



JUNE XXXX

INTERMEDIATE LEVEL

Subject Title	Engineering Science 2
Subject Code No.	5155
Paper No.	TWO

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Duration: 2 hours 30 minutes

Paper two carries 60% of the total mark

Attempt any six questions

All questions carry equal marks

Where necessary, take the value of the acceleration of free fall as  $10\text{m/s}^2$  and  $\pi$  as  $22/7$

Calculator are allowed

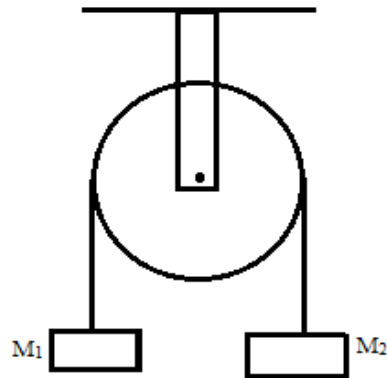
You are reminded of the necessity for good English and orderly presentation in your answers.

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*Turn Over*

1)

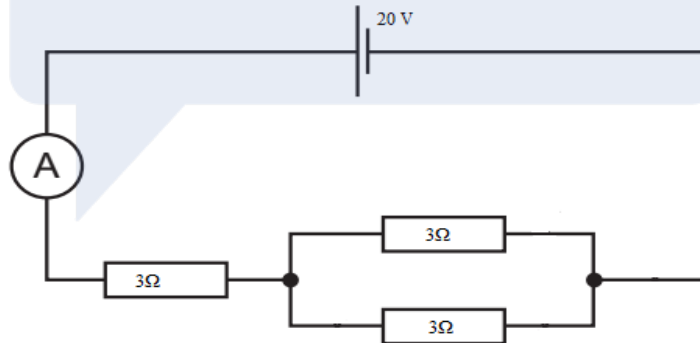
Two objects with masses  $M_1$  and  $M_2$  are suspended on a smooth pulley by an inelastic string as shown in figure 1 below



**Figure 1**

- (a) Explain the terms.
- Smooth pulley
  - Inelastic string
- (b) Copy the diagram and indicate all the forces acting in the system.
- (c) If  $M_1 < M_2$ , indicate the direction of the motion of each particle on the diagram in (b) above and establish the equations of motion for the system.
- (d) Given that  $M_1 = 2\text{kg}$  and  $M_2 = 3\text{kg}$ , calculate the tension in the string and the acceleration of the system.
- (e) State one condition necessary for the system to be in equilibrium.

- 2) (a) Three identical resistors are connected to a 20V power supply as shown in Figure 2 below.

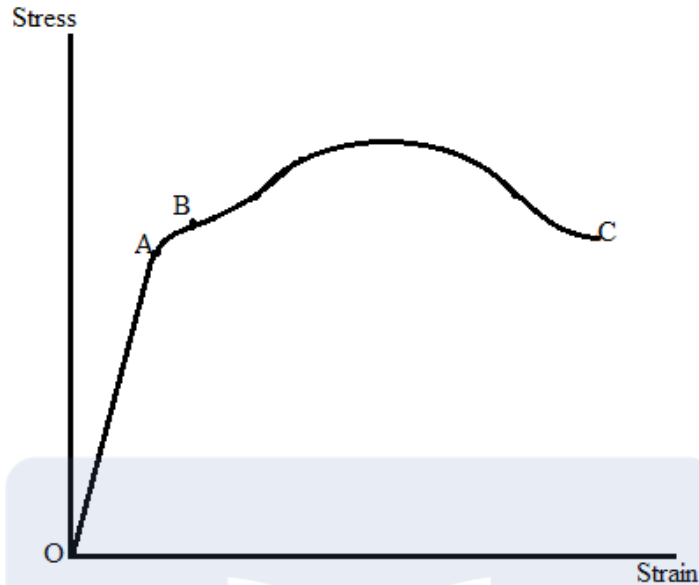


**Figure 2**

- State Ohm's law.
  - Calculate the combined resistance of the circuit.
  - Calculate the current flowing in the circuit.
  - Calculate the voltage drop across the resistors connected in parallel.
- (b) A resistor manufactured from a tungsten wire has the following characteristics:  
Resistance =  $4.7\Omega$ , Power = 10 W, Cross sectional area =  $2.0 \times 10^{-7} \text{m}^2$ , Resistivity =  $5.0 \times 10^{-7} \Omega\text{m}$ .  
Determine:
- The maximum current that should pass in the resistor.
  - The maximum p.d. across the resistor.
  - The length of wire used to make the resistor.

- (c) An electric kettle of power 2300 W is connected to the 230 V mains supply.
- What is the current through the kettle? **(2 marks)**
  - 8A, 10A, 12A fuses are available, choose a fuse to use in the plug of the kettle)? **(2 marks)**
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- 3) (a) Figure 3 shows the stress-strain graph for a mild steel wire.



**Figure 3**

- Label the points A, B and C. **(3 marks)**
  - State the relationship for the stress and the strain within OA. **(1 mark)**
  - Which law is satisfied by the relationship in a(ii) above? **(1 marks)**
  - The wire of diameter 3 mm is 50 cm long. It produces an extension of 0.3 mm when a force of 890N is applied. Calculate the modulus of elasticity of mild steel. **(4 marks)**
- (b) Plastics are used in making many different types of items used in our homes, offices, industries, etc.
- State three factors responsible for the extensive use of plastics. **(3 marks)**
  - How can plastics be disposed of so as not to cause pollution? **(1 mark)**
  - Name the industrial process used for manufacturing plastics. **(1 mark)**
  - Name one type of plastic manufactured by the process in b(iii) above. **(1 mark)**
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- 4) (a) Consider the following ions:  $H^+$ ,  $OH^-$ ,  $Na^+$ ,  $Cl^-$ ,  $Li^+$ ,  $Br^-$ . Which ion is present in the following solutions?
- Acidic solution. **(1 mark)**
  - Alkaline solution. **(1 mark)**
- Which two ions will combine to form the following substances?
- Water. **(2 marks)**
  - Sodium chloride. **(2 marks)**
  - Name the bond type present in sodium chloride. **(1 mark)**
- (b) The electronic configuration of magnesium and chlorine are given as: Mg: 2, 8, 2; Cl: 2, 8, 7
- How many electrons will magnesium lose to form an ion? **(1 mark)**
  - How many electrons will chlorine gain to form an ion? **(1 marks)**
  - Write the chemical formula of magnesium chloride. **(1 mark)**

- (c) (i) State the laws of magnetism. (2 marks)  
 (ii) Two bar magnets are placed as shown in Figure 4 below.



**Figure 4**

Copy the diagram and draw the magnetic field lines, indicating the neutral point. (3 marks)

- 5) (a) State two methods by which heat can be transferred from one place to another. (2 marks)  
 (b) (i) Which three energy transformations take place in a television set? (3 marks)  
 (ii) Among the energy transformations in b(i) above, which two are useful in a television? (2 marks)  
 (iii) Explain why a television set has ventilation slots at the back. (1 marks)  
 (c) Explain why fitting each of the following when building a house will reduce heat loss.  
 (i) Cavity wall insulation. (2 marks)  
 (ii) Double glazing. (2 marks)  
 (d) A student whirls a stone of mass 4 kg in a circle of radius 1.2 m, completing one revolution in 1.4 seconds. Determine  
 (i) The speed of the stone. (2 marks)  
 (ii) The tension in the student's arm. (Ignore the mass of the arm) (1 mark)

- 6) (a) Consider the table below

Liquid	Boiling point ( $^{\circ}\text{C}$ )	Freezing point ( $^{\circ}\text{C}$ )
Alcohol	78	-130
Mercury	350	-39

State with a reason which liquid is suitable for measuring

- (i) Low temperatures. (2 marks)  
 (ii) High temperatures. (2 marks)  
 (iii) State two reasons why water is not a good thermometric liquid. (2 marks)  
 (b) Explain the meaning of the following as used in thermometers.  
 (i) Lower fixed point. (3 marks)  
 (ii) Upper fixed point. (3 marks)  
 (c) Draw the symbols for the following electronic components.  
 (i) NOT gate. (1 mark)  
 (ii) Capacitor. (1 mark)  
 (iii) Diode. (1 mark)

- 7) (a) (i) What is electromagnetic induction? (2 marks)  
 (ii) State two ways by which the e.m.f. induced in a coil can be increased. (2 marks)  
 (iii) A conductor of length 100 mm lies at an angle of  $30^{\circ}$  to a magnetic field of strength 0.1 T. Calculate the force exerted on the conductor if it carries a current of 2 A. (3 marks)  
 (b) Draw the safety symbols for the following  
 (i) Risk of electric shock.  
 (ii) Toxic chemical.  
 (iii) Radioactive substance.  
 (iv) Risk of fire. (4 marks)  
 (d) (i) Name the greenhouse gas released when fossil fuels are burnt. (1 mark)  
 (ii) What is the consequence of increasing levels of green house gases in the atmosphere? (1 mark)  
 (iii) Name two substances that can cause atmospheric pollution. (2 marks)

- 8) (a) The critical angle of light travelling from water to air is  $49^\circ$ .
- (i) Calculate the refractive index of water. **(2 marks)**
- (ii) If the angle of incidence is  $20^\circ$ , use your answer from a(i) above to calculate the angle of refraction. **(2 marks)**
- Find (b) An object placed 6 cm in front of a convex lens of focal length 15 cm produces a magnified image.
- (i) image distance. **(2 marks)**
- (ii) the magnification of the lens **(1 mark)**
- (c) Figure 5 below is a wave profile.

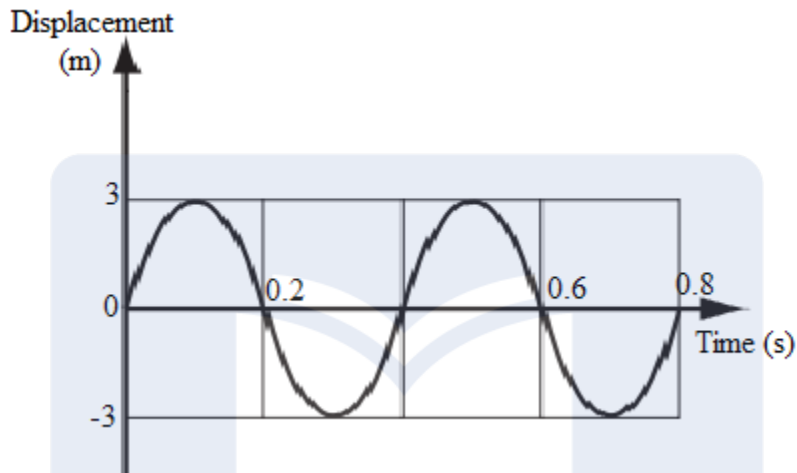


Figure 5

Determine:

- (i) The period. **(1 mark)**
- (ii) The frequency. **(1 mark)**
- (iii) The amplitude. **(1 mark)**
- (iv) The wavelength given that the speed of the wave is 10 m/s. **(2 marks)**
- (d) Figure 6 below is a logic gate.

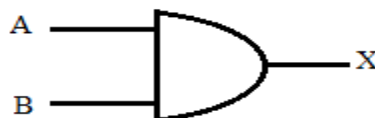


Figure 6

- (i) Identify the logic gate. **(1 mark)**
- (ii) Construct the truth table for the logic gate. **(2 marks)**