

Matriculation and Secondary Education Certificate
Examination Board
University of Malta

Physics SEC
Sample Paper II B

Syllabus 2012

1. *This question is about heat transfer and specific heat capacity.*



Leo Graetz

Leo Graetz and Ernst Smidt were two German scientists who studied heat radiation properties of solids. One instance where it is important to reduce heat losses is in our homes. Knowing the heat properties of solids can save energy and reduce the damage to our environment.



Ernst Smidt

Mary was given by her Physics teacher a diagram showing the cross-section of the walls of the living room of a house which is planned to keep heat losses to a minimum.

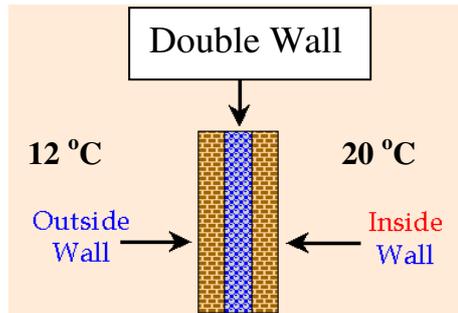


Diagram 1

- (a) The living room temperature is $20\text{ }^{\circ}\text{C}$ while that in the street is $12\text{ }^{\circ}\text{C}$. Draw an arrow on **Diagram 1** to show the direction in which heat energy will be transferred. (1)

- (b) The space between the walls is filled with polymer foam, which is a type of plastic material with air trapped in it.

- (i) Why is air trapped between the walls?

(1)

- (ii) Can heat transfer take place by convection in this case? Explain.

- (iii) Name **two** other methods by which heat transfer can take place. (2)

(2)

- (iv) What will happen during summer when the outside temperature is higher than the room temperature? Explain.

(2)

- (c) Mary placed two thermometers A and B at the same distance from the metal as shown in **Diagram 2**. She heated the metal strongly.

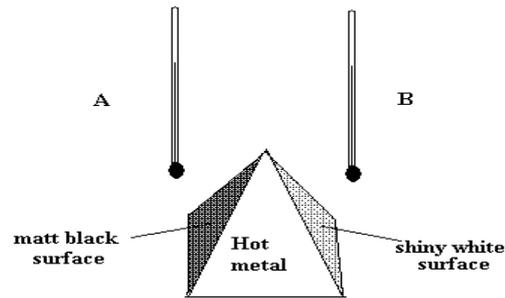


Diagram 2

- (i) Which thermometer shows the highest reading after five minutes?

(1)

- (ii) Which is better at emitting (giving off) heat energy, the matt black or the shiny white surface?

(1)

- (iii) The radiator of a car engine is painted black. Why is this so?

- (iv) Explain why houses in very hot countries are painted white.

- (v) Give **two** examples from everyday life where the principles involved in the above investigation are applied to practical situations.

(2)

- (d) The metal shown in **Diagram 2** has a specific heat capacity of $800 \text{ J/kg}^\circ\text{C}$. The mass of the metal is 600 g and its temperature rises from 20°C to 45°C . Calculate:

- (i) the mass of the metal in kg _____

(1)

- (ii) the temperature rise expected _____

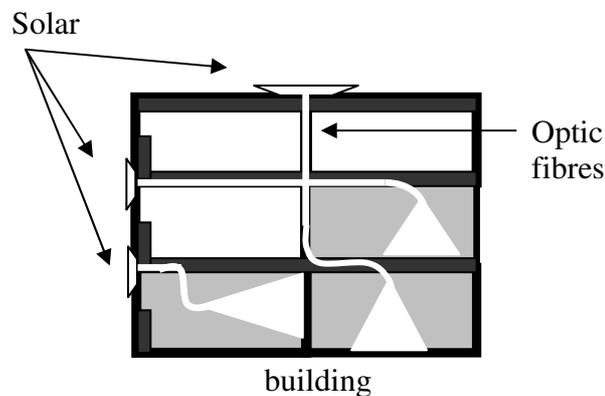
(1)

- (iii) the heat energy needed to raise its temperature from 20°C to 45°C .

(2)

2. **This question is about the nature of waves.**

'Fibre optics solar lighting' is a method of lighting up the rooms of a building by means of the sun's light. Sun light is collected by solar panels and transferred through optic fibres.



(a) The solar panel on the roofs and facades collects incoming sunlight by a system of lenses and prisms.

A ray of light hits side AB of an isosceles right-angled glass prism at 90° and is transmitted through the prism to side AC. (**Diagram 3**)

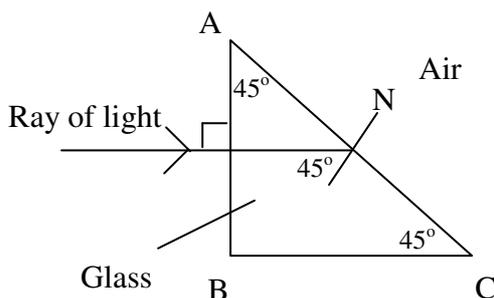


Diagram 3

- (i) On **Diagram 3** above label the angle of incidence 'i' of the ray of light on side AC of the prism. (1)
- (ii) Draw the path of light as it emerges out of the glass prism, given that the critical angle of light in glass is 42° . (1)
- (iii) Label the angle of reflection, 'r'. (1)
- (iv) What is the size of the angle of reflection? Explain. (1)

(2)

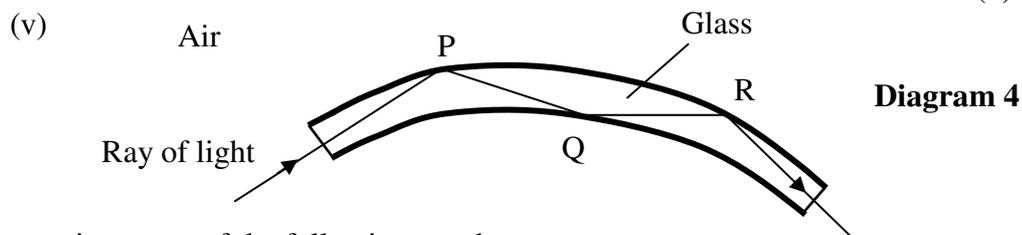


Diagram 4

Complete using **some** of the following words.

medium, reflection, refraction, communications, smaller, larger, energy

A fibre optic is a very thin glass tube through which a ray of light passes from one end to the other. At points P, Q and R, the ray undergoes total internal _____. This happens because the angle of incidence of light in glass is _____ than the critical angle and light passes from a more optically dense to a less optically dense _____. One advantage of using fibre optics rather than electric wires is that there are less _____ losses. Today fibre optic cables are used in _____.

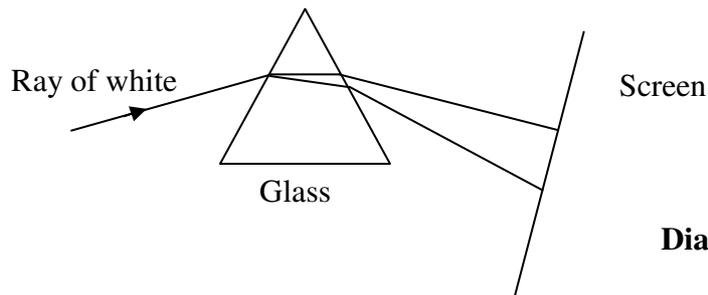
(5)

- (vi) Using this 'fibre optic solar lighting' system, will it be possible to channel the solar light to all the rooms of the building? Give **one** reason for your answer.

- (vii) Name **one** major advantage of using this system to light up a building. (2)

- (viii) Visible light has a wavelength of 5.05×10^{-7} m (0.000000505 m). Calculate its frequency in Hertz, given that the velocity of light waves in air is 3×10^8 m/s (300,000,000 m/s). (1)

- (b) A group of students in a school science laboratory investigate how white light travels through an equilateral glass prism as shown in **Diagram 5**. (2)

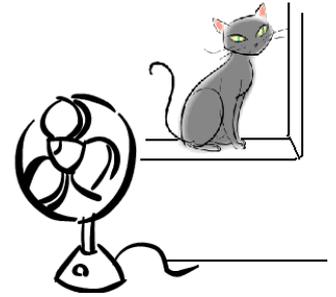


- (i) On **Diagram 5** above label the **two** extreme colours observed on the screen. (2)
- (ii) The spreading out of white light into different colours of the spectrum is called _____ . (1)
- (iii) Suggest how a rainbow forms in the sky, using the sun's light and the water droplets in the air.

(2)

3. **This question is about current electricity and house wiring.**

Philip F. Labre, an American student who lived in 1928, noticed that each time his cat went on the window, it knocked over his fan. Each time he plugged the fan back, he would get an electric shock.



(a) (i) Complete using **some** of the following words.

insulators, liquids, conductors, resistors

Philip noticed that he was getting an electric shock since metals are _____ of electricity. Metals have more free electrons when compared to _____. (2)

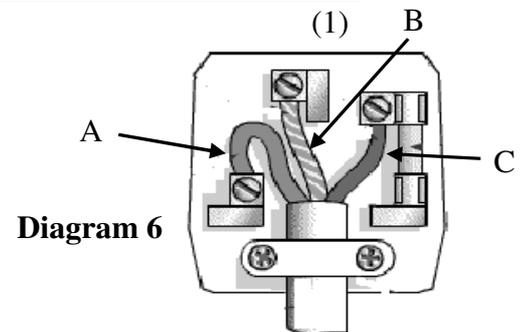
(ii) Philip found that when he connected the fan to the ground, electric current passes through this wire and not through his body. What is this wire called?

(iii) **Diagram 6** shows a three-pin plug. Name

wire A _____

wire B _____

wire C _____ (3)



(b) Sandra buys a radio player. When she uses it for the first time, she notices that it comes with a two-pin plug. She decides to plug a three-pin plug adapter into the plug socket.

(i) She notices that there are only two wires connected to the radio player. Which wire is missing? Give a possible reason why it is missing.

(ii) The radio player is rated 240 V, 100 W. If left switched on for six hours, calculate the amount of energy used in kWh, given that 1 kWh is equivalent to 3,600,000 J. (2)

(iii) Calculate the cost of energy transferred if 1 kWh costs 15 euro cents. (3)

(2)

(c) Sandra has a portable CD player which is rated as 12 V, 48 W. It works either with batteries or by connecting it to the mains plug.

(i) The CD uses a special device that decreases the 240 V mains voltage to a safe 12 V. What is the name of this device?

(ii) Calculate the value of the current used by the CD player. (1)

(iii) Which is the most suitable fuse rating for the plug of this CD player, 2A, 5A or 13A? (2)

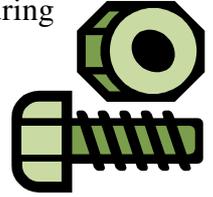
(iv) A two-pin plug does not even have a fuse. What is the function of a fuse? (1)

(v) A fuse is made up from resistance wire. How will the resistance of the wire change if a thicker wire is used? Explain. (1)

(2)

4. *This question is about electromagnets and the application of electromagnetic induction.*

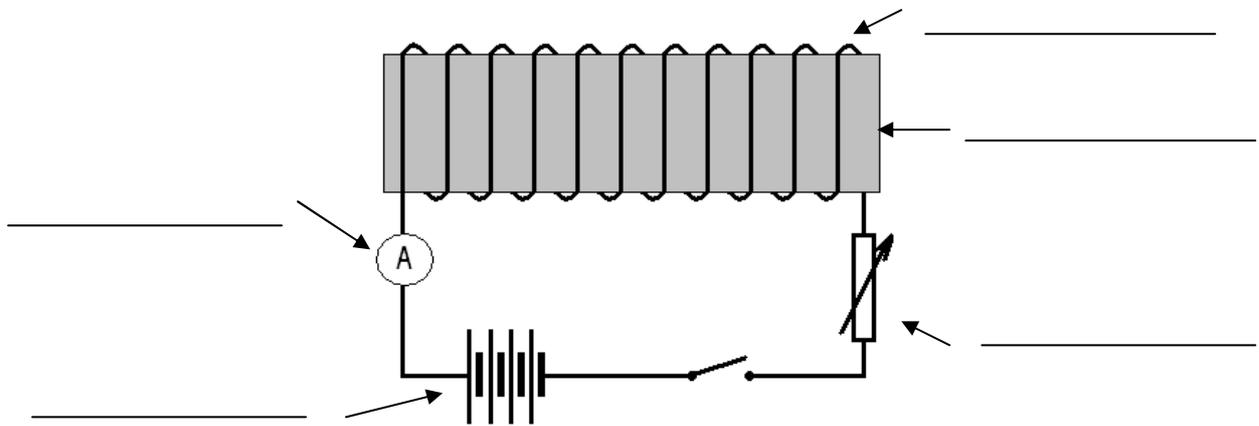
(a) Mikela and Daniel work in a factory that produces metal parts for industrial use. A large number of aluminium nuts and iron bolts mix together during the manufacture process.



(i) Mikela suggested to her employer that they could use an electromagnet to separate the nuts from the bolts. Explain how the electromagnet can be used to separate the nuts from the bolts.

(2)

(ii) Label the diagram showing the main features of an electromagnet connected to a circuit.



(5)

(b) Daniel was asked by his employer to investigate how the number of items attracted is related to the current in the electromagnet.

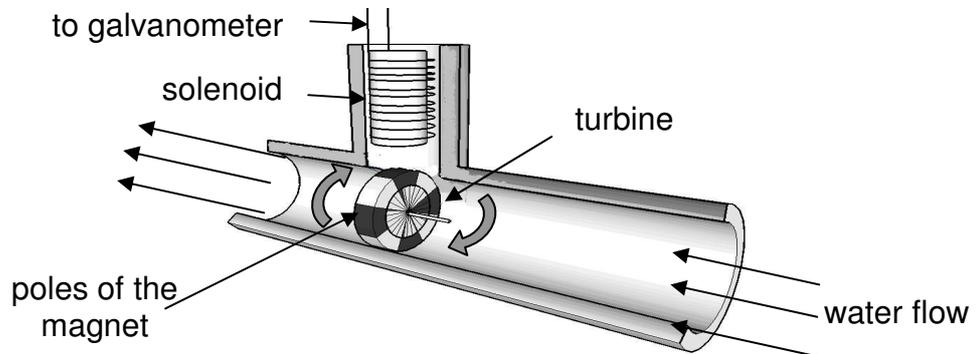
(i) Describe the procedure he should follow.

(3)

(ii) Give **two** precautions taken during such an experiment.

(2)

- (c) The same factory produces magnetic flow meters that measure the rate of flow of water through a pipe. A small turbine is placed in the pipe so that the water flow turns the blades and the attached magnets. A solenoid attached to a galvanometer is placed over the turbine.



- (i) Complete the following:

As the turbine and magnets are turned by the water, the _____ cut the wires in the _____. This induces a _____ in the solenoid that is measured by the galvanometer.

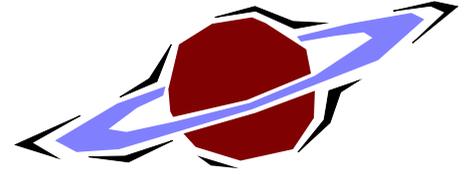
(4)

- (ii) Suggest **two** changes in the setup so that a higher current is caused for the same water flow.

(2)

- (iii) Mikela noticed that the water flow (litres/second) is directly proportional to the current measured on the galvanometer (mA). She also observed that a water flow of 1.5 litres/second produces a current of 5 mA. Work out the current measured when water flows at a rate of 7.5 litres/second.

(2)



5. *This question is about the Earth and the Universe.*

(a) The Earth is one of eight planets in orbit around the sun in what is known as the solar system. These planets are:

Mercury Venus Earth Mars Jupiter Saturn Uranus Neptune

(i) How long does the Earth take to orbit the sun once?

_____ (1)

(ii) How long does the Earth take to rotate upon itself?

_____ (1)

(iii) Which planet of the solar system has the **shortest** year? Explain.

(iv) Why do all the planets in the solar system orbit the sun? Explain.

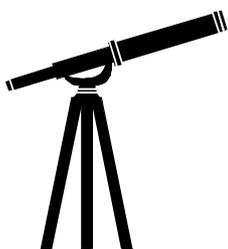
(v) Give **one** reason why Pluto was officially removed from being one of the planets of our solar system.

_____ (1)

(vi) **Name** the galaxy that our solar system forms part of.

_____ (1)

(b) In 1609, Galileo Galilei, an Italian scientist, performed the first observation of the planets using a telescope of only 4 cm in diameter. He observed the distant planet Jupiter and discovered four faint dots around this planet.



(i) Suggest what the four faint dots around Jupiter might be.

_____ (1)

(ii) Name the force that keeps these 'dots' in orbit around Jupiter.

_____ (1)

- (iii) Would you expect the average surface temperature on Jupiter to be colder / warmer than that on surface of Earth? Give **one** reason for your answer.

(2)

- (c) It was not until the twentieth century that astronomers realized that there were galaxies in the Universe.

- (i) What is a galaxy?

(1)

- (ii) Why are telescopes used?

(1)

- (iii) Some telescopes use light while other telescopes use radio waves. Is this statement true? Explain.

(2)

- (iv) Name **one** possible advantage of having a telescope installed on a satellite in orbit around the earth, such as the well known Hubble Space telescope.

(1)

- (d) On a crisp and cloudless night, Sarah and Toyah together with a member of an astronomy society set up a telescope to observe the night sky.

- (i) The astronomy enthusiast claims that the image of Jupiter observed by the students has left Jupiter about 30 minutes before. Is this possible? Explain.

(2)

- (ii) The Ursa Major galaxy is 1×10^9 light years away from us. What is a light year?

(1)