

Figure 11

Copy the diagram and mark on it the distance  $d$ , calculated in a (i) above. Explain why you have chosen the indicated point

(f) Explain briefly with the aid of a diagram what you would expect to happen to a nearly spherical droplet of water resting on a horizontal surface, if a tiny droplet were added to it. How would you account for the change that might occur?

(i) Define surface tension

(ii) Give a brief explanation, in terms of intermolecular forces, of the origin of surface tension

(iii) In terms of intermolecular forces explain how the surface of a liquid differs from the bulk of the liquid.

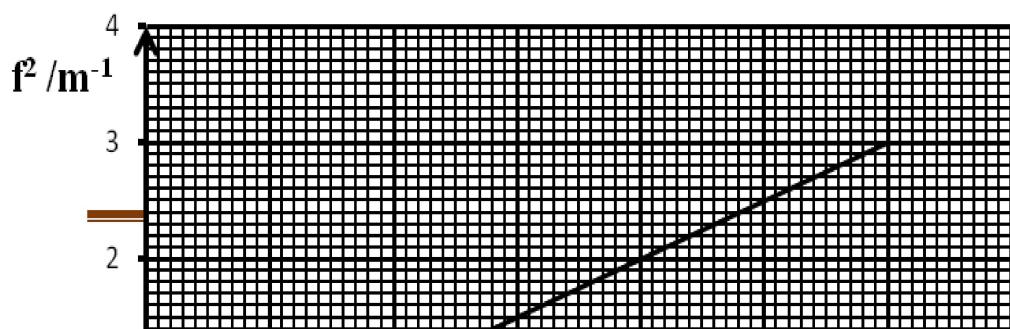
(h) The two vertical arms of a manometer containing water have different internal radii of  $10^{-3}$  m and  $2.0 \times 10^{-3}$  m respectively. What is the difference in height of the two liquids when the arms are open to the atmosphere? (Density of water =  $10^3$  kg and surface tension =  $7.0 \times 10^{-2}$  N m $^{-1}$ )

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#### STUDENT'S PROPOSED ANSWERS TO JUNE 2004

#### JUNE 2005

1. (a) Explain what is meant by the homogeneity of a physical equation.  
 (b) Show that the expression  $c^2 \mu_0 \epsilon_0 = 1$  is homogeneous where  $\mu_0$  is the permeability of free space,  $\epsilon_0$  is the permittivity of free space and  $c$  is the speed of light.  
 (c) Given that  $\mu_0 = 4\pi \times 10^{-7} \text{ H m}^{-1}$ , calculate the value of  $\epsilon_0$ .
2. Figure 1 shows a graph of the square of the frequency against the inverse of the length for a simple pendulum.



(i) Use the graph to determine the acceleration due to gravity  
 (ii) Calculate the length for which the pendulum would have a frequency of 20.0 Hz

3.



Figure 2

Figure 2 shows snooker ball A moving with velocity of  $5.5 \text{ ms}^{-1}$ , which hits a stationary snooker ball B. after collision A moves with a velocity of  $2.5 \text{ ms}^{-1}$  at  $60^\circ$  to its original path. Calculate the velocity of B after collision

4. Figure 3 shows two light beams X and Y of wavelength 450 nm travelling in air and incident on a composite crystal of thickness 20  $\mu\text{m}$ . The refractive index of P is 1.40 and that of Q is 1.45

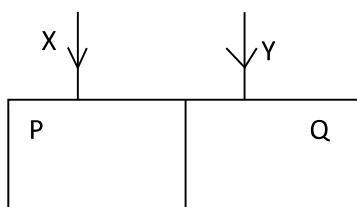
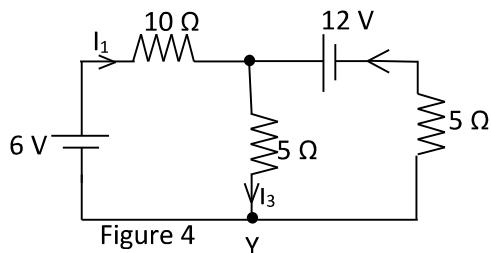


Figure 3

a) Determine which will first emerge from the crystal  
 b) If X and Y are in phase as they enter the crystal, calculate their phase difference as they leave the crystal.

5. A converging lens of focal length 20.0 cm is placed 25.0 cm away from a screen on which an image is formed. A biconcave lens of focal length -30.0 cm is now placed between the converging lens and the screen so that it is 10.0 cm from the converging lens. Calculate how far the screen has to be moved to focus the new image.

6. Figure 4 shows an electrical circuit.



Determine the  
 (i) Currents  $I_1$ ,  $I_2$  and  $I_3$   
 (ii) Pd between X and Y

7.

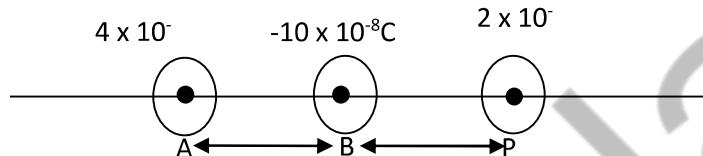
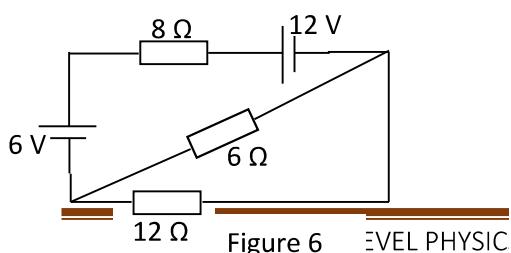


Figure 5

Figure 5 shows three charges A, B and P placed in a straight line. The charge at A is  $4 \times 10^{-8} \text{C}$ , that at B is  $-10 \times 10^{-8} \text{C}$  and that at P is  $2 \times 10^{-8} \text{C}$

a) Calculate the force on the charge at P due to the charges A and B.  
 b) Show that the resultant force on P cannot be zero, if P is placed between A and B.

8. (a) (i) State Newton's laws of motion  
 (ii) Show how the principle of conservation of momentum could be derived from the second and third laws of motion.  
 (b) Describe an experiment to verify the principle of conservation of linear momentum.  
 (c) Distinguish between conservative force and non - conservative forces, giving one example of each.  
 (d) (i) State Kirchhoff's laws  
 (ii) Explain how each of the laws is essentially a statement of either the conservation of energy or the conservation of electric charge.  
 (e) Describe an experiment to investigate how the pd across a wire filament varies with current through it at constant temperature.  
 (f) Given the circuit in figure 6.



Calculate

a) The current in the  $6 \Omega$  resistor  
 b) The pd across the  $6 \Omega$  resistor

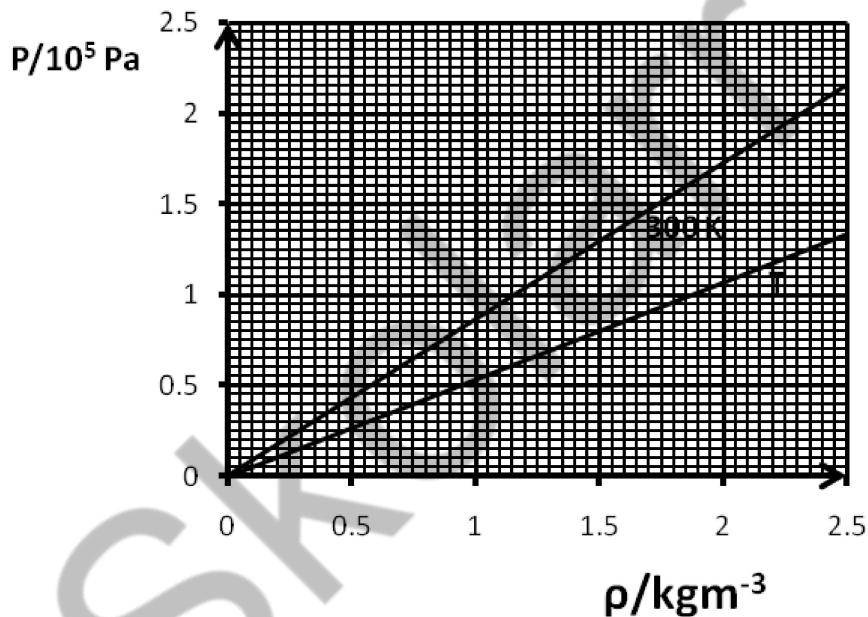
9. (a) State the assumptions used in deriving the kinetic theory equation. From these assumptions, derive the kinetic theory equation

$$P = \frac{1}{3} \rho c^2$$

Where  $P$  = pressure of the ideal gas

$\rho$  = density of the gas molecules.

(b) Figure 7 shows how the pressure of oxygen at temperature T and 300 K varies with density.



Use the graph to

- Calculate the value for the r.m.s speed of oxygen molecules at 300 K
- Explain whether T is higher or lower than 300 K

(c) (i) On the same axis sketch labeled graphs to show how the speed of the molecules in an ideal gas are distributed at temperatures of 300 K and 600 K.

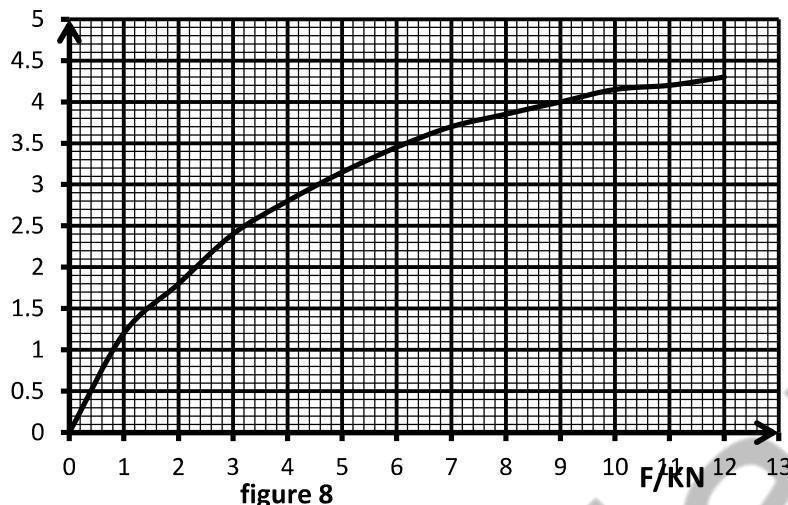
ii) On one of the graphs, show the position of average velocity, r.m.s speed and most probable speed.

(d) Materials could be classified as *crystalline*, *amorphous* or *polymeric*. Define the terms in italics. Give one example for each of the terms.

(e) An aluminum wire and a glass thread are subjected to linear stress until they break. On the same axis, sketch graph of stress – strain to show the behavior of each material.

(f) Figure 8 shows a graph of extension, e, against force, F, for a certain nylon climbing robe.

**e/m**



**figure 8**

A climber of mass 80 kg attached to a 10 m length of robe can withstand a force from the rope of not more than 7.5 KN without the risk of serious injury. Use the graph to

- (i) Estimate the maximum energy stored in the rope when climber is not at risk.
- (ii) Explain how you would determine a value for Young's modulus for a given extension.

10. (a) Differentiate between interference and diffraction of light

(b) A parallel beam of light of wavelength  $5.5 \times 10^{-2}$  m in air is incident on the slits in Young's double slit experiment. A thin film of transparent plastic of refractive index 1.48 and thickness  $5.2 \times 10^{-6}$  m is placed over one of the slits.

- i. Determine the increase in the optical path of the light passing through the thin film. Hence determine the number of fringes by which the central bright fringe is displaced.
- ii. Explain how the fringe spacing would change if the slit separation were increased, the slit – screen distance were increased.

(c) Light of wavelength  $5.5 \times 10^{-7}$  m falls on a single slit of width 0.15 mm. A screen is placed 1.2 m beyond the slit.

- i. Sketch a graph showing the light pattern observed on the screen
- ii. Calculate the width of the central fringe

(d) State the following laws

- (i) Newton's law of gravitation (ii) Coulomb's law.

(e) Explain in what way the Coulomb force between two charge particles is

- i. Different
- ii. Similar to the gravitational force between two masses

(f) The gravitational potential energy  $U$  of a mass,  $m$ , a distance  $h$  above the surface of the earth is

$$U = -\frac{GMm}{(R + h)}$$

Where M is the mass of the earth, R the radius of the earth and G, the gravitational constant ( $R = 6.4 \times 10^6$ )

- i. Show that this expression is equivalent to  $U = mgh$  usually quoted in elementary physics courses where  $g$  is the gravitational force per unit mass near the surface of the earth.
- ii. How much kinetic energy must a 100 kg space craft have at the surface of the earth to be able to leave the earth completely?
- iii. Explain what would happen if the spacecraft had
  - Less energy, More energy

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#### **STUDENT'S PROPOSED ANSWERS TO JUNE 2005**

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