



**Coimisiún na Scrúduithe Stáit
State Examinations Commission**

LEAVING CERTIFICATE EXAMINATION, 2016

PHYSICS – ORDINARY LEVEL

MONDAY, 20 JUNE – MORNING, 9:30 TO 12:30

Answer **three** questions from **Section A** and **five** questions from **Section B**.

SECTION A (120 marks)

Answer **three** questions from this section.

Each question carries 40 marks.

1. A student carried out an experiment to verify the principle of conservation of momentum. During the experiment, the student took measurements to find mass and velocity.
- (i) Draw a labelled diagram of the arrangement of the apparatus used in this experiment. (12)
 - (ii) How was mass measured? (6)
 - (iii) What measurements were taken to calculate velocity?
How were these measurements used to calculate velocity? (9)
 - (iv) How did the student determine the momentum? (6)
 - (v) How did the student verify the principle of conservation of momentum? (7)
2. An experiment was set up to determine the refractive index of a material.
- (i) Draw a labelled diagram of the arrangement of the apparatus used in this experiment. (12)
 - (ii) Indicate on your diagram the measurements that were taken. (9)
 - (iii) What instrument was used to take these measurements? (6)
 - (iv) How was the refractive index calculated? (7)
 - (v) Why should the experiment be repeated? (6)

3. A student carried out a laboratory experiment to find the speed of sound in air.
- (i) Draw a labelled diagram of the arrangement of the apparatus used in this experiment. (12)
 - (ii) How did the student find the frequency of the sound wave used? (6)
 - (iii) What other measurements did the student take? (9)
 - (iv) How did the student calculate the speed of sound in air? (9)
 - (v) State one precaution which the student might have taken to get an accurate result. (4)

4. In an experiment to verify Joule's law, a heating coil was placed in a fixed mass of water. A current I was allowed to flow through the coil for a fixed length of time and the rise in temperature, $\Delta\theta$, was recorded.

This was repeated for different values of I .

The table below shows the data recorded.

- (i) Draw a labelled diagram of the arrangement of the apparatus used in this experiment. (12)
- (ii) How was the current changed during the experiment? (4)
- (iii) Copy the table below and complete it in your answerbook. (6)

I (A)	1.0	1.5	2.0	2.5	3.0	3.5	4.0
I^2 (A ²)		2.25					
$\Delta\theta$ (°C)	2.3	4.9	8.8	13.0	20.2	26.0	35.2

- (iv) Using the data in the completed table, draw a graph on graph paper of $\Delta\theta$ against I^2 . (12)
- (v) Explain how your graph verifies Joule's law. (6)

SECTION B (280 marks)

Answer **five** questions from this section.

Each question carries 56 marks.

5. Answer any **eight** of the following parts, (a), (b), (c), etc.

(a) State the principle of Archimedes.

(b) A tractor applies a force of 500 N to pull a trailer a distance of 3 km. Calculate the work done by the tractor.



(c) Choose from the list below the instrument used to measure (i) pressure, and (ii) energy.

opisometer barometer hydrometer joulemeter

(d) State two uses for a concave mirror.

(e) Conduction is one method of heat transfer. Name the other two methods.

(f) What is the function of a lightning conductor?

(g) There are 150 turns in the primary coil of a transformer and 3000 turns in the secondary coil. Calculate the output voltage when 12 V a.c. is connected across the primary coil.



(h) State one common use of the electroscopes.

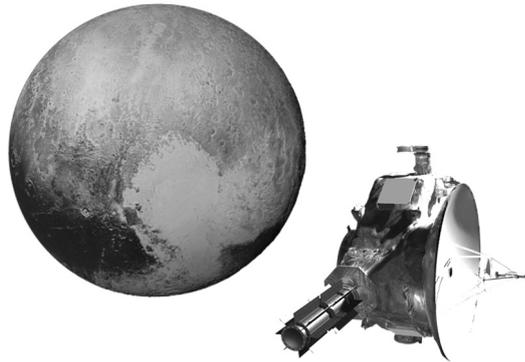
(i) What is the photoelectric effect?

(j) What are alpha-particles?

(8 × 7)

6. Define the term force and state the unit of force. (9)

Force is a vector quantity. Name another example of a vector quantity. (6)



The *New Horizons* spacecraft visited the minor planet Pluto in 2015.

Newton's law of universal gravitation is used to calculate the force between two bodies, for example Pluto and the *New Horizons* spacecraft.

State the factors which affect the size of the gravitational force between two bodies. (9)

Pluto has a mass of 1.3×10^{22} kg and a radius of 1186 km. Use the equation below, which is taken from page 56 of the *Formulae and Tables* booklet, to calculate g , the acceleration due to gravity on the surface of Pluto. (12)

$$g = \frac{GM}{d^2}$$

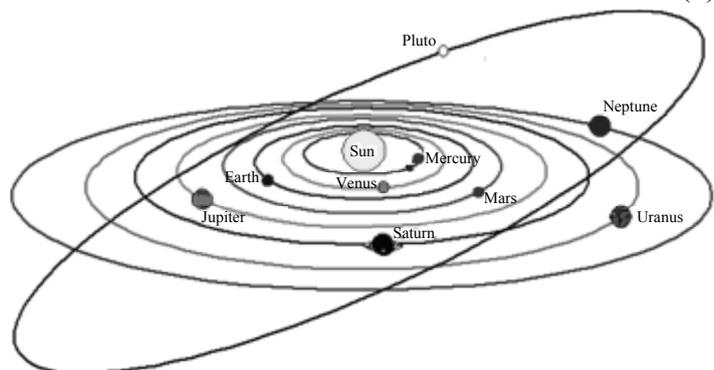
The mass of the *New Horizons* spacecraft is 450 kg. Calculate the weight it would have on the surface of Pluto.

The closest the spacecraft got to Pluto was 11000 km from the surface of the planet. Would you expect its weight at this position to be greater or less than it would be at the surface? Explain your answer. (12)

The Earth is surrounded by a layer of air, called its atmosphere, which exerts a pressure on the surface of the planet. Explain why Pluto's atmosphere exerts a very low pressure on its surface. (3)

The *New Horizons* spacecraft used a radioactive isotope to generate electricity, instead of the solar panels used on most spacecraft.

Suggest a reason why solar panels were unsuitable in this case. (5)



7. Sound and light travel as waves. Sound travels as a longitudinal wave whereas light travels as a transverse wave.

Explain the underlined terms. (8)

Describe a laboratory experiment which demonstrates that sound requires a medium to travel through. (12)

Total internal reflection is the basis of operation of optical fibres.

(i) With the aid of a labelled diagram, explain how total internal reflection occurs. (9)

(ii) State two uses of optical fibres. (6)

(iii) The refractive index of a material in an optical fibre is 1.44. Calculate the minimum angle at which light can strike the sides of the fibre and still be transmitted through the fibre. (9)

The picture shows a sound-level meter, which is used to measure sound intensity level.

(iv) What is the unit of sound intensity level? (6)

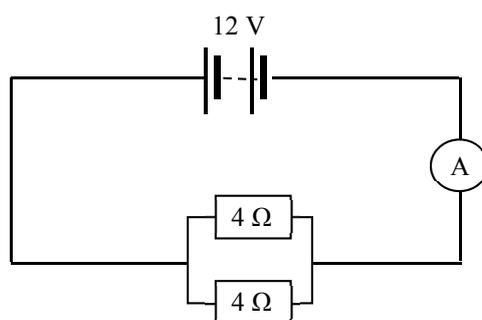
(v) Why might a sound-level meter be used in a workplace? (6)



8. Define *voltage* and *resistance*. (9)

Name an instrument used to measure each of these quantities. (6)

Name a source of voltage. (6)



The diagram above shows a circuit with a 12 V d.c. power supply, an ammeter, and two 4 Ω resistors connected in parallel.

Calculate

- (i) the total resistance of the circuit
 (ii) the current flowing through the ammeter
 (iii) the current flowing through each resistor. (21)

One effect of an electric current is the heating effect. Name the two other effects of an electric current. Describe an experiment to demonstrate one of these two effects. (14)

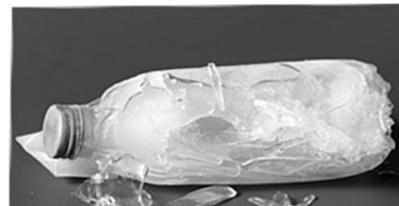
9. What is meant by *latent heat*? (6)

Name an instrument used to measure temperature. (3)

A glass bottle is filled with 0.75 kg of water at a temperature of 20 °C. The bottle is then placed in a freezer, which freezes the water and cools it to -15 °C.

Calculate the energy removed from the water to

- (i) reduce its temperature to 0 °C
- (ii) convert the water at 0 °C to ice at 0 °C
- (iii) to cool the ice at 0 °C to ice at -15 °C. (24)



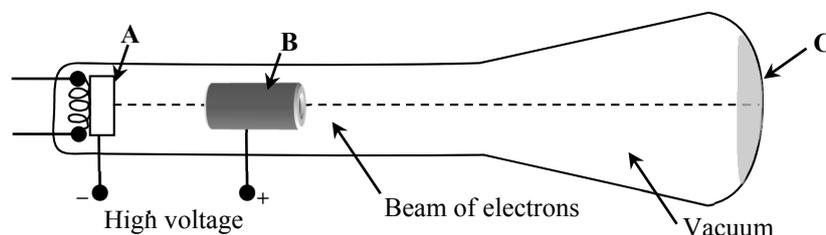
<i>specific heat capacity of water</i>	$= 4200 \text{ J kg}^{-1} \text{ K}^{-1}$
<i>specific latent heat of fusion of water</i>	$= 3.3 \times 10^5 \text{ J kg}^{-1}$
<i>specific heat capacity of ice</i>	$= 2200 \text{ J kg}^{-1} \text{ K}^{-1}$

The power rating of the freezer is 300 W. How long will it take for the freezer to remove 9000 J of energy from the water? (5)

As the water freezes, the glass bottle cracks and shatters. Explain why this occurs. (6)

The freezer is an example of a heat pump. Outline the operation of a heat pump. (12)

10. X-ray tubes and cathode ray tubes are practical applications of thermionic emission. Thermionic emission causes the emission of electrons, which are sub-atomic particles.



The diagram shows a simple cathode ray tube, which produces a beam of electrons by thermionic emission.

- (i) State two properties of the electron. Name another sub-atomic particle. (9)
- (ii) Name the parts labelled **A**, **B**, and **C** in the diagram. (9)
- (iii) State the function of any two of these parts. (9)
- (iv) How could the beam of electrons be deflected? (6)
- (v) Why is it important to have a vacuum inside a cathode ray tube? (6)
- (vi) State one use of a cathode ray tube. (3)

Electrons are produced by thermionic emission in an X-ray tube also.

Draw a sketch of an X-ray tube. (11)

Why are lead aprons often worn when using an X-ray tube? (3)

11. Read this passage and answer the questions below.

Experimentum crucis

Once he returned to Cambridge from the country in 1667, Newton began to gain honours with startling rapidity and became the second holder of the Lucasian Professorship in Mathematics, a position later held by Stephen Hawking. This new job obliged Newton to give occasional lectures but he was also able to spend much more time on experiments.

To isolate a single colour (or at least what the eye sees as a colour – a spectrum in fact consists of an innumerable range of colours, each blending into the next), he put a card with a hole in it next to a prism, only letting through a narrow band of light. Not only did he confirm his view that when this beam was passed through a second prism no different colours were produced – red light remained red, blue remained blue and so on – he discovered that red coloured light was bent much less by the prism than blue light. The degree of bending, the refraction, varied as he moved through the different colours.



He later referred to this discovery as the *experimentum crucis*, the crucial experiment, emphasising its significance as a turning point in the understanding of the nature of light. He had found something fundamental and new - that light was made up of colours that were distinct entities, impossible to change from one into the other, each bent differently by a prism. For good measure, his experiment explained why a prism worked at all. When a beam of light hit an ordinary block of glass there was no rainbow produced. As the light passed from air to glass it was true that the blue light would bend further than the red, splitting it out, but when it reached the far side of the block it would move back the other way an equal amount and the result would be to recombine the colours. The prism's triangular faces meant that the two opportunities to bend - towards the vertical of the first face and away from the vertical of the second - both resulted in movement in the same direction. The colours remained separate.

(Adapted from *Light Years - The Extraordinary Story of Mankind's Fascination with Light*, Brian Clegg, Icon Books, 2015)

- (a) What word is used to describe the bending of light by a prism?
- (b) What does the spectrum of light consist of?
- (c) Which colour of light is bent the most?
- (d) Draw a diagram to show how a spectrum can be produced using a prism.
- (e) What was the significance of Newton's experiment?
- (f) Without using a prism, how else can a spectrum be produced?
- (g) Why is a spectrum not produced by an ordinary block of glass?
- (h) Name another field of physics for which Newton is famous.

(8 × 7)

12. Answer any **two** of the following parts, (a), (b), (c), (d).

(a) Define *kinetic energy* and *potential energy*. (6)

Students carried out an experiment to investigate how to protect a falling egg from breaking.

They observed the results when an egg of mass 52 g was dropped from a height of 2 m, when protected and unprotected.

(i) Calculate the potential energy of the egg before it was dropped. (6)

(ii) Calculate the velocity of the egg as it hit the ground. (6)

Suggest how the egg could be protected from breaking when it hits the ground. (6)

State one everyday application of the principal behind the protection of the egg. (4)

(acceleration due to gravity, $g = 9.8 \text{ m s}^{-2}$)



(b) The diagram shows a bar magnet.



(i) Copy the diagram and show on it the magnetic field lines around the magnet. (6)

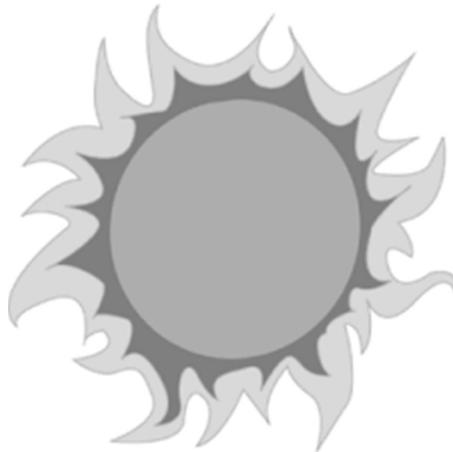
(ii) Describe an experiment to plot the magnetic field lines around the magnet. (12)

(iii) Name a metal that is attracted to a magnet. (4)

(iv) State two practical uses of a magnet. (6)

- (c) A ring circuit is used in domestic wiring.
- (i) State one advantage of using of a ring circuit when wiring a house. (6)
 - (ii) *Earthing* is a safety measure included in domestic circuits.
What is meant by earthing? How does earthing contribute to safety? (9)
 - (iii) Name one other safety device used in domestic wiring. (4)
 - (iv) In a standard domestic three-pin plug, the live wire is covered in brown plastic.
Name the other two wires and state the colour associated with each of them. (9)

- (d) *Nuclear fusion* is the source of the Sun's energy.



- (i) What is meant by nuclear fusion? (6)
- (ii) Name the other type of nuclear reaction used in nuclear power stations. (6)
- (iii) State one advantage and one disadvantage of each of these sources of nuclear energy. (12)
- (iv) Name the scientist whose equation $E = mc^2$ explained why a large amount of energy is available from a small mass of fuel in nuclear reactions. (4)

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