In addition to the 1 hour, candidates are allowed a reading time of 10 minutes. Candidates must NOT write in their answer booklets during this time.

READ THE FOLLOWING DIRECTIONS CAREFULLY

1. Answer ANY THREE questions.

2. ALL WORKING MUST BE SHOWN in your answer booklet, since marks will be awarded for correct steps in calculations.

3. The use of non-programmable calculators is allowed.

4. Mathematical tables are provided.
1. (a) Describe how you would determine the latent heat of fusion of ice. Your account should include the method and outline the calculations which you would make. (8 marks)

   (b) A glass contains 0.25 kg of water at 0°C. 0.15 kg of ice, also at 0°C, is added to the water and it is noticed that after 11 minutes all the ice has melted and all the water is now at 15°C. Assuming that the thermal capacity of the glass may be ignored, calculate the

   (i) thermal energy absorbed by the ice for it to melt
   (ii) total thermal energy absorbed by the contents of the glass
   (iii) average rate of energy absorption by the contents of the glass.

   (The specific latent heat of ice is $3.4 \times 10^7$ J kg$^{-1}$ and the specific heat capacity of water is 4200 J kg$^{-1}$ K$^{-1}$) (9 marks)

   (c) An electrical heater, rated at 750 W, is used to raise the temperature of the water to boiling point. Calculate how long this would take if no heat is lost to the surroundings. (3 marks)

   Total 20 marks

2. (a) (i) The terms electric field, electric charge and potential difference are frequently encountered in the study of electrostatics. Define the unit in which EACH of these quantities is usually expressed.

   (ii) Distinguish between electric field and electric field strength.

   (iii) Draw a diagram to represent the electric field between two oppositely charged parallel plates.

   (iv) Write down an equation relating, the electric field, the potential difference between the two plates, and the distance between them. (8 marks)

   (b) In a television tube a beam of electrons is accelerated through a potential difference of 5 000 V.

   (i) Find the energy gained by a single electron as it moves through this potential difference.

   (ii) Calculate its final speed.

   (iii) If the current in the electron beam is 2.0 mA, calculate the number of electrons passing a point in the tube in one second.

   (iv) Electrons travel down the tube and strike a screen at the far end causing the screen to give out light. Find the energy converted per second as the electrons strike the screen.

   (Charge on electron = $1.6 \times 10^{-19}$ C, mass of electron = $9.1 \times 10^{-31}$ kg.) (12 marks)

   Total 20 marks
3. (a) (i) Explain with the aid of a diagram, how the human eye forms an image.

(ii) State the characteristics of the image formed and compare the properties of this image with that formed by a diverging lens. (8 marks)

(b) 

Figure 1

*Figure 1* shows a thick-bottomed, glass aquarium containing water. A beam of light from a submerged source, S, is incident on the base at point X. The angle of incidence at X is 58°. If the refractive index for light going from water to glass is 1.13, calculate the

(i) angle of refraction in the glass.

(ii) critical angle for light striking the glass to air boundary.

(Refractive index for air to glass = 1.50.) (6 marks)

(c) Use the angles you have calculated to draw a diagram showing the path of the refracted beam after it leaves X. Partial reflection also occurs at X. Draw the reflected ray on your diagram. (6 marks)

Total 20 marks
4. (a) (i) Define the moment of a force and state the principle of moments.

(ii) Describe how you would find the centre of gravity of a piece of cardboard of irregular shape.  

(b) **Figure 2** represents a tray held horizontally by a waiter. The tray has a weight of 6 N and supports a drink of weight 3 N. The waiter provides a force at P. The tray may pivot about point T.

![Figure 2](image)

(i) Use the information in **Figure 2** to find the force provided by the waiter at P and the upward force the hand exerts at T.

(ii) The drink is moved along the tray closer to the hand. Is the force needed at P to keep the tray horizontal now less, greater or the same? Explain your answer.

(iii) How much work is done by the waiter in lifting the tray and drink through a height of 0.60 m?

Total 20 marks

5. (a) **Figure 3** shows two circuits, A and B. When the switch, S, is closed the lamp, L, lights. Explain how this occurs.

(i) If the battery in circuit B were to be replaced by an a.c. supply, would the lamp still light? Explain your answer.

Total 20 marks
Figure 4

A copper rod, connected to a battery, is suspended in the centre of the magnetic field of a solenoid in **Figure 4**. The copper rod experiences a force.

(i) Explain the origin of this force and determine its direction, stating any rule you use.

(ii) Would the magnitude and direction of the force change if the current in the coil were reversed? Explain your answer.

(iii) The current in the solenoid is gradually increased. Explain the effect of this on the tension in the suspending wires.

(12 marks)

Total 20 marks

**END OF TEST**