Coimisiún na Scrúduithe Stáit
State Examinations Commission

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LEAVING CERTIFICATE EXAMINATION, 2014

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PHYSICS – ORDINARY LEVEL

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MONDAY, 16 JUNE – MORNING, 9:30 TO 12:30
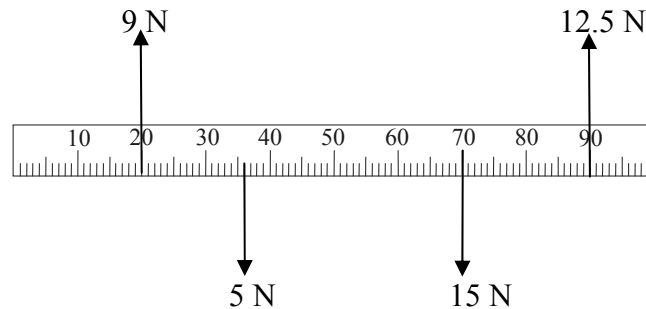
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Answer **three** questions from **Section A** and **five** questions from **Section B**.

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N.B.   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 investigated the laws of equilibrium for a set of co-planar forces acting on a metre stick. The weight of the metre stick was 1.5 N and its centre of gravity was at the 50 cm mark. The student applied the forces shown to the metre stick until it was in equilibrium.

   (*i*)   How did the student measure the upward forces?   (4)

   (*ii*) Copy the diagram and show **all** the forces acting on the metre stick.   (6)

   (*iii*) (*a*) Find the total upward force acting on the metre stick.
           (*b*) Find the total downward force acting on the metre stick.
           (*c*) Explain how these values verify one of the laws of equilibrium.   (15)

   (*iv*) (*a*) Find the sum of the anticlockwise moments of the upward forces about the 0 mark.
           (*b*) Find the sum of the clockwise moments of the downward forces about the 0 mark.
           (*c*) Explain how these values verify the other law of equilibrium.   (15)

2. A student carried out an experiment to measure the specific latent heat of fusion of ice. The following is an extract from her report.

   "I got ice which was at 0 °C and prepared it for my experiment by crushing and drying it. I added the ice to water in a calorimeter and waited for the ice to melt before taking more measurements. I used the measurements to calculate the specific latent heat of fusion of ice. I then repeated my experiment."

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

   (*ii*) What measurements would the student have taken for this experiment?   (12)

   (*iii*) How was the ice crushed?   (4)

   (*iv*) Why was the ice crushed?   (6)

   (*v*)   Why was the experiment repeated?   (6)

3. An experiment was set up to investigate how the fundamental frequency of a stretched string varied with its length. The length, *l*, of the string and its fundamental frequency, *f*, were recorded. The procedure was repeated for different values of *f* and *l*.

(*i*)   Draw a labelled diagram of the apparatus used in the experiment.   (9)

(*ii*) Indicate on your diagram the length of the string that was measured.   (6)

(*iii*) Describe how the string could have been set vibrating.   (3)
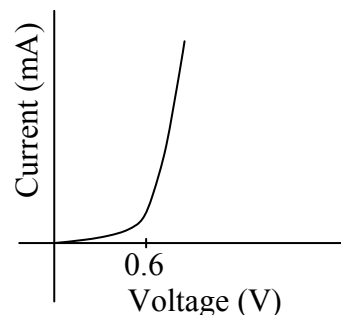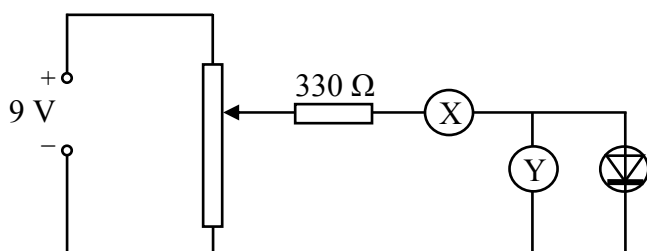
(*iv*) How was the frequency determined?   (6)

The following results were recorded during the experiment.

f (Hz)	256	288	320	341	384	480
l (m)	0.80	0.71	0.64	0.60	0.53	0.43
$1/l$ (m^{-1})		1.41				

(*v*)   Copy and complete the table into your answer book. Draw a graph on graph paper of *f* on the *X*-axis against $1/l$ on the *Y*-axis. What conclusion can be drawn from your graph?   (16)

4. A student carried out an experiment to investigate the variation of current, *I*, with voltage, *V*, for a semiconductor diode in forward bias and wrote the following report.

"I set up the circuit shown below for the experiment. During the experiment I varied the voltage and I recorded the current flowing at the different voltages and plotted a graph of my results, as shown below."

(*i*)   How was the voltage changed in this experiment?   (6)

(*ii*) What is the function of part X?   (6)

(*iii*) What is the function of part Y?   (6)

(*iv*) What does the graph tell you about conduction in a diode?   (12)

(*v*)   How would a student connect the diode in reverse bias?   (6)

(*vi*) What is the function of the 330 Ω resistor?   (4)

SECTION B (280 marks)

Answer **five** questions from this section.
Each question carries 56 marks.

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

(*a*)   A crane, powered by an electric motor, has a bucket that weighs
540 N when empty. The crane uses the bucket to lift 800 N of
concrete up 75 m on a building site. Calculate the work done by
the crane's motor.

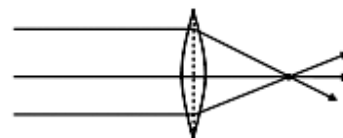(*b*)   Which of the following are vector quantities and which are scalar quantities?

time   force   mass   velocity

(*c*)   Which of the following is used in the flash of a camera?

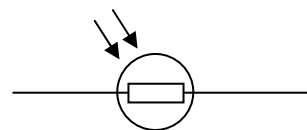**electroscope   hydrometer   capacitor   barometer**

(*d*)   What is the Doppler effect?

(*e*)   Name the lens shown and give an application of it.

(*f*)   What is meant by the *U*-value of a material?

(*g*)   Name the component with the symbol shown in the diagram.

(*h*)   Name a piece of laboratory equipment used to separate white light into its colours.

(*i*)   How are X-rays produced?

(*j*)   In the Sun, a mass of 4×10^9 kg is converted into energy every second.
Calculate the energy released each second.
(speed of light, $c = 3 \times 10^8$ m s^{-1})

(8×7)

6. Sir Isaac Newton deduced that the weight of an object is due to the force of gravity.

Define force and give the unit of force.
State Newton's law of universal gravitation. (18)

Use the equation below, which is from page 56 of the *Formulae and Tables* booklet, to calculate, to one decimal place, the acceleration due to gravity on Mars. The radius of Mars is 3.4×10^6 m and the mass of Mars is 6.4×10^{23} kg.
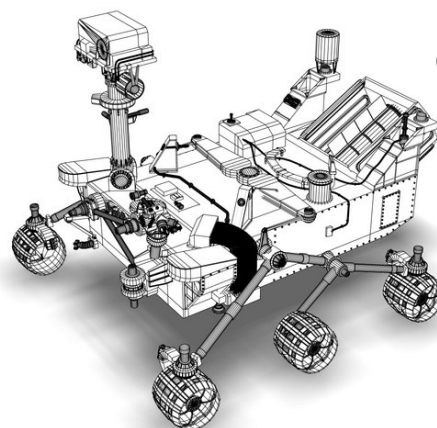
$$g = \frac{GM}{d^2}$$

(10)

In August 2012 the *Curiosity* rover landed on Mars.
The wheels of the rover are not as strong as the wheels
that would be needed if the rover was to be used on Earth.
Give a reason for this. (6)

The *Curiosity* rover was built on Earth to travel on the
surface of Mars. The rover has a mass of 899 kg.
Find

    (*i*)   the weight of *Curiosity* on Earth

    (*ii*)   the mass of *Curiosity* on Mars

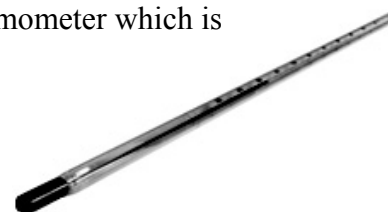   (*iii*) the weight of *Curiosity* on Mars. (16)

The *Curiosity* rover communicates with Earth using radio waves, which are part of the electromagnetic spectrum. Name one other part of the electromagnetic spectrum. (6)

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

7.   (*a*) The temperature of an object can be measured using a thermometer which is based on a suitable thermometric property.

    (*i*)   What is heat?
    (*ii*)   What is meant by temperature?
    (*iii*) Give an example of a thermometric property.
    (*iv*) The SI unit of temperature is the kelvin. Give another temperature scale.
    (*v*)   Express 310 K in the units of the scale you have named in part (*iv*). (30)

   (*b*) The photograph shows an experiment to compare the heat transfer in different metals. A piece of wood is placed in a drop of wax at the end of each piece of metal and a heat source is used to heat the metals at the centre of the apparatus.
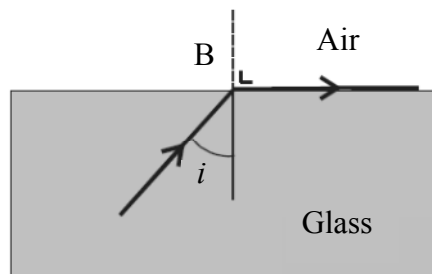
    (*i*)   How is heat transferred in metals?
    (*ii*)   Name the two other methods of heat transfer.
    (*iii*) How can this experiment be used to find out which of the metals is best at allowing heat transfer?
    (*iv*) State one way to make sure that this is a fair test. (26)

8. A ray of light can undergo both reflection and refraction.

(*i*)   Explain what is meant by reflection of light.   (6)

(*ii*) State the laws of reflection of light.   (9)

(*iii*) Give an application of reflection of light.   (5)

(*iv*) Describe an experiment to demonstrate one of the laws of reflection of light.   (12)

The diagram shows a ray of light travelling from glass to air. The ray of light undergoes refraction at B.

(*v*)   Explain what is meant by refraction of light.   (6)

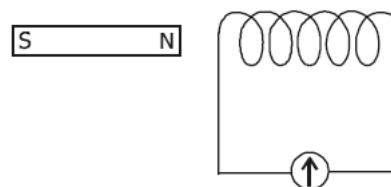(*vi*) What special name is given to the angle of incidence, *i*, when the effect shown in the diagram occurs?   (6)

In the diagram the value of the angle *i* is 38°.

(*vii*) Calculate the value of the refractive index of the glass.   (6)

(*viii*) Draw a diagram to show what happens to the ray of light when the angle of incidence is increased to 40°.   (6)

9. A magnetic field exists around a current-carrying conductor.

(*i*)   What is a magnetic field?   (6)

(*ii*) How does a compass indicate the direction of a magnetic field?   (6)

(*iii*) Describe an experiment to show that there is a magnetic field around a current-carrying conductor and sketch the field lines around the conductor.   (12)

(*iv*) Sketch the magnetic field around a bar magnet.   (6)

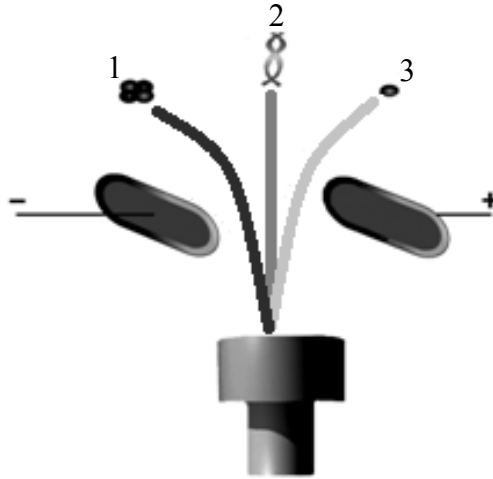A coil of wire is connected as shown in the diagram to a galvanometer. A bar magnet is placed near the coil.

(*v*)   What is observed when the magnet is moved towards the coil?   (6)

(*vi*) What is observed when the magnet is stationary?   (6)

(*vii*) Explain these observations.   (9)

(*viii*) How would increasing the speed of movement of the magnet alter the observations?   (5)

10. (*i*) What is meant by radioactivity? (6)

In an experiment, the radiation from a radioactive source is passed through an electric field, as shown in the diagram.
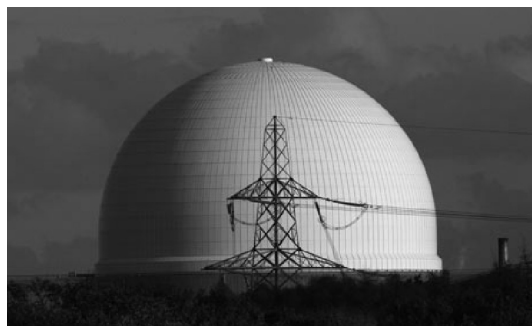
(*ii*) What does this experiment indicate about radiation? (6)

State which type of radiation (1, 2 or 3)

(*iii*) is unaffected by electric fields

(*iv*) is positively charged

(*v*) is negatively charged.

(*vi*) Give the name of radiation types 1, 2 and 3, in that order. (18)

Nuclear fission occurs in a nuclear power station such as the one shown in the photograph.

(*vii*) Name a suitable fuel for nuclear fission. (6)

(*viii*) Explain the role of neutrons in nuclear fission. (6)

(*ix*) Explain how the control rods can control the rate of fission, or stop the reaction completely. (6)

(*x*) Iodine–131 is a product of nuclear fission. The half-life of iodine–131 is 8 days. What fraction of iodine–131 remains after 24 days? (8)

11. Read this passage and answer the questions below.

Lightning is one of the most deadly natural phenomena known to man. Lightning begins with the water cycle. To understand the water cycle we must first understand the principles of *evaporation* and *condensation*.

Evaporation is the process by which a liquid absorbs heat and changes to a gas. When a liquid is heated its molecules move around faster. Some of the molecules may move quickly enough to break away from the surface of the liquid and carry heat away in the form of a gas. Once free the gas begins to rise into the atmosphere due to *convection*.

Condensation is the process by which a gas loses heat and turns into a liquid. As the gas rises higher, the temperature of the surrounding air drops. Eventually the gas cools and turns back into a liquid. Earth's gravitational pull then causes the liquid to fall back down to the earth, thereby completing the cycle.

In an electrical storm, the storm clouds become charged due to convection in the cloud. The upper portion of the cloud becomes positively charged and the lower portion becomes negatively charged. The cloud's strong electric field creates a conductive path between the cloud and the earth's surface. This allows a current to flow which we see as the 'spark' of lightning.

The lightning causes air to heat up and expand rapidly, creating a sound wave that travels through the surrounding air. Sound travels much slower than light, so we see the flash before we hear the thunder.

(Adapted from '*howstuffworks.com*')

(*a*)   Explain the term *evaporation*.

(*b*)   What effect does the addition of heat have on the molecules of a liquid?

(*c*)   What happens to the temperature of a gas rising through the atmosphere?

(*d*)   What part does gravity play in the water cycle?

(*e*)   Explain the term *convection*.

(*f*)   What helps create the conductive path needed for lightning to occur?

(*g*)   Name an instrument used in the laboratory to study static electricity.

(*h*)   Why do we see the flash of lightning before we hear the thunder?

(8 × 7)

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

(*a*) Explain the distinction between speed and velocity. (6)

A bus leaves a bus stop and accelerates from rest at 0.5 m s^{-2} to reach a speed of 15 m s^{-1}. It then maintains this speed for 100 seconds. When it approaches the next stop, the driver applies the brakes uniformly to bring the bus to a stop in 20 seconds.

Calculate

(*i*)   the time it took the bus to reach its top speed

(*ii*)   the distance it travelled while at its top speed

(*iii*) the acceleration required to bring the bus to a stop. (15)

Sketch a velocity-time graph of the bus journey. (7)

(*b*) State the unit of pressure.

Describe an experiment to demonstrate that the atmosphere exerts pressure. (14)

State Archimedes' principle.

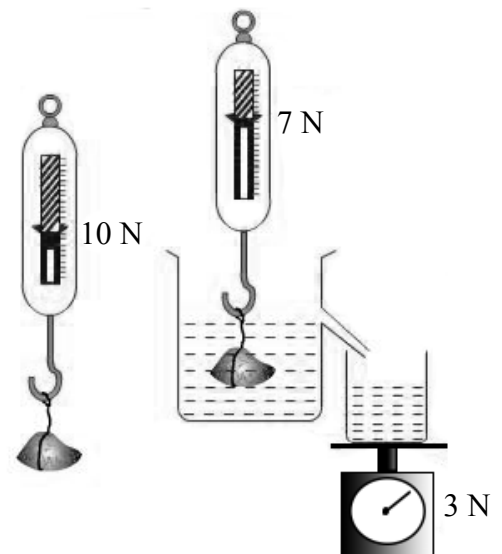The diagram shows the reading on a newton balance for an object suspended in air and in a liquid.

The weight of the liquid displaced is also shown on a balance.

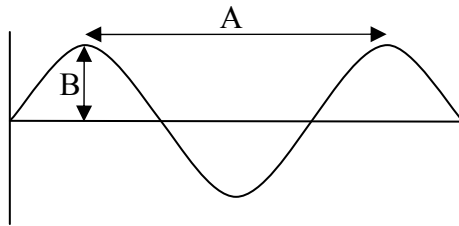(*i*)   What is the upthrust (buoyancy force) on the object caused by the liquid?

(*ii*)   Will the object float in the liquid if released?
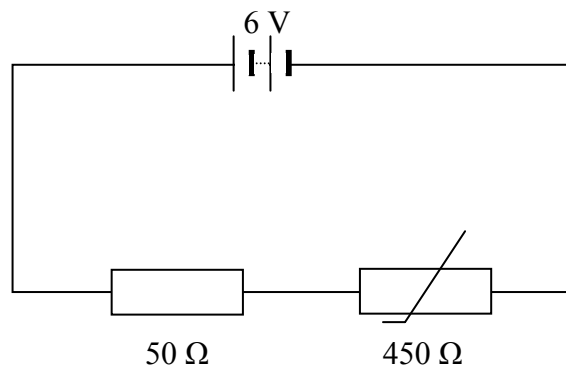Explain your answer. (14)

7 N

10 N

3 N

(*c*)   The diagram shows a transverse wave.

A

B

(*i*)   Name the distances labelled A and B.   (10)

(*ii*)   20 waves pass a fixed point every second. What is the frequency of the wave?   (6)

(*iii*) Calculate the velocity of the wave if distance A = 1.5 m.   (6)

(*iv*)   Transverse waves can be polarised. Name a type of wave that cannot be
        polarised.   (6)

(*d*)   The circuit diagram shows a resistor and a thermistor connected in series with a 6 V
       battery. At a certain temperature the resistance of the thermistor is 450 Ω.

6 V

50 Ω   450 Ω

(*i*)   State Ohm's law.   (6)

(*ii*)   What is the total resistance of the circuit?   (4)

(*iii*) What is the current in the circuit?   (6)

(*iv*)   What is the potential difference across the 50 Ω resistor?   (6)

(*v*)   What would happen to the resistance of the circuit if the temperature were
        increased?   (6)

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