JUNE 2015

1. (a) What is a homogeneous equation?
   (b) The equation $P + h\rho g + \rho v^2 = K$ is homogeneous, where P is the pressure, h is the depth, g is the acceleration due to gravity, ρ is the density, v is the velocity and K is a constant. Determine the base units of K.
2. A girl swings a stone of mass 100 g at the end of a string in a horizontal circle of diameter 80.0 cm above her head. Her friends observing the action sees a shadow of the motion of the stone on a nearby wall and and notices that the stone makes 150 revolutions in 5 minutes. Calculate
   (a) The frequency of the motion.
   (b) The centripetal force on the stone
   (c) Sketch a distance – time graph for this motion of the shadow for two cycles.
3. A quantity of steam at 100^0 C is passed into a 1.5 kg of pure melting ice in a highly insulated calorimeter so that the heat given out by the steam in condensing is just enough to melt the ice. Determine
   (a) The quantity of steam passed into the ice to melt it completely.
   (b) The equilibrium temperature attained by the mixture
4. Figure 1 show a small spherical charged metal bob 50 g which initially hangs vertically between two conducting plates. When a potential difference of 12.0 V is maintained across the plates the thread makes an inclination of 30^0 to the vertical.

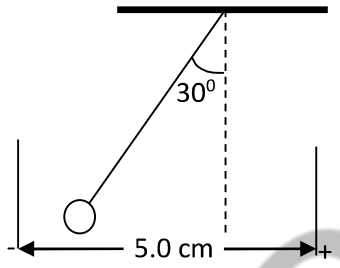


Figure 1

(a) Draw a free body diagram for the bob when the p.d is applied.
(b) Determine the charge on the bob

5. Figure 2 shows how resistors may be connected in an electrical circuit. The bridge circuit is balanced when the voltmeter M_3 reads 3.0 V

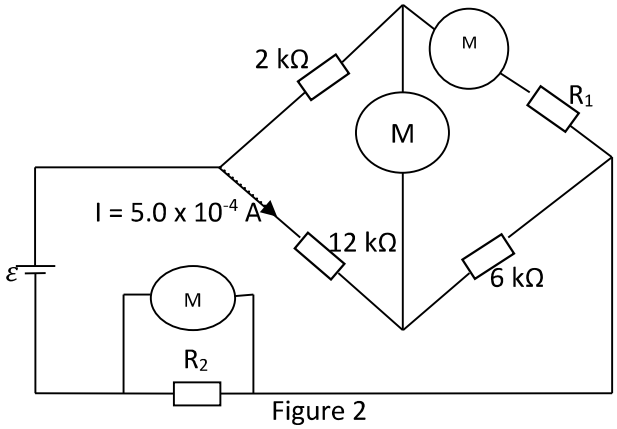


Figure 2

Determine the
(a) Reading of M_1 and M_2
(b) Resistance of R_1 and R_2

6. (a) (i) What is meant by a coherence light source?

(ii) Describe how you can determine the wavelength of monochromatic light using Young's Double slits. Your account should include a diagram, observations, precautions and how you would use the observations to reach a conclusion.

(b) A car sounding an alarm at a frequency of 512 Hz is approaching a stationary listener at a speed of 8 ms^{-1}.

(i) Explain why the listener has the impression that the frequency of the sound heard is varying.

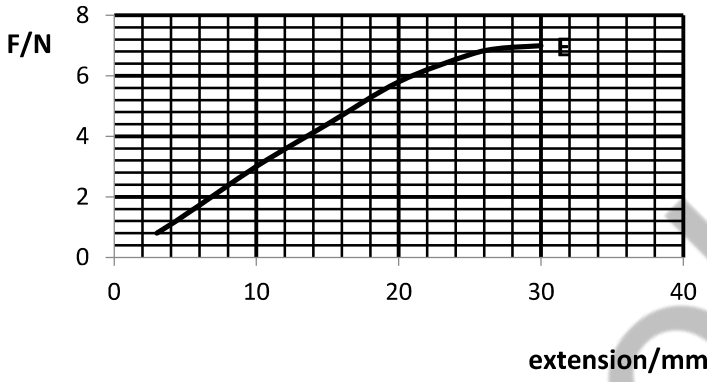
(ii) What is the apparent frequency of the horn as perceived by the listener?

(c) An object is placed 20. Cm away from a thin convex lens and then a thin concave lens each of focal length 10.0 cm and perpendicularly to the principal axis in each case. Use either ray diagrams or otherwise distinguish between the images obtained in each case when the object is brightly illuminated such that light rays from the object reach the lens parallel to the principal axis.

(d) (i) Explain what is meant by a material is elastic?

(ii) Describe an experiment to determine Young's modulus for a copper wire. Your description should include a diagram, procedure, precautions observations and conclusions.

(e) A toy having a plastic head resting on one end of a light spring is stretched as shown in figure 3



(i) Explain why there is a change in the gradient at the point E

(ii) Calculate the maximum elastic potential energy of the toy – spring system

(iii) Explain what happens to the energy of the system when the load is removed and the spring regains it original length.

(f) The kinetic theory of matter describes the behavior of a gas in terms of the properties of its molecules. Use this theory to explain

(i) Why a gas in a container at room temperature exerts pressure on the walls of the container.

(ii) Why the pressure increases when more of the same gas is introduced into the same container at the same temperature.

7. An experiment was performed to investigate how the resistance of a material wire varies with the temperature. The following data was recorded.

Resistance/Ω	Temperature
330.0	10
340.0	20
350.0	30
360.0	40

Theory suggests that the resistance of the wire is related to its temperature by the expression $R = R_0(1 + \alpha\theta)$ where R_0 is the resistance at a temperature 0^0C, and α is a constant.

(a) Plot a suitable graph from which R_0 and α could be obtained.

(b) Use the graph to obtain the values of R_0 and α

370.0	50
380.0	60
389.0	70
400.0	80
410.0	85

OPTIONS

OPTION 1: ENERGY RESOURCES AND ENVIRONMENTAL PHYSICS

8. (a) Sate two advantages of nuclear fusion over nuclear fission as sources of energy

(b) Biomass, solar energy and hydroelectricity are some of the sources of energy from which functional energy could be obtained.

(i) What is meant by functional energy?

(ii) Choose any two of the sources and briefly explain how functional energy could be obtained from them.

(c) The power derived from a windmill is given by the equation $P = \frac{\rho A v^2}{2}$, where ρ is the average air density and, A is the area of the blade and v is the average wind speed. One such aero – generator has a blade of diameter 6.0 m. given that the efficiency of the system is 25 % at a wind speed of 13.5 ms^{-1},

(i) Calculate the power output of the aero – generator. Assume the average density of the air to be 1.2 kgm^{-3}

(ii) Why is the efficiency of the system less than 100 %

(d) (i) Name a substance which is responsible for the depletion of ozone layer.

(ii) State and explain the impact of the depletion of ozone layer on the environment.

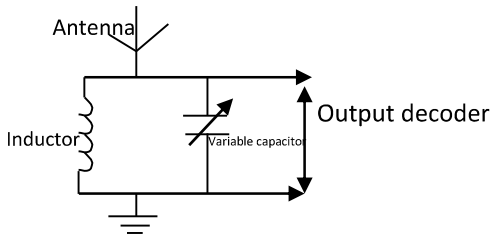
OPTION 2: COMMUNICATION

9. (a) A radio station uses a **carrier frequency** of 200 kHz to transmit an **amplitude – modulated** wave. The transmission consists of audio signals within the frequency range 50 kHz – 9 kHz.

(i) Explain the meaning of the bolded phrases

(ii) Calculate the minimum and the maximum frequency sidebands and the bandwidth.

(b) Figure 4 shows a simple tuning radio circuit.



(i) Explain how the tuning circuit functions

(ii) Given that the coil used has an inductance of 4.0 MH, calculate the value for the capacitor required to tune into the broadcast described in 9(a)

(iii) What is the use of the decoder in this circuit?

(c) (i) State three advantages which digital transmission has over analogue transmission.

(ii) Explain how several telephones conversation can be transmitted at the same time along a single optical fibre.

OPTION 3: ELECTRONICS

10. (a) (i) What is meant by thermionic emission?
    (ii) Distinguish between n – type and p – type semiconductors
    (b) You are given two circuits consisting of:
    (i) A resistor of 500Ω and a capacitor connected in series to 9.0 V d.c supply.
    (ii) An inductor and a resistor of 500 Ω connected in series to 9.0 V dc supply.
    Sketch current – time graphs for these circuits and explain the difference between them.
    (c) (i) Explain how a transistor is used as a switch.
    (ii) State in words and in the form of a truth table, the action of an OR logic gate with two inputs.

OPTION 4: MEDICAL PHYSICS

11. (a) (i) Draw a simple diagram of the human eye, showing clearly the parts which enable the eye to form an image of an object.
    (ii) Name any two eye defects, explaining how each defect manifests and explain how each defect may be corrected.
    (b) X – rays and ultrasound are two techniques used for imaging of parts of the human body.
    (i) State one part of the body where each of the techniques would be more suitable than the other.
    (ii) Explain why ultrasound is not likely to replace X – rays completely for medical diagnosis.
    (c) Explain how the magnetic Resonance (MR) scanner produces a visual image of a cross – section of a part of the body of a patient.