Physics II
030
15 Nov. 2012 8.30 am – 11.30 am

REPUBLIC OF RWANDA

RWANDA EDUCATION BOARD (REB)

ADVANCED LEVEL NATIONAL EXAMINATION 2012

SUBJECT: PHYSICS II

COMBINATIONS: **Physics-Chemistry-Mathematics PCM**
: **Physics –Chemistry- Biology PCB**
Physics – Economics- Mathematics PEM
Mathematics –Physics- Geography MPG
Mathematics- Physics- Computer science MPC

DURATION: 3 HOURS

INSTRUCTIONS:

This paper consists of **two** sections **A** and **B**.
Section A: Attempt **all** questions. **(55 marks)**
Section B: Answer **any three** questions. **(45 marks)**

Non programmable scientific calculators and geometric instruments may be used:

Useful constants:

Acceleration due to gravity:	$g = 9.81 m/s^2$
Magnitude of charge of electron:	$e = 1.6 \times 10^{-19} C$
Speed of light in vacuum or in air:	$C = 3 \times 10^{8} m/s$
Refractive index of air:	$n_a \approx 1$
Permeability of free space:	$\mu_0 = 4 \pi \times 10^{-7} Hm^{-1}$
Permittivity of free space:	$\varepsilon_0 = 8.85 \times 10^{-12} C^2/Nm^2$
Relative permittivity of air:	$\varepsilon_r = 1$
Relative permeability of air:	$\mu_r = 1$
Young's modulus of steel:	$Y = 2 \times 10^{11} Pa$

SECTION A: Attempt all questions (55 marks)

01. Describe the differences between solid, liquid, and gas in term of

(a) the arrangement of the molecules throughout the bulk of the material. **(1.5 marks)**

(b) the motion of molecules. **(1.5 marks)**

02. A concave mirror has a radius of curvature of 34 cm.

(a) State one law of reflection on the concave mirror. **(1 mark)**

(b) What is the focal length of this mirror? **(1 mark)**

(c) If the mirror is immersed in water, refractive index 1.33, what is its focal length? **(2 marks)**

03. A Carnot cycle is pictured in P-V diagram below (figure 1) where P is the pressure and V represents the volume of ideal gas.

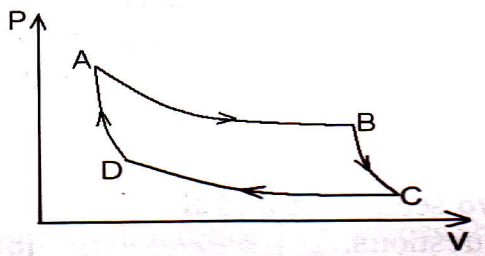

Figure 1

What thermodynamic processes are involved at boundaries CD and AB? Explain your reasoning. **(3 marks)**

04. (a) The biomass energy is renewable energy and comes from the sun. Explain this statement. **(2 marks)**

(b) State two examples, other than biomass, which come from the sun. **(1mark)**

05. (a) What is meant by an electric field? **(1mark)**

(b) A particle has charge -3 nC. Find the magnitude and direction of the electric field due to this particle at a 25 cm directly above it in air. **(2 marks)**

06. Two light bulbs of (60 W, 120 V) and (200 W, 120 V) are connected in series across a 240 V line. Assuming that the resistance of each bulb does not vary with current.

(a) Calculate the current through the bulbs. **(3 marks)**

(b) Find the power dissipated in (200 W, 120 V) light bulb. **(1 mark)**

07. While sitting in front of a colour TV with a 25 kV picture tube potential, you have an excellent chance of being irradiated with X-rays.

(a) Explain clearly how X-rays are produced, on the basis of the target atoms. **(2 marks)**

(b) How do X-rays cause damage to living tissues? **(2 marks)**

08. Calculate the power dissipated in the circuit (figure 2) if R has zero reactance but resistance 3Ω, L has zero resistance but reactance 4Ω and the applied voltage is 10 V r.m.s. **(4 marks)**

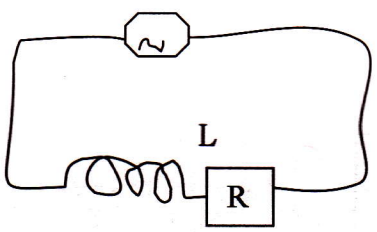

Figure 2

09. ABC is a triangular prism, made of glass of refractive index 1.5; in which the angle A is 30° and the angle C is 60°. A ray of light in air is incident normally on the face AB.

(a) What is meant by refractive index of 1.5? **(1 mark)**

(b) Determine the angle of emergence. **(3 marks)**

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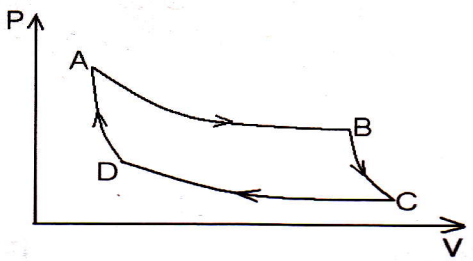

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$\frac{\mu_0 I N}{2\pi r}$

10. (a) Draw the magnetic field patterns due to a plane circular coil carrying current. **(2 marks)**

    (b) Find the magnetic induction at the centre of a circular coil of diameter 10cm and has 15 turns of wire carrying a current of 1.2 A. The coil is placed in air. **(2 marks)**

11. The wavelength of a red light from a helium neon laser is 633 nm in air but its wavelength is 474 nm in the aqueous humour inside the eye ball.

    (a)What is meant by photon? **(1 mark)**

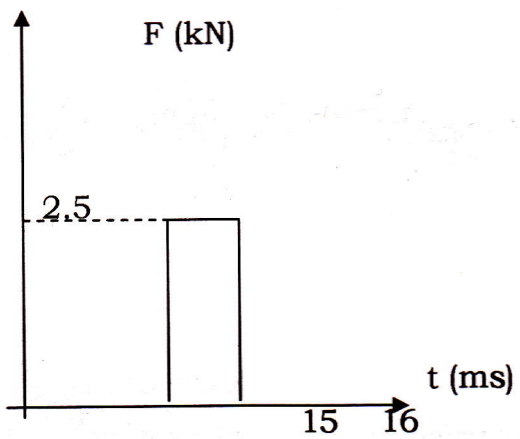
    (b) Compute the frequency of light in the aqueous humor. **(3 marks)**

12. A certain simple pendulum has a period on the earth of 1.6 s.

    (a) What is meant by period of 1.6 s of a simple pendulum? **(1 mark)**

    (b) What is its period on the surface of Mars, where $g = 3.71\ m/s^2$? **(2 marks)**

13. A 2 kg stone is sliding to the right on a frictionless horizontal surface at 5 m/s when it is suddenly struck by an object that exerts a large horizontal force on it for a short period of time. The graph in figure 3 shows the magnitude of this force as a function of time. The force acts to the left.



$\frac{\lambda}{T} = \frac{v}{f}$

$v = f\lambda$

$f = \frac{v}{\lambda}$

Figure3

(a) What impulse (magnitude and direction) does this force exert on the stone? **(2 marks)**

(a) By considering the forces on the mass, show that the motion is simple harmonic and derive an expression for the time period. Assume hat the spring obeys Hooke's law. The resistance of air is negligible.

(8 marks)

(b) A 0.5 kg stone attached to the end of an ideal spring with force constant k = 450 N/m, undergoes simple harmonic motion with an amplitude of 0.04 m. Compute

(i) The maximum speed of the stone, **(2 marks)**

(ii) The speed of the stone when it is at x = - 0.015 m, **(2 marks)**

(iii)The acceleration of the stone at x = - 0.015 m, **(1 mark)**

(iv) The total mechanical energy of the stone at any point in its motion. **(2 marks)**

(c) State the law used to solve question 18. (a) **(2 marks)**

19. (a) The two blocks in figure 5 are connected by a heavy uniform rope with a mass of 2 kg .An upward force of 90 N is applied as shown.

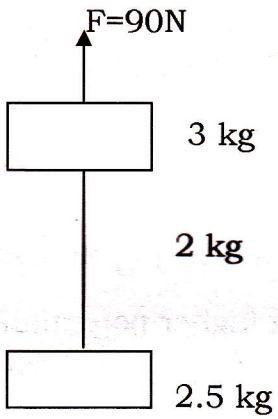


Figure 5

(i) Draw three free-body diagrams, one for the 3 kg bloc, one for the 2 kg rope and another one for the 2.5 kg block. For each force, indicate what body exerts that force. **(4 marks)**

(ii) What is the acceleration of the system? **(3 marks)**

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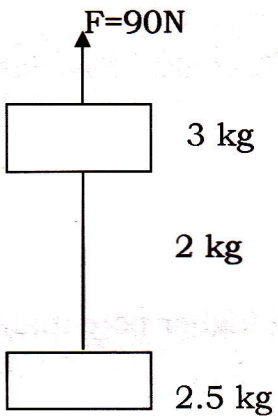

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(iii) Calculate the tension at the top of the heavy rope. **(3 marks)**

(iv) Determine the tension at midpoint of the rope. **(3 marks)**

20. Consider the circuit shown in figure 6. Let ε = 60 V, R_1 = 40 Ω, R_2 = 25 Ω, and L = 0.3 H.

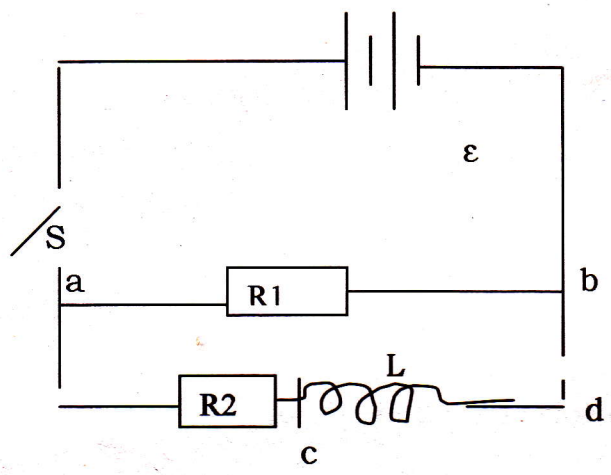


Figure 6

Switch S is closed at t = 0. Just after S is closed,

(a) What is the potential difference V_{ab} across the resistor R_1? **(2 marks)**

(b) Which point a or b is at a higher potential? **(1mark)**

(c) What is the potential difference V_{cd} across the inductor L? **(3 marks)**

(d) Which point c or d is at a higher potential? **(1 mark)**

The switch is left closed for a long time and then opened.

Immediately after the switch is opened,

(i) What is the potential difference V_{ab} across the resistor **(7 marks)**

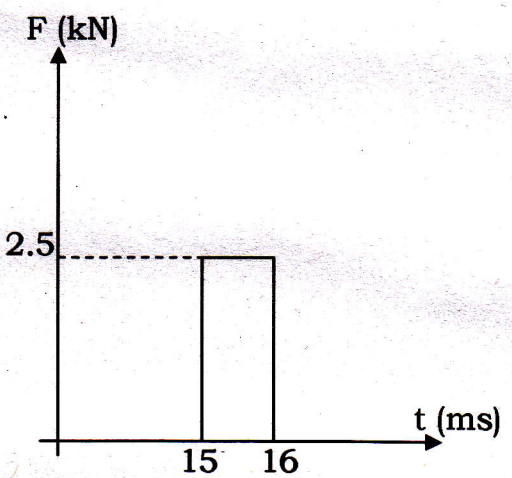
(ii) Which point a or b is at a higher potential **(1 mark)**

ERRATA

Physics II (Code:030)

Corrected diagrams for questions 13 and 20

Question 13



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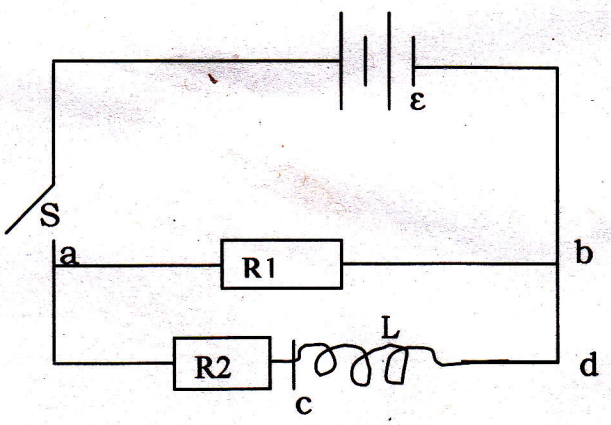

Figure 6

$v = \lambda f$

$f = \frac{v}{\lambda}$