Physics 218
FINAL EXAM
SPRING 2004

Fill in the OPSCAN Sheet:

1) Name
2) Student identification number
3) Exam number as 03
4) Sign the OPSCAN sheet

Important: This test consists of 18 multiple-choice problems. Check that you have all of them in your copy. You are taking the green exam. Be sure your answer key is green.

Instructions: For each problem, choose the one answer that is correct or most nearly correct. Make a small mark, for your eyes only, near the letter of your choice. After you finish and check all the multiple-choice problems, transfer your answers to the OPSCAN sheet, with a #2 pencil. Then, until you hand in the OPSCAN sheet, turn the sheet over and leave it face down. You may keep your copy of the exam.

The correct answers will be displayed on the course web page the day after the exam, and you can find your score for this exam on CHIP in one or two days.

This is a closed book exam, but an equation sheet is provided. You may also use a single handwritten sheet of notes and a numerical calculator.

Any form of cheating will result in severe penalties, which will include a score of zero for this exam and may result in a grade of F for the course and referral to the Dean of Students.

All wireless devices must be securely put out of sight and may not be touched during the exam.

Temperature

$T_c = T - 273.15$

$\Delta L/L = \Delta A/2A = \Delta V/3V = \alpha \Delta T$

Ideal gas

$N_A = 6.022 \times 10^{23} mol^{-1}$

$k = 1.38 \times 10^{-23} J/K$

$R = N_A k = 8.31 J/mol \cdot K$

$\text{molecules}/mol = N/n = N_A$

$1u = 1.66 \times 10^{-27} kg$

$PV = NkT = nRT = \frac{2}{3} N \langle K_{tr} \rangle$

Heat

$1cal = 4.186J$

$1Calorie = 1{,}000\,cal$

$heat\ capacity = Q/\Delta T$

$specific\ heat\ capacity = Q/(m\Delta T)$

$molar\ specific\ heat\ C = Q/(n\Delta T)$

for monatomic ideal gas at constant volume:

$Q = \frac{3}{2} nR\Delta T = nC_v \Delta T$

$latent\ heat\ L = \frac{|Q|}{m}$

Heat Conduction

$I_{CD} = Q/t = \kappa A \Delta T/d$

$R = d/\kappa A$

$R - factor = d/\kappa = RA$

with units:

$\left({}^{\circ}F - ft^2/(Btu/h) \right)$

Heat Radiation

$I_{em} = \sigma A T^4$

where $\sigma = 5.67 \times 10^{-8} W/\left(m^2 K^4\right)$

$\lambda_{max} T = 2.898 \times 10^{-3} mK$

Heat Engines

$Q = Q_H + Q_C = W$

$e = W/Q_H$

Translation

m

x

$v_{av} = \frac{\Delta x}{\Delta t}$

$a_{av} = \frac{\Delta v}{\Delta t}$

$v = v_0 + at$

$x - x_0 = \frac{1}{2}(v + v_0)t$

$x - x_0 = v_0 t + \frac{1}{2}at^2$

$v^2 = v_0^2 + 2a(x - x_0)$

$\sum \vec{F} = m\vec{a}$

$\vec{p} = m\vec{v}$

$\sum \vec{F}_{av} = \frac{\Delta \vec{p}}{\Delta t}$

$W = F\Delta r \cos\theta$

$K = \frac{1}{2}mv^2$

$U = mgy + \frac{1}{2}kx^2$

$P = Fv\cos\theta$

$f = \mu N$

$F = kx$

Rotation

$I = \sum m_i r_i^2$

θ

$\omega_{av} = \frac{\Delta\theta}{\Delta t}$

$\alpha_{av} = \frac{\Delta\omega}{\Delta t}$

$\omega = \omega_0 + \alpha t$

$\theta - \theta_0 = \frac{1}{2}(\omega + \omega_0)t$

$\theta - \theta_0 = \omega_0 t + \frac{1}{2}\alpha t^2$

$\omega^2 = \omega_0^2 + 2\alpha(\theta - \theta_0)$

$\sum \tau = I\alpha$

$L = I\omega$

$\sum \tau_{av} = \frac{\Delta L}{\Delta t}$

$W = \tau\theta$

$K = \frac{1}{2}I\omega^2$

$P = \tau\omega$

$I_{\parallel} = I_{cm} + Mh^2$

Elasticity

$\frac{F}{A} = Y\frac{\Delta L}{L}$

$\frac{F}{A} = S\frac{\Delta x}{L}$

$\Delta P = -B\frac{\Delta V}{V}$

Simple Harmonic Motion

$a_x = -\omega^2 x$

$x = A\cos(\omega t)$

$E = \frac{1}{2}kA^2$

$\omega = 2\pi f = \frac{2\pi}{T}$

$\omega = \sqrt{\frac{k}{m}}$

$\omega = \sqrt{\frac{g}{L}}$

Traveling Wave

$v = \lambda f$

$k = \frac{2\pi}{\lambda}$

$y = A\cos(\omega t - kx)$

Sound

$\beta = (10dB)\log_{10}\frac{I}{I_0}$

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

$f_0 = \left(\frac{1 - v_0/v}{1 - v_s/v}\right) f_s$

Translation ↔ Rotation Conversion

$v = r\omega \qquad a_r = \frac{v^2}{r} = \omega^2 r$

$a_t = r\alpha \qquad \tau = r_\perp F = rF_\perp = rF\sin\theta$

Gravitational Force

$F = \frac{Gm_1m_2}{r^2}$

Constants

$g = 9.8 m/s^2$

$G = 6.67 \times 10^{-11} N - m^2/kg^2$

$M_E = 5.98 \times 10^{24} kg$

$R_E = 6.37 \times 10^6 m$

$\rho_{water} = 1000 kg/m^3$

Fluids

$\rho = \frac{m}{V}$

$P = \frac{F}{A}$

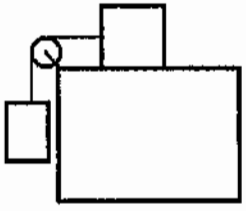
$P_2 = P_1 + \rho g d$

$Av = \text{constant}$

$P + \frac{1}{2}\rho v^2 + \rho g y = \text{constant}$

1) A 3.0 kg ball is thrown vertically into the air with an initial velocity of 15 m/s. The maximum height of the ball is,

a) 12.0 m
b) 11.5 m
c) 10.0 m
d) 9.5 m
e) 9.0 m



2) Two masses are connected by a string which passes over a frictionless, mass less pulley. One mass hangs vertically and one mass slides on a frictionless horizontal surface. The vertically hanging mass is 6.0 kg and the mass on the horizontal surface is 4.0 kg. the acceleration of the 4.0 kg mass is,

a) 1.98 m/s^2
b) 3.92 m/s^2
c) 5.88 m/s^2
d) 6.75 m/s^2
e) 7.84 m/s^2

3) A 5,000 kg satellite is orbiting the earth in a circular path. The height of the satellite above the surface of the earth is 800 km. The velocity of the satellite is, ($Me = 5.98 \times 10^{24}$ kg, $Re = 6.37 \times 10^{6}$ m, $G = 6.67 \times 10^{-11}$ Nm^2/kg^2)

a) 7,460 m/s
b) 6,830 m/s
c) 6,430 m/s
d) 5,950 m/s
e) 5,350 m/s

4) A 95 kg person is standing on a scale to measure weight in an elevator near the surface of the earth. If the elevator is accelerated upward at 4.0 m/s^2, then the reading on the scale is,

a) 1,310 N
b) 1,010 N
c) 932 N
d) 850 N
e) 750 N

5) A 120 N force is applied at an angle of 30 degrees above the horizontal to a 4.0 kg box. The box moves a horizontal distance of 8.0 meters. The change in the kinetic energy of the box is,

a) 667 J
b) 750 J
c) 831 J
d) 890 J
e) 920 J

6) Two ice skaters are at rest and facing each other. One skater weighs 70 kg and the other skater weighs 90 kg. The skaters "push off" of each other. The 70 kg skater is moving at 5.0 m/s to the EAST. What is the velocity of the 90 kg skater?

a) 6.50 m/s EAST
b) 6.50 m/s WEST
c) 3.89 m/s EAST
d) 3.89 m/s WEST
e) 1.55 m/s EAST

7) A 10 kg solid cylinder ($I = 1/2\ MR^2$) with a radius of 30 cm is rotating about a vertical axis through its center. If the angular momentum is increasing at the rate of 25 kg m^2/s, then what is the angular acceleration?

a) 75.3 rad/s^2
b) 65.9 rad/s^2
c) 55.6 rad/s^2
d) 40.5 rad/s^2
e) 35.2 rad/s^2

8) A submarine is located 1.0 km below the surface of the water. What is the absolute pressure of the seawater on the outside of the submarine? (density of seawater is 1,025 kg/m^3, and 1atm is 0.1013×10^6 Pa)

a) 90.8 atm
b) 93.5 atm
c) 98.2 atm
d) 100.2 atm
e) 121.2 atm

9) An incompressible fluid is flowing through a horizontal pipe with a constriction. The velocity of the fluid in the wide section of the pipe is 5.0 m/s and the velocity of the fluid in the narrow section of pipe is 8.0 m/s. The pressure of the fluid in the wide section is 200 kPa. What is the pressure in the narrow section of the pipe? (density of the fluid is 680 kg/m^3)

a) 155 kPa
b) 160 kPa
c) 175 kPa
d) 187 kPa
e) 207 kPa

10) A wire is 1.5 m long and has a diameter of 1.5 mm. The stretch modulus Y of the wire is 6.2×10^{10} N/m^2. If a force of 400 N is applied to end of the wire, then the increase in length of the wire is,

a) 5. 48 mm
b) 4.28 mm
c) 3.95 mm
d) 3.84 mm
e) 3.45 mm

11) A 2.0 kg mass is connected to a spring with a spring constant of 9.0 N/m. The displacement is given by the expression $x(t) = 12.0 \text{ cm } \sin(\omega t)$. What is the period of the simple harmonic motion?

a) 4.75 sec
b) 4.27 sec
c) 3.95 sec
d) 3.36 sec
e) 2.96 sec

12. A sound source of 150 watts radiates sound uniformly in all directions. The intensity of the sound at a distance of 4.0 m is,

a) 0.389 W/m^2
b) 0.403 W/m^2
c) 0.582 W/m^2
d) 0.746 W/m^2
e) 0.927 W/m^2

13. A transverse wave travels at 250 m/s along the z-axis. If the frequency of the periodic vibrations of the wave is 440 Hz, then what is the wavelength of the wave?

a) 21.9 cm
b) 26.7 cm
c) 35.7 cm
d) 56.8 cm
e) 73.7 cm

14) A stationary siren is generating sound at a frequency of 2,000 Hz. The velocity of sound is 345 m/s. A car is approaching the siren at a velocity of 24.0 m/s. What is the frequency of the siren perceived by the driver?

a) 2,640 Hz
b) 2,559 Hz
c) 2,324 Hz
d) 2,139 Hz
e) 2,003 Hz

15) A brass rod is 25.0 cm long at a temperature of 20° C. The coefficient of linear expansion of brass is 19×10^{-6} ($^{\circ}C^{-1}$). If the temperature changes to 25° C, then the increase in length of the brass rod is,

a) 1.65×10^{-5} m
b) 2.37×10^{-5} m
c) 3.03×10^{-5} m
d) 3.72×10^{-5} m
e) 4.01×10^{-5} m

16) 200 Joules of heat flows into a 35 g sample. If the temperature increases by 10° C, then what is the specific heat capacity of the sample, in J/kg ° C?

a) 175
b) 254
c) 375
d) 422
e) 571

17) An engine goes through a cyclic process. During the cyclic process the engine does 600 J of work and has a heat output of 2400 J. What is the efficiency of the engine?

a) 10%
b) 20%
c) 35%
d) 55%
e) 62%

18) In the figure above, a airport luggage carrying train with a tractor T is pulling three luggage carts, M_1, M_2, and M_3 .with an acceleration of 1.0 m/s^2 . If T = 300 kg, M_1 = 200 kg, M_2 =100 kg, and M_3 =100 kg, then the force in the connection between cart M_2, and cart M_3 is,

a) 700 N
b) 400 N
c) 200 N
d) 100 N
e) 0 N

PHYSICS 218 FINAL EXAM KEY SPRING 2004

RED KEY:

1:d,
2:b,
3:c
4:a
5:a
6:c
7:d
8:c
9:d
10:d
11:a
12:e
13:d
14:d
15:d
16:b
17:e
18:b

GREEN KEY:

1:b
2:c
3:a
4:a
5:c
6:d
7:c
8:d
9:d
10:a
11:e
12:d
13:d
14:d
15:b
16:e
17:b
18:d