FINAL EXAM **PHYSICS 103** **FALL 2011** **A**

Fluid: $p = F/A$; $\sigma = \frac{F}{A}$ $\sigma = Y\varepsilon$ $\varepsilon = \frac{L - L_o}{L_o}$ $p_h = \rho gh$; 1 atm = 1.013 x10^5 Pa, $F_B = \rho gV$ $A_1v_1 = A_2v_2$

Av -volume flow rate **mass flow rate** $= Av\rho$ $p_1 + 1/2\rho v_1^2 + \rho gh_1 = p_2 + 1/2\rho v_2^2 + \rho gh_2$

horizontal pipe: $p_1 + 1/2\rho v_1^2 = p_2 + 1/2\rho v_2^2$ $T(^0C) = \frac{5}{9}[T(^0F) - 32]$; $T(^0F) = \frac{9}{5}T(^0C) + 32$; $T(K) = [T(^0C) + 273]$

$L - L_0 = \alpha L_0 (T-T_0)$; $A - A_0 = 2\alpha A_0 (T-T_0)$; $V - V_0 = \beta V_0 (T-T_0)$ $\beta = 3\alpha V$ $\sigma = Y\alpha (T-T_0)$ **heat:** $Q = mc(T-T_0)$,

$Q = mL_F$ $Q = kA\frac{T_1 - T_2}{L}t$ $Q = A\frac{T_1 - T_2}{R_1 + R_2 + R_3}t$ $R = \frac{L}{k}$ $Q = \varepsilon\sigma A(T^4 - T_0^4)t$

$\sigma = 5.67\text{x}10^{-8}$ W/m^{2}K^4 **ideal gas:** $PV = nRT$ T- in kelvins, $N_{Av} = 6.02\text{x}10^{23}$ /mole $N = nN_{av}$ $R = 8.313$ J/mol·K

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$; P – absolute $\rho = \frac{m}{V}$ $n = \frac{\text{mass}}{\text{molecular} - \text{mass}}$ **Thermodynamics:** $\Delta U = -W$ $W = P\Delta V$

$Q_h = W + Q_c$ $e = \frac{W}{Q_h}$ $e = 1 - \frac{T_c}{T_h}$ $COP = \frac{Q_c}{W}$ $COP = \frac{T_c}{T_h - T_c}$ **Oscillations** $x = A\cos(\omega t)$ $\omega = 2\pi f$

$v = -\omega A\sin(\omega t)$ $\omega = \frac{2\pi}{T}$ $f = \frac{1}{T}$ $F = -kx$ **period:** $T_{spring} = 2\pi\sqrt{\frac{m}{k}}$; $T_{pend} = 2\pi\sqrt{\frac{L}{g}}$ $\omega = \sqrt{\frac{k}{m}}$ $v_{max} = A\omega$

$E = \frac{1}{2}mv^2 + \frac{1}{2}kx^2$; $E = \frac{1}{2}kA^2$; **Waves:** $v = \lambda \cdot f$ $\mu = \frac{m}{L}$ $v = \sqrt{\frac{F}{\mu}}$ **Sound:** $v = 343$ m/s $I_0 = 10^{-12}$ W/m^2

$I = \frac{E}{t \cdot A}$ $I = \frac{P}{4\pi R^2}$ $\beta = 10\text{dB}\log\frac{I}{I_0}$ $\beta_2 - \beta_1 = 10\text{dB}\log\frac{I_2}{I_1}$ $f = f_0\frac{343\text{m/s} \pm v_d}{343\text{ m/s} \mp v_s}$ **Standing waves:**

on string and in open pipe : $n = 1, 2, 3.$, $f = \frac{v}{2L}n$ $\lambda = \frac{2L}{n}$ **in pipe closed at one end:** $n = 1, 3, 5, \ldots$ $f = \frac{v}{4L}n$

$\lambda = \frac{4L}{n}$ **interference: constructive:** $\Delta d = n\lambda$ **destructive:** $\Delta d = (n+\frac{1}{2})\lambda$ **Electric charge:** $q = Ne$

$F = k\frac{q_1q_2}{r^2}$ $E = k\frac{q}{r^2}$ $F = qE$ $qE = ma$ $k = 8.99\text{x}10^9$ Nm^2/C^2 **Circuits:** $R = \rho\frac{L}{A}$; V =

I*R $I = \frac{\Delta q}{\Delta t} = \frac{Ne}{t}$; $P = \frac{E}{\Delta t}$ $P = I^2R$ $P = \frac{V^2}{R}$ $P = I*V$; $V = V_m\sin\omega t$ $V_{rms} = \frac{V_m}{\sqrt{2}}$

$I_{rms} = \frac{I_m}{\sqrt{2}}$ $P_{avg} = \frac{V_{rms}^2}{R}$ $P_{avg} = I_{rms}^2R$ **in series :** $R_{eq} = R_1+R_2+\ldots+R_n$ **in parallel:** $R_{eqv} = (\frac{1}{R_1} + \frac{1}{R_2})^{-1}$

Light:

$n = \frac{c}{v}$ $\lambda = \lambda_0/n$ $c = 3\text{ x}10^8$ m/s $n_1\sin\theta_1 = n_2\sin\theta_2$ $n_1\sin\theta_{cr} = n_2\sin 90^0$ **grating:** $d\sin\theta = m\lambda$; $d = L/N$

$y = D\frac{m\lambda}{d}$ $\tan\theta = \frac{y}{D}$ $A_{circle} = \pi r^2$ $V_{cube} = a^3$ $V = \frac{4}{3}\pi r^3$ $V_{cyl} = \pi r^2L$

1 nm = 10^{-9} m 1 km = 1000 m 1 kg = 1000 g 1 m = 100 cm= 1000 mm 1 ft = 12 in.

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NAME _____SEC_____SCORE____

Honors Code Pledge: As an NJIT student I _____, pledge to comply with the provisions of the NJIT Academic Honor Code. I assert that I have not violated the NJIT Academic Honor Code.

Answer each question on the Scantron card using #2 pencil. Also circle your answers on the question papers. SHOW HOW YOU GOT YOUR ANSWERS ON THE EXAM SHEETS. Use the back if necessary.

1. A copper wire of length 2.0 m, cross sectional area 7.1×10^{-6} m^2 and Young's modulus 11×10^{10} N/m^2 has a 200-kg load hung on it. What is its increase in length? (g = 9.8 m/s^2)

a. 0.50 mm
b. 1.0 mm
c. 2.5 mm
d. 5.0 mm
e. 7.5 mm

2. A block of wood has density 0.50 g/cm^3 and mass 1 500 g. It floats in a container of oil (the oil's density is 0.75 g/cm^3). What volume of oil does the wood displace?

a. 3 000 cm^3
b. 2 000 cm^3
c. 1 500 cm^3
d. 1 000 cm^3
e. 500 cm^3

3. It takes 2.0 minutes to fill a gas tank with 40 liters of gasoline. If the pump nozzle is 1.0 cm in radius, what is the average speed of the gasoline as it leaves the nozzle? (1 000 liters = one cubic meter)

a. 0.27 m/s
b. 1.1 m/s
c. 11 m/s
d. 64 m/s
e. 32 m/s

4. At what temperature will a steel beam with maximum strength of 7 x10^7 Pa fail if it is placed between two rigid walls? The beam was installed at 18^{0}C, the Young's modulus Y (modulus of elasticity E) of the steel is 200x10^{9}Pa and α = 12x10^{-6} /C.

a. 150^{0}C
b. 30^{0}C
c. -15^{0}C

d. cannot tell
e. 47^0C

5. A pipe of length 10.0 m increases in length by 1.5 cm when its temperature is increased by 90°F. What is its coefficient of linear expansion?

a. 30×10^{-6}/°C
b. 17×10^{-6}/°C
c. 13×10^{-6}/°C
d. 23×10^{-6}/°C
e. 3×10^{-6}/°C

6. A manufacturer fills the space between two windows with argon at a gauge pressure of 1.1atm. How much mass of argon is needed? The volume is 0.035 m^3, atomic mass of argon is 40g/mol and the temperature is 20^0C. R = 8.31J/K·m

a. 0.14 g
b. 1.75 g
c. 64 g
d. 54 g
e. 0.054 g

7. An 800-MW electric power plant has an efficiency of 30%. It loses its waste heat in large cooling towers. Approximately how much waste heat (in MJ) is discharged to the atmosphere per second?

a. 1 200 MJ
b. 1 900 MJ
c. 800 MJ
d. 560 MJ
e. 150 MJ

8. A water heater is operated by a solar power. If the solar collector has an area of 6 m^2, and the intensity delivered by sunlight is 550 W/m^2, how long does it take to increase the temperature of 1000 kg of water from 20^0C to 60 ^{0}C?

a. 0.55 h
b. 2.00 h
c. 7.50 h
d. 14.0 h
e. 21.0 h

9. What is the temperature increase of 4.0 kg of water when heated by an 800-W immersion heater for 10 min? (c_w = 4186 J/kg·°C)

a. 56°C
b. 51°C
c. 29°C
d. 14°C
e. 8°C

10. A 120-g block of copper is taken from a kiln and quickly placed into a beaker of negligible heat capacity containing 300 g of water. The water temperature rises from 15°C to 35°C. Given c_{Cu} = 419 J/kg·°C, and c_{water} = 4186 J/kg·°C, what was the temperature of the kiln?

a. 500°C
b. 360°C
c. 720°C
d. 535°C
e. 863°C

11. A silver bar of length 30 cm and cross-sectional area 1.0 cm^2 is used to transfer heat from a 100°C reservoir to a 0°C block of ice. How much ice is melted per second? (For silver, k = 427 J/s·m·°C. For ice, L_f = 334 000 J/kg.)

a. 4.2 g/s
b. 2.1 g/s
c. 0.80 g/s
d. 0.054 g/s
e. 0.043 g/s

12. The tungsten filament of a light bulb has an operating temperature of about 2 100 K. If the emitting area of the filament is 1.0 cm^2, and its emissivity is 0.68, what is the power output of the light bulb? ($\sigma = 5.67 \times 10^{-8}$ W/m^2·K^4)

a. 100 W
b. 75 W
c. 60 W
d. 40 W
e. 25 W

13. How long will it take to transfer 5.5 MJ of heat through a 2.25 m^2 pane of 3 mm thick glass (k=0.84 J/sm^0 C) if the temperature difference is 12^0 C.

a. 208 hr
b. 20.8 hr
c. 12.1 min
d. 75 s
e. 15 s

14. The position of a 0.64-kg mass attached to a spring and undergoing simple harmonic motion is given by x = (0.160 m) cos [(35 rad/s)t]. The spring constant of the spring is closest to:

a. 784 N/m
b. 1256 N/m
c. 2280 N/m
d. 3168 N/m
e. 4750 N/m

15. The lower A on a piano has a frequency of 27.5 Hz and the wavelength of 4 m . If the tension in the 2.0-m-long string is 304 N what is the mass of the string?

a. 100 g
b. 25 g
c. 37 g
d. 50 g
e. 78 g

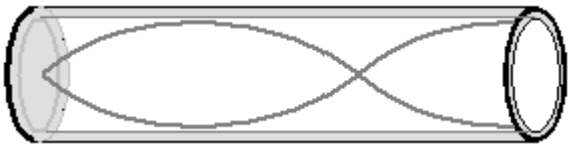
16. A standing wave is set up in a 200-cm string fixed at both ends. The string vibrates in 5 distinct segments when driven by a 120-Hz source. What is the wavelength?

a. 10 cm
b. 20 cm
c. 40 cm
d. 80 cm
e. 120 cm

17. A very loud train whistle has an acoustic power output of 100 W. If the sound energy spreads out spherically, what is the intensity level in dB at a distance of 100 meters from the train? ($I_0 = 10^{-12}$ W/m^2)

a. 78.3 dB
b. 81.6 dB
c. 89.0 dB
d. 95.0 dB
e. 105 dB

18. If an organ pipe shown is to resonate at 370 Hz, what is its required length?



a. 70 cm
b. 60 cm
c. 50 cm
d. 40 cm
e. 30 cm

19. 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. What is the frequency heard by the driver of the lead car? (v_{sound} = 340 m/s)

a. 463 Hz
b. 640 Hz
c. 579 Hz
d. 425 Hz
e. 500 Hz

20. The electric field in a cathode ray tube is supposed to accelerate electrons from 0 to 1.60×10^7 m/s in a distance of 2.00 cm. What electric field is required? ($m_e = 9.11 \times 10^{-31}$ kg and $e = 1.60 \times 10^{-19}$ C)

a. 9 110 N/C
b. 18 200 N/C
c. 36 400 N/C
d. 72 800 N/C
e. 5 000 N/C

21. An AC voltage source, with a peak output of 200 V, is connected to a 50-Ω resistor. What is the rate of energy dissipated due to heat in the resistor?

a. 200 W
b. 400 W
c. 566 W
d. 800 W
e. 128 W

22. Number 10 copper wire (radius = 1.3 mm) is commonly used for electrical installations in homes. What is the power sissipated in the 40 m of #10 copper wire if it carries a current of 10 A? (The resistivity of copper is 1.7×10^{-8} Ω·m.)

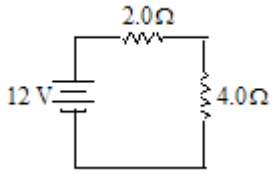
a. 13 W
b. 0.77 W
c. 0.50 W
d. 0.13 W
e. 0.07 W

23. An electric clothes dryer draws 15 A at 220 V. If the clothes put into the dryer have a mass of 7.0 kg when wet and 4.0 kg dry, how long does it take to dry the clothes? (Assume all heat energy goes into vaporizing water, $L_v = 2.26 \times 10^6$ J/kg).

a. 55 min
b. 34 min
c. 20 min
d. 16 min
e. 5 min

24. In the circuit shown what is the potential difference across 2Ω resistor?

a. 2 V
b. 4 V
c. 6 V
d. 8 V
e. 10 V



25. An uncoated optical fiber is made of clear plastic with index of refraction $n = 1.50$. For what angles with the normal will light remain within the plastic "guide"?

a. $\varphi > 66.6^{\circ}$
b. $\varphi > 57.1^{\circ}$
c. $\varphi > 51.7^{\circ}$
d. $\varphi > 41.8^{\circ}$
e. none of the above

26. The critical angle of a certain piece of plastic in air is 38^0. Suppose light is incident at an angle of θ with the normal. Total internal reflection will occur if the incident medium is:

a. air and $\theta = 38^0$
b. plastic and $\theta < 38^0$
c. air and $\theta > 32^0$
d. plastic and $\theta > 38^0$
e. air and $\theta < 38^0$

27. A 4-cm tall object is placed 40 cm away from a converging lens of a focal length 60 cm. Which of the following statements pertaining to a image is CORRECT?

a. The image is real, 2.5 cm tall, 30 cm on the same side as object.
b. The image is virtual, 2.5 cm tall, 30 cm on the other side of the lens.
c. The image is virtual, 12 cm tall, 120 cm on the same side as object.
d. The image is real, 12 cm tall, 120 cm on the other side of the lens.
e. none of the above.

28. Ansel places an object 30 cm from a thin convex lens along the axis. If a real image forms at a distance of 10 cm from the lens, what is the focal length of the lens?

a. 30 cm
b. 15 cm
c. 10 cm
d. 7.5 cm
e. 2.5 cm