$; but the wavelength increases $\lambda_1 > \lambda_0$,
- (c) The wavelength is unchanged $\lambda_1 = \lambda_0$; but the velocity decreases $v_1 < v_0$,
- (d) The velocity is unchanged $v_1 = v_0$; but the wavelength increases $\lambda_1 > \lambda_0$,
- (e) The frequency is unchanged $f_1 = f_0$; but the velocity decreases $v_1 < v_0$

14) A worker (weight 800 N) stands on a 4 m long scaffold to work on a billboard. The scaffold (weight 500 N) is supported by vertical ropes at each end. The worker stands 1m from one end. The tension in the rope nearest the worker is:

- (a) 500 N
- (b) 800 N
- (c) 450 N
- (d) 850 N
- (e) 1000 N

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15) Water (an ideal fluid) flows at 10 m/s through a pipe of radius 3 cm. The pipe goes up to the second floor of the building (2 m higher) and the pressure remains unchanged. The radius of the pipe on the second floor is:

- (a) radius = 4.6 cm
- (b) radius = 3.4 cm
- (c) radius = 1.2 cm
- (d) cannot be determined from the information given
- (e) radius = 2.6 cm

16) A block of wood is floating partially submerged in large pail of water. It is placed on the floor of an elevator. As the elevator accelerates upward, the block of wood

- (a) sinks
- (b) rises
- (c) remains submerged at the same level
- (d) none of the above
- (e) cannot be predicted

17) When you stand half way between two loudspeakers, with one on your left and one on your right, a musical note from the speakers gives you constructive interference. How far to your left should you move to obtain destructive interference?

- (a) one and a half wavelengths
- (b) half a wavelength
- (c) a quarter of a wavelength
- (d) one wave length
- (e) not move at all

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18) A violinist tunes his instrument using a 440 Hz tuning fork. At one moment he perceives a beat frequency of 7 Hz. The frequency of vibration of his string is:

- (a) exactly 447 Hz
- (b) exactly 433 Hz
- (c) either 433 Hz or 447 Hz
- (d) exactly 880 Hz
- (e) both 433 Hz and 447 Hz

19) You are a passenger on a hot air balloon that is rising with constant velocity and you are carrying a cell phone that rings with a sound of frequency f . As you open it, you drop it and it falls to earth still ringing. As it is falling you note that the ringing:

- (a) increases in frequency and intensity.
- (b) decreases in frequency and intensity.
- (c) decreases in frequency and the intensity increases.
- (d) increases in frequency and the intensity decreases.
- (e) maintains its frequency and intensity unchanged.

20) Sunlight falls on the Earth delivering energy E to the earth every day. The Earth is at a temperature of 18°C while the Sun has surface temperature 5000°C . The Earth radiates an energy W away to outer space each day. Indicate which of the following statements is true;

- a.) $W = E$ and the entropy received from the Sun is $>$ the entropy exported from the Earth.
- b.) $W < E$ and the entropy received from the Sun is $<$ the entropy exported from the Earth.
- c.) $W = E$ and the entropy received from the Sun is $<$ the entropy exported from the Earth.
- d.) $W > E$ and the entropy received from the Sun is $=$ the entropy exported from the Earth.
- e.) $W < E$ and the entropy received from the Sun is $>$ the entropy exported from the Earth.

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21) A rock is thrown straight up from the Earth's surface. Indicate which one of the following statements concerning the rock at the top of its path is false:

- a.) The net force acting on the rock is down and constant.
- b.) Its velocity is zero.
- c.) Its vertical position is at maximum.
- d.) Its kinetic energy is zero.
- e.) Its acceleration is zero.

22) Two canoes are 10 m apart on Lake Mendota. A student observes that her canoe bobs up and down and up again 6 times in one minute. When one canoe is at its lowest point, the other is at the highest. Both canoes are within a single cycle of the waves. The wave velocity is:

- a.) 1.4 m/s
- b.) 2.0 m/s
- c.) 5.0 m/s
- d.) 0.5 m/s
- e.) 0.7 m/s

23) A 2 kg ball has zero kinetic and potential energy. Alfred drops the ball into a 20 m deep well. Just before the ball hits the bottom, the sum of its kinetic and potential energy is:

- (a) 392 J
- (b) -392 J
- (c) 784 J
- (d) zero
- (e) 196 J

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24) George drives a truck with a flat cargo bay horizontally at 15 m/s. He is transporting a crate of delicate lead crystal. If the coefficient of static friction between the crate and the truck bed is 0.4, the minimum stopping distance for the truck so that the crate will not slide is:

- (a) 28.7 m
- (b) 51.0 m
- (c) 33.6 m
- (d) 44.4 m
- (e) 20.1 m

25) A package of mass $m = 2$ kg is released from rest at a height 2 m above the floor and slides along a track inclined at an angle of 45° to the horizontal. The coefficient of sliding friction between the track and package is 0.33. Its velocity as it reaches the bottom is:

- a.) 3.65 m/s
- b.) 2.6 m/s
- c.) 7.29 m/s
- d.) 5.11 m/s
- e.) 10.03 m/s

26) Ten moles each of neon ($m = 20$) and helium ($m = 4$) gas are at thermal equilibrium at temperature 17°C in a 2 m^3 volume. The ratio of the rms velocity of neon to that of helium is:

- a.) 0.45
- b.) 0.20
- c.) 5.00
- d.) 2.24
- e.) not calculable

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27) A “grandfather’s” clock is based on a pendulum of length exactly 1 m at temperature -20°C . If the clock is taken to a location at -30°C the clock

- a.) is unchanged
- b.) gains a little bit each day
- c.) loses a little bit each day
- d.) becomes inoperative
- e.) stops.

28) A phonograph record of moment of inertia I_0 is initially at rest and falls on the rotating turntable (moment of inertia I_1) which is rotating with angular velocity ω_1 . Because the surfaces are rough the two eventually reach the same angular speed ω . The ratio of ω_1 to ω is

- a.) I_1/I_0
- b.) I_0/I_1
- c.) $(I_0+I_1)/I_1$
- d.) $(I_0+I_1)/I_0$
- e.) $I_0/(I_0+I_1)$

29) Which of the following is not an example of convective heat transfer:

- a.) Boiling water in a pan
- b.) A sailplane circling in the sky
- c.) A southerly wind
- d.) A sunburn
- e.) A “drafty” room

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30) If the amplitude of a system moving in simple harmonic motion is reduced by half, which statement is false:

- a.) The total energy is halved
- b.) The period is unchanged.
- c.) The frequency is unchanged
- d.) The maximum speed is halved
- e.) The maximum acceleration is halved

31) Three balls are thrown with exactly the same speed from the top of a building of height H . Ball A is thrown upwards at 30° to horizontal, ball B is thrown horizontally, and ball C is thrown down at 30° to the horizontal. Neglecting air resistance, which statement is true.

- a.) All the balls strike the ground with the same speed.
- b.) Ball C strikes the ground with the highest speed, then B, then A.
- c.) Ball C strikes the ground with the highest speed, then A, then B.
- d.) Ball A strikes the ground with the highest speed then B, then C
- e.) Ball A strikes the ground with the highest speed then C, then B

32) Two cars, one in front of the other, are traveling down the highway at 25 m/s. The car behind sounds its horn, which has a frequency of 500 Hz. The frequency of the sound heard by the driver of the lead car is:

- a.) 463 Hz
- b.) 540 Hz
- c.) 579 Hz
- d.) 500 Hz
- e.) 427 Hz

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33) A fireperson is 50 m from a burning building and directs a stream of water from a fire hose at an angle of 30° above the horizontal. If the initial speed of the stream is 40 m/s the height that the stream of water will strike the building is:

- (a) 9.6 m
- (b) 13.4 m
- (c) 18.7 m
- (d) 22.4 m
- (e) 30.0 m

34) You are lifting a book to a shelf of a bookcase. You can take the book to the shelf by various paths. Which one of the following statements is true:

- (a) Work done on the book depends on the path taken by book.
- (b) Work done on the book depends on the time taken to move it.
- (c) The power required depends on the mass of the book and the height of the book shelf only.
- (d) The power required varies depending on the path taken, if you move the book at constant speed along various paths.
- (e) No work is done on the book at all.

35) A heavily loaded boat is floating in a small shallow pond. The boat springs a leak and sinks. The surface level of the pond:

- a) stays the same
- b) goes higher
- c) goes lower
- d) more information is needed to reach a conclusion.
- e) depends on the depth of the pond

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The following three questions pertain to the situation described below:

Three carts are on a frictionless air track as shown. One (A) of mass 1500 g. is at rest and a similar one (B) also of mass 1500 g is moving toward it at 2 m/s. They make a completely inelastic collision and then they (as a unit) collide inelastically with a third cart (C) of mass 500 g. which is moving toward the pair with speed 6 m/s.



36) The velocity of the pair A-B after their collision is:

- a.) 2.0 m/s
- b.) 1.5 m/s
- c.) 1.0 m/s
- d.) 0.5 m/s
- e.) 0.0 m/s

37) The velocity of the group A-B-C after the collision is:

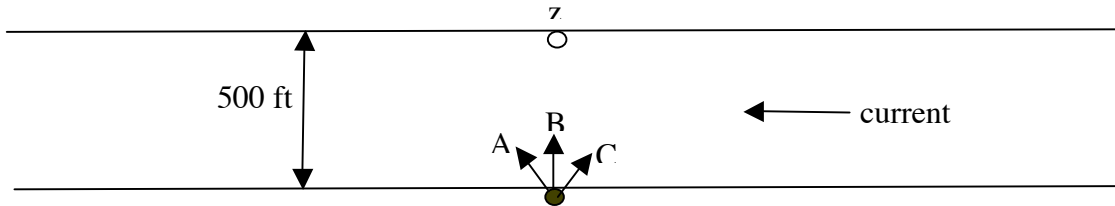
- a.) 2.0 m/s
- b.) 1.5 m/s
- c.) 1.0 m/s
- d.) 0.5 m/s
- e.) 0.0 m/s

38) The amount of the initial kinetic energy (A and B and C) lost to heat in the two collisions is:

- a.) 1.5 J
- b.) 12.0 J
- c.) 3.0 J
- d.) 6.0 J
- e.) 24.0 J

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Three swimmers Alma, Betty and Carol, *all* of whom swim at the same velocity through the water (3 mph) set out for the other side of a river which is 500 ft across and has a current of 1 mph as shown.



39) Which of the swimmers will reach the other side farthest from the point z directly opposite the starting point?

- a.) Alma
- b.) Betty
- c.) Carol
- d.) All will fail to get to the other side
- e.) All will reach the other side simultaneously.

40) Which of the swimmers will reach the other side in the shortest time, irrespective of their final location.

- a.) Alma
- b.) Betty
- c.) Carol
- d.) All will fail to get to the other side
- e.) All will reach the other side simultaneously.