JUNE 2014

1. The resonant frequency, f, of an inductor – capacitor circuit (L –C) is given by the equation $f_r = \frac{1}{2\pi\sqrt{LC}}$ where L and C are respectively the inductance and capacitance of the circuit.
   (i) Show that the equation is homogeneous.
   (ii) Calculate the inductance of the circuit if the resonant frequency is 10^4 Hz, across a circuit of capacitance 4.0 x 10^{-9} F.
2. Figure 1 shows how capacitors are connected in a circuit.

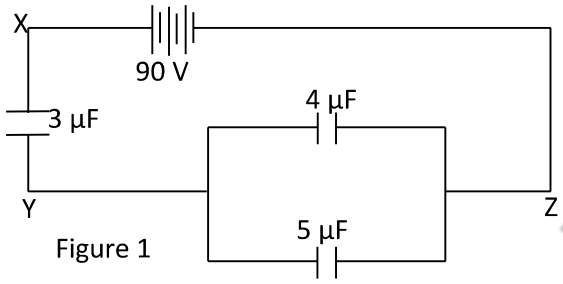
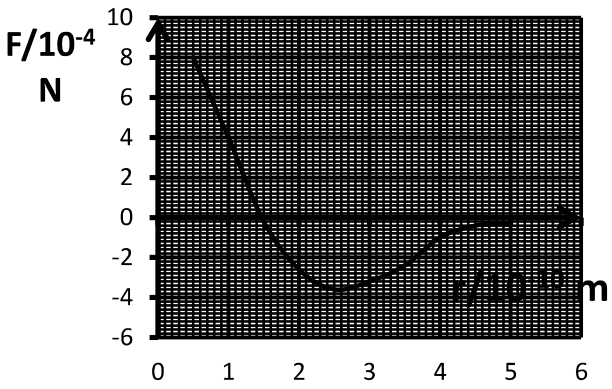


Figure 1

Calculate the
(i) Charge stored by the 4 µF capacitor.
(ii) Potential difference across YZ

3. (a) Explain why the specific latent heat of vaporization of a substance is always larger than the specific latent heat of fusion for the same substance.
   (b) A mixture of 50 g of ice and 210 g of water at 0^0 C is passed in until all the ice just melts. Calculate the mass of the water now in the container.
4. (a) Consider the acceleration of free fall on the moon's surface to be 1.6 ms^{-2}. Determine the length of a simple pendulum which has a period of 1.0 s on the moon's surface.
   (b) A particle executing simple harmonic motion has 5 times the energy of another particle but their masses and frequencies are equal. Calculate the ratio of the amplitudes for the two motions.
5. (a) Explain how the internal energy of a system is modified when it undergoes an isothermal change. In one such change, 200 J of energy was added to a system. How much work was done on or by the system?
   (b) Scientific analysis shows that light gases such as helium nuclei undergo fusion to release energy in the sun. Estimate the root – mean – square speed of helium atom of mass 6.6 x 10^{-27} kg near the surface of the sun where the temperature is about 6000 K.
6. (i) Draw a diagram of a tuning circuit of a radio.
   (ii) Distinguish between A.M and F.M radio transmission systems.
7. (a) Figure 2 shows how the force, F, between two molecules varies with the separation, r.



Use the graph to calculate

(i) The energy needed to completely separate the two molecules initially at their equilibrium separation

(ii) Calculate the gradient of the graph around the linear region. What is the significance of the slope?

8. (a) (i) Define the term resistivity

(ii) Describe an experiment you will carryout to determine the electrical resistance of a specimen of copper wire.

(b) A student designs an electrical heating element using a wire 5.0 m long of diameter 1.00mm so that it dissipates 2 KW when connected to a 240 V mains. Calculate,

(i) The resistivity of the wire

(ii) The cost of using the element for 30 days if ENEO CAMEROON charges 60 frs per kilowatt – hour and the coil is used for 6 hrs each day.

(c) Sketch on the same axis, graphs to show how the current across the following material vary with potential difference across their ends.

(i) Copper wire (ii) Silicon (iii) Filament bulb

(d) (i) Define temperature coefficient of resistance of a material.

(ii) Describe an experiment you can carryout to determine the temperature coefficient of resistance of a metal wire.

(c) A surface of a metal is illuminated with light of wavelength 590 nm. A p.d of 0.15 V is applied between the metal surface and collecting electrodes in order to prevent the collection of electrons. Calculate

(i) The work function of the metal (ii) The work done against the most energetic photoelectrons.

(iii) The speed of the most energetic electron.

(f) Light of varying frequencies is incident on the surface of three different metals, X, Y, and Z. the work function (W_0) are in the order $W_{0z} < W_{0y} < W_{0x}$. sketch on the same axis graphs to show how the maximum kinetic energies of photoelectrons vary with frequency.

9. (a) State Newton's laws of motion

(b)

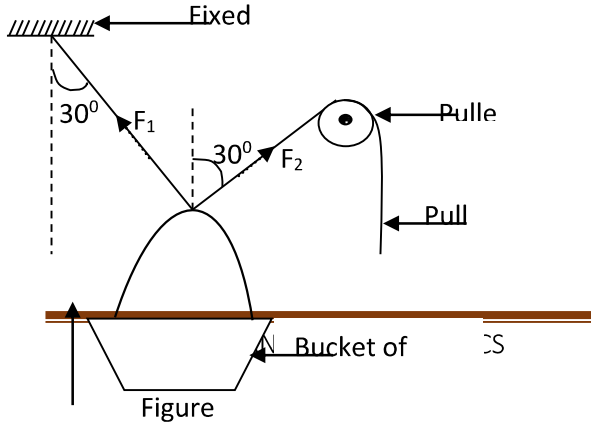


Figure 3 shows a bucket of sand which is pulled upward at a building site at the instant shown, the forces F_1 and F_2 have equal magnitudes of 600 N and the bucket is moving with an acceleration of 2 ms^{-2}. Determine the mass of the bucket and its content.

(c)

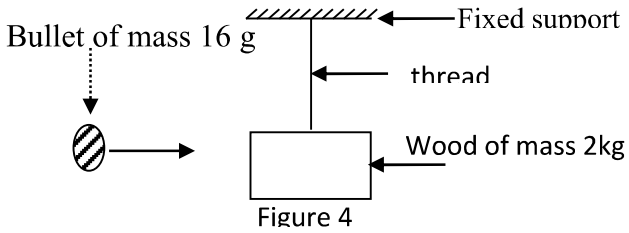


Figure 4

A bullet is fired horizontally as shown in figure 4, so that it strikes the wood with a velocity of 18 ms^{-1}. It gets embedded in a block of wood suspended freely using a long thread. Calculate

(i) The magnitude of the momentum of the bullet just before it enters the block.

(ii) The magnitude of the initial velocity of the block immediately after the impact.

(iii) The kinetic energy of the block and bullet immediately after impact and use it to say whether the or not the collision is elastic.

(iv) The maximum height attained above the equilibrium position by the block and the embedded bullet.

(d) (i) State the following laws: Newton's law of universal gravitation, Coulomb's law and Faraday's law of electromagnetic induction.

(ii)

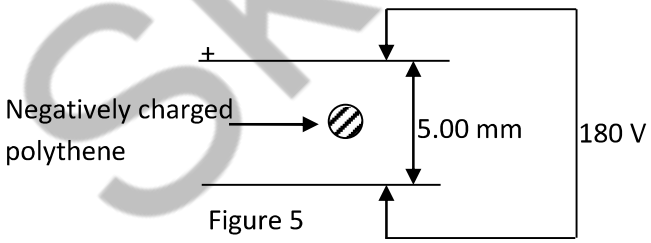


Figure 5

Figure 5 shows a negatively charged polythene sphere of mass 3.5 x 10^{-15} kg held stationary between two parallel plates. How many excess electrons are on the sphere?

(e) A space ship of mass 6.0 x10^{6} kg is launched into space so that it orbits the earth at a height, H, above the earth's surface. Where H = R_E is the mean radius of the earth.

(i) Explain why an astronaut moving about in the spacecraft at this height feels weightless.

(ii) Determine the minimum energy required to take the spaceship to the desired height. Explain why more energy is needed in the practical situation than in the calculated value?

(ii) Calculate the period of the space ship in its orbit at this height and hence explain whether or not the space ship is in a geo – stationary orbit.

10. A student used the diffraction experiment to investigate the variation of nuclear radius, R, and nucleon number, A, for several nuclear species. The corresponding value of R and A are recorded in the table which follows.

$R/10^{-15}$ m	4.4	4.7	5.0	5.3	5.7	6.0	6.2	6.5	6.8	7.0
A	25	50	75	100	125	150	175	200	225	250

R and A are related by an expression of the form $R = R_0 A^n$ where, R_0 and n are constants

(a) (i) Plot a suitable graph to determine the values of R_0 and n

(ii) Hence determine the values of R_0 and n

(b) (i) What is the physical significance of R_0

(ii) State the relationship between R and A

STUDENT'S PROPOSED ANSWERS TO JUNE 2014