TEST CODE 002471

FORM TP 99219

PILOT/JUNE 1999

CARIBBEAN EXAMINATIONS COUNCIL

ADVANCED PROFICIENCY EXAMINATION

PHYSICS

UNIT 1 - Paper 01

2 hours

In addition to the 2 hours, candidates are allowed a reading time of 15 minutes. Writing may begin during the 15-minute period.

READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This paper consists of TWELVE questions. Candidates must attempt **ALL** questions.

2. Candidates MUST write in this answer booklet and all working MUST be clearly shown.

1. A ball of weight 0.4 N, with a string tied to it, is suspended from a point B. The ball is pulled aside by a horizontal force, F, as shown in **Figure 1** below, so that the string makes an angle θ with the vertical.

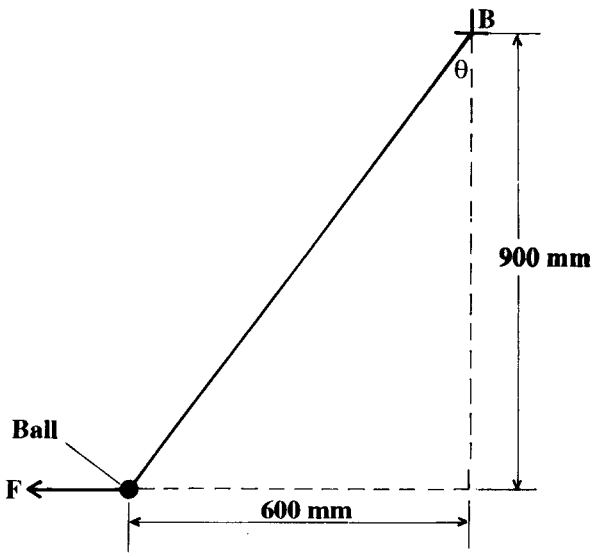

Figure 1

The ball remains at rest in this position.

(i) By taking moments about B, or otherwise, calculate the magnitude of the force, F.

[3 marks]

(ii) A tension force, T, in the string, acts on the ball. Show this force on **Figure 1** above and explain why this force does not cause any turning effect about B.

_____

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_____

[4 marks]

GO ON TO THE NEXT PAGE

(iii) Calculate this tension, T, in the string.

[3 marks]

Total 10 marks

2. (a) A body of mass, m, starts from rest and moves a distance, S, when a constant force, F, acts on it. Show that the kinetic energy, E_K, gained by the body is given by

$E_K = \frac{1}{2} mv^2$, where v is the velocity.

[4 marks]

(b) (i) A truck of mass 1500 kg, travels at a steady speed of 72 km h^{-1}. Calculate the force exerted by the engine if the power output is 80 kW.

[3 marks]

(ii) What is the total drag force acting on the truck?

_____

[1 mark]

(iii) The truck is now travelling with constant acceleration of 3.0 m s^{-2}. Assuming the total drag force is the same as that stated in (b) (ii) above, calculate the total force now exerted by the engine.

[2 marks]

Total 10 marks

3. (a) State Newton's law of gravitation, and explain what is meant by gravitational field strength.

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[2 marks]

(b) A satellite is in a circular orbit above the equator of the earth.

(i) Show that the radius, r, of the orbit of the satellite moving with angular velocity, ω, is given by the expression

$$GM = r^3\omega^2$$

where M is the mass of the Earth.

[3 marks]

(ii) When viewed by an observer on the earth, the satellite appears to remain stationary. Find the angular velocity, ω, of the satellite.

[2 marks]

(iii) At what radius, r, of the orbit, would the satellite appear to remain stationary?

[3 marks]

Total 10 marks

4. (a) State Newton's laws of motion.

[3 marks]

(b) A barrel of mass 20 kg is being pulled up a smooth plane, inclined at 30° to the horizontal, by means of a rope which is parallel to the surface of the plane.

(i) Show, on a diagram, the force(s) acting on the barrel.

[2 marks]

(ii) If the tension in the rope is 240 N, what is the acceleration of the barrel?

[3 marks]

(iii) What is the reaction force between the barrel and the plane?

[2 marks]

Total 10 marks

5. (a) The graph shown in **Figure 2** below shows the variation of displacement with time for a mass oscillating freely on a spring.

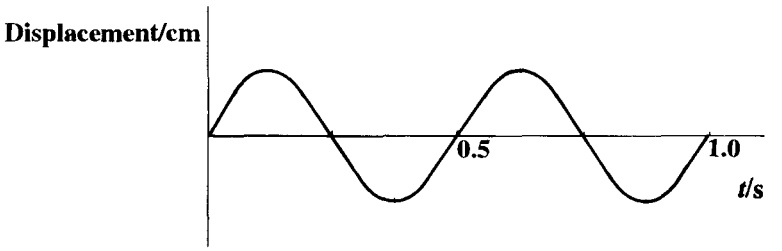
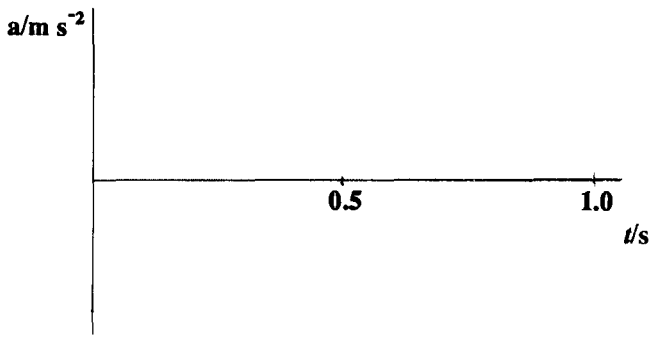


Figure 2

(i) On the axes below, show clearly how the acceleration varies with time for the same mass.



[2 marks]

(ii) Given that the mass above was 500 g, calculate the force constant of the spring.

[3 marks]

(b) **Figure 3** below shows the variation of kinetic energy with displacement for the mass-spring system. On the same diagram, draw the graph showing the variation of potential energy with displacement for the same system.

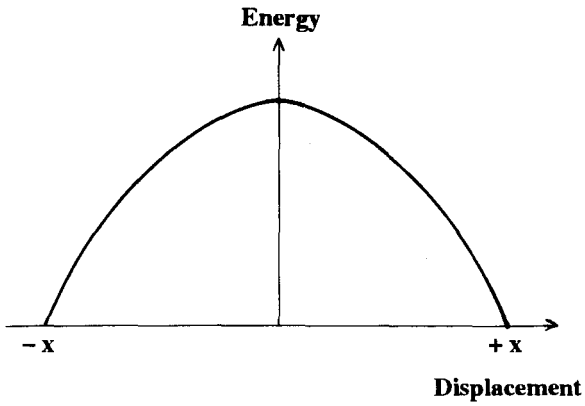


Figure 3 **[2 marks]**

(c) A pendulum has a length of 1.80 m and a bob of mass 2 kg. The bob is pulled aside a horizontal distance of 20 cm and then released. Calculate the kinetic energy of the bob as it passes through its lowest position. Assume no energy dissipation.

[3 marks]

Total 10 marks

6. (a) Distinguish between a stationary wave and a progressive wave, making reference to the amplitude and phase of the particles of the medium through which they move.

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[2 marks]

(b) State THREE conditions necessary for two-source destructive interface of sound waves to be observed.

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[3 marks]

(c) Imagine that you are standing in a room in which stationary sound waves exist. Describe what you would hear over a period of time, if you were standing at a position where an antinode occurs. Assume that your ears can follow any variation of sound intensity which may occur.

_____

_____

[1 mark]

(d) **Figure 4** below demonstrates an experiment to calculate the speed of sound in air using stationary sound waves. The speaker lies 2 m from the metal reflector, generates waves of frequency 600 Hz and wavelength 0.56 m. A stationary wave pattern is set up between the reflector and the speaker.

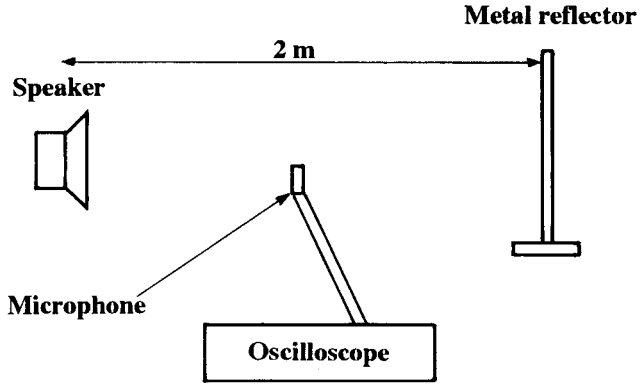

Figure 4

(i) State the distance apart of the nodes.

_____

[1 mark]

(ii) Calculate the speed of sound for this experiment.

[2 marks]

(iii) Describe what happens to the trace on the oscilloscope screen when the microphone is gradually moved towards the plate.

_____

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_____

[1 mark]

Total 10 marks

7. (a) Two light sources are said to be coherent. Describe what is meant by the term 'coherent'.

_____

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[3 marks]

(b) A double slit arrangement for light waves is set up as shown in **Figure 5**. The slits are 0.1 mm apart. The positions of the first two maxima, P and Q, on either side of the central maximum are shown.

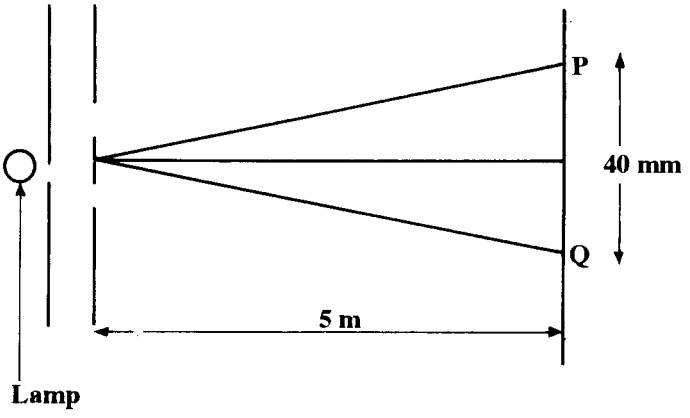

Figure 5

(i) Calculate the wavelength of the light used.

[3 marks]

(ii) Without doing any further calculations state the distance apart of the two second-order maxima.

_____

[1 mark]

(c) A transparent plastic layer is placed to the right of the double slit, covering the lower slit in **Figure 5**. Explain how the central maximum would change.

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[3 marks]

Total 10 marks

8. (a) Light is described as 'electromagnetic radiation'.

(i) Explain what is meant by 'electromagnetic radiation'.

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_____

[1 mark]

(ii) Give ONE other example of this form of radiation.

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[1 mark]

(b) You can hear the sound coming out of the door of an otherwise closed room while standing in position A, as shown in **Figure 6**, even though you are not in line with the door and cannot see the sound source.

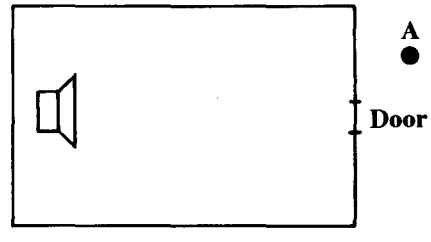

Figure 6

Explain this phenomenon.

[2 marks]

(c) A beam of light consists of two wavelengths of 7.0×10^{-7}m and 5.0×10^{-7}m. Which wavelength could represent red light?

[1 mark]

(d) The beam is directed at a transparent material, making an angle of incidence of 30°, as shown in **Figure 7**. The refractive index of the material for the longer wavelength is 1.51 and the angle separating the two refracted rays in the material is 0.3°.

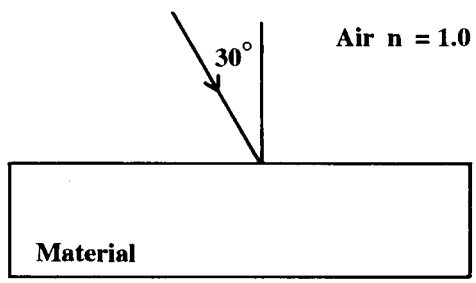

Figure 7

(i) Calculate the angle of refraction in the block for the longer wavelength.

[3 marks]

(ii) State the angle of refraction in the material for the second wavelength.

[1 mark]

(iii) Calculate the speed of the red light as it passes through the material.

[1 mark]

Total 10 marks

9. (a) Describe THREE properties that are required of a satisfactory thermometric material.

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[3 marks]

(b) The graph on page 15 shows how the resistance of a thermistor varies with temperature measured on the centigrade scale of a mercury-in-glass thermometer.

(i) At what temperature on the mercury scale is the resistance of the thermistor 500 Ω?

_____

[1 mark]

(ii) If the thermistor were used as a thermometer calibrated at the ice point and steam point, what temperature on the thermistor's empirical scale would correspond to 65.0 degrees centigrade on the mercury-in-glass scale?

[4 marks]

(iii) Why is there such a large difference between the temperatures on the two temperature scales? What can be done to get better agreement between the two temperature scales?

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_____

[2 marks]

Total 10 marks

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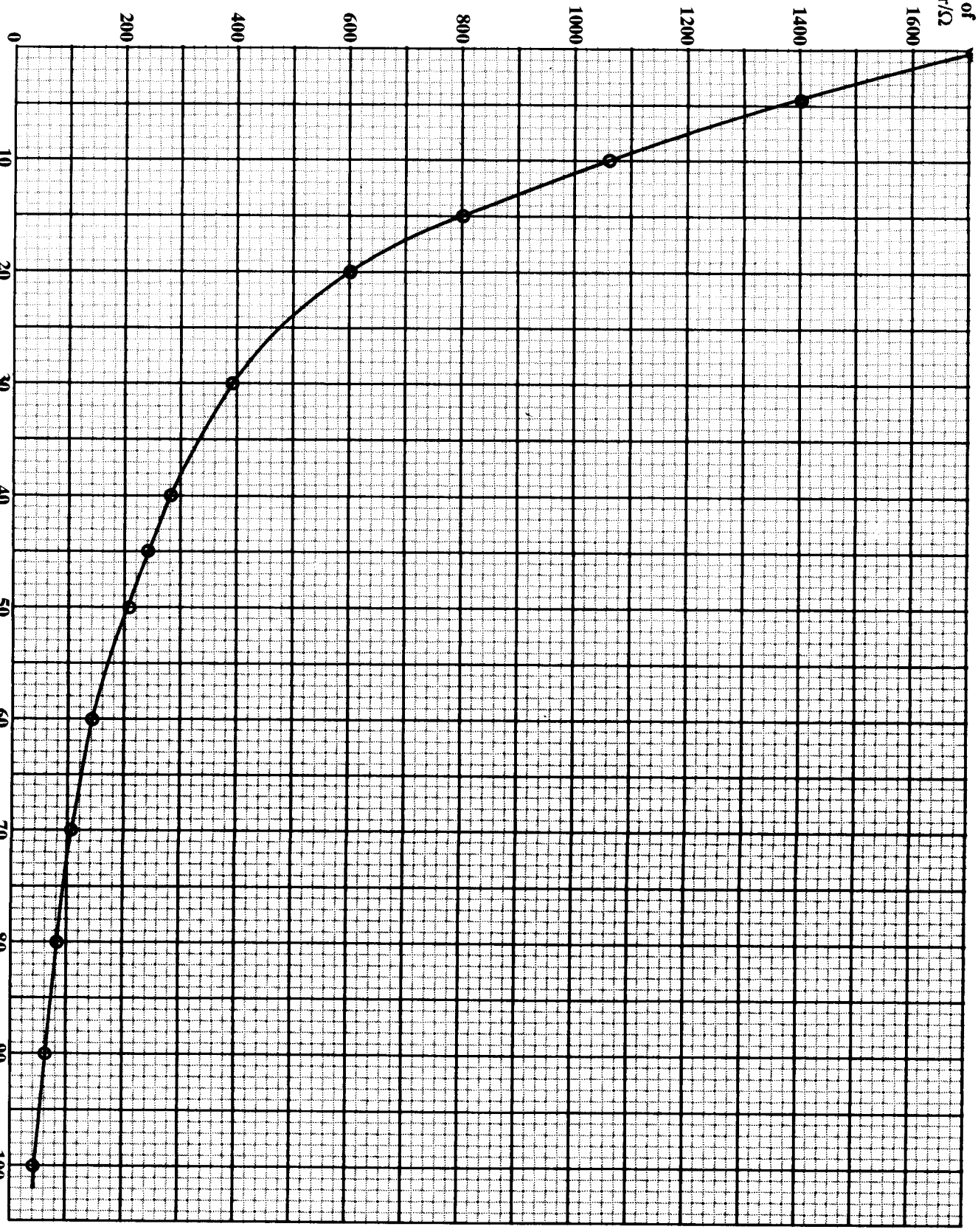

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10. (a) State TWO mechanisms by which heat may be conducted through a solid. Metals are better heat conductors than non-metals. Why is this so?

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_____

[3 marks]

(b) Two straight metal bars, M_1 and M_2, of circular cross-section and equal lengths are joined end to end, as shown in the **Figure 8** below. The thermal conductivity of metal, M_1, is twice that of metal, M_2. The exposed ends of M_1 and M_2 are maintained at temperatures θ_1 and θ_2, respectively, and $\theta_1 > \theta_2$. If the sides of the bars are well lagged, sketch a graph on the axes shown in **Figure 9** below to illustrate how the temperature varies between the ends of the composite bar under steady state conditions.

Figure 8

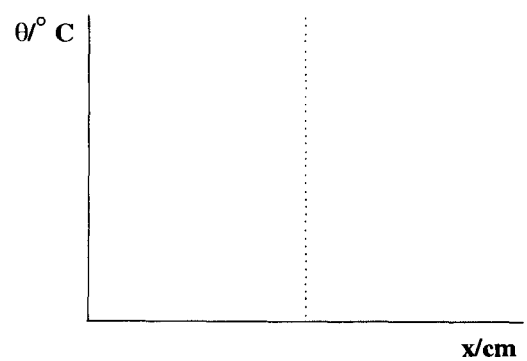

Figure 9

[2 marks]

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(c) The external wall of the freezer room in a supermarket is made of an outer layer of bricks and an inner layer of expanded, polystyrene tiles as shown in **Figure 10.**

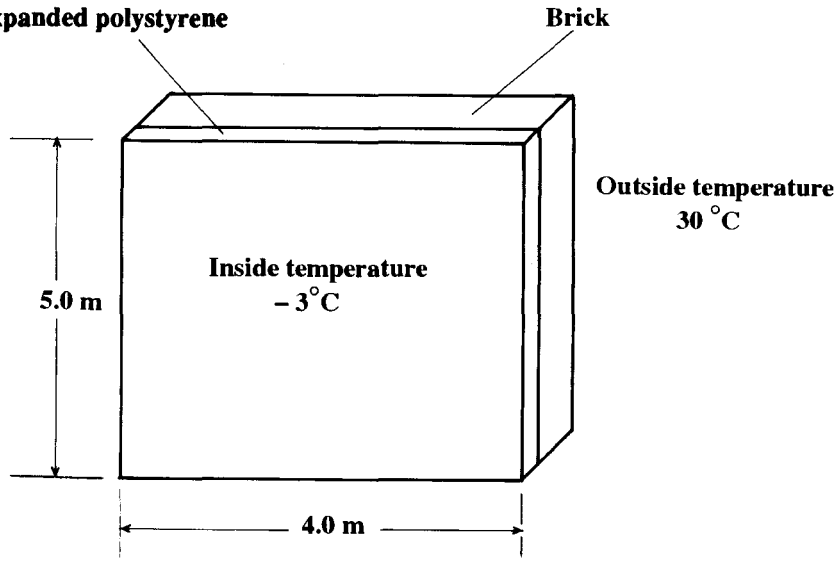

Figure 10

The brick section is 12.0 cm thick while the polystyrene tiles are 4.0 cm thick. If the thermal conductivities of brick and polystyrene are 0.5 W $m^{-1} K^{-1}$ and 0.03 W $m^{-1} K^{-1}$ respectively, find the

(i) temperature of the brick– tile interface

[3 marks]

(ii) rate at which heat flows into the freezer room through the wall.

[2 marks]

Total 10 marks

11. (a) Explain what is meant by the terms 'internal energy of a gas' and 'ideal gas'.

[2 marks]

(b) Write down the first law of thermodynamics in the form of an equation, explaining clearly the meaning of EACH term in your equation.

[3 marks]

(c) (i) An ideal gas undergoes a cycle of changes a →b →c →d as shown in the graph in **Figure 11** below. Complete **Table 1** below for the cycle.

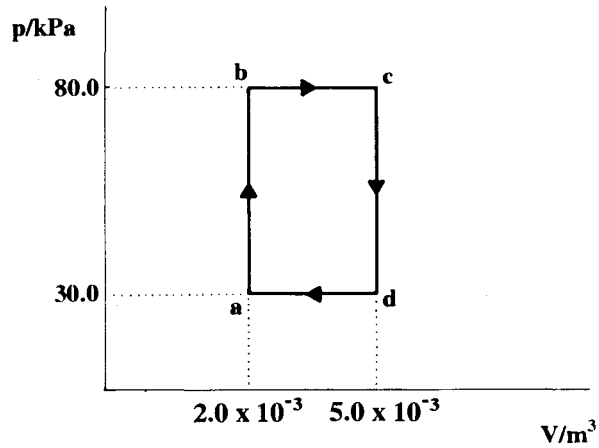

Figure 11

Table 1

	Increase in internal energy of gas/J	Heat supplied to gas/J	Work done on gas/J
a→b		600	
b→c	- 40		
c→d		-500	
d→a			

[4 marks]

(ii) Find the net work done on the gas during the cycle.

_____

[1 mark]

Total 10 marks

12. (a) A graph of tensile stress against tensile strain is shown in **Figure 12** for a metal wire.

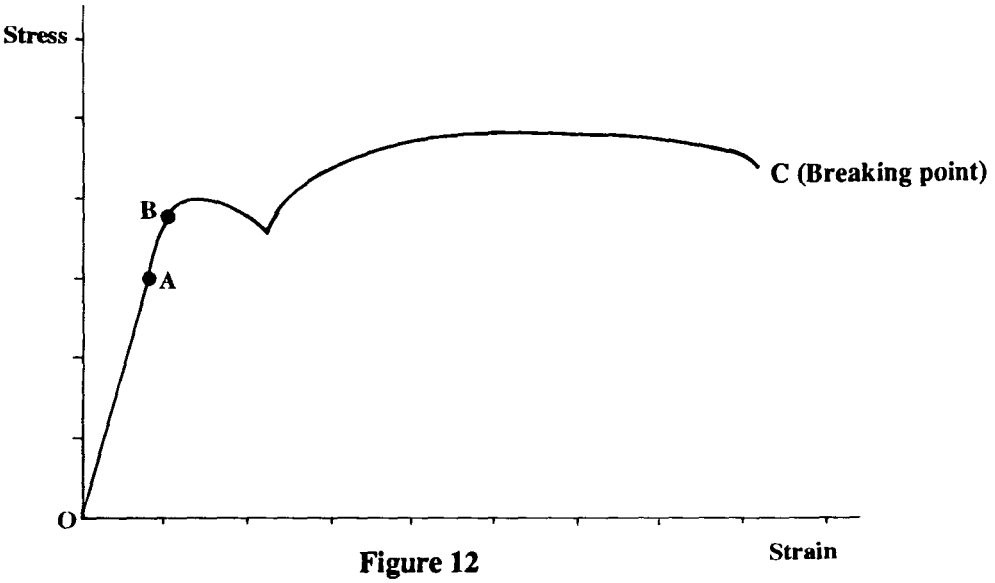

Figure 12

Describe the

(i) region labelled OA

_____

_____

_____

[1 mark]

(ii) point B

_____

_____

_____

[1 mark]

(iii) region labelled BC.

_____

_____

_____

[1 mark]

(b) Using the apparatus sketched in **Figure 13**, a student took the following readings to determine the value of the Young modulus of the material of the wires X and Y.

Original length of wire = 2.015 m
Cross-sectional area of wire = 1.96×10^{-7} m^2

Load/N	0	10.0	20.0	30.0
Vernier reading/mm	0.02	0.15	0.30	0.44

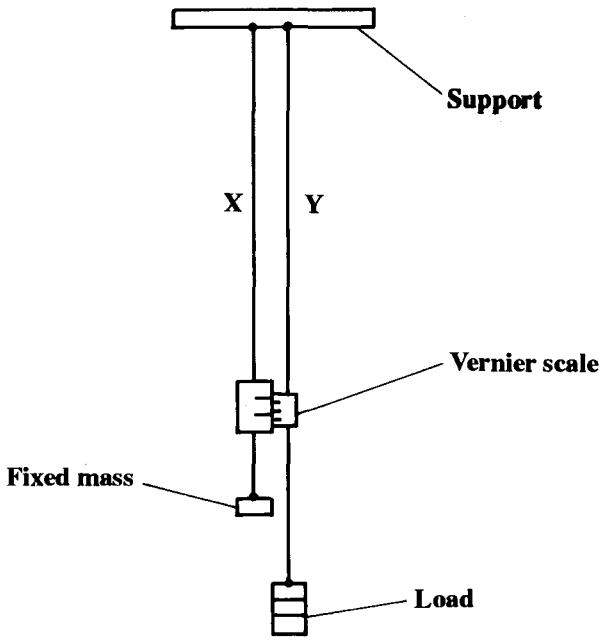

Figure 13

(i) Give TWO reasons for using two wires of the same length and material.

_____

_____

_____

[2 marks]

(ii) Find the average extension of wire Y for a force of 10.0 N.

[1 mark]

(iii) Find the stress in the wire for a force of 10.0 N.

[2 marks]

(iv) Find the average strain in the wire for a force of 10.0 N.

[1 mark]

(v) Calculate the Young modulus of the wire.

[1 mark]

Total 10 marks

END OF TEST