

MIDTERM EXAM-4 – v1

PHYS 201 (Spring 2018), 04/24/18

Name:

Solution Key

Last 4 digits of UIN:

Lab-Sect. no.:

Signature:

In taking this exam you confirm to adhere to the Aggie Honor Code:
“An Aggie does not lie, cheat, steal or tolerate those who do.”

Duration: 90 minutes

Show all your work for full/partial credit!

Include the correct units in your final answers for full credit!

Unless otherwise stated, quote your results in SI units!

1.) Multiple Choice

(21 pts.)

For each statement below, circle the correct answer (A, B or C, no reasoning required).

- (a) Sound waves can propagate
☒ (A) only in a medium (B) only in vacuum (C) in media and in vacuum.
- (b) When the sound intensity increases by a factor of 10, the intensity level increases by
 (A) a factor of 2 (B) 3 dB ☒ (C) 10 dB.
- (c) When the temperature of a blackbody emitter increases from 0°C to 50°C , its radiated heat increases by a factor of approximately
☒ (A) 2 (B) 4 (C) 6.
- (d) When heat is conducted through a metal wire, the heat current
☒ (A) doubles (B) triples (C) quadruples,
 if you double the cross-sectional area of the wire.
- (e) When adding heat to a substance during a phase change, the substance's temperature
 (A) decreases ☒ (B) stays constant (C) increases.
- (f) When an ideal gas does expansion work without heat being added to it, its temperature
☒ (A) decreases (B) stays constant (C) increases.
- (g) When the average speed of the atoms in an ideal gas doubles, its equilibrium temperature (in K) increases by a factor of
 (A) 2 ☒ (B) 4 (C) 8.

No.	Points
1	AS
2	AS
3	AS
4	SE
5	SE
Sum	

2.) Periodic Waves

(24 pts.)

A seagull floating on the ocean is moved up and down by periodic waves. The horizontal spacing between adjacent minima is 6 m , and the wave speed is given by $v = \sqrt{g\lambda/(2\pi)}$ (where $g=9.8\text{ m/s}^2$ and λ is the wavelength). The height difference between minima and maxima is 0.5 m . Calculate the waves'

(a) wavelength and speed;

(b) frequency;

(c) amplitude.

(a) $\lambda = 6\text{ m}$

$$v = \sqrt{\frac{g\lambda}{2\pi}} = 3.06\text{ m/s}$$

(b) $v = f\lambda \Rightarrow f = \frac{v}{\lambda} = 0.51\text{ Hz}$

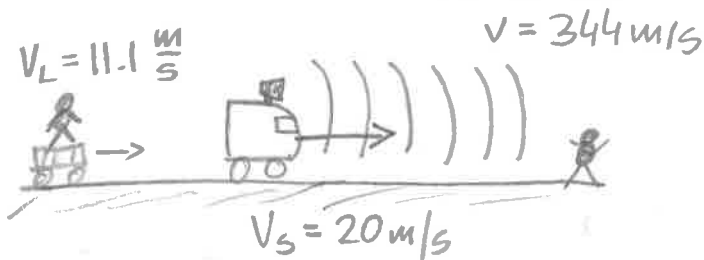
(c) $A = \frac{0.5}{2} = 0.25\text{ m}$

3.) Doppler Effect

(14 pts.)

A freight train is traveling due east at a speed of 45 mph. When approaching a street crossing, the engineer on the train blows the train's horn which has a source frequency of 800 Hz.

- What is the frequency heard by a person standing at the street crossing?
- What is the frequency heard by a railworker on a construction vehicle which is moving behind the train at 25 mph due east?



$$(a) \quad f_L^{(a)} = f_s \frac{V}{V - V_s} = 849 \text{ Hz}$$

$$(b) \quad f_L^{(b)} = f_s \frac{V + V_L}{V + V_s} = 780 \text{ Hz}$$

4.) Heat and Phase Changes

(16 pts.)

A cook takes an iron skillet (mass 1.05 kg at initial temperature of 220°C) off the stove and cools it by pouring 20 g of water at room temperature (20°C) onto it. All the water evaporates.

- (a) How much heat has been extracted from the iron skillet?
 (b) What is the final temperature of the iron skillet, in °C and in °F?

$$(a) \quad \boxed{Q_{\text{extr}} = Q_{\text{water}} = c_w m_w \Delta T + L_v^w m_v} \\ = 0.02 (4190 \cdot 80 + 22.6 \cdot 10^5) = \boxed{5.19 \cdot 10^4 \text{ J}}$$

$$(b) \quad Q_{\text{extr}} = -\Delta T c_{\text{iron}} m_{\text{iron}}$$

$$\Rightarrow \Delta T = \frac{-Q_{\text{extr}}}{c_{\text{iron}} m_{\text{iron}}} = -105 \text{ } ^\circ\text{C}$$

$$\Rightarrow \boxed{T_f = T_i + \Delta T = 115 \text{ } ^\circ\text{C}} \quad * \frac{9}{5} + 32^\circ\text{F} = \boxed{239^\circ\text{F}}$$

5.) *Ideal-Gas Law and First Law of Thermodynamics*

(25 pts.)

A container of an ideal gas (monatomic) at initial temperature of 320 K and initial volume of 0.3 m^3 expands at constant pressure of $2 \cdot 10^5\text{ Pa}$ to a final volume of 0.5 m^3 .

- (a) How many moles of gas are in the container?
- (b) What is the final temperature of the gas?
- (d) By how much did the internal energy of the gas change?
- (d) How much work has been done by the gas?
- (e) How much heat was added (+) or subtracted (-) in the expansion process?

$$(a) \quad p_i V_i = n R T_i \Rightarrow \boxed{n = \frac{p_i V_i}{R T_i} = \frac{2 \cdot 10^5 \cdot 0.3}{8.31 \cdot 320} = 22.6 \text{ mol}}$$

$$(b) \quad p_f V_f = n R T_f \Rightarrow T_f = \frac{p_f V_f}{n R} = 533 \text{ K}$$

$$(\text{or } T_f = T_i \frac{V_f}{V_i})$$

$$(c) \quad \boxed{\Delta U = \frac{3}{2} n R \Delta T = 6 \cdot 10^4 \text{ J}}$$

$$(d) \quad \boxed{W = p \Delta V = 4 \cdot 10^4 \text{ J}}$$

$$(e) \quad \Delta U = Q - W$$

$$\Rightarrow \boxed{Q = \Delta U + W = 1.0 \cdot 10^5 \text{ J}}$$