MINISTRY OF EDDUCATION

**DEPARTMENT OF NATURAL SCIENCES**

**JUNIOR PHYSICS OLYMPIADS 2012**

**QUESTION 1**

1. (a) Transverse waves are produced in a long rope by securing one end of the rope to a wall and

 then moving the other end from side to side by hand. The frequency of the wave is 2Hz.

 (i) What does the term ‘transverse’ mean? [1]

 (ii) Explain the meaning of the expression ‘ the frequency is 2Hz ’ [2]

 (iii) What is determines the amplitude of the waves produced? [1]

 (b) Explain what is meant by the refraction of light and state the conditions needed for refraction

 to take place. [4]

 (c) The figure below shows a ray of light KLMN passing through a triangular prism QRS.

 S

 K N

 Q R

 (i) Using a protractor, measure and record the angle of incidence and the angle of refraction at a

 point L. [1]

 (ii) Measure and record the angle of incidence and the angle of refraction at the point M. [1]

 [TOTALMARKS: 10]

 **SOLUTIONS**

Q1.(a) (i) It means the oscillations of the particles is perpendicular to the direction of the wave

 motion.

 (ii) It means that each particle on the rope is oscillating at 2 cycles per second. [2]

 (iii)The amplitude of source i.e. the vibrating hand determines the amplitude of the wave.[1]

 (b) When light passes from one medium to another at an angle, it bends. This bending of light is

 called refraction.

 **Conditions**

 (i) the 2 media must have different optical densities,

 (ii) the incident ray must not be perpendicular to the boundary.

 (c) (i) At point L,the angle of incidence is 450 and angle of refraction is 290.

 (ii) At point M, angle of incidence is 300 and angle of refraction is 520.

**QUESTION 2.**

**2.** The diagram below shows a section of a transverse wave.

C

B

A

a

 (a)Draw a line across the section of the wave to indicate;

 (i) the rest position

 (ii) Amplitude

 (iii)Wavelength [3]

 (b) Give two examples of transverse waves. [2]

 (c) The distance between A and C is 3m.Calculate the wavelength of the wave. [2]

 (d) Define

 (i) Speed of a wave [1]

 (ii) Frequency of a wave [2]

 (e) If the period of the above wave is 4 seconds, calculate its frequency. [1]

**SOLUTION**

(a) (i)

 (b) Electromagnetic waves, water waves

 (c) 2m

 (d) Distance travelled by any part of a wave in one second.

 (e) f = 1/T = ¼ = 0.25Hz

**QUESTION 3**

 (a) In relation to a sound wave define the following

 (i) Compression [1]

 (ii) Rarefaction [1]

 (b) Briefly explain what happens to the pressure of a region when a sound wave passes by [2]

 (c) On a rainy day, a person sees a flash of lightening before hearing the bang from the

 thunder. Explain the reason for this. [2]

 (d) If it takes 2 seconds between hearing the sound and seeing the flash of lightening produced

 740m away, from the observer, calculate the speed of sound in air. [2]

 (e) Explain how an echo is formed. [2]

 **SOLUTION**

(a) (i) A compression is a region where particles are close to each other.

 (ii) A rarefaction is a region where particles are far apart.

 (b) The pressure increases when a compression passes by and the pressure decreases when a

 rarefaction passes.

 (c) The reason is that light travels faster than sound.

 (d) Speed = distance/time = 740m/2s = 370m/s.

 (e) An echo is formed when sound is reflected (bounces back) off a barrier.

 **QUESTION 4**

 A cuboid measures 4cm x 8cmx12cm.It has a mass off 307.2g.Take g to be 10N/kg.

 (a) Calculate the wright of this cuboid [1]

 (b) Find the density of this cube and therefore state whether this cube can sink in or float on water

 given that the density of water is 1g/cm3. [3]

 (c) (i) Calculate the maximum pressure this cuboid will exert on a table. [2]

 (ii)Calculate the minimum pressure the cuboid exerts on a table. [2]

 (d)What is the surface area of this cuboid [2]

**SOLUTIONS**

(a) W = m g 307.2g /1000 = 0.3072 Kg

 = 0.3072 x 10

 = **3.072N**

(b) D = m/V V = l x b x h A = l x b

 = 307.2/384 = 4 x 8 x 12 = 0.04 x 0.08

 = **0.8g/cm**3 = 384 cm3  = 0.0032 m2

(c) P = F/A F = m g

 = 3.072/0.0032 = 0.3072 x 10

 = **960N/m**2 = 3.072 N

(d) P = F/A A = l x b

 = 3.072/0.0096 = 0.08 x 0.12

 = **320 N/m**2 = 0.0096 m2

(e) Total surface area = 2 (l x b) + 2 (l x h) + 2 (h x b)

 = 2 (8 x 12) + 2(8 x 4) + 2 (4 x 12)

 = 2 (96) + 2 (32) + 2 (48)

 = 192 + 64 + 96

 = 352cm2

 **Question 5**

 A rectangular shaped aquarium with base measuring 0.40m x 0.20m and height 0.2m is filled with water to a depth 0.15 m as shown below.

 0.15m

 0.2m

 0.4m

 0.2

(a) Calculate the volume of water in the aquarium. [2]

(b) What is the mass of this water in kg? (Density of water = 1000Kg/m3) [2]

(c) What is the weight of the water? [2]

(d) 1.92g of ornamental gravel is spread on the base of the tank and the water level rises to a height of 0.16 m.

(i) Calculate the volume of the displaced water. [2]

(ii) What is the density of the gravel? [2]

(e) State two uses of the density of a material. [2]

(f) A tin containing 5000cm3 of paint has a mass of 7 Kg. If the mass of the empty tin including the lid is 0.5 Kg, calculate the density of the paint. [2]

(g) What is relative density? [1]

**Solutions**

V = l x b x h

 = 0.4 m x 0.2 m x 0.15 m

 = **0.012 m3**

(b) D = m/V

 m = D x V

 = 1000 Kg/m3 x 0.012 m3

 = **12 Kg**

(c) W = m g

 = 12 Kg x 9.8 N/Kg

 = **117.6 N**

(d) (i) V = l x b x h

 = 0.4 m x 0.2 m x o.01 m

 = **0.0008 m3**

 (ii) D = m/V

 = 1.92 Kg /0.0008 m3

 **= 2400Kg/m3**

(e) (i) It is used to identify substances

 (ii) It is used for determining the purity of a substance.

 (iii) It is used for separating chemicals and /or substances in industries.

(f) D = m/V

 = 7 Kg -0.5 Kg

 V

 = 6500g/5000cm3

 = **1.3g/cm3 or 1300 Kg/m3**

(g) Relative density is the ratio of the mass of any given volume of a substance to the mass of an equal volume of water.

**Question 6**

(a) The diagram below shows a ray of light undergoing reflection after striking a mirror at an angle.

 incident ray reflected ray

 1100

 Mirror

Using the diagram above, determine the angle of incidence and reflection. [2]

(b) State the laws of reflection. [2]

(c) The diagram below shows how the image of an object is observed in a plane mirror.

 object

 observer

 mirror

(i) Complete the diagram above to show where the image is as seen by the observer. [3]

(ii) What is meant by the following terms when used in describing the images formed by by a plane mirror?

 *(a)* Laterally inverted

 *(b)* Virtual image [2]

 (d) In a plane mirror, how does the image size compare with the object size? [1]

(e) If the object is 1 m from the mirror, how far is the image from the object? [2]

(f) What is the formula for linear magnification? [2]

**Solutions**

(a)(i) angle of incidence = 550

 (ii) angle of reflection = 550

(b) Angle of incidence = angle of reflection.

 The incident ray, the normal and the reflected ray all lie in the same plane.

(c) (i) mirror

 Object image

 observer

 (ii)(a) Laterally inverted means the left and right of the object are exchanged with the left and

 right of the image.

 (b)Virtual image means that the image is not real or it cannot be formed on the screen.

(d) The image size is the same as the object size. They are same.

(e) Image distance from object = 2 m or 1 m x 2 = 2 m or 1 m + 1 m = 2 m.

(f) Magnification = image height/object height or magnification = image distance/object distance.

**Question 7**

(a) Why does a vacuum flask have

 (i) a silver layer on its thin glass walls? [2]

 (ii) a vacuum between its glass walls? [2]

 (iii) a cork stopper in its top? [2]

(b)(i) Why are copper pipes in a solar hot water collector painted black? [2]

 (ii) Why cant heat reach us from the sun by conduction and convection? [2]

(c) State the process by which energy is

 (i) transferred from the hot plate to the water. [1]

 (ii) spread through the water. [1]

(d)(i) State one reason why the water would reach boiling point more rapidly with a lid on the pan[1]

 (ii) The sides of a source pan are often polished. How does this reduce heat loss? [2]

**Solutions**

(a) (i) To reduce heat loss by radiation

 (ii) To reflect heat back into the flask. [2]

(b) (i) Because black surfaces are good absorbers of heat. [2]

 (ii) Because heat from the sun is emitted in form of electromagnetic waves/ infrared radiation or

 rays [2]

(c) (i) Conduction. [1]

 (ii) Convection [1]

(d) (i) Because heat loss by convection is reduced by the lid [1]

 (ii) Polished surfaces are bad emitters of heat, hence heat loss by radiation is minimised. [2]

**Question 8**

(a) A person sitting on a beach on a calm hot summer day is aware of a cool breeze blowing from the

 sea

 (i) Explain why there is a sea breeze. [2]

 (ii) Explain why the direction of the breeze often reverses late at night [2]

(b) The diagram below shows a clinical thermometer.

 (i) What is the purpose of the constriction? [2]

 (ii) Why is the stem often oval shaped in cross section? [2]

 (iii) Why is the back surface of the thermometer often colored white? [2]

 (iv) Why does the scale range only from 350C to 420C? [2]

 (v) Name a liquid which could be used in the thermometer above. [1]

 (vi) What is the reading on the thermometer above? [1]

 (vii) What should be done before the thermometer could be used again to obtain a correct

 reading? [2]

**Solutions**

 (a) (i) To cool the land / To replace warm air on the land with colder air from the sea. [2]

 (i) To warm the land / To replace colder air on the land with warmer air from the sea. [2]

(b) (i) to prevent the mercury from flowing back. [2]

 (ii) The oval stem acts as a magnifying glass such that the reading can be observed easily. [2]

 (iii) This allows the easy reading of the mercury thread to be taken against the temperature

 graduation. [2]

 (iv) Because it only measures our body temperature. [1]

 (v) Mercury [1]

 (vi) 37.50C [1]

 (vii) To shake it so that mercury can go back to the bulb [2]

**End of questions**