JUNE 2016

1. (a) Explain why the homogeneity of a physical equation is not a sufficient condition for the correctness of the physical equation?

   (b) Faraday's law may be stated in the form $E = -L\frac{dI}{dt}$, where, E, is the induced emf, L is the inductance of the coil and $\frac{dI}{dt}$ is the rate of change of current. Determine the base units of L, if the equation is homogeneous.

2. A simple pendulum of length ℓ, has a period T, on the surface of the earth. The simple pendulum is carried in a space craft to a height of 2R, above the earth's surface where R is the radius of the earth. Explain where the period of the pendulum at this height would increase or decrease.

3. (a)Distinguish between thermionic emission and photo-electric effect.

   (b) An electromagnetic radiation of wavelength 6.3 x 10^{-14}m falls on a clean metal surface which has a work function of 2.25 x 10^{-14} J. Explain whether photo – electrons would be emitted or not.

4. (a) A transformer cannot be used to run a 230 V, 100 V mains lamp directly from a 12 V d.c car batter

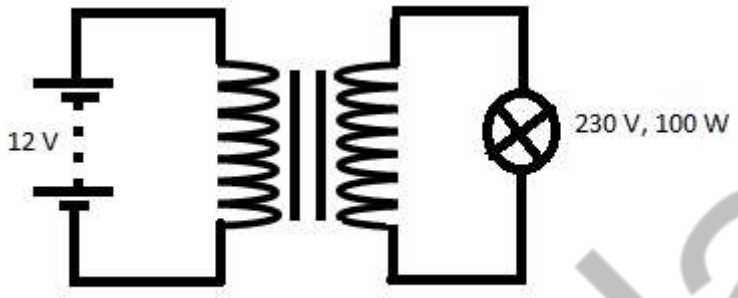

Figure 1

   Suggest in terms of fields and energy why the system cannot work

   (b) (i) Discuss how the system can be adapted to function

   (ii) What type of transformer does figure 1 represents?

5. Figure 2 shows how resistors and cells may be connected in an electric circuit.

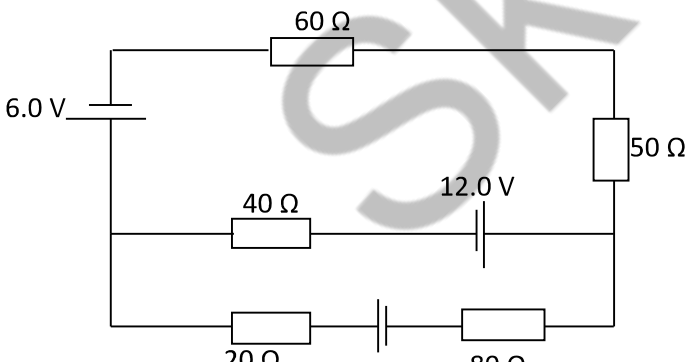

Figure 2

Calculate the:

(i) Current flowing through the 40 Ω resistors

(ii) Voltage drop across the 80 Ω resistor

6. (a) (i) Distinguish between transverse and longitudinal waves

   (ii) Describe an experiment to determine the speed of sound in air. Your account should include a diagram, procedure, precautions, observation and conclusion

   (b) A source of sound whose frequency is 51.6 Hz is placed in front of a flat vertical smooth wall, if a microphone is moved from the source directly towards the wall a series of minimum and maximum values in its output are observed at equally spaced intervals. The speed of sound at room temperature is 330 ms^{-1}.

   (i) Explain how these minimum positions are formed

   (ii) Calculate the separation of these minimum points

(iii) What can be done to increase the separation calculated in (ii) above.

(d)Explain why the specific heat capacities of gases are either measured at constant pressure or at constant volume while this is not requiring for solids or liquids.

(e) Describe an experiment to determine the specific heat capacity of a liquid. Your account should include a diagram, procedure, precautions, and conclusion.

(f) In terms of molecular behavior explain,

(i) How liquids are similar to gases but different from gases.

(g) A highly lagged compound bar 25.0 cm long is made from a copper 15.0 cm long joined to aluminum bar of equal cross – sectional area. The free end of the copper is maintained at 100^0C while that of aluminum is maintained at 0^0C. Calculate the temperature gradient for each of the bars under steady states, given that the ratio of thermal conductivities of copper to aluminum is 15:7

7.Table 1 shows the force, F, between two charged particles in a substance. The force is given by the equation $F = \frac{Q^2}{r^2 4\pi\varepsilon}$. In order to confirm this relationship the following data was recorded for various values of F and r, the distance between the charged particles. Q = 4.4 x 10^{-6} C

F/N	1.0	1.5	2.0	2.5	3.0	4.0	4.5	5.0	6.0
r/nm	355.1	297.5	258.2	230.6	210.8	182.6	172.0	163.3	149.0

Table 1

(a) Plot a suitable graph from which ε could be determine

(b) (i) Find the slope S of the graph (ii) What does S represent? (iii) Calculate the value of ε

(c) What would the nature of the forces if the experiment was conducted in a medium of higher dielectric constant?

OPTIONS

OPTION 1: ENERGY RESOURCES AND ENVIROMENTAL PHYSICS

8. (a) (i) What do you understand by finite and renewable energy resources?

(ii) Given that the mean distance of the earth from the sun is 1.5 x 10^{11} m and the power output of the sun is 4 x 10^{26} W, calculate a value for the solar constant. State the assumption that you have made in your calculation.

(b) Describe the processes by which electrical energy could be obtained from the following sources of energy.

- Geothermal energy
- Wind energy

(c) (i) Discuss the consequences on humanity of the destruction of the ionosphere layer

(ii) Explain ways by which the ionosphere can be protected from destruction.

OPTION 2: COMMUNICATION

9. (a) (i) Draw a basic block diagram of a mobile phone handset

(ii) Compare the use of optical fibres and copper cables in the transmission of information in terms of: Security, Noise, and Signal attenuation

(b) What is the full meaning of the following abbreviations?

- SIM
- SMS

(c) Explain how a radio receiver works

OPTION 3: ELECTRONICS

10. (a) Explain why a piece of pure silicon may not conduct electricity at 10^0C but would conduct at 80^0C

(b) A Capacitor, an ammeter and an a.c power source are connected in series and the readings on the ammeter noted. The capacitor and the ammeter are disconnected and connected to a d.c power source. The reading is also noted will the ammeter readings in the two cases be similar or different? Explain.
Figure 3 is an amplifier circuit using NPN transistor in the common emitter mode. The base current is 25 μF when the output voltage V_0 is 6.0 V for a current gain of 60.

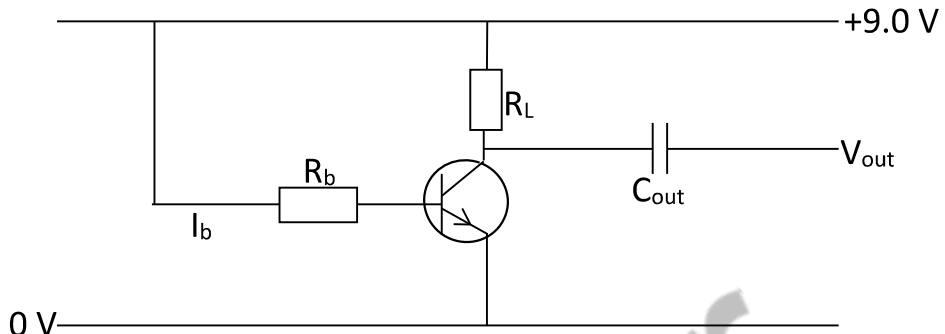

Figure 3

Calculate
(i) The base current (ii) The value of R_L (iii) Explain the use of the capacitor C_{out}

OPTION 4: MEDICAL PHYSICS

11. (a) (i) Draw a simple structure of the ear and describe how the ear functions.
(b) (i) Name two light – sensitive receptors in the human eye.
(ii) By reference to refraction at the cornea and the lens, draw a diagram showing how the rays from a distant object form a blurred image in the eye.
(iii) A patient suffering from long sight has a near point which is 1.5 m from his eyes. Determine the type of lens that the patient should use to correct this defect.
(c) Explain the principle of operation for obtaining the ECG waveform. How is it useful in diagnosing the heart problems?