

## PHY 101 Practice Final

**Review Sessions: Tuesday, Dec. 12, 11AM-12PM and 4-5PM in PB202**

Please be sure to show your work where it is requested. If no work is shown where it is requested, you will not receive any points. Also, partial credit will be given where appropriate, so *show me your physics thoughts*.

Please answer the following multiple choice questions. Circle only one answer per question.

- (1) Faraday's law of induction states that the voltage induced in a rectangular loop of wire is proportional to
  - A. the magnetic flux.
  - B. the time variation of the magnetic flux.
  - C. current divided by the time.
  - D. the magnetic flux density times the area of the loop.
- (2) Doubling the diameter of a loop of wire produces what change of induced voltage in the presence of an external magnetic field?
  - A. The induced voltage is 4 times as much.
  - B. The induced emf is twice as much.
  - C. There is no change in the induced emf.
  - D. The induced emf is 6.28 times as much.
- (3) If the average kinetic energy of a *constant* volume of ideal gas increases, what must be true?
  - A. the density decreases
  - B. the pressure increases while the temperature stays the same
  - C. the temperature increases while the pressure stays the same
  - D. both the pressure and temperature increase
- (4) The south end of a bar magnet is pushed downward toward a wire loop in the plane of the paper. In which direction is the induced current, and which way is the induced magnetic field?
  - A. clockwise, out of the paper
  - B. clockwise, into the paper
  - C. counter-clockwise, out of the paper
  - D. counter-clockwise, into the paper
- (5) When a person stands on a scale, which of the following is not a force exerted on the scale?
  - A. a contact force due to the floor
  - B. a contact force due to the person's feet
  - C. the weight of the person
  - D. the weight of the scale
- (6) What is the unit of heat?
  - A. N
  - B. J
  - C.  $\text{N/m}^2$
  - D.  $\text{J/m}^2$
- (7) To be dimensionally consistent, force, pressure, and length must be related as follows:
  - A.  $\text{force} = \text{pressure}^2 \text{ length}^2$

- B. force = pressure<sup>2</sup> length
- C. force = pressure length<sup>2</sup>
- D. force = pressure length

(8) What physical quantity is represented by the area under a curve on a P-V diagram where pressure is in Pa and V is in m<sup>3</sup>

- A. Area in meters<sup>2</sup>
- B. Work in Joules
- C. Heat in Watts
- D. Heat in Joules

(9) As a system undergoes a constant-volume process

- A. the pressure does not change.
- B. the internal energy does not change.
- C. the work done on the system is zero.
- D. the entropy stays the same.

(10) Which of these statements are implied by the second law of thermodynamics?

- A. The entropy of an engine operating in a cycle never decreases.
- B. The increase in internal energy of a system in any process is the sum of the heat absorbed plus work done on the system
- C. A heat engine, operating in a cycle, that exhausts no heat to the low-temperature reservoir is impossible.
- D. Both A and C.

(11) How does the resistance of a piece of conducting wire change if both its length and diameter are quadrupled?

- A. Remains the same
- B. half as much
- C. third as much
- D. fourth as much

(12) A vertical spring system with a bob having mass  $m$  is set into motion with amplitude  $A$ . When the bob replaced by one having mass  $4m$ , the following can be concluded:

- A. The period is 0.7 times as large as before
- B. The period is unaffected.
- C. The period is twice as large as before.
- D. The period is half as large as before.

(13) The net force on a moving object suddenly becomes zero. The object then

- A. stops abruptly.
- B. stops during a short time interval.
- C. changes direction.
- D. continues at a constant velocity.

(14) A blue ball is dropped from the roof of a tall building simultaneously with the horizontal launch of a red ball. Which statement is true?

- A. the red ball strikes the ground first with the higher speed
- B. both balls hit the ground at the same time, but the red ball has the higher speed
- C. the blue ball strikes the ground first, but with the lower speed
- D. both balls hit the ground at the same time with the same speed

(15) Two balls are thrown from the roof of a building with the same initial speed. One is thrown

horizontally while the other is thrown at an angle of 30 degrees above the horizontal. Which hits the ground with the greatest speed?

- A. The one thrown horizontally
- B. The one thrown at 30 degrees
- C. They hit the ground with the same speed.
- D. The answer cannot be determined with the given information.

(16) The electric field of a point charge decreases with distance  $r$  from the point charge as

- A.  $1/r^2$
- B.  $1/r$
- C.  $1/r^{1/2}$
- D.  $1/r^3$

Now respond to the following short answer questions. Please answer TWO out of THREE for questions (17)-(19). CLEARLY indicate which ones you would like to be graded on the front sheet of the exam.

(17) Why do lakes and rivers freeze first at their surfaces?

(18) Describe how a heat engine works—it could be a Stirling engine or even a combustible engine. What does a heat engine do? Can even an ideal engine (with no friction between moving parts, etc.) be 100 percent efficient? Please answer each part of the question.

(19) A ping-pong ball that has been dented during hard play can often be restored by placing it in hot water. Explain *why* this works.

Please answer TWO out of THREE for questions (20)-(22). CLEARLY indicate which ones you

would like to be graded on the front sheet of the exam.

(20) Describe how a direct current (DC) motor works. Be sure to list the parts and describe the function for each part. What does a DC motor do? Please answer each part of the question.

(21) An SUV collides with a Mini Cooper convertible. Is the force exerted on the Mini by the SUV greater than, equal to, or less than the force exerted on the SUV by the Mini? Explain what physics principle/law is at work here.

(22) Draw the electric field lines for two protons at distance  $d$  apart from each other.

Now answer TWO of the following THREE quantitative questions (23)-(25). Please clearly indicate which ones you would like to be graded on the front sheet of the exam. You are welcome to approximate  $g$  as  $10 \text{ m/s}^2$ ,  $\epsilon_0$  as  $9 \times 10^{-12} \text{ C}^2/(\text{N m}^2)$ , the mass of the electron as  $9 \times 10^{-31} \text{ kg}$ , the charge of the electron as  $-2 \times 10^{-19} \text{ C}$ , and  $k_B = 1 \times 10^{-23} \text{ J/K}$  to obtain numbers. See how close you come to reaching a number without the use of a calculator.

(23) An external magnetic field pointing along the central axis of a 50 turn coil of radius 3 cm increases from 0 to 2 T in 3 seconds.

(a) If the resistance of the coil is 3 Ohms, what is the magnitude of the induced current in the coil?

(b) What is the direction of the current if the external magnetic field points away from the viewer as the viewer looks down the central axis of the coil?

(24) The alveoli—tiny air sacs in the lungs— have an average radius of 0.1 mm and are approximately spherical. If the pressure in the sacs is  $1 \times 10^5 \text{ N/m}^2$ , and the temperature is 310 K (average body temperature), how many air molecules are in an alveolus?

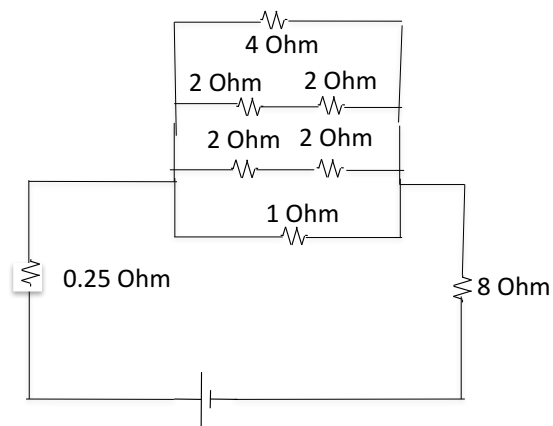
(25) Calculate the maximum possible efficiency of a heat engine that uses surface lake water at 18 degrees Celsius as a source of heat and rejects waste heat to the water 0.1 km below the surface where the temperature is 4 degrees Celsius. (Hint: What units of temperature should you be using?)

Please answer TWO of the next THREE questions (26)-(28).

(26) A spring gun with spring constant  $k = 10 \text{ N/m}$  is used to shoot a 100 g ball horizontally. Initially the spring is compressed by 20 cm. The ball loses contact with the spring and leaves the gun when the spring is uncompressed. What is the speed of the ball when it hits the ground 1 m below the spring gun?

(27) Isabella slides a paper plate with a slice of pizza across a horizontal table to her friend Petra. The coefficient of friction between the table and plate is 0.4. If the pizza must travel 50 cm to get from Isabella to Petra, what initial speed should Isabella give the plate of pizza so that it stops just when it gets to Petra?

(28) Consider the circuit diagram below.



(a) Find the equivalent resistance for the circuit.

(b) If the battery is a 40 V battery, what is the current going through the 8 Ohm ( $\Omega$ ) resistor?

Please answer ONE of the final THREE questions (29)-(31).

(29) Consider a ping pong ball inside a long tube at one end. Seal both ends of the tube and remove the air from it. When the seal at the end of the tube where the ping pong ball sits is broken what happens to the ping pong ball and why?

Can you construct a quantitative question and answer about this setup using estimates of the radius and mass of the ping pong ball of 20 mm and 3 grams respectively? Also,  $1 \text{ atm} \approx 1 \times 10^5 \text{ N/m}^2$ .

(30) Walter White and Jessie (two “Breaking Bad” characters) want to, let’s say, corrupt magnetically-stored data from a laptop that sits in police storage without having to go “in” and retrieve the laptop. They do this from “afar” by creating their own magnet. How would you create a magnet to do this?

Can you construct a quantitative question and answer about the “Breaking Bad magnet” if 2 Tesla were needed to corrupt the data from 5 meters away?

(31) When I stood with my back to the wall and released a very heavy ball attached to a cord hanging from the ceiling of Stolkin that was initially just an inch away from my nose, why did the heavy ball not bash me in the nose on its return swing provided I did not give the ball a push (just let it fall)?

Can you construct a quantitative question and answer about the nose basher pendulum knowing the mass of the ball is approximately 10 kg?