



The University of Fiji



SCHOOL OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF SCIENCE

FINAL EXAMINATION SEMESTER 2, 2015

FOUNDATION PHYSICS II

PHYF 12

Time Allowed: Three hours (3 hours)

(An extra ten minutes is allowed for reading this paper)

TOTAL: 100 MARKS (50% OF THE FINAL GRADE)

INSTRUCTIONS

- 1.0 Write **all** your answers in the **Answer Book** provided.
- 2.0 There are nine (9) pages of questions in this Question Booklet (including the Cover Page)
- 3.0 Write your **Student Identification Number** on the front page of the **Answer Book**.
- 4.0 If you use extra sheets of paper, be sure to show clearly the question number(s) being answered and to tie each sheet securely in your Answer Book at the appropriate place.
- 5.0 There are 5 questions in this paper. **All the questions are compulsory.**
- 6.0 **Programmable calculators** are not allowed.
- 7.0 Unless otherwise stated, all symbols have their usual meanings.

DATA:

Acceleration due to gravity, $g = 9.8 \text{ m s}^{-2}$

Avogadro number, $N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$

Mass of the Earth, $M_E = 5.98 \times 10^{24} \text{ kg}$

Radius of the Earth, $R_E = 6.38 \times 10^6 \text{ m}$

Specific heat capacity of ice, $c_{\text{ice}} = 2090 \text{ J kg}^{-1} \text{ }^\circ\text{C}^{-1}$

Specific heat capacity of water, $c_{\text{water}} = 4186 \text{ J kg}^{-1} \text{ }^\circ\text{C}^{-1}$

Universal gravitational constant, $G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$

Universal gas constant, $R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$

Boltzmann's constant, $k_B = 1.38 \times 10^{-23} \text{ J/K}$

Stefan-Boltzmann's constant, $\sigma = 5.67 \times 10^{-8} \text{ W/m}^2 \text{ K}^4$

Rydberg's constant, $R = 1.097 \times 10^7 \text{ m}^{-1}$

Speed of light in a vacuum, $c = 3.0 \times 10^8 \text{ ms}^{-1}$

Coulomb's constant, $k = 9.0 \times 10^9 \text{ Nm}^2\text{C}^{-2}$

Charge on electron, $e = 1.6 \times 10^{-19} \text{ C}$

Electron mass, $m_e = 9.11 \times 10^{-31} \text{ kg}$

Permittivity of free space, $\epsilon_0 = 8.85 \times 10^{-12} \text{ Fm}^{-1}$

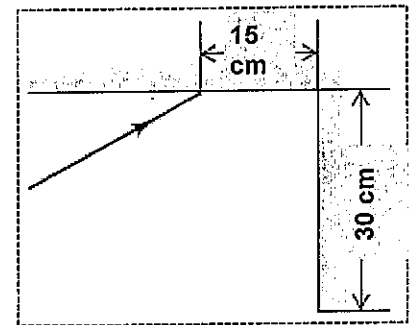
Permeability of free space, $\mu_0 = 4\pi \times 10^{-7} \text{ Tm.A}^{-1}$

Question 1 (Start on a new page)

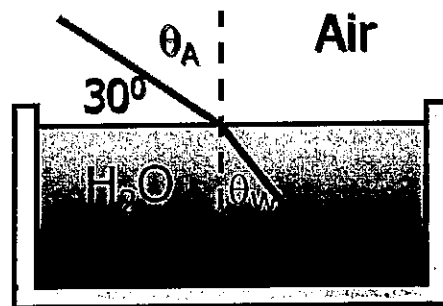
[15 Marks]

- I. Differentiate between specular and diffused reflection. [2]
- II. Why does a clear stream always appear to be shallower than it actually is? [2]

- III. Two plane mirrors intersect at right angles. A laser beam strikes the first of them at a point 15 cm from their point of intersection, as shown in Figure. For what angle of incidence at the first mirror will this ray strike the midpoint of the second mirror (which is 30 cm long) after reflecting from the first mirror? [3]



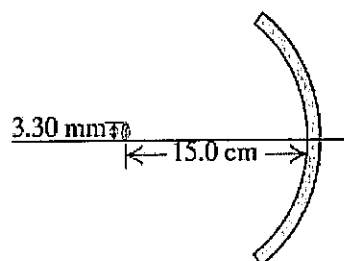
- IV. A laser beam in a darkened room strikes the surface of water at an angle of 30° . The velocity in water is 2.26×10^8 m/s. What is the angle of refraction? [3]



- V. The thin glass shell shown in the Figure below, has a spherical shape with a radius of curvature of 12.0 cm, and both of its surfaces can act as mirrors. A seed 3.30 mm high is placed 15.0 cm from the center of the mirror along the optic axis, as shown.

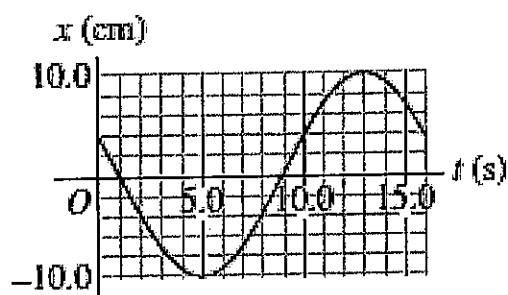
- (a) Calculate the location of the image of this seed.
- (b) Determine the height of the image of this seed.
- (c) Describe the nature of the image.

[2, 1, 2]



Question 2 (Start on a new page)**[15 Marks]**

- I. Define the term “amplitude”. [1]
- II. The displacement of an oscillating object as a function of time is shown in the Figure. For the motion depicted by the Figure, determine the following:
- (a) the frequency;
 - (b) the amplitude;
 - (c) the period;
 - (d) the angular frequency.
- [1, 1, 1, 2]



- III. A Simple Harmonic Motion is described by the following equation:

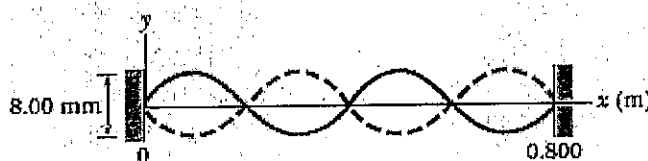
$$y = 6.5 \cos\left(2\pi t + \frac{\pi}{2}\right)$$

Calculate:

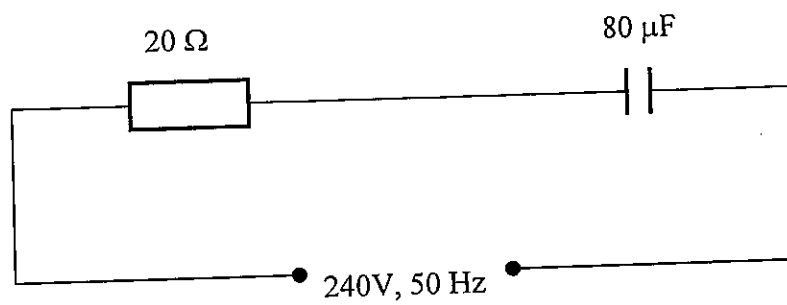
- (a) the period, amplitude and phase constant of the motion. [1, 1, 1]
- (b) the velocity at $t = 3$ s. [4]
- (c) the maximum speed. [2]

Question 3 (Start on a new page)**[25 Marks]**

- I. The scanning of delicate body tissues is usually done using an ultrasound scan. In a typical ultrasound scan, the waves travel through body tissue with a speed of 1500 m/s. For a good, detailed image, the wavelength should be no more than 1.0 mm.
- (a) What does ultrasound mean?
- (b) What frequency of sound is required for a good ultrasound scan? [2, 2]
- II. A Young's experiment is performed with light from excited helium atoms ($\lambda = 502 \text{ nm}$). Fringes are measured carefully on a screen 1.20 m away from the double slit, and the center of the 20th fringe (not counting the central bright fringe) is found to be 10.6 mm from the center of the central bright fringe. What is the separation of the two slits? [3]
- III. A sugar – cane carting train is traveling at 30 m/s in still air. The frequency of the note emitted by the train whistle is 262 Hz. What frequency is heard by a passenger on a car moving in the opposite direction to the train at 18 m/s? [3]
- IV. Figure below shows a pattern of resonant oscillation of a string of mass $m = 2.500 \text{ g}$ and length $L = 0.800 \text{ m}$ and that is under tension $T = 325.0 \text{ N}$.
- a) What is the wavelength λ of the transverse waves producing the standing-wave pattern?
- b) What is the harmonic number n ?
- c) Calculate the mass per unit length of the string.
- d) Determine the velocity of the oscillations moving on the string?
- e) What is the frequency f of the transverse waves? [2, 1, 1, 2, 2]



V. The ends of the RC circuit below are connected to an AC outlet of 240 V, 50 Hz.



Calculate:

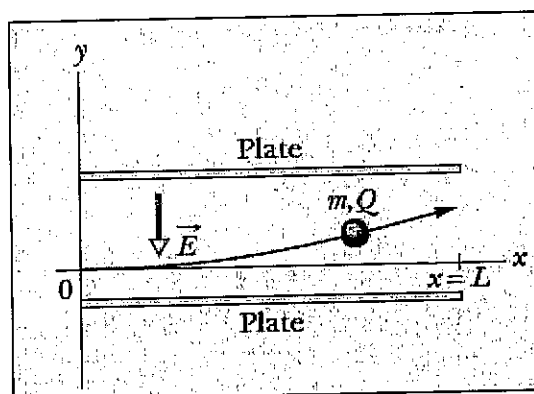
- (a) the reactance of the capacitor.
- (b) the total impedance of the circuit.
- (c) the circuit current.

[2, 3, 2]

Question 4 (Start on a new page)

[25 Marks]

- I. Explain from an atomic viewpoint why charge is usually transferred by electrons? [2]
- II. Figure below shows the deflecting plates of an ink-jet printer, with superimposed coordinate axes. An ink drop with a mass m of 1.3×10^{-10} kg and a negative charge of magnitude $Q = 1.5 \times 10^{-13}$ C, enters the region between the plates, initially moving along the x axis with speed $v_x = 18$ m/s. The length L of each plate is 1.6 cm. The plates are charged and thus produce an electric field at all points between them. Assume that field is downward directed, is uniform, and has a magnitude of 1.4×10^6 N/C. (The gravitational force on the drop is small relative to the electrostatic force acting on the drop and can be neglected.)

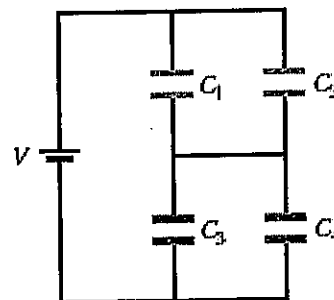


- (a) What is the acceleration of the charge due to the electric field?
- (b) How long does it take the charge to travel to the far edge of the plates?
- (c) Hence or otherwise, compute the vertical deflection of the drop at the far edge of the plates? [2, 2, 3]

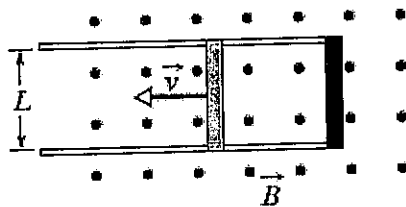
- III. The diagram below shows a combination of capacitors. The supply voltage $V = 12$ V, $C_1 = C_4 = 2.0 \mu\text{F}$, $C_2 = 4.0 \mu\text{F}$, and $C_3 = 1.0 \mu\text{F}$.

- (a) Calculate the effective capacitance of the circuit.
- (b) Calculate the charge supplied by the power supply.
- (c) What is the charge on capacitor 4 (C_4)?
- (d) Find the energy stored in the capacitor C_1 .

[3, 2, 3, 2]

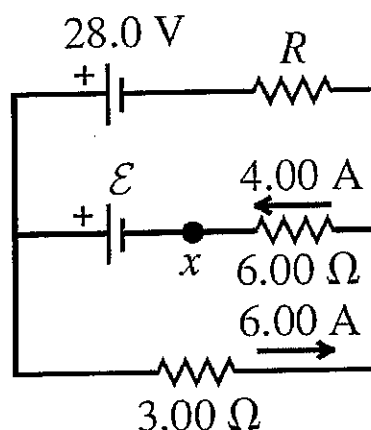


- IV. In Figure below, a metal rod is forced to move with constant velocity along two parallel metal rails, connected with a strip of metal at one end. A magnetic field of magnitude $B = 0.350 \text{ T}$ points out of the page.
- (a) If the rails are separated by $L = 25.0 \text{ cm}$ and the speed of the rod is 55.0 cm/s , what emf is generated?
- (b) If a resistor of resistance 18.0Ω is connected across the rails determine the current in the circuit.
- (c) At what rate is energy being transferred to thermal energy? [3, 1, 2]



Question 5 (Start on a new page)**[20 Marks]**

- I. The circuit shown below has 3 resistors and two power supplies. Use the knowledge of Kirchhoff's voltage and current laws to determine;
- (a) the current in resistor R;
 - (b) the resistance R;
 - (c) the unknown emf.
 - (d) If the circuit is broken at point x , what is the current in resistor R?

[4, 1, 2, 3]

- II. The emission spectrum of hydrogen consists of several series of sharp emission lines in the ultraviolet (Lyman series); in the visible (Balmer series); and in the infrared (Paschen series, Brackett series, etc.) regions of the spectrum.
- (a) What feature of the electronic energies of the hydrogen atom explains why the emission spectrum consists of discrete wavelengths rather than a continuum of wavelengths?
 - (b) Account for the existence of several series of lines in the spectrum. What quantity distinguishes one series of lines from another?
 - (c) Draw an electronic energy level diagram for the hydrogen atom and indicate on it the transition corresponding to the lines in the Balmer series.

[2, 2, 3]

- III. The work function of tungsten is 4.50 eV. Calculate the speed of the fastest electrons ejected from a tungsten surface when light whose photon energy is 5.80 eV shines on the surface.

[3]

