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Brock University

Final Examination
Course: Physics 1P23/1P93
Date of Examination: December 12, 2012
Time of Examination: 09:00–12:00

Number of pages: 11
Number of Students: 125
Number of hours: 3
Instructor: E. Sternin

Name	
Student ID	

No examination aids other than those specified on this examination script are permitted (FHB 5.1.2.A). Use or possession of unauthorized materials will automatically result in the award of a zero grade for this examination.

This is a closed–book test, only calculators are allowed
Formulas not on the separately supplied formula sheet must be derived

For the multiple-choice questions 1–10 circle one of a–e on the front page

Question		Mark	Out of
1	a b c d		2
2	a b c d		2
3	a b c d		2
4	a b c d		2
5	a b c d		2
Bonus			3
6	a b c d e		2
7	a b c d e		2
8	a b c d e		2
9	a b c d e		2
10	a b c d e		2
11			10
12			10
13			10
14			10
15			10
16			10
17			10
18			10
Total			103

This exam contains 11 pages, plus a separate formula sheet. Please, verify that your copy is complete.

(2) **1**. Which of the following statements is true?

a. Water flows through a pipe with varying width. More water flows per second through the wide section of the pipe than through the narrow one.
b. If you increase the pressure on the surface of the water, you will increase the buoyant force on objects submerged in that water.
c. If a uniform sphere is compressed to half of its original diameter, its mass remains the same but its density becomes eight times as great.
d. According to Pascal's principle, if you increase the pressure enough so that the force at one end of an oil-filled tube increases by 10 N, the force will increase at all points in the tube by 10 N.

(2) **2**. A harmonic wave is described by the equation $y(x,t) = (6.00\text{ mm}) \times \cos\left[(3.25\text{ m}^{-1})\,x - (7.22\text{ s}^{-1})\,t\right]$ What is the wavelength of the wave?

a. 1.93 m
b. 0.870 m
c. 0.380 m
d. 0.139 m

(2) **3**. Phase equilibrium between the gaseous and liquid states describes the situation when

a. no more molecules leave the liquid and enter the gas.
b. no more molecules leave the gas and enter the liquid.
c. as many molecules go from liquid to gas as from gas to liquid.
d. the liquid is boiling.

(2) **4**. The Bernoulli effect is responsible for the lift force on an airplane wing. Wings must therefore be designed so that

a. air molecules are deflected downward when they hit the wing.
b. air molecules move more rapidly past the upper surface of the wing than past the lower surface.
c. air molecules move more rapidly past the lower surface of the wing than past the upper surface.
d. wings are thick enough to create a significant pressure difference between the top and bottom surfaces of the wings because of the different heights of the air columns above them.

(2) **5**. A submarine rests on the sea bottom. The normal force exerted on the sub by the sea-floor is equal to:

a. the weight of the sub
b. the weight of the displaced water
c. the weight of the sub less the weight of the displaced water
d. the buoyant force

(3) **Bonus**. You know that $\sin(2\alpha) =$_____ and $\cos(2\alpha) =$_____. Given that $(\alpha + \beta)$ is an expression symmetric with respect to interchanging α and β, write down the expressions for the following trigonometric identities:

a. $\sin(\alpha \pm \beta) =$_____
b. $\cos(\alpha \pm \beta) =$_____, and then
c. simplify

$$\frac{\sin(\alpha+\beta)+\sin(\alpha-\beta)}{\cos(\alpha+\beta)+\cos(\alpha-\beta)} =$$

(2) **6**. Bar 1 has a Young's modulus that is bigger than that of Bar 2. This indicates that Bar 1

a. is longer than Bar 2.
b. has a greater cross-sectional area than Bar 2.
c. has a greater elastic limit than Bar 2.
d. is made of a material different from that of Bar 2.
e. will require a greater force to stretch than Bar 2.

(2) **7**. When you get out of a swimming pool and stand dripping wet in a light breeze, you feel much colder than you feel after you dry out. This is primarily

a. because the moisture on your skin has good thermal conductivity.
b. a purely psychological effect resulting from the way the sensory nerves in the skin are stimulated.
c. because the water on your skin has a relatively large heat capacity.
d. because 539 calories of heat are required to evaporate each gram of water from your skin, and most of this heat flows out of your body.
e. because the air humidity near the pool is high.

(2) **8**. Light travels from water (with index of refraction 1.33) into air (index of refraction 1.00). Which of the following statements about this light is true?

a. The light travels faster in the air than in the water.
b. The light has the same wavelength in the air as it does in the water.
c. The light has the same speed in the air as in the water.
d. The wavelength of the light in the water is greater than the wavelength in the air.
e. For all angles of incidence, some light always enters the air.

(2) **9**. The transverse nature of light waves is apparent because

a. they are electric in nature.
b. they are magnetic in nature.
c. they are electromagnetic in nature.
d. they can be polarized.
e. they travel in ether which does not support longitudinal waves.

(2) **10**. In air ($n_{air} = 1.00$) a concave mirror has a focal length of 30.0 cm. Under water ($n_{water} = 1.33$) that same mirror would have _____ focal length.

a. a larger
b. the same
c. a smaller
d. infinite
e. negative

(10) **11**. The normal force of the ground on the foot can reach three times a runner's body weight when the foot strikes the pavement. By what amount does the 52-cm-long femur of an 80-kg runner compress at this moment? The cross-sectional area of the femur bone can be taken as $5.2 \times 10^{-4}\text{m}^2$, and the Young's modulus for cortical bone is $1.6 \times 10^{10}\text{N/m}^2$.

(10) **12**. Consider a copper belt (a rod) encircling the Earth (radius 6378 km). If the temperature of the belt increases by $1.0\,\mathrm{C}^\circ$, how high off the ground would the expanded ring be, assuming uniform clearance all around? The linear expansion coefficient of Cu is $1.7 \times 10^{-5}\ (\mathrm{C}^\circ)^{-1}$.

(10) **13**. An ideal monatomic gas undergoes a reversible expansion in which its volume changes from V_1 to $V_2 = 5 \times V_1$ while the pressure, varying linearly with volume, changes from p_1 to $p_2 = 3 \times p_1$.

a. Sketch, to scale, the pV-diagram of the process.

b. What is the change in internal energy of the gas in this process, in terms of the initial volume and pressure?

c. How much heat is gained by the gas in this process, in terms of the initial volume and pressure?

(10) **14**. Light in water (refractive index 1.33) has a wavelength of 475.8 nm. A ray of this light is incident on the glass (refractive index 1.50) wall of the aquarium at an angle 26° (with respect to the normal). It exits into the air (refractive index 1.00).

a. Draw a clear diagram indicating what happens at both water-glass and glass-air interfaces.
b. Calculate the light's wavelength in the air.
c. Calculate the angle at which the light enters the air, with respect to the normal to the glass.

(10) **15**. Two metal rods, one silver and the other gold, are attached to each other. The free end of the silver rod is connected to a steam chamber, with a temperature of 100°C, and the free end of the gold rod to an ice water bath, with a temperature of 0°C. The rods are 5.0 cm long, and have a square cross-section, 2.0 cm on a side. What is the temperature at the point where the two rods are in contact with one another? The thermal conductivity of silver is $k_{Ag} = 417\,\mathrm{W/(m{\cdot}K)}$, and that of gold is $k_{Au} = 291\,\mathrm{W/(m{\cdot}K)}$. No heat is exchanged between the rods and the surroundings, except at the ends.

(10) **16**. A corn syrup is fed through a pipe into a mixing vat at a candy factory. A different batch of syrup is found to have a viscosity that is 25% lower than usual. To compensate and to maintain the same rate of syrup flow into the vat, a different pipe of the same length is substituted. What is the change in the size (diameter) of the pipe that restores the usual flow rate?

(10) **17**. As you stand by the side of the road, a car approaches you at a constant speed, sounding its horn, and you hear a frequency of 76 Hz. After the car goes by, you hear a frequency of 65 Hz. What is the speed of the car?

The speed of sound in the air is 343 m/s.

(10) **18**. A 4-cm-high object is placed in front of a converging lens of focal length 20 cm. The image is formed 60 cm on the other side of the lens. Draw a diagram approximately to scale. Determine the object distance, the image height, and the magnification.