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Student Number: _____

UNIVERSITY OF TORONTO
Faculty of Arts and Science

APRIL 2013 EXAMINATION – version 1
PHY 205H1S

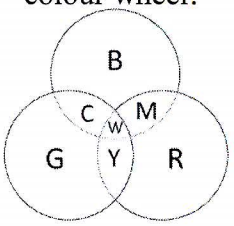
This examination has 9 pages and should take no longer than 2 hours.

Aids allowed: A calculator without communication capability. Up to three 8×13 cm index cards or equivalent area, which may be written upon on both sides.

Before starting, please fill out your identifying information at the top of this page and on the front of your answer sheet.

Assume that the acceleration due to gravity in all problems is $g = 10\ \text{m/s}^2$. Unless otherwise indicated in a particular question, you may assume the density of water is $1000\ \text{kg/m}^3$, the speed of sound in air is 340 m/s, and air resistance is negligible.
Common Prefixes: m = "milli-" = 10^{-3} c = "centi-" = 10^{-2} k = "kilo-" = 10^{3}
M = "mega-" = 10^{6}

colour wheel:



Good luck!

Written Answer Part (A - F)
Show all your reasoning and work legibly in the blank space provided, and write your final numerical answers in the boxes provided. For final numerical answers be sure to include units, and direction if the quantity is a vector. You may use the back of the page for rough work, which will not be graded.

Written A:	/4
Written B:	/4
Written C:	/4
Written D:	/4
Written E:	/4
Written F:	/4

+ 24 multiple choice worth 2 points each. Exam total possible is 72.

Multiple-Choice Questions (1 - 24)

- Each correct answer is awarded ~~5~~ 2 marks.
- Blank or incorrect answers are awarded zero marks
- Multiple answers for a question are graded as a wrong answer

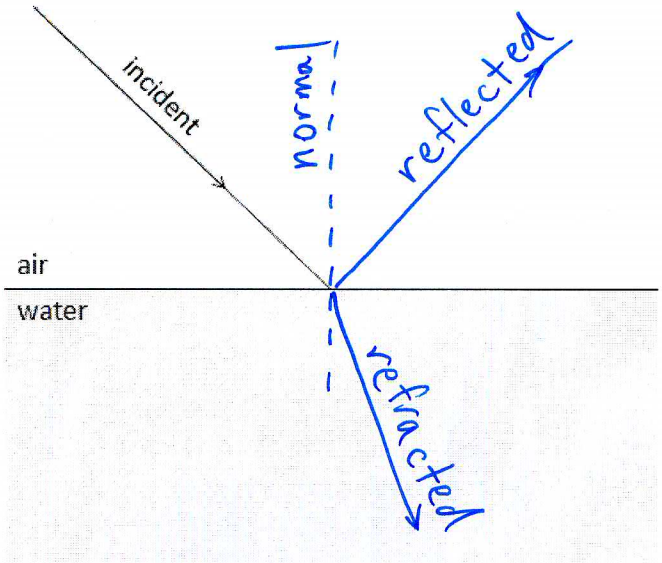
A. A laser beam begins in the air, and is incident upon a flat, calm lake, as shown in the diagram, and labeled "incident".

i. Sketch a line which is the normal to the surface at the point where the incident ray hits the lake. Label this line "normal".

ii. Sketch the reflected ray. Label this ray "reflected".

iii. Sketch the refracted ray. Label this ray "refracted".

Ch. 28



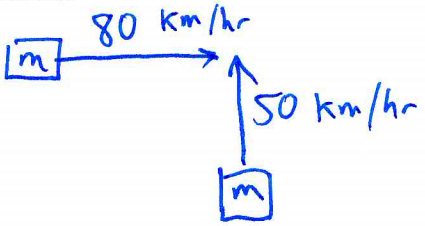
iv. What causes the laser beam to bend as it refracts into the water? [Please write your answer in the box below.]

The speed of light abruptly decreases, causing the beam to bend toward the normal.

B. A car is driving North at 50 km/hr. A second car, with the same mass as the first car, is driving East at 80 km/hr. They collide and stick together. What is the magnitude of the velocity of the two cars immediately after the collision?

Ch. 6

Initial:

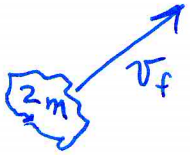


$\vec{p}_i = m_1\vec{v}_1 + m_2\vec{v}_2$

$p_i = m\sqrt{v_1^2 + v_2^2}$

$p_i = m \cdot 94.34$ km/hr

Final:



$p_f = 2m\,v_f$

Conservation of momentum: $p_f = p_i$

$\Rightarrow 2m\,v_f = m \cdot 94.34$ km/hr.

$v_f = \frac{94.34}{2}$ km/hr

47 km/hr

C. An ideal transformer in your house has 50 turns in its primary coil, and 300 coils in its secondary. An alternating current (ac) power source with 120 V and 60 Hz is connected to the primary coil.

i. What is the voltage produced in the secondary coil?

Ch. 25 (pg. 448)

$$\frac{V_1}{N_1} = \frac{V_2}{N_2}$$

$$V_2 = N_2 \cdot \frac{V_1}{N_1} = 300 \cdot \frac{120\ V}{50}$$

720 V

ii. If the secondary coil is part of a circuit, and this circuit, including the secondary coil, has a total resistance to 60 Hz ac current of 10 Ω, how much ac current is drawn by the secondary coil?

Ohm's Law:

$$I = \frac{V}{R} = \frac{720\ V}{10\ \Omega} = 72\ A$$

72 A

iii. Assuming this is an ideal transformer, how much power is supplied to the primary coil?

Power into primary = Power out of secondary.

For secondary:

$$P = V \cdot I$$
$$= (720\ V)(72\ A)$$
$$P = 51{,}840\ W$$

52 kW

D. Your dishwasher draws an average power of 2500 W when it is operated for its entire cycle, which lasts for 30 minutes. When operated at "on-peak rate", Ontario Hydro charges 11.8 cents/kWh. How much does it cost you to run your dishwasher at this rate through its entire cycle?

Ch. 23 (pg. 414)

$$P = \frac{E}{t} \Rightarrow E = P \cdot t = 2.5\ kW \times 0.5\ h$$

$$E = 1.25\ kWh$$

$$Cost = E \times rate = 1.25\ kWh \cdot 11.8\ \frac{¢}{kWh}$$

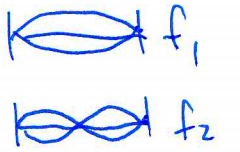
$$cost = 14.75\ ¢$$

$0.15

E. The note middle C on a piano has a fundamental frequency of 262 Hz.

i. What is the frequency of the second harmonic of middle C?

Ch. 21 $f_2 = 2 f_1$



$= 2 \times 262\ Hz$

524 Hz

ii. What is the oscillation period of the middle C on a piano string when vibrating at the fundamental frequency?

freq = 262 Hz.

Ch. 19: $T = \frac{1}{f} = \frac{1}{262} = 0.003816$

3.8 ms

iii. What is the wavelength of sound produced by the middle C on a piano when vibrating at the fundamental frequency?

Ch. 19 wave speed = freq × wavelength

front page says $v = 340\ m/s$

wavelength $= \frac{v}{f} = \frac{340\ m/s}{262\ Hz} = 1.298\ m$

1.3 m

F. A large pot can hold up to 3 L of water. 1 L of water at 20°C is poured into the pot. The pot is placed on the stove, and after 5 minutes, 42 kJ of heat have been added to the 1 L of water. The new temperature is found to be 30°.

i. Next, another 1 L of water at 20°C is poured into the pot, and stirred. What will be the temperature of the stirred 2 L of water? [You may neglect heat losses to the environment, and neglect the small amount of heat added to the water by the stirring process.]

Ch. 15: Equilibrium temperature will be the average of the two identical samples that are mixed.

$T_f = \frac{20°C + 30°C}{2} = 25°C$

25 °C

ii. Next, the stove is turned on for another 5 minutes, adding 42 kJ more of heat to the 2 L of water. What will be the new temperature of the water? [Assume the 2 L of water is all one temperature, and neglect heat losses to the environment during this time.]

When 42 kJ are added to 1 L, $\Delta T = 30 - 20 = +10°C$.
Therefore, when 42 kJ are added to 2L, $\Delta T = \frac{+10°C}{2} = +5°C$.

$T_f = T_i + \Delta T = 25°C + 5°C$
$= 30°C$

30°C

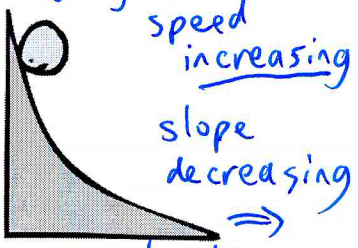
Multiple Choice Part (2 points per question)
Please fill in your answers on the provided answer-sheet. Be sure to fill in the identifying information on the top of your answer sheet. You may use pen or pencil when filling in the circles. IMPORTANT: There are multiple versions of this exam. On your bubble sheet, please fill in **1** for version.

Ch. 2

1. Galileo first stated the law of inertia, which was later refined by Newton to become Newton's first law. Which of the statements below is the best statement of Newton's first law?
   N2. A. The acceleration of an object is directly proportional to the net force acting on the object, is in the direction of the net force, and is inversely proportional to the mass of the object.
   B. Every object continues in a state of rest or of uniform speed in a straight line unless acted on by a nonzero net force.
   N3 C. For every action, there is an equal and opposite reaction.
   D. When the speed of a fluid increases, internal pressure in the fluid decreases.
   E. The work done on an object by the net force equals the change in kinetic energy of the object.

Ch. 3 (like Exercise 3)

2. What happens to the speed and acceleration of this ball as it is rolling down this curved hill?



   A. Both the speed and acceleration are constant.
   B. Both the speed and acceleration are increasing.
   C. The speed is decreasing, but the acceleration is increasing.
   D. The speed is increasing, but the acceleration is constant.
   E. The speed is increasing, but the acceleration is decreasing.

Ch. 4 (like Pr. 6)

3. Leroy, who has a mass of 100 kg, is skateboarding at 9.0 m/s when he smacks into a brick wall and comes to a dead stop in 0.3 s. What is the average force of impact on Leroy during this collision?

Impulse = change in momentum

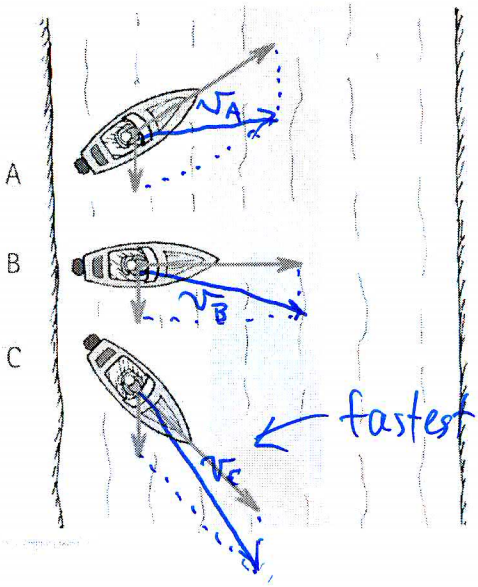
$F \cdot t = \Delta p$

$F = \frac{\Delta(mv)}{t} = \frac{100\,kg \cdot 9\,m/s}{0.3\,s} = 3000\,N$

   A. 100 N
   B. 1000 N
   C. 3000 N
   D. 4500 N
   E. 9000 N

Ch. 5 (like Ranking 4)

4. The drawing shows top views of three motorboats crossing a river. All have the same speed relative to the water, but are pointing in different directions, as shown by the longer arrows. All boats experience the same river flow, as shown by the shorter arrows. Which boat has the largest speed relative to the shore?



   A. Boat A.
   B. Boat B.
   C. Boat C.
   D. All three boats have the same speed relative to the shore.
   E. Boats A and C have the same speed relative to the shore, and this speed is larger than the speed of boat B relative to the shore.

Ch. 6

5. An apple falls, not far from a tree. As the apple is falling, which of the following statements is true?
   A. The momentum of the apple is conserved. × it is speeding up!
   B. The momentum of the apple is downward, and its magnitude constant.
   C. The momentum of the apple is downward, and its magnitude is decreasing.
   D. The momentum of the apple is downward, and its magnitude is increasing.
   E. The total momentum of the system consisting of the apple and the tree is conserved.

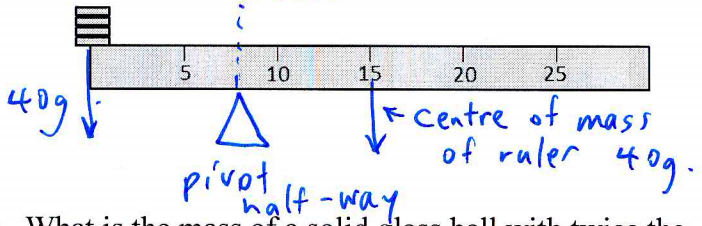
Ch. 7

6. A bag of groceries weighs 40 N. What is required in order to lift the bag a distance of 2 m upward?
   A. The bag must do about 20 Joules of work on you.
   B. You must apply a net force of about 20 Newtons to the bag.
   C. You must apply a net force of about 80 Newtons to the bag.
   D. You must do about 20 Joules of work on the bag.
   E. You must do about 80 Joules of work on the bag.

$W = F \cdot d$
$= 40\ N \cdot 2m$
$W = 80\ J$

Ch. 8 → like tutorial worksheet

7. A ruler is 30 cm long, and has a mass of 40 g. There are 4 washers stacked in a pile on the 0 cm mark. Each washer has a mass of 10 g. At what point should you place a pivot under the ruler to balance the ruler and washers?
   A. 0 cm
   B. 4 cm
   C. 7.5 cm
   D. 10 cm
   E. 15 cm



Ch. 12

8. A solid glass ball has a mass of 1 kg. What is the mass of a solid glass ball with twice the diameter?
   A. 1 kg
   B. 2 kg
   C. 4 kg
   D. 6 kg
   E. 8 kg

Density $= \frac{m}{V}$ constant.

$\frac{m_1}{V_1} = \frac{m_2}{V_2}$

Volume increases by d^3 ← scaling,
$2^3 = 8$.
$V_2 = 8 V_1$
$m_2 = \frac{V_2}{V_1} m_1 = 8 m_1 = 8\ kg$.

Ch. 13

9. Why does a life jacket help you float?
   A. If you begin to sink, the jacket sinks with you.
   B. The average density of both you and the jacket together is less than your density alone.
   C. The jacket has the same density as an average human.
   D. The jacket makes you weigh less.
   E. The jacket repels water.

Ch. 14

10. When you drink soda or water through a straw, which of the following properties are you using?
   A. Archimedes' principle
   B. atmospheric pressure
   C. Bernoulli's principle
   D. capillary action
   E. surface tension

Ch. 15 thermal expansion

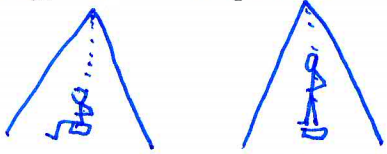
11. When a bimetallic bar made of copper and iron strips is heated, the bar bends toward the iron strip. Why does this happen?
    A. The heat flows through the iron strip slower than through the copper strip.
    B. The length of the copper strip increases faster than the length of the iron strip.
    C. The length of the iron strip increases faster than the length of the copper strip.
    D. The temperature of the copper rises faster than the temperature of the iron.
    E. The temperature of the iron rises faster than the temperature of the copper.

Ch. 16 Blackbody radiation.

12. At night a car can cool by radiating energy from its surface. Which of the following colours of paint will radiate energy the fastest?
    A. black
    B. silver
    C. red
    D. white
    E. All of these colours will radiate energy at the same rate.

Ch. 19 Period of Pendulum.

13. A child sits on a swing, and swings back and forth with a period of 3.4 seconds. If the child stands up on the swing, instead of sitting, what will the period of the swinging motion be?
    A. more than 3.4 seconds
    B. less than 3.4 seconds
    C. 3.4 seconds



Centre of mass is higher when standing so length of pendulum is shorter.

Ch. 20

14. Which of the following properties, if changed, would result in the biggest change in the speed of a sound wave in air?
    A. The frequency of the sound.
    B. The intensity of the sound.
    C. The speed of the source emitting the sound.
    D. The temperature of the air.
    E. The timbre of the sound.

None of the other choices affect the speed of sound in air.

Ch. 21 (like Exercise 34)

15. The note middle C on a piano has a fundamental frequency of 262 Hz. What is the frequency of a C-note two octaves higher than middle C?
    A. 131 Hz
    B. 262 Hz
    C. 524 Hz
    D. 786 Hz
    E. 1048 Hz

Each octave is ×2 higher in freq.
1 octave higher: 524 Hz
2 octaves higher: 1048 Hz

Ch. 22

16. What might cause a balloon to be attracted to an electrically neutral wooden wall by the electric force?
    A. If the balloon was charged, either negatively or positively.
    B. If the balloon was negatively charged. If it were positively charged it would repel the wall.
    C. If the balloon was positively charged. If it were negatively charged it would repel the wall.
    D. Nothing; a charged balloon cannot be attracted to an electrically neutral wooden wall by the electric force.

Ch. 23

17. A 10 Ω resistor has a 5 A of dc current running through it. What is the voltage across this resistor?
    A. 0.5 V
    B. 2 V
    C. 5 V
    D. 20 V
    E. 50 V

Ohm's Law: $I = \frac{V}{R}$

$\Rightarrow V = IR = (5A) \cdot 10\Omega$

$= 50\ V$

Ch. 24

18. The magnetic force on a moving charged particle
    A. can change both the direction of the particle's velocity and its speed.
    B. can change the direction of the particle's velocity, but not its speed.
    C. can change the particle's speed, but not the direction of its velocity.
    D. cannot change the particle's speed nor the direction of its velocity.

Ch. 25

19. Why is power transmitted over long distances at high voltage?
    A. Because higher voltages can reach out over longer distances.
    B. So the electric potential energy is high, increasing the kinetic energy delivered.
    C. So the current can be high, increasing the amount of power delivered.
    D. So the current can be low, reducing heating of the wires.
    E. Power is not transmitted over long distances at high voltage.

Ch. 26

20. What is the main way that radio waves are different from light?
    A. Radio waves are basically the same thing as light, but with a lower frequency.
    B. Radio waves are electromagnetic, but light is photonic.
    C. Radio waves are electromagnetic, but light is a pressure wave in the air.
    D. Radio waves are pressure waves in the air, but light is an electromagnetic wave.
    E. Radio waves are musical, but light can only carry white noise, or other colours of noise.

Ch. 27

21. If you mix cyan and yellow pigments on white paper, what colour is produced?
    A. blackish brown
    B. blue
    C. green
    D. magenta
    E. orange

look at colour wheel on pg. 1 C + Y = G.

Ch. 28

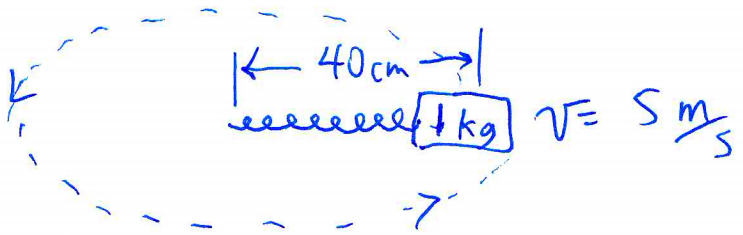
22. White light is incident upon a white piece of paper and a mirror. Which object reflects more of the incident light?
    A. The mirror
    B. The white piece of paper
    C. Both objects reflect about the same amount of the incident light.

Combo Newton's 3rd Law & Electrostatics

23. A proton and an electron are separated by a small distance. Which is true about the magnitudes of forces on they exert on each other?
    A. The electron exerts a force on the proton, but the proton does not exert a force on the electron.
    B. The electron exerts a large force on the proton, and the proton exerts a smaller force on the electron.
    C. The proton and electron exert the same amount of force on each other. ← That's Newton's 3rd Law!!
    D. The proton exerts a force on the electron, but the electron does not exert a force on the proton.
    E. The proton exerts a large force on the electron, and the electron exerts a smaller force on the proton.

Challenge: combo of Chs. 8 & 12

24. A spring ordinarily has a length of 30 cm. You then attach a 1 kg ball to the end of the end of the spring, and swing the ball around in a horizontal circular path. As it is swinging around at a speed of 5 m/s, one end of the spring is at the centre of the circular path, and the length of the spring is equal to the radius of the circular path, which is 40 cm. What is the spring constant of the spring? (You may ignore the effect of gravity in this question.)
    A. 0.625 N/m
    B. 12.5 N/m
    C. 156 N/m
    D. 625 N/m
    E. 12,500 N/m



$r = 40\text{ cm} = 0.4\text{ m}.$

Centripetal force from Ch. 8:

$$F = \frac{mv^2}{r} = \frac{1\text{ kg}\cdot(5\text{ m/s})^2}{0.4\text{ m}}$$

$$F = 62.5\text{ N}.$$

Hooke's Law from Ch. 12 (and class notes).

$F = k\,\Delta x$, where k = spring constant

$\Delta x = 40\text{ cm} - 30\text{ cm} = 10\text{ cm} = 0.1\text{ m}.$

$$k = \frac{F}{\Delta x} = \frac{62.5\text{ N}}{0.1\text{ m}} = \boxed{625\text{ N/m}}$$