HONG KONG ADVANCED LEVEL EXAMINATION
AL PHYSICS
1992 Structural Question

7.

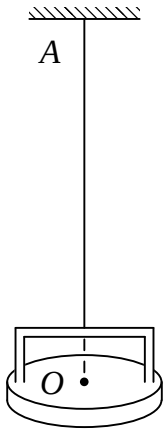


Figure 7.1

A student wants to use an 'inertia table' to determine the moment of inertia of a cylinder about its central axis. The inertia table consists of a circular platform suspended by a wire, and can be set into torsional oscillations.

(a) Indicate on Figure 7.1 the directions of the torsional oscillations of the table. (1 mark)

(b) Briefly explain the meaning of the moment of inertia of an object. (2 marks)

(c) If I = the moment of inertia of the table about the axis of oscillation, and
c = the torsional constant of the wire,
derive an expression for the period of oscillation of the table. (4 marks)

(d) If the cylinder is placed on the platform with its axis lying along the line AO, the period of oscillations changes from 2.96 s to 3.21 s. Determine the moment of inertia of the cylinder, assuming that the moments of inertia of the table is 2.2×10^{-3} kg m^2. (4 marks)

(e) Mention two possible major sources of error in this experiment. (2 marks)

8. (a)

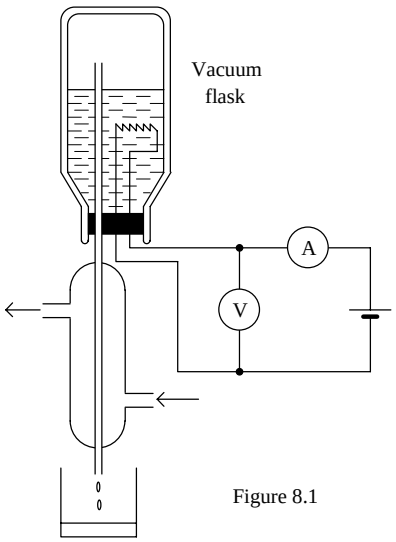


Figure 8.1

Figure 8.1 shows the apparatus used for the measurement of the specific latent heat of vaporisation of water. Under steady state conditions, the following data were obtained:

voltmeter reading	= 9 V
ammeter reading	= 6 A
time interval	= 30 min
mass of water (condensed vapour) collected	= 44 g

(i) Estimate the specific latent heat of vaporisation of water. (2 marks)

(ii) A student argues that the result obtained is inaccurate because the heat absorbed by the vacuum flask has not been taken into consideration. Explain whether this argument is correct. (2 marks)

(b) At a temperature of 100 ºC and a pressure of 10^5 Pa, 1.00 kg of steam occupies 1.67 m^3, but the same mass of water occupies only 1.04×10^{-3} m^3. For a system consisting of 1.00 kg of water changing to steam at 100 ºC and 10^5 Pa, find:

(i) the heat supplied to the system; (1 mark)

(ii) the work done by the system; (3 marks)

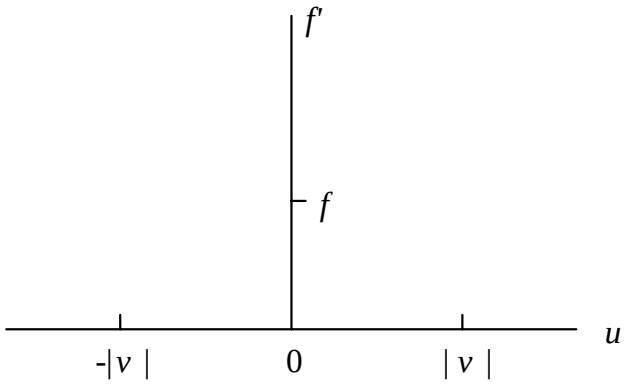
(iii) the increase in internal energy of the system. (3 marks)

(c) What happens to the internal energy absorbed during the vaporisation process? (2 marks)

9. (a) A source emitting sound waves of frequency f moves away from a stationary observer with speed u.

(i) If the speed of sound in air is v, derive an expression for the frequency f' of the waves heard by the stationary observer. (3 marks)

(ii) Sketch a graph showing how f' varies with u. (3 marks)



(b) A police radar device sends out radio waves at a frequency of 10^{10} Hz towards an approaching car. The waves reflected from the car and the incident waves produce beats at a frequency of 1.03 kHz.

(i) Estimate the speed of the car. (4 marks)

(ii) If the beat frequency can be measured to an accuracy of ± 3%, can the police use the above information to prosecute the driver for exceeding the local speed limit of 50 km/h? Explain your answer briefly.(2 marks)

10.

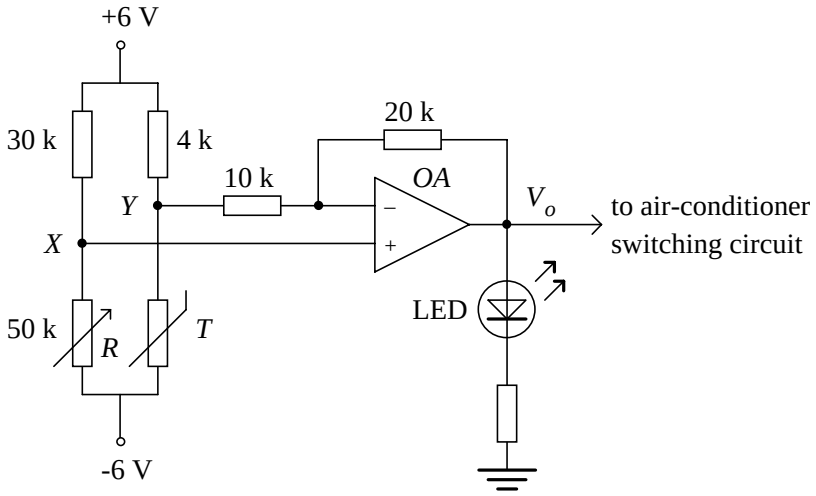


Figure 10.1

The temperature of an air-conditioned room can be controlled by means of a thermostat circuit which consists of a thermistor bridge circuit and an ideal operational amplifier *OA*. *T* is the thermistor. An indicator LED light is to be switched on if the room temperature is higher than the preset value and the air conditioner is then switched on automatically.

(a) (i) With the variable resistor *R* set at its midpoint position, the LED lights up when the room temperature is 25 ºC. If now *R* is decreased slightly the LED turns off automatically. Explain why this happens. (You may assume that the LED lights when $V_o > 0$). (3 marks)

(ii) Briefly explain how the circuit controls the switching on and the switching off of the air-conditioner. (3 marks)

(iii) What is the use of the variable resistor *R* in the bridge circuit? (1 mark)

(b) For a room temperature of 25 ºC, and with *R* set at its mid-position (R = 25 k), calculate the potential at point *X* with reference to earth. (3 marks)

11.

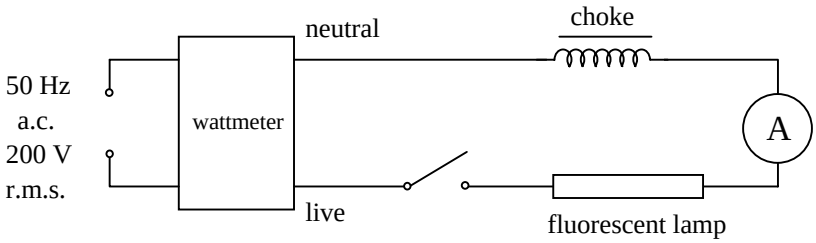


Figure 11.1

Figure 11.1 shows a simplified diagram of a domestic circuit, consisting of an inductor acting as a choke connected in series with a fluorescent lamp and an a..c. supply. A wattmeter is used to measure the power delivered to the circuit.

(a) Why is it important to connect the switch in the live wire? (2 marks)

(b) After being switched on, the ammeter in the circuit registers 0.5 A r.m.s. and the wattmeter indicates that the power delivered to the circuit is 40 W.

(i) Find the power factor of the circuit. (2 marks)

(ii) What is the phase angle between the current in the choke and the p.d. across it? Draw a phasor diagram to illustrate your answer. (Assume that when the fluorescent lamp conducts, its resistance is negligible). (2 marks)

(iii) Calculate the resistance and the inductance of the choke. (4 marks)

(c) The household voltage supply in Hong Kong is being changed form 200 V a.c. to 220 V a.c. Give one reason to support such a change. (2 marks)

12.

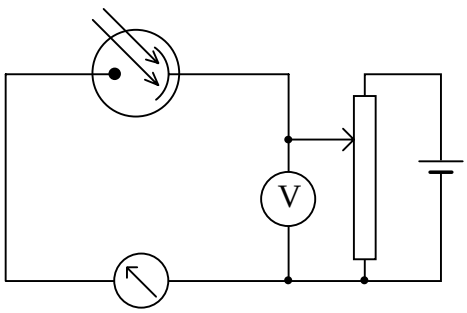


Figure 12.1

(a) In an experiment with an illuminated photocell using caesium as the cathode, a small current is detected by the microammeter even when the anode is made slightly negative with respect to the cathode, using the circuit of Figure 12.1. Briefly account for this. (2 marks)

(b) The current falls to zero only when the reverse p.d. across the tube reaches a value V_s, which varies with the frequency f of the radiation used to illuminate the cathode. Figure 12.2 shows the relationship between V_s and f.

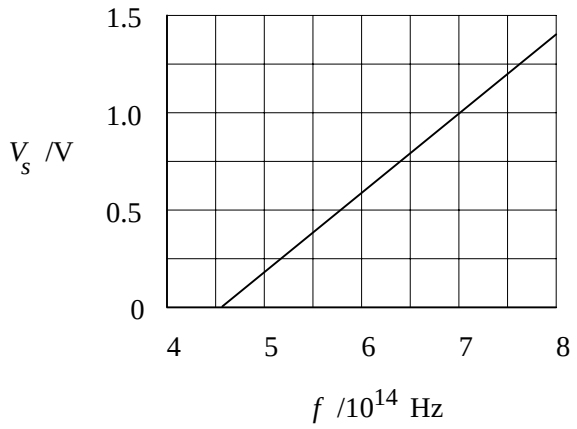


Figure 12.2

(i) What is the relationship between V_s and f as predicted by Einstein's photoelectric theory? (2 marks)

(ii) What is the value of the threshold frequency for caesium? (1 mark)

(iii) If the electronic charge is 1.6×10^{-19} C, estimate a value for the Planck constant. (2 marks)

(iv) Calculate the work function for caesium in electron-volts. (3 marks)

(v) Sketch on Figure 12.2 the corresponding variation between V_s and f for a photocell whose cathode has a larger work function than caesium. (2 marks)

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