Matriculation and Secondary Education Certificate Examination Board
University of Malta

Physics SEC
Sample Paper II A

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, planned to keep the transfer of heat to a minimum.

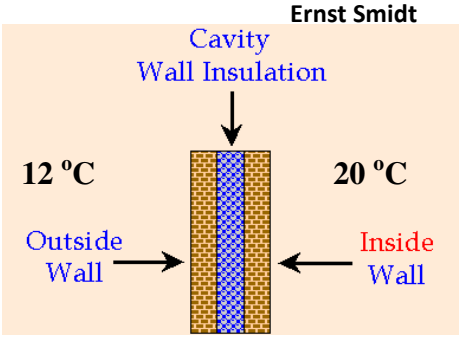

Diagram 1

(a) The living room temperature is 20 °C while that in the street is 12 °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) Can heat transfer take place by convection?

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(1)

(ii) Explain your answer.

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_____

(2)

(iii) Can heat transfer take place by conduction?

_____

(1)

(iv) Explain your answer.

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(2)

(v) Use your answers to the previous questions to explain why buildings with cavity walls insulation help to keep the cost of heating as low as possible, especially during winter.

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(2)

(vi) What will happen during summer when the outside temperature is higher than the room temperature?

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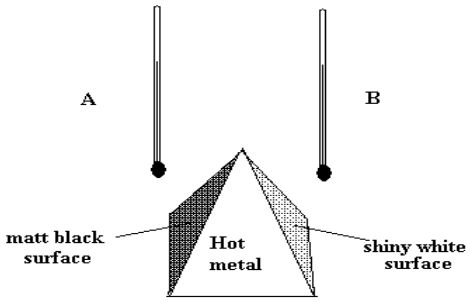
_____

(2)

(c) Mary is then asked to devise an experiment to compare the heat radiation properties of solids. She heats the metal shown in the **Diagram 2** and places two thermometers A and B at the same distance from the metal.

Diagram 2



(i) What happens to the reading of the thermometers A and B after five minutes?

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(2)

(ii) Explain why.

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(2)

(iii) The metal shown in **Diagram 2** has a specific heat capacity of 800 J/kg^{o}C. 12,000J of heat energy are supplied to the metal to raise its temperature from 20^{o}C to 45^{o}C. Work out the mass of the metal.

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_____

(3)

(iv) Give **two** examples from everyday life where the principle involved in the above investigation is applied to practical situations.

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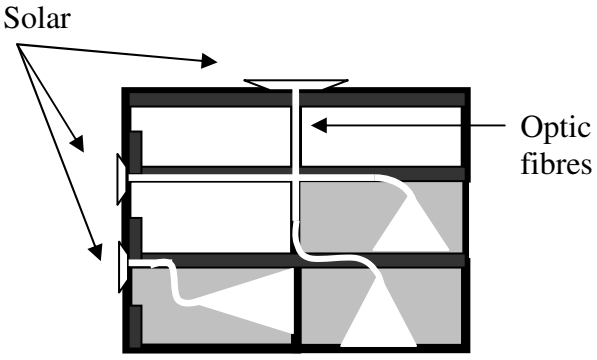
(2)

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



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

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

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

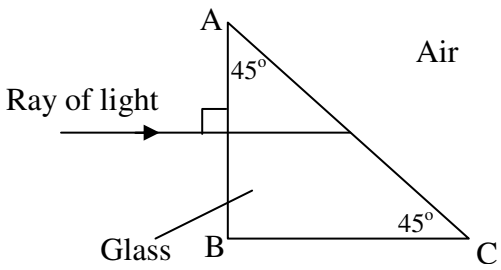


Diagram 3

(i) On **Diagram 3** draw and label the normal and the angle of incidence of the ray of light on side AC of the prism. (2)

(ii) Calculate this angle of incidence.

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(1)

(iii) On **Diagram 3**, draw the path of light as it emerges out of the glass prism, given that the critical angle of light in glass is 42^o. (2)

(b) The guiding of light through fibre optics was first shown in the mid-nineteen century. A fibre optic is a very thin glass or plastic tube through which light passes from one end to the other as shown in **Diagram 4**.

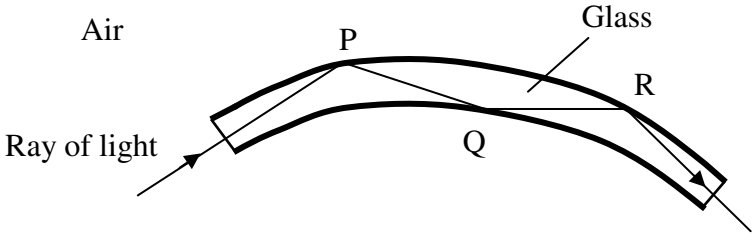

Diagram 4

(i) Describe what happens to the light ray at points P, Q and R in the fibre optic.

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(1)

(ii) State **two** conditions needed for this to occur.

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_____

(2)

(iii) 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.

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(2)

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

_____

(1)

(v) Light rays lose part of their energy as they travel through fibre optics. Give **one** possible reason for this loss of energy.

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(1)

(vi) Give **one** advantage of using fibre optics instead of electrical wires for telecommunications and networking.

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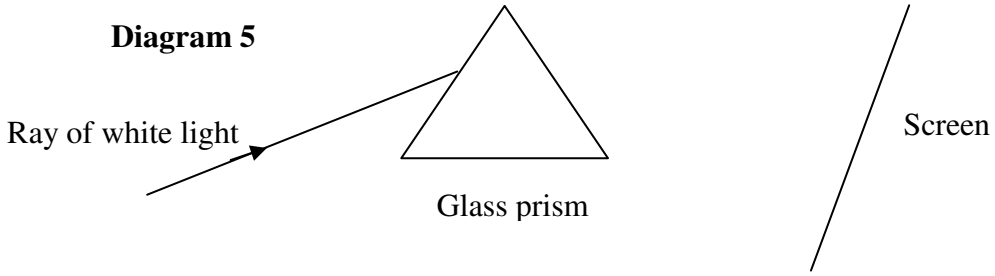
(1)

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

Diagram 5



(i) Complete the ray diagram to show the emergent rays. (2)

(ii) On **Diagram 5** above, label the **two** extreme colours observed on the screen. (1)

(iii) Name the observed phenomenon of light.

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(1)

(iv) Give **one** reason for what is observed on the screen.

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(1)

(v) Suggest how a rainbow forms in the sky.

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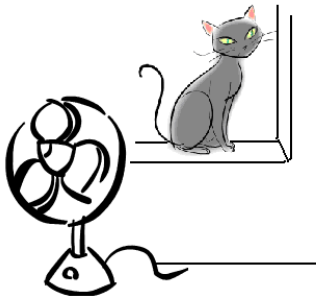
(2)

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



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

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

_____

(1)

(ii) Explain how an electric current flows through the metal fan.

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_____

(2)

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

wire A _____

wire B _____

wire C _____

(3)

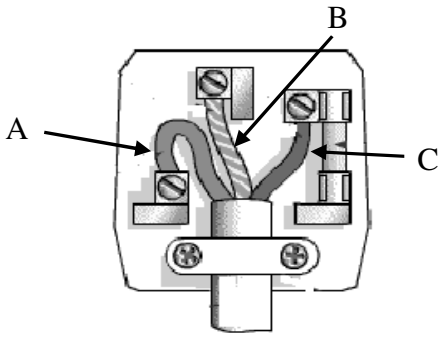

Diagram 6

(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. The third wire is missing. Explain why this wire is missing?

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_____

(2)

(ii) The radio player is rated 240 V, 100 W. If left switched on for six hours, calculate the cost of the energy transferred assuming that 1 kWh costs 15 euro cents.

_____

_____

_____

_____

(4)

(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?

_____

(1)

(ii) Calculate the most suitable fuse rating for the plug of this CD player.

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_____

(2)

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

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(1)

(iv) A fuse is made up of resistance wire. How is the current through the wire affected if thicker resistance wire is used? Explain.

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_____

(2)

(v) Name **two** other features that affect the resistance of a wire other than its thickness.

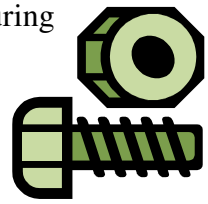
_____

_____

(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.

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(2)

(ii) Draw a labelled diagram showing the main features of an electromagnet connected in a circuit through which the current can be varied. Name all the components in the circuit.

(4)

(iii) State **one** advantage of the electromagnet over the permanent magnet.

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(1)

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

(i) Describe the procedure he should follow.

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_____

_____

(3)

(ii) What can he conclude?

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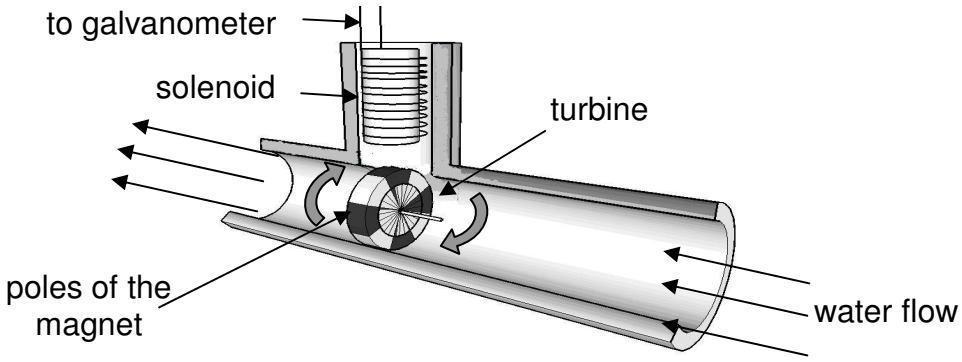
(1)

(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) Explain how the flow of water induces a current in the solenoid.

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(2)

(ii) Daniel indicates that the pipes in the magnetic flow meters are usually made of plastic. Explain why it is not advisable to use steel pipes in the flow meters.

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(2)

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

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(2)

(iv) Mikela noticed that the water flow (litres/second) is directly proportional to the current measured by the galvanometer (mA). She also observed that a water flow of 1.5 litres/s produces a current of 5 mA. Calculate the electrical energy generated in 10 s when water flowing at a rate of 7.5 litres/second induces a voltage of 2 V.

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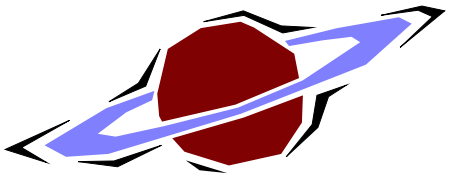
(3)

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.

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

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(2)

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

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_____

(2)

(iii) Explain why a day on earth is 24 hours long.

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(2)

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

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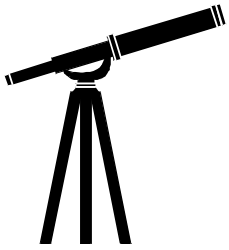
(1)

(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.

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(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.

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_____

(2)

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

(i) Suggest why.

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(1)

(ii) Radio telescopes and optical telescopes may be used to observe the sky. Explain.

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(2)

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

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(1)

(d) On a crisp and cloudless night, Sarah and Toyah together with a member of an astronomy society set up a telescope in a place far away from street lights.

(i) The astronomy enthusiast claims that the image of Jupiter observed by the students has left Jupiter about 30 minutes ago. Explain.

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_____

(2)

(ii) The Ursa Major galaxy is 1×10^9 **light years** away from us. If light travels with a speed of 3×10^8 m/s, calculate the distance of the galaxy from Earth. Give your answer in standard form.

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(3)