Coimisiún na Scrúduithe Stáit
State Examinations Commission

LEAVING CERTIFICATE EXAMINATION, 2025

PHYSICS – ORDINARY LEVEL

WEDNESDAY, 18TH JUNE – MORNING, 9:30 TO 12:30

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

Do not hand this up.

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Relevant data are listed in the *Formulae and Tables* booklet, which is available from the Superintendent.

SECTION A (120 MARKS)

Answer **three** questions from this section.

Each question carries 40 marks.

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1. A student carried out an experiment to verify the principle of conservation of momentum between two trolleys, A and B. Trolley A travelled at a constant velocity down a track and then collided with trolley B which was at rest. Trolleys A and B then moved together with the same velocity, v_{final}.

She measured the mass of each trolley and then took further measurements to determine the velocities of the trolleys.

The following data were recorded.

mass of trolley A, m_A	0.34 kg
mass of trolley B, m_B	0.36 kg
velocity of trolley A before the collision, u_A	1.85 m s^{-1}
velocity of trolley B before the collision, u_B	0 m s^{-1}
velocity of trolley A and trolley B after the collision, v_{final}	0.90 m s^{-1}

(*i*) Draw a labelled diagram of the arrangement of the apparatus used in this experiment.

(*ii*) Describe how the student measured the mass of each trolley.

(*iii*) State the formula used to calculate velocity. (21)

She used the recorded data and the following formula to verify the principle of conservation of momentum.

$$\text{total momentum before} = \text{total momentum after}$$

$$(m_A \times u_A) + (m_B \times u_B) = (m_A + m_B) \times v_{final}$$

(*iv*) Calculate

(*a*) the total momentum before the collision,

(*b*) the total momentum after the collision.

(*v*) Explain how your calculations can be used to verify the principle of conversation of momentum.

(*vi*) How could the student have minimised the effect of friction? (19)

2. In an experiment to verify Boyle's law, a student measured the pressure p of a gas at different volumes V. The student recorded the following results.

V (cm^3)	5	10	15	20	25	30
p (MPa)	0.203	0.108	0.073	0.054	0.043	0.035
$\frac{1}{p}$ (MPa^{-1})	4.93	9.26	13.70			

(*i*) Draw a labelled diagram of the arrangement of the apparatus used in this experiment.

(*ii*) Describe how the student measured both the pressure and the volume.

(*iii*) State one quantity that must be kept constant during the experiment. (18)

(*iv*) Copy and complete the table above into your answerbook by calculating the value of $\frac{1}{p}$ to 2 decimal places.

(*v*) Plot a graph, on graph paper, of $\frac{1}{p}$ against V.

(*vi*) Explain how your graph verifies Boyle's law. (22)

3. In an experiment to calculate the refractive index n of glass, a student passed a ray of light through a rectangular glass block. He measured the angle of incidence i and the corresponding angle of refraction r. He repeated this for different values of the angle i.

(*i*) Draw a labelled diagram of the arrangement of the apparatus used in this experiment.

(*ii*) On your diagram, draw and label the incident ray, the refracted ray and the normal to the surface of the glass block.

(*iii*) What piece of equipment did the student use to measure the angles? (21)

The student recorded the following results.

i (degrees)	r (degrees)	sin i	sin r	$n = \frac{\sin i}{\sin r}$
20	13	0.34	0.22	
46	28			
61	35			

(*iv*) Copy and complete the table above into your answerbook by calculating the missing values to 2 decimal places.

(*v*) Use the data to calculate an average value for the refractive index n of the glass.

(*vi*) State one precaution the student should take when carrying out the experiment. (19)

4. A student carried out an experiment to measure the specific latent heat of vaporisation of water. She added steam to cold water in a copper calorimeter. When the steam had condensed, she recorded a number of measurements and calculated the specific latent heat of vaporisation of water.

The following results were recorded.

mass of calorimeter + cold water	0.196 kg
mass of calorimeter + water + steam	0.198 kg
final temperature of calorimeter, water and added steam	42 ˚C

(*i*) Draw a labelled diagram of the apparatus used in the experiment.

(*ii*) The initial temperature of the steam was 100 ˚C. Calculate the change in temperature of the steam.

(*iii*) Calculate the mass *m* of the steam added. (24)

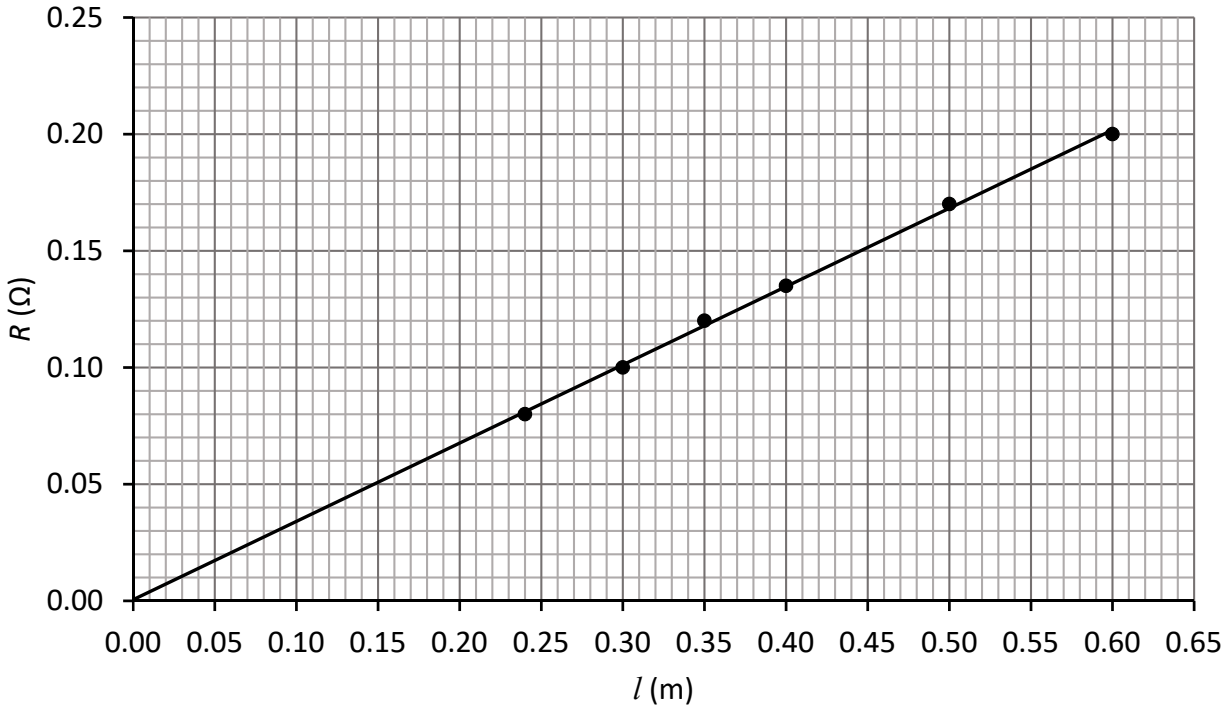
She calculated the latent heat released ΔE when the steam condensed to be 4600 J.

(*iv*) Calculate, l, the specific latent heat of vaporisation of the water.

(*v*) Suggest a reason why the student used cold water at the start of the experiment.

(*vi*) State one safety precaution the student should take when carrying out the experiment. (16)

5. In an experiment to measure the resistivity ρ of the material of a wire, a student measured the length l and the resistance R of the wire. He repeated this for six different lengths of the same wire. The student completed the following graph to show the relationship between l and R. He also measured the diameter d of the wire.



(*i*) Describe how the student measured

(*a*) the length l of the wire,

(*b*) the resistance R of the wire.

radius of the wire = 0.00124 m

(*ii*) Describe the steps the student used to find the diameter of the wire.

(*iii*) The radius of the wire is 0.00124 m. Calculate the circular cross-sectional area A of the wire. (24)

(*iv*) Describe the relationship between l and R shown in the graph.

(*v*) Calculate the slope of the graph.

(*vi*) Using the formula, ρ = slope × A, calculate the resistivity ρ of the wire. (16)

SECTION B (280 MARKS)

Answer **five** questions from this section.

Each question carries 56 marks.

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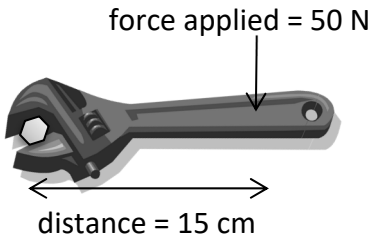
6. Answer any **eight** of the following parts (*a*), (*b*), (*c*), etc.



(*a*) The diagram shows a force of 50 N applied to a wrench. Calculate the moment of the force about the fulcrum at the centre of the nut.

(*b*) State one condition necessary for equilibrium.

(*c*) State the three primary colours of light.

(*d*) Choose, from the following list of apparatus, an instrument used to measure

(i) atmospheric pressure,

(ii) potential difference.

barometer **joulemeter** **sound level meter** **voltmeter**

(*e*) Two resistors, 5 Ω and 10 Ω, are connected in parallel. Calculate the total resistance of the two resistors.

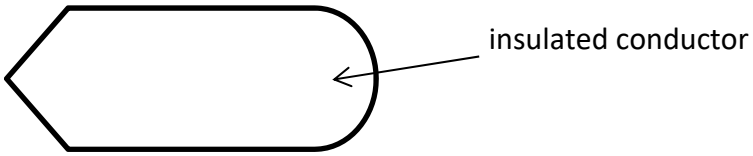
(*f*) State two characteristics of a musical note.

(*g*) Why does the north pole of a magnet, that is free to rotate, point north?

(*h*) Sketch the electric field due to a positive point charge.

(*i*) Explain what is meant by a semiconductor.

(*j*) The insulated conductor shown below is positively charged. Copy the diagram into your answer book and show the distribution of charge on it.



(*k*) Draw a labelled diagram of an atom. Include in your diagram the names and locations of the subatomic particles of the atom.

(*l*) Explain what is meant by the photoelectric effect.

(8 x 7)

7. In 1867, Isaac Newton published his ideas on motion in a book called *The Principia*. In it Newton developed an understanding of the idea of 'force'.

(*i*) Explain what is meant by force.

(*ii*) State the SI unit for force.

(*iii*) Force is a vector quantity. Explain what is meant by a vector quantity.

(*iv*) State another example of a vector quantity. (18)

A person wishes to go skydiving. She boards an airplane at rest on a horizontal runway. The airplane reaches a velocity of 24 m s^{-1} in 8 s before take-off.

(*v*) Calculate the horizontal acceleration of the airplane.

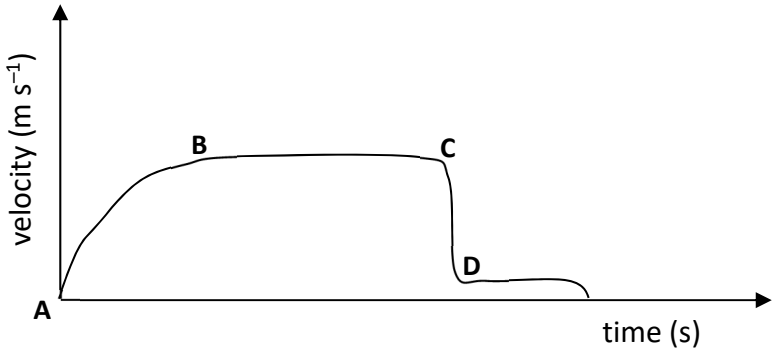
Some time after take-off, the skydiver jumps out of the plane. The total mass of the skydiver is 70 kg, including the parachute.

(*vi*) Calculate the total weight of the skydiver.

(*vii*) What happens to the force of air resistance when the parachute is opened?

(*viii*) After the parachute has opened, the skydiver travels at constant velocity. Draw a labelled diagram to show the forces now acting on the skydiver. (21)

The graph shows how the velocity of the skydiver changes with respect to time once she leaves the airplane.



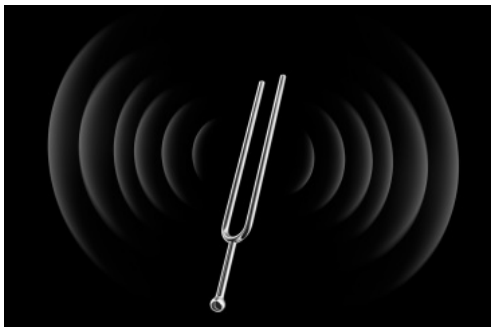
(*ix*) How can we tell from the graph that the skydiver is accelerating between **A** and **B**?

(*x*) Describe the skydiver's velocity between **B** and **C**.

(*xi*) Identify the point that represents when the skydiver opens her parachute.

(*xii*) Why is it safe for the skydiver to land after **D**? (17)

8. Sound is produced when an object vibrates, causing the particles in the surrounding medium to have vibrational energy. As the particles vibrate, they cause nearby particles to vibrate thus transmitting the sound until it is detected by the ear of a nearby person.



(*i*) Describe an experiment to show that sound requires a medium to travel through.

(*ii*) Explain what is meant by the frequency of a wave.

(*iii*) State the relationship between the frequency and the period of a wave. (21)

A speaker emits a sound wave with a frequency f of 220 Hz. It has a wavelength λ of 1.5 m.

(*iv*) Calculate the speed of the sound wave produced.

(*v*) Does a sound wave travel faster in a solid or in air? (13)

Sound waves can undergo diffraction and interference.

(*vi*) Explain what is meant by diffraction.

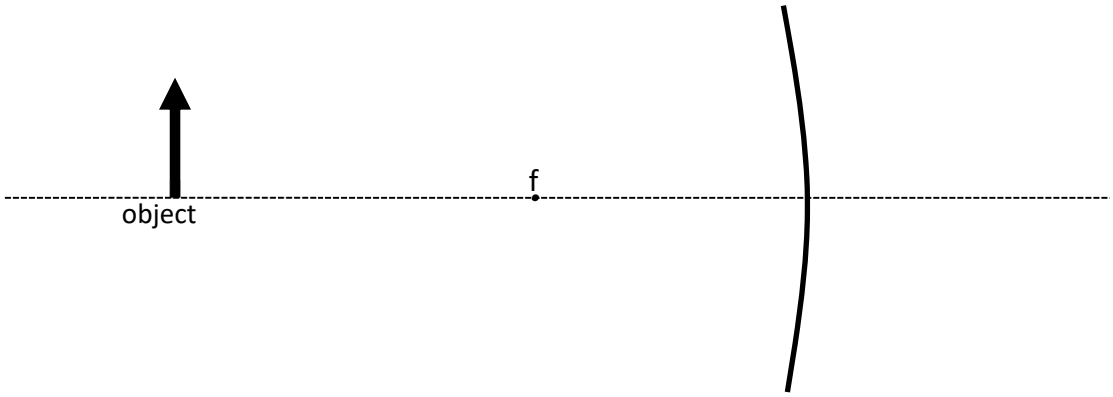
(*vii*) Explain why a sound wave diffracts after passing through a doorway but a light wave does not.

(*viii*) Describe an experiment to show that sound is a wave by showing that it can undergo interference**.** (22)

9. A concave mirror can be used to form real or virtual images.

(*i*) Distinguish between a real image and a virtual image.

(*ii*) In your answer book, copy and complete the ray diagram below to show the formation of a real image in a concave mirror.



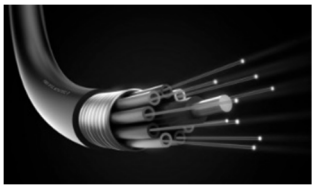
(*iii*) A concave mirror has a focal length *f* of 8 cm. An object is placed with an object distance *u* of 20 cm in front of the mirror. Using the formula $\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$, calculate the image distance *v*.

(*iv*) Calculate the magnification of the image produced.

(*v*) The concave mirror in the ray diagram is replaced with a convex lens. Describe one difference between the ray diagram for the lens and the ray diagram for the concave mirror.

(36)

Fibre broadband uses fibre optic cables to deliver data to homes and businesses across Ireland. A fibre optic cable is a thin flexible fibre with a glass core that can transmit light from one end to the other by total internal reflection.



(*vi*) Draw a labelled diagram to show how a ray of light is transmitted through a fibre optic cable by total internal reflection.

(*vii*) The critical angle *C* of the glass in a fibre optic cable is 42.8˚.
Calculate the refractive index *n* of the glass.

(*viii*) State one advantage of using fibre optic cables instead of copper conductor cables.

(*ix*) State one other use of fibre optic cables. (20)

10. (*i*) Explain what is meant by a magnetic field.

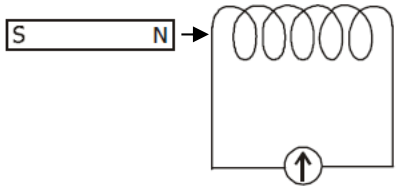
(*ii*) Draw a sketch of the magnetic field around a bar magnet.

(*iii*) Explain what is meant by an electric current.

(*iv*) Name an instrument used to measure electric current.

(*v*) State one effect of an electric current. (26)

An electrical generator is based on the principle of electromagnetic induction. It can be demonstrated by moving a magnet towards a coil as shown.

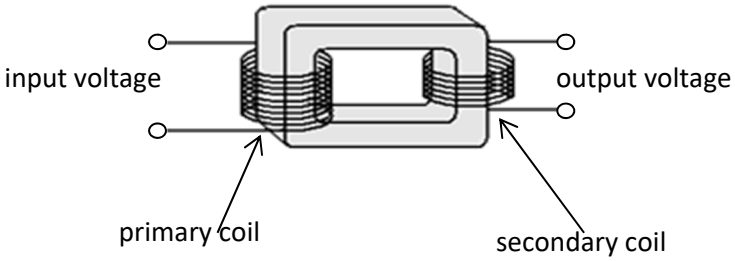


(*vi*) Explain what is meant by electromagnetic induction.

(*vii*) What is observed on the meter when the magnet is moved in and out of the coil?

(*viii*) What is observed on the meter when the magnet is stationary within the coil? (14)

A transformer is also based on the principle of electromagnetic induction. An a.c. source is connected to the primary coil of a transformer to provide an input voltage.



(*ix*) The primary coil of a transformer has 200 turns of wire and the secondary coil has 50 turns. The input voltage is 230 V a.c.
Calculate the output voltage across the secondary coil.

(*x*) Draw a sketch of a graph to show how an a.c. voltage *V* changes with time *t*.

(*xi*) State one use of a transformer. (16)

11. An air to water system is one of the most common ways to heat modern homes.

(*i*) Distinguish between heat and temperature.

(*ii*) State two methods by which heat can be transferred throughout a home. (12)

Internal temperature monitors are used to record the indoor temperature. The temperature of a living room is 292 K.

(*iii*) Calculate the temperature of the living room in degrees celsius (°C).

(*iv*) The internal temperature monitors are based on a thermometric property. State one example of a thermometric property.

A U-value is the measure of the rate of heat loss in a house.

(*v*) State two ways in which the U-value of a house can be reduced. (19)

In addition to air to water systems, modern homes can also have solar panels installed as a source of electricity. Solar energy is a renewable energy source.

(*vi*) Explain what is meant by the term renewable energy source.

(*vii*) State one advantage and one disadvantage of using solar energy.

(*viii*) State one other renewable source of energy.

(*ix*) A solar cell can be used to charge a mobile phone. The power output from the solar cell is 3 W. The mobile phone requires 3.6 kJ of energy to charge.
Calculate the time taken for the mobile phone to charge. (25)

12.

(*a*) Radon is a naturally occurring radioactive gas which can pose a health risk if it is found in high concentrations in indoor environments. Radon is produced from natural radioactive decay and is found in rocks and soils.

(*i*) Explain what is meant by radioactivity.

Rn_{86}^{222} is a radon atom.

(*ii*) How many protons are in an atom of radon?

(*iii*) Calculate how many neutrons are in an atom of radon–222.

Rn_{86}^{222} emits an alpha particle.

(*iv*) Determine what element is formed after an alpha particle, α_2^4, is emitted from Rn_{86}^{222}.

(20)

(*b*) Nuclear fission reactors are used to generate electricity.

(*i*) Explain what is meant by nuclear fission.

(*ii*) Explain what is meant by a chain reaction.

(*iii*) State a suitable fuel used in a nuclear fission reactor.

(*iv*) State the function of

(*a*) the moderator,

(*b*) the shielding in a nuclear reactor.

Einstein's equation $E = mc^2$ is used to explain the energy conversion taking place in a nuclear reactor.

(*v*) Identify what the letters *m* and *c* stand for.

The Sun's energy is produced by nuclear fusion.

(*vi*) Explain what is meant by nuclear fusion.

(*vii*) State *one* advantage of using nuclear fusion over nuclear fission as a source of energy. (36)

13 Read the following passage and answer the questions below.

Domestic electricity refers to electrical circuits and safety devices around the home, like circuit breakers (e.g. fuses and RCDs), the ring mains circuit and the functions of the live, neutral and earth wires.

Circuit breakers are automatically operated electrical switches that protect the home. A fuse breaks the circuit if a fault causes too much current to flow.

The copper wiring in a house connects appliances together in parallel. This is so that each appliance (e.g. an electric kettle) has 230 V across it.

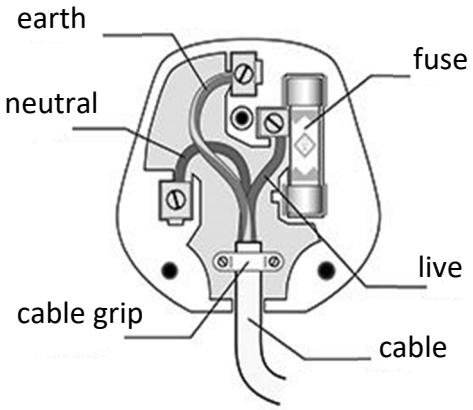
Electricity meters measure the number of units, kilowatt-hours (kW h), of electricity used in the home.

adapted from www.bbc.co.uk/bitesize

(*i*) Name a common material used to conduct electricity in an electrical cable. (7)

(*ii*) Explain the function of an earth wire. (7)

(*iii*) A fuse is a type of circuit breaker. Explain how a fuse works. (7)



(*iv*) An electric kettle has a power rating of 2300 W. Identify, from the list below, which is the most appropriate fuse that should be used.

3 Amp **5 Amp** **13 Amp** (7)

(*v*) In an electric plug, state the colour of

(*a*) the live wire,

(*b*) the neutral wire. (7)

(*vi*) The cost of electricity is calculated using the following equation.

$$\text{units (kW h)} = \text{power (kW)} \times \text{time (h)}$$

The price of a unit is 30 cent.

Calculate the cost of using a 1.2 kW electric heater for 3 hours. (7)

(*vii*) Explain why appliances in the home are connected in parallel. (7)

(*viii*) Another device used in domestic circuits is a residual current device (RCD). Explain the function of an RCD. (7)

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

(*a*) A crane lifts large objects from the ground.

(*i*) Explain what is meant by energy.

(*ii*) State the principle of conservation of energy.

(*iii*) Calculate the work done in lifting a weight of 12 000 N to a height of 3.5 m.

(*iv*) Calculate the power output required by the crane to raise the weight to this height in a time of 12 seconds.

(*v*) The input power of the crane is 5000 W. Calculate the percentage efficiency of the crane.

(28)

(*b*) A moving train's whistle emits a note with a constant frequency of 2.4 kHz. The frequency of the sound emitted appears different to a stationary observer. This phenomenon is described by the Doppler effect.

(*i*) Explain what is meant by the Doppler effect.

(*ii*) Describe a laboratory experiment to demonstrate the Doppler effect. (18)

To the observer, the frequency of the note appears to be higher than 2.4 kHz.

(*iii*) Is the train moving towards or moving away from the observer?

(*iv*) Describe the frequency that the train driver hears.

(*v*) State one application of the Doppler effect. (10)

(*c*) A gold leaf electroscope has many uses in the field of electrostatics.

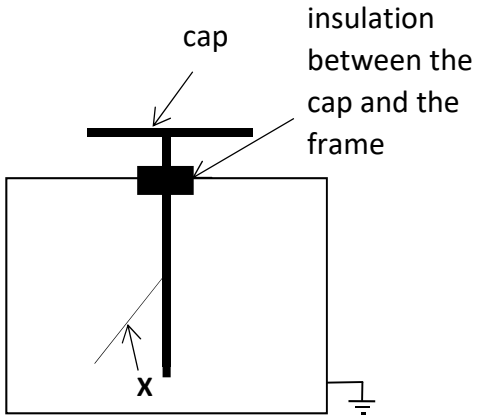
(*i*) Identify the part labelled **X** on the electroscope in the diagram.

(*ii*) Describe how to charge an electroscope negatively.

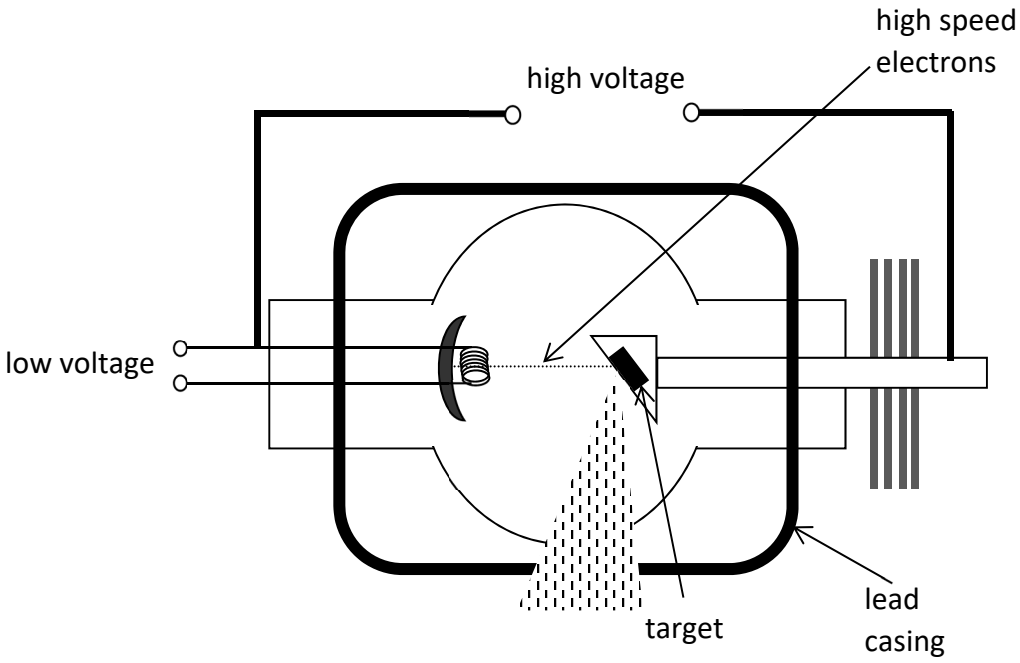
(*iii*) State one use of an electroscope. (18)

(*iv*) State Coulomb's law.

(*v*) Describe a method used to remove the charge from an electroscope. (10)



(*d*) X-rays are produced when high speed electrons collide with a target in an X-ray tube as shown in the diagram.



(*i*) What are X-rays?

(*ii*) Identify a suitable material that could be used for the target.

(*iii*) Describe how electrons are produced in the X-ray tube. (18)

(*iv*) Why is a lead casing put around an X-ray tube?

(*v*) State one use of X-rays. (10)

Acknowledgements

Images

Image on page 6:	Word clip art plus Word shapes
Image on page 7:	ramblers.com.au
Image on page 8:	bbc.co.uk/bitesize
Image on page 9:	limerickleader.ie
Images on page 11:	pipelife.ie; energywiseireland.ie

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Leaving Certificate Examination – Ordinary Level

Physics

Wednesday, 18 June
Morning, 9:30 – 12:30