Coimisiún na Scrúduithe Stáit

State Examinations Commission

Leaving Certificate Examination, 2026

Physics – Ordinary Level

Wednesday, 17th June – Morning, 9:30 to 12:30

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

Do not hand this up.

This document will not be returned to the State Examinations Commission.

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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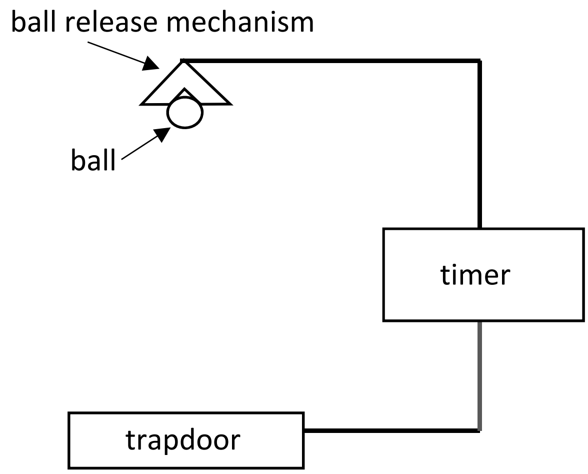
1. A student carried out an experiment to measure the value for the acceleration due to gravity *g*.

She drew the following diagram to show the apparatus that she used.



(*i*) Copy the diagram above into your answerbook and mark the displacement *s* that the student measured.

(*ii*) On your diagram, add in the piece of apparatus used to measure the displacement *s*.

(*iii*) Suggest a reason why the trapdoor is connected to the timer. (15)

The following data were recorded.

s (cm)	65	70	75	80	85	90
t (s)	0.36	0.38	0.39	0.40	0.41	0.43

(*iv*) Copy and complete the table below into your answerbook by calculating the missing values for 2*s* in metres.

s (cm)	65	70	75	80	85	90
2*s* (m)	1.3	1.4				

(*v*) Copy and complete the table below into your answerbook by calculating the missing values for t^2.

t (s)	0.36	0.38	0.39	0.40	0.41	0.43
t^2 (s^2)					0.168	0.185

(*vi*) Use the data to draw a graph of 2*s* (y–axis) against t^2 (x–axis).

(*vii*) Calculate the slope of the graph to get a value for *g*. (25)

2. A student carried out an experiment to measure the focal length *f* of a concave mirror.
She measured the object distance *u* to be 25 cm.
She measured the image distance *v* to be 48 cm.

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

(*ii*) On your diagram, indicate the object distance *u* and the image distance *v*.

(*iii*) Describe the steps used to determine *v*. (27)

(*iv*) (*a*) State the formula used to calculate the focal length *f*.

(*b*) Calculate *f*.

(*v*) Describe one precaution that the student could have taken to improve the experiment. (13)

3. In an experiment to investigate the relationship between frequency *f* and length l for a stretched string, a student set a length of string vibrating and adjusted the length until resonance occurred. He measured l and noted the corresponding *f*. He repeated this for different values of *f*.

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

(*ii*) On your diagram, indicate the length l the student measured.

(*iii*) Describe the steps that the student used to determine l for a particular value of *f*. (21)

The student recorded the following results.

f (Hz)	256	288	320	341	384	426
l (cm)	50	44	40	37	33	30
$\frac{1}{l}$ (cm^{-1})	0.020	0.023				

(*iv*) Copy and complete the table above into your answerbook by calculating the missing values for $\frac{1}{l}$ to 3 decimal places.

(*v*) Draw a graph of *f* against $\frac{1}{l}$.

(*vi*) State the relationship between *f* and l. (19)

4. A student carried out an experiment to measure l the specific latent heat of fusion of ice. She added ice to warm water in a copper calorimeter. When the ice had fully melted, she recorded the measurements below. She then calculated l.

mass of calorimeter + warm water (kg)	0.450
mass of calorimeter + water + melted ice (kg)	0.474
initial temperature of the calorimeter and warm water (°C)	27
final temperature of calorimeter, water and melted ice (°C)	20
energy lost by calorimeter and water and given to the ice (J)	9585

(*i*) Draw a labelled diagram of the apparatus used in the experiment. (12)

When the ice was added to the warm water, all the ice melted.

(*ii*) The initial temperature of the ice was 0 °C.
Calculate the change in temperature of the melted ice, $\Delta\theta$.

(*iii*) Calculate the mass *m* of the ice added.

The student wrote the following equation:

energy lost by calorimeter and water and given to the ice	=	*energy needed to melt the ice*	+	*energy needed to change the temperature of the melted ice from 0 °C to 20 °C*
9585	=	$m\,l$	+	$m\,c\,\Delta\theta$

(*iv*) (*a*) Calculate the energy needed to change the temperature of the melted ice from 0 °C to 20 °C.

(*b*) Calculate l, the specific latent heat of fusion of the ice. (18)

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

(*vi*) State one precaution the student should take to improve the accuracy of the experiment. (10)

specific heat capacity of water, c = 4180 J kg^{-1} *K*$^{-1}$

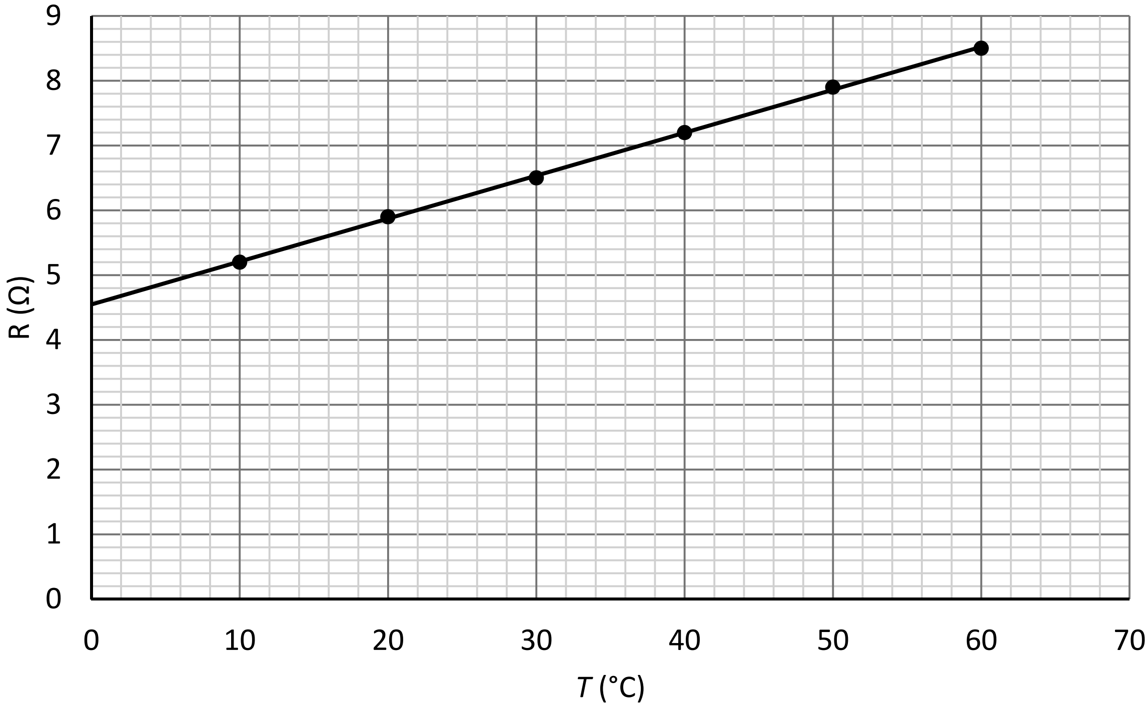
5. A student carried out an experiment to investigate how the resistance *R* of a metallic conductor changes with temperature *T*.

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

(*ii*) Name the piece of apparatus used to measure the resistance.

(*iii*) Describe how the student varied the temperature of the metallic conductor. (24)

The student used their recorded data to plot the following graph.



(*iv*) Describe the relationship between *T* and *R*.

(*v*) Use the graph to find the resistance of the metallic conductor when it was placed into melting ice.

The student used the apparatus to estimate the temperature of an unknown liquid.
The resistance was measured as 7.6 Ω.

(*vi*) Use the graph to estimate the temperature of the unknown liquid. (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*) State the difference between a vector and a scalar quantity.

(*b*) Copy and complete the following sentences.

An object moving at constant velocity will continue moving at constant velocity unless a net ___________ acts on it.

The force on an object is ___________ to the rate of change of the object's momentum.

(*c*) Calculate the work done in giving an 11 kg mass potential energy by raising it through a height of 0.5 m.

acceleration due to gravity $g = 9.8$ *m* s^{-2}

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

(*i*) energy transferred,

(*ii*) force.

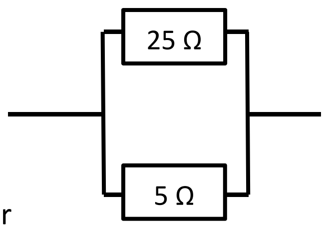
Write your answer in your answerbook.

barometer **joulemeter** **newton balance** **voltmeter**

(*e*) State Boyle's law.

(*f*) Draw the magnetic field around a bar magnet.

(*g*) Two resistors are connected in parallel as in the diagram on the right. Calculate the total resistance in the circuit.



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

(*i*) Infrared radiation is electromagnetic radiation with a wavelength longer than visible red light. Describe how infrared radiation can be detected.

(*j*) Explain the difference between an electrical insulator and an electrical conductor.

(*k*) Explain what is meant by doping a semiconductor.

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

(8 × 7)

7. Apollo 11 launched from Kennedy Space Station in Florida on 16th July, 1969.

(*i*) State Newton's 3rd law of motion.

(*ii*) Use Newton's 3rd law to explain why the rocket was able to lift off from the Earth.

Apollo 11 started from rest (u = 0 m s^{-1}). Its engine exerted a force that increased its velocity.

(*iii*) Explain what is meant by a force.

(*iv*) State the unit of force. (24)

(*v*) Assume that it reached a velocity v of 7800 m s^{-1} in a time t of 600 s. Calculate the average acceleration a during this phase of the flight.

(*vi*) Assume that the rocket's average mass m is 45 702 kg. Calculate the average net force F on the rocket during this phase of the flight.

After this, the rocket went into orbit around the Earth. During this next phase, Apollo 11 was moving at a constant speed of 7800 m s^{-1}.

(*vii*) Is Apollo 11 moving at a constant velocity while in orbit? Explain your answer. (18)

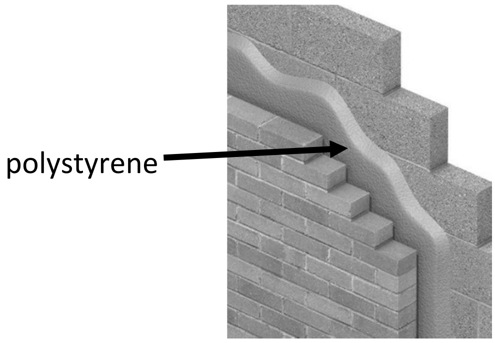
Apollo 11 landed on the Moon on 20th July, 1969. Neil Armstrong became the first person to step on the Moon.

(*viii*) Neil Armstrong, while wearing his spacesuit, had a mass of 163 kg on Earth. Given that the acceleration due to gravity on the Moon is 1.6 m s^{-2}, calculate his weight on the Moon

(*ix*) What was his mass on the Moon?

(*x*) Buzz Aldrin, the second person on the Moon left a footprint. That footprint has remained on the Moon as the Moon has no atmosphere. Explain why there is no atmosphere on the Moon. (14)

8. Polystyrene boards can be used to insulate the wall cavity of a house. This improves the U-value of the house.



(*i*) Explain what is meant by U-value.

Insulation helps to keep the temperature inside the house at a comfortable level. A thermometer inside the house can be used to monitor this temperature.

(*ii*) The temperature inside a house is maintained at 20 °C. Calculate this temperature in kelvin.

(*iii*) All thermometers are based on a thermometric property. Explain what is meant by a thermometric property.

(*iv*) State an example of a thermometric property. (24)

When heat is added to the inner wall, its temperature slowly increases.

(*v*) Explain the difference between heat and temperature.

(*vi*) The mass m of a block used to construct the inner wall in a house is 23 kg. Energy ΔE of 41 400 J is needed to raise the temperature of the block by 2 °C.
Calculate the specific heat capacity c of the block. (15)

The external surface of the house is heated by the Sun. Heat is transferred from the Sun by radiation.

(*vii*) Radiation is one type of heat transfer. Name another way in which heat can be transferred.

(*viii*) Describe an experiment to show how heat can be transferred. (17)

9. Spearfishing is one of the oldest human hunting practices. Even without formal science, early spear fishers realised fish weren't where they "appeared" to be in the water. Hunters adapted and learned to adjust their aim. This is one of humanity's earliest applications of refraction.

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

(*ii*) Describe an experiment to show that light undergoes refraction.

(*iii*) A fish is at a depth of 2 m below the surface of the water. The refractive index of the water is 1.33. Calculate the apparent depth of the fish.

Note: $\frac{\text{real depth}}{\text{apparent depth}} = \text{refractive index}$

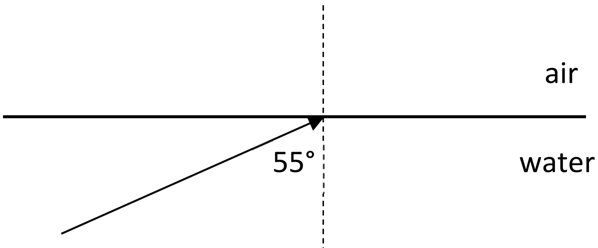
(*iv*) Does the hunter need to aim above or below where the fish appears to be? (27)

Refraction is also used in underwater photography. The phenomenon in the photograph on the right is called Snell's window. It happens due to the critical angle and total internal reflection.

(*v*) Explain what is meant by the critical angle. A diagram may help your answer.

(*vi*) A diver notes that the critical angle *C* of water is 49°. Calculate the refractive index of the water *n* to 3 decimal places.

(*vii*) Copy and complete the diagram below to show the path of the light. The light is travelling in the water. (18)

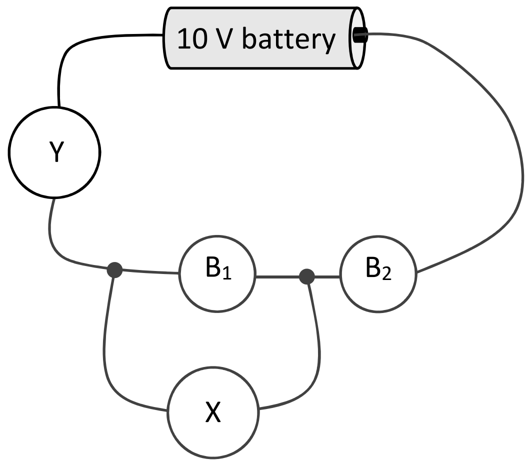


A fibre optic cable is a thin flexible fibre with a glass core that can transmit light from one end to the other by total internal reflection.

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

(*b*) State one use of fibre optic cables. (11)

10. A student drew the electrical circuits shown below to show bulbs B_1 and B_2 connected in series, and then connected in parallel. B_1 and B_2 are identical bulbs.



(*i*) Explain what is meant by electric current.

(*ii*) (*a*) Instrument X is used to measure voltage. Name the instrument.

(*b*) Instrument Y is used to measure current. Name the instrument.

(*iii*) The voltage across B_1 is 5 V. What is the voltage across B_2? Explain your answer.

(*iv*) The current through B_1 is 0.5 A. The voltage across it is 5 V. Calculate the resistance of B_1.

(*v*) Write one of the following statements **(*1*)**, **(*2*)** or **(*3*)** in your answerbook to describe how the bulbs light in the circuit when the battery is connected.

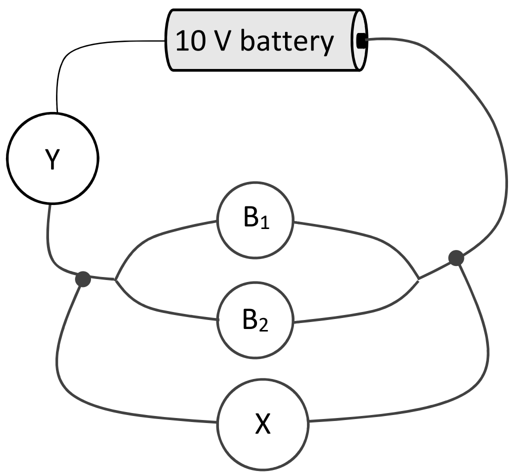
(*1*) B_1 lights first.

(*2*) B_2 lights first.

(*3*) B_1 and B_2 light at the same time.

(*vi*) Use electrical circuit symbols to redraw the series circuit above.
Note: You may refer to the electrical circuit symbols on pages 72 to 78 of the *Formulae and Tables* booklet when answering this question. (38)

In the circuit above the bulbs are connected in series but they can also be connected in parallel (as shown below).



(*vii*) State one advantage of connecting bulbs in parallel.

(*viii*) Compare the voltage across B_1 with the voltage across B_2 in the new circuit.

(*ix*) Instrument Y now reads 2 A. Calculate the current now flowing through B_1.

(*x*) What effect would increasing the voltage of the battery have on the current flowing through each of the bulbs in this parallel circuit? (18)

11. Police use radar guns to measure the speed of moving vehicles by detecting changes in the frequency of reflected microwaves. This is an application of the Doppler effect.

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

Reflection is a wave phenomenon.

(*ii*) State one of the laws of reflection.

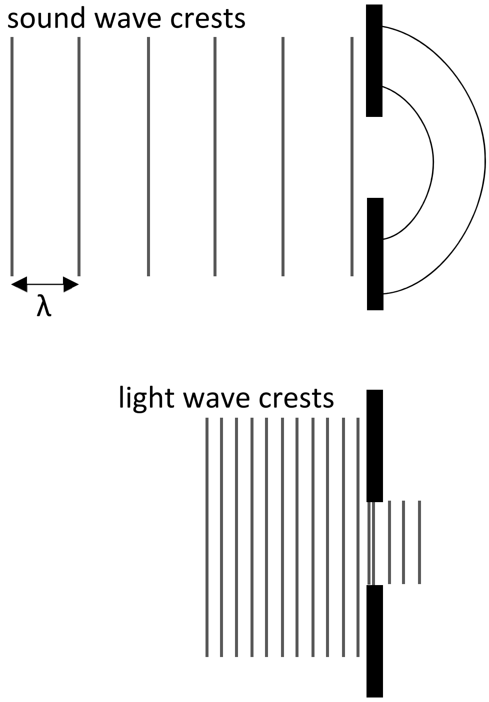
(*iii*) Describe an experiment to show that a wave can undergo reflection.

Refraction is another wave phenomenon.

(*iv*) Light strikes a glass block at an angle of incidence of 40°. It is refracted at an angle of 25°. Calculate the refractive index *n* of the glass block. (30)

Waves can also undergo diffraction, interference and polarisation.

Diffraction is the sideways spreading of a wave as it passes through a gap.



(*v*) The diagrams on the right show a sound wave and a light wave as they pass through a doorway. Explain why the sound wave diffracts as it passes through the door but the light wave does not.

(*vi*) Describe an experiment to show that light undergoes diffraction and interference.

(*vii*) Two coherent waves meet out of phase. Do they undergo constructive or destructive interference?

(*viii*) Explain why light waves can be polarised but sound waves cannot. (26)

12. According to J. J. Thomson's plum pudding model, atoms were like buns: a soft, positive "dough" with negative electrons dotted around like raisins.

Ernest Rutherford wasn't convinced of this. He decided to test this idea in the laboratory. His team fired tiny particles, called alpha particles (helium nuclei), at an extremely thin sheet of gold foil.

(*i*) State two properties of an electron.

Rutherford's gold foil experiment changed scientific views on the structure of the atom.

(*ii*) Draw a labelled diagram of an atom showing the position of the protons, neutrons and electrons.

Gold was used in this experiment. Gold appears on the periodic table as $^{197}_{79}$Au.
79 is the atomic number and 197 is the mass number.

(*iii*) Explain what is meant by the atomic number of an element.

(*iv*) Calculate the number of neutrons that are in an atom of $^{197}_{79}$Au. (26)

In Thomson's earlier work, he used a piece of apparatus called a cathode ray tube. A cathode ray is a beam of electrons.

(*v*) How are the electrons produced in a cathode ray tube?

The electrons are accelerated to very high speeds in the tube.

(*vi*) How are the electrons accelerated in the tube?

(*vii*) Describe how the direction of a beam of electrons can be controlled in a cathode ray tube.

In a cathode ray tube, a zinc sulphide screen can be used to convert the electrons' kinetic energy into light energy.

(*viii*) Given that an electron in a cathode ray tube has a mass *m* of 9.1×10^{-31} kg and moves with a velocity *v* of 3×10^{6} m s^{-1}, calculate the kinetic energy of the electron travelling in the cathode ray tube.

(*ix*) State one use for a cathode ray tube. (30)

13. Every kind of sound is produced by vibrations. The sound source may be a violin, a car horn or a barking dog. Whatever it is, some part of it is vibrating while it is producing sound. The vibrations from the source disturb the air in such a way that sound waves are produced. These waves travel through a substance in all directions, by passing the vibrations from molecule to molecule. If the waves happen to reach someone's ear, they set up vibrations that are perceived as sound.

Detecting sound depends on three things. There must be a vibrating source to set up sound waves, a medium to carry the waves, and a receiver to detect them. Sound waves cannot travel through a vacuum.

There is an age-old question concerning the definition of sound. If a tree falls in a forest far from any sound detector (such as a human ear or a microphone), does the tree's crash make any noise?

Adapted from https://kids.britannica.com/students/article/sound/277144

(*i*) Explain how sound is produced. (7)

(*ii*) Sound needs a medium to carry the waves.

(*a*) Explain what is meant by a medium.

(*b*) Identify if sound is a mechanical wave or an electromagnetic wave. (7)

(*iii*) Describe a laboratory experiment to show that sound cannot travel through a vacuum. (12)

(*iv*) Explain why sound travels faster in solids than in gases. (7)

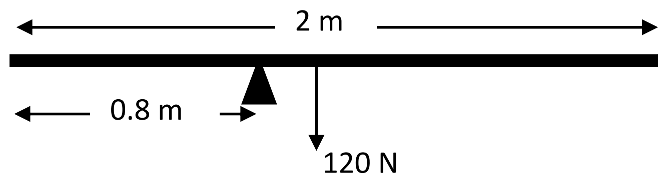
(*v*) Sources can vibrate at different frequencies. Explain what is meant by the frequency of a wave. (7)

(*vi*) The speed of sound in air c is 340 m s^{-1}. A sound wave has a wavelength λ of 0.78 m. Calculate the frequency f of the wave. (9)

(*vii*) Another sound has a frequency of 200 Hz. Identify if changing the frequency affects the loudness, the pitch or the quality of the sound. (7)

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

(*a*) A uniform beam with length 2 m has a weight of 120 N. It appears that the 120 N acts through the centre of gravity of the beam. It is placed horizontally on a pivot which is 0.8 m from the left end of the beam.

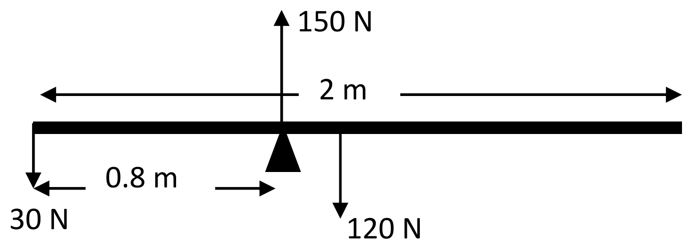


(*i*) Explain what is meant by the moment of a force.

(*ii*) Calculate the distance between the pivot and the centre of gravity of the beam.

(*iii*) Calculate the moment, about the pivot, due to the 120 N weight of the beam acting through its centre of gravity.

Students hang a 30 N weight on the left-hand side of the beam, as shown below. The pivot exerts an upward force of 150 N. The beam is now stationary and in equilibrium.

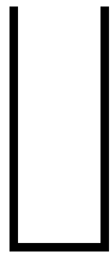


(*iv*) State the two conditions necessary for equilibrium.

(*v*) Show by calculation that the beam is in equilibrium. (28)

(*b*) A group of students investigate how different musical instruments produce sound. A clarinet can be treated as a pipe that is closed at one end. Different harmonics can be set up in a pipe closed at one end.

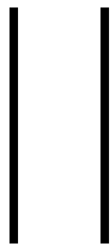
(*i*) Explain what is meant by harmonics.



(*ii*) (*a*) Copy and complete the diagram on the right to show the fundamental frequency in a pipe closed at one end, showing any nodes or antinodes in the diagram.

(*b*) Label a node and an antinode on your diagram.

A flute can be treated as a pipe that is open at both ends.



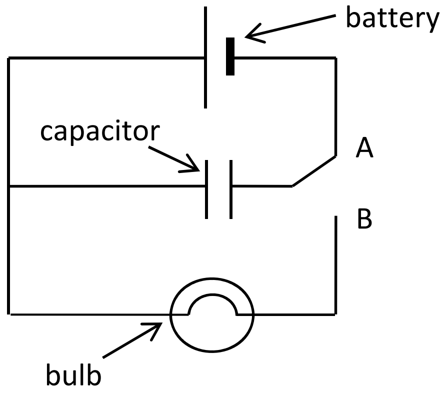
(*iii*) Copy and complete the diagram on the right to show the fundamental frequency in a pipe open at both ends, showing any nodes or antinodes in the diagram.

A guitar string is vibrating at its fundamental frequency.

(*iv*) The length of the string is 0.6 m. Calculate the wavelength of the wave.

(28)

(*c*) A student investigates how capacitors store and release charge using a simple circuit.



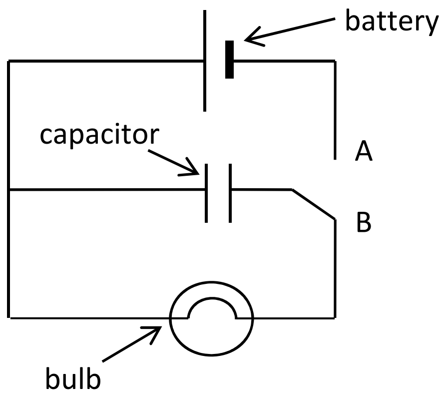
(*i*) Explain what is meant by capacitance.

When the switch is at A, the capacitor charges. When a capacitor is charged, one plate is positively charged and the other is negatively charged. An electric field is set up between the plates.

(*ii*) Copy and complete the diagram below to show the shape of the electric field between two parallel plates.

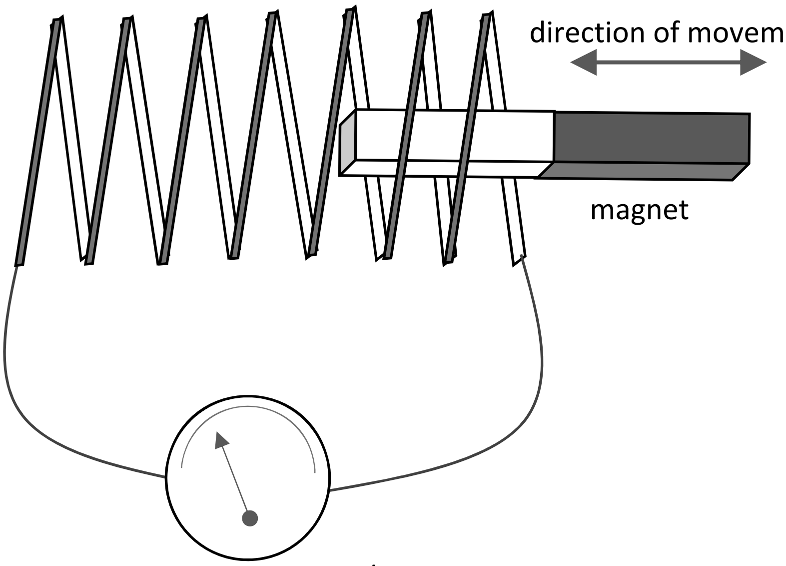
(*iii*) Describe an experiment to show the electric field between two parallel plates.

(*iv*) Describe what happens when the switch is moved to B.



(28)

(*d*) Electromagnetic induction is used to generate electricity. The diagram below shows a laboratory experiment to demonstrate electromagnetic induction.



(*i*) Describe what happens on the ammeter as

(*a*) the magnet is moved into the coil,

(*b*) the magnet is moved out of the coil.

The size of the induced emf can be calculated using the formula $\Phi = BA$.

(*ii*) Calculate the magnetic flux Φ through a coil with an area A of 0.3 m^2 when placed at right angles to a magnetic flux density B of 2 T.

(*iii*) Describe what happens on the ammeter if

(*a*) the magnet is moved in and out of the coil more quickly,

(*b*) a similar sized copper rod is moved in and out of the coil.

(*iv*) This experiment is usually done with a galvanometer instead of an ammeter.

(*a*) Suggest a reason why a galvanometer may be used instead of an ammeter.

(*b*) Draw the circuit symbol for a galvanometer. (28)

Acknowledgements

Images

Images on page 7:	nasa.gov, bbc.com
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Images on page 9:	hawaiialive.org, lowyinstitute.org
Image on page 11:	carkeys.co.uk
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Leaving Certificate Examination – Ordinary Level

Physics

Wednesday, 17 June
Morning, 9:30 – 12:30