

ANSWER ALL QUESTIONS

1a.) The resonant frequency f_r of an inductor – capacitor circuit 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

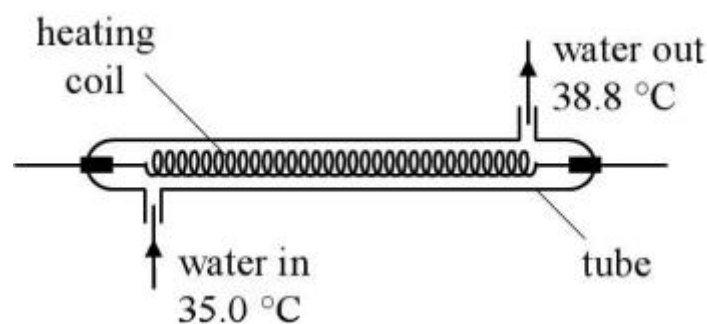
ii.) Calculate the inductance of the circuit if the resonant frequency is 10^4 Hz and the capacitance of the capacitor is $4.0 \times 10^{-9} \mu\text{F}$ **(7 marks)**

b.) Given that the AC circuit consist of an inductor of inductance 200 mH having an internal resistance of 2Ω connected in series to the capacitor of capacitance $4.0 \times 10^{-9} \mu\text{F}$ and the circuit is powered by a 240 V rms , 50 Hz ac source. Calculate

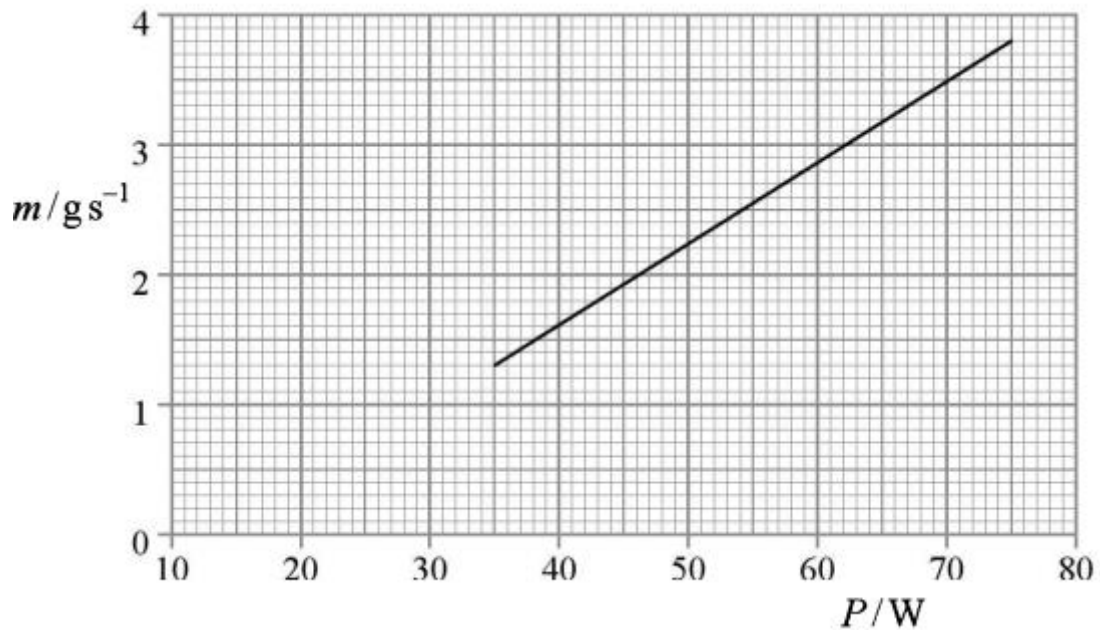
iii.) The voltage across the inductor

iv.) The maximum current through the circuit **(3marks)**

2.) a.) An electric heating coil is used to heat water flowing through a tube as shown on the diagram below.



Water flows into the tube at 35.0°C . The power P of the heater and flow rate m of the water are adjusted so that the water flowing out is always at 38.8°C . The graph below shows the variation of m with P



- i.) What is the significance of the intercept of the power axis. **(1 marks)**
 ii.) Find a value for the specific heat capacity of the water in $\text{Jkg}^{-1}\text{K}^{-1}$ **(3 marks)**

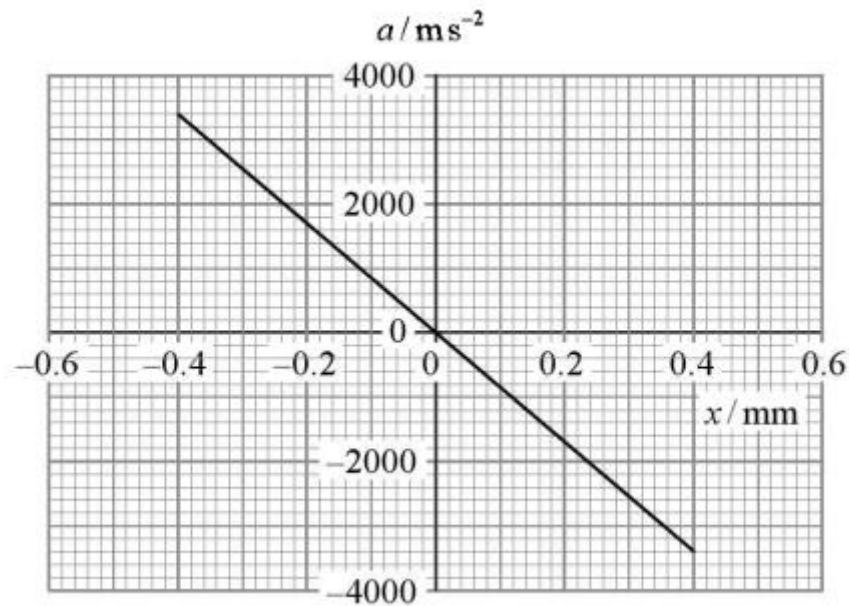
b.) An engine is used to raise an 800 Kg of iron at a speed of 6.7 m/s. 0.5 kg of glycerine initially at room temperature of 23°C is required every second to maintain the temperature of the engine being at θ . The power developed by the engine is $1.0 \times 10^5 \text{ W}$. If the specific heat capacity of glycerine is $2.5 \times 10^5 \text{ Jkg}^{-1}\text{K}^{-1}$. Calculate the value θ . **(3 marks)**

c.) A liquid in a glass vessel of wall area 595 cm^2 and thickness 2.0 mm is agitated by a stirrer driven at a uniform rate by an electric motor rated 100 W. The efficiency of conversion of electrical to mechanical energy in the motor is 75%. The temperature of the outer surface of the glass is maintained at 15°C . Estimate the equilibrium temperature of the liquid stating the assumption you made in your calculation
 (Take the thermal conductivity of glass as $0.84 \text{ Wm}^{-1}\text{K}^{-1}$) **(3 marks)**

3.) A copper wire of length 45.0cm, mass 12.3 g and electrical resistance of $1.1 \text{ m}\Omega$, falls through a horizontal magnetic field with flux density of 0.35T. As the wire falls, its ends slide smoothly down two thick vertical rails, the bottom ends of which are connected by a wire of negligible resistance

- a.) State the laws of electromagnetic induction **(2 marks)**
 b.) Explain why the wire reaches a terminal velocity **(3 marks)**
 c.) Calculate the magnitude of the terminal velocity **(3marks)**
 d.) What will be the effect on the terminal velocity if the magnetic flux intensity was increased **(2 marks)**

4.) A particle P is attached to the cone of a loud speaker . The variation of its acceleration with its displacement x is shown in the figure below.



- a.) By referring to the graph above ,

i.) Give an explanation why the motion of the particle is simple harmonic

(2 marks)

ii.) Show that the particle P is oscillating with a frequency of 460 Hz

(2 marks)
- b.) The graph has a gradient G. Given that P has a mass m and is oscillating with amplitude A , show that the maximum kinetic energy is given by $E_{max} = \frac{1}{2}mGA^2$

(2 marks)
- c.) Find E_{max} for P of mass $2.5 \times 10^{-3} \text{Kg}$

(2 marks)
- d.) Sketch a graph to show the variation of the velocity of the particle with its displacement from equilibrium position

(2 marks)

- 5.) a.) The wavelength of ultra-violet light from a source is $2.55 \times 10^{-7} \text{m}$. Determine the energy of the photon of this wavelength

(2 marks)

b.) Figure 1 below shows a zinc plate which has been cleaned , illuminated by the source referred in (a) above and placed a few millimeters beneath a piece of gauze . The plate emits photoelectrons which are attracted to the positive gauze because of their potential difference V between the plate and the gauze. Curve A in figure 2 shows the variation with V of the photoelectric current.

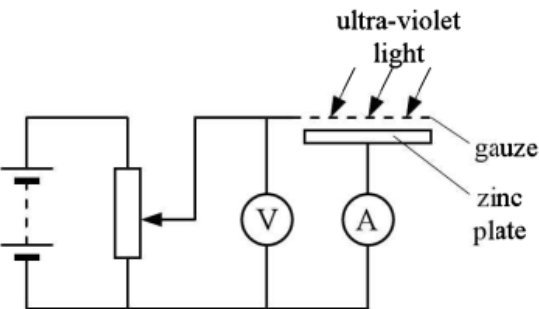


Figure 1

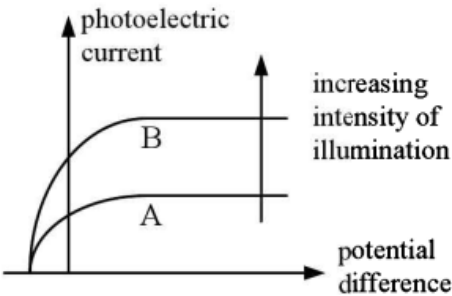


Figure 2

i.) The photoelectric current, according to the curve A, reaches a maximum value no matter how large V is made. Explain why? **(2 marks)**

ii.) The potential difference V is made negative by reversing the battery connections.

Explain why, although photoelectrons are now repelled, some still reach the gauze **(2 marks)**

c.) Curve B in figure 2 is obtained when the experiment is repeated with intensity of illumination increased

i.) The maximum photoelectric current is increased. Explain why? **(2 marks)**

ii.) The value of V necessary to prevent any photoelectric current remains constant.

Suggest why? **(2 marks)**