Cambridge O Level

Cambridge International Examinations
Cambridge Ordinary Level

CANDIDATE NAME			
CENTRE NUMBER		CANDIDATE NUMBER	

4053145049

PHYSICS **5054/22**

Paper 2 Theory **October/November 2015**

1 hour 45 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Section A
Answer **all** questions.
Write your answers in the spaces provided on the Question Paper.

Section B
Answer any **two** questions.
Write your answers in the spaces provided on the Question Paper.

Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **19** printed pages and **1** blank page.

CAMBRIDGE International Examinations

Section A

Answer **all** the questions in this section. Answer in the spaces provided.

1 Water is transported to a village in a tank pulled by a tractor.

Fig. 1.1 shows the tank being pulled by a tractor.

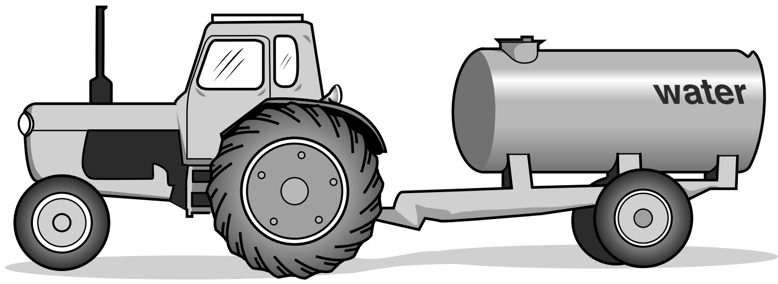

Fig. 1.1

The combined mass of the tractor and the tank is 4100 kg when the tank is empty and 6500 kg when the tank is full of water.

(a) The density of water is 1000 kg / m^3.

Calculate the volume of water in the tank when it is full.

volume = ... [2]

(b) At the start of the journey, the tractor and tank accelerate from rest along a straight, horizontal road. As their speed increases, one form of energy is decreasing.

(i) State the name of the form of energy that is decreasing.

.... [1]

(ii) Explain what happens to this energy.

....

....

....

.... [2]

(c) The village is located on a mountain at a vertical height of 850 m above the water supply. The gravitational field strength g is 10 N / kg.

Calculate the gravitational potential energy gained by the water as it is transported from the supply to the village.

energy gained = ... [2]

2 **(a)** The surface of a running track is made of rubber. A heavy trolley is pulled on to the track and it exerts a large force on the rubber track.

State two effects that this force has on the rubber.

1. ....

2. .... [2]

(b) A spring is suspended from a support with a small pan attached to its lower end. Masses are added to the pan until the spring is extended well beyond the limit of proportionality.

Fig. 2.1 shows this apparatus.

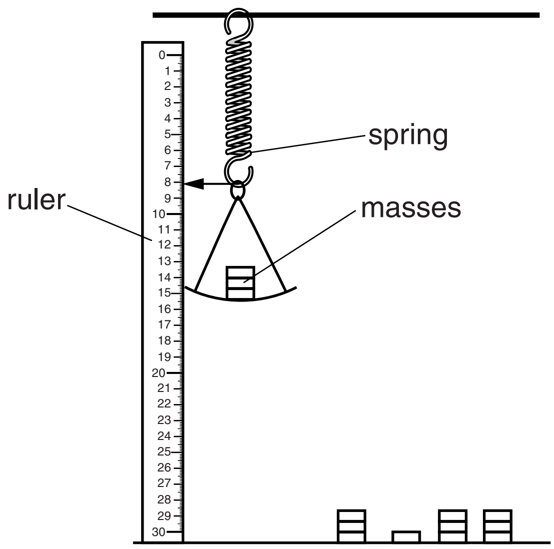

Fig. 2.1

A ruler is used when determining the extension of the spring.

(i) On Fig. 2.2, sketch the extension-load graph for the spring and label the limit of proportionality P. [2]

Fig. 2.2

(ii) The masses are then removed and the extension of the spring decreases.

Suggest what is observed when all the masses are removed.

....

.... [1]

3 A very deep tank is used when training sailors to escape from submarines. The tank is cylindrical and open to the air at the top. Fig. 3.1 shows the tank.

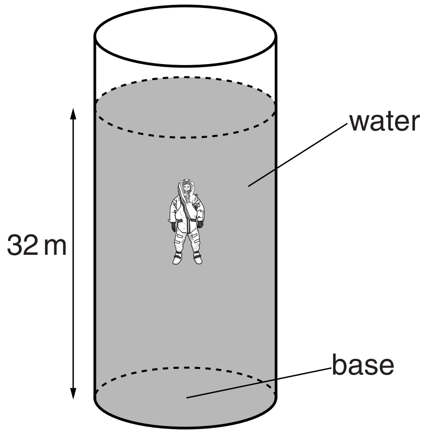

Fig. 3.1 (not to scale)

The area of the base of the tank is $45\,m^2$ and the tank is filled with water to a depth of 32 m.

(a) The density of water is $1000\,kg/m^3$ and the gravitational field strength g is 10 N/kg.

Calculate the pressure, due to the water, on the base of the tank.

pressure = ... [2]

(b) The pressure in the water at the base of the tank is 4.2×10^5 Pa.

(i) Explain why the pressure in the water at the base of the tank differs from the value calculated in **(a)**.

....

....

.... [1]

(ii) Calculate the force exerted on the base of the tank.

force = ... [2]

(c) Force is a vector quantity and pressure is a scalar quantity.

State how a vector quantity differs from a scalar quantity.

....

.... [1]

4 A copper saucepan with a wooden handle contains cold water. The saucepan is placed on a red-hot heating element that is a part of an electric cooker.

Fig. 4.1 shows the saucepan on the heating element.

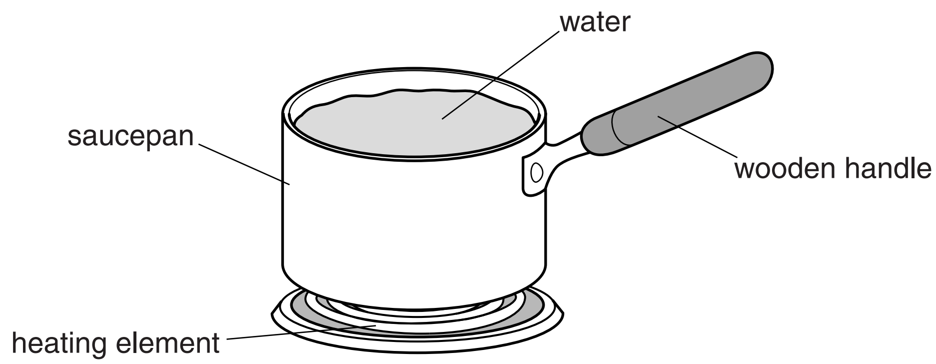

Fig. 4.1

(a) Explain why wood is a suitable material for the handle of the saucepan.

.... [1]

(b) (i) Describe and explain, in terms of free electrons, how thermal energy is transferred through the copper base of the saucepan.

....

....

....

....

....

.... [3]

(ii) Describe and explain how thermal energy is transferred upwards through the water.

....

....

....

....

....

....

.... [3]

5 All thermometers use the value of a physical property to measure temperature.

(a) **(i)** State what makes a physical property suitable for the measurement of temperature.

....

....

.... [1]

(ii) State two properties that are used for the measurement of temperature.

1. ....

2. ....
[2]

(b) When a thermometer is calibrated, two fixed points are used.

(i) One fixed point is the ice point. State what is meant by the *ice point*.

....

....

.... [1]

(ii) Explain how the fixed points are used when calibrating a thermometer.

....

....

....

....

....

....

....

.... [2]

6 A gas is trapped at atmospheric pressure in a cylinder by a piston. The piston is held in a fixed position by a movable rod. Fig. 6.1 shows the cylinder.

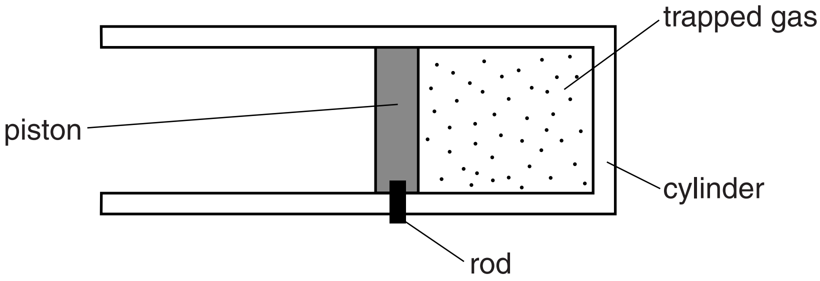

Fig. 6.1

The cylinder is heated. As the temperature of the gas increases, its pressure increases.

(a) Explain, in terms of molecules, why the pressure of the trapped gas increases.

....

....

....

.... [2]

(b) The rod is pulled down and the piston is then free to move as shown in Fig. 6.2.

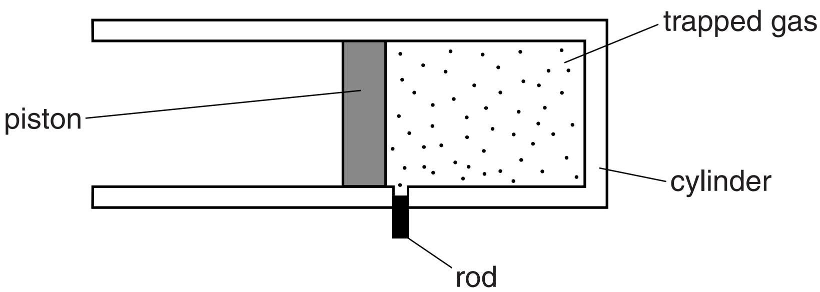

Fig. 6.2

As the piston moves, the temperature of the gas remains constant.

State and explain, in terms of molecules, what happens to the pressure of the gas.

....

....

....

....

....

.... [3]

7 Light enters a parallel-sided glass block at A. The angle between the side of the block and the ray of light in air is 35°.

The light then strikes the edge of the block at B. Fig. 7.1 shows the ray of light and the glass block.

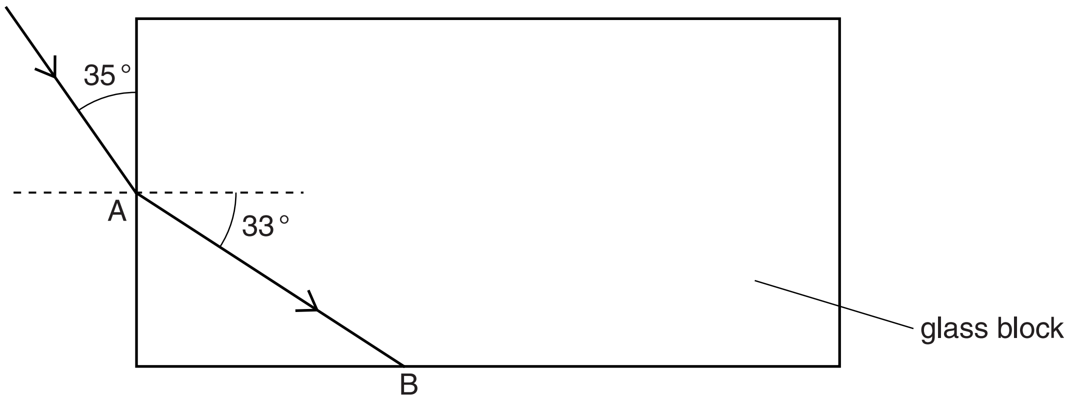

Fig. 7.1

The angle of refraction in the glass at A is 33°.

(a) Calculate the refractive index for light in the glass.

refractive index = ... [2]

(b) The light undergoes total internal reflection at B.

(i) State one condition necessary for total internal reflection to occur.

....

....

.... [1]

(ii) On Fig. 7.1, continue the ray to show the path of the light after total internal reflection at B and until it leaves the block. [1]

8 A spotlight in a television studio is at full brightness. The lamp inside the spotlight is powered by a 230 V supply and the current in the filament of the lamp is 27 A.

(a) Calculate the power of the lamp.

power = ... [2]

(b) The spotlight is kept switched on at full brightness.

(i) Calculate the energy transformed by the lamp in 30 minutes.

energy = ... [1]

(ii) The cost of using one kilowatt-hour (kWh) of electricity is 23 cents.

Calculate the cost of using the spotlight for 30 minutes.

cost = ... [2]

Section B

Answer **two** questions from this section. Answer in the spaces provided.

9 Aeroplanes fly at high altitudes where the temperature is well below 0 °C. Ice that forms on an aeroplane can fall to earth and strike the ground.

Fig. 9.1 shows a block of ice falling from an aeroplane as it approaches an airport.

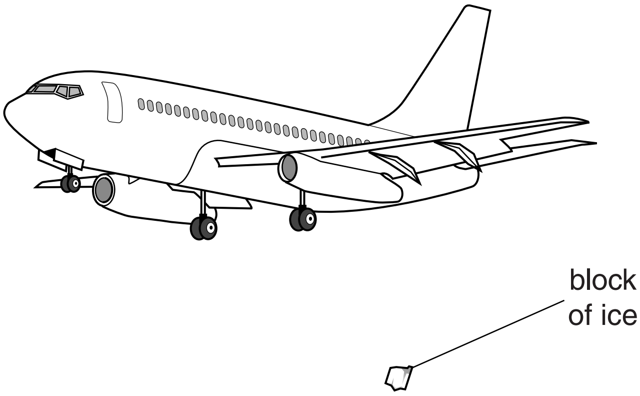

Fig. 9.1 (not to scale)

The mass of the falling block of ice is 1.2 kg and the gravitational field strength *g* is 10 N / kg.

(a) Calculate the weight of the block of ice.

weight = ... [1]

(b) Fig. 9.2 is the speed-time graph for the block of ice as it falls to the ground.

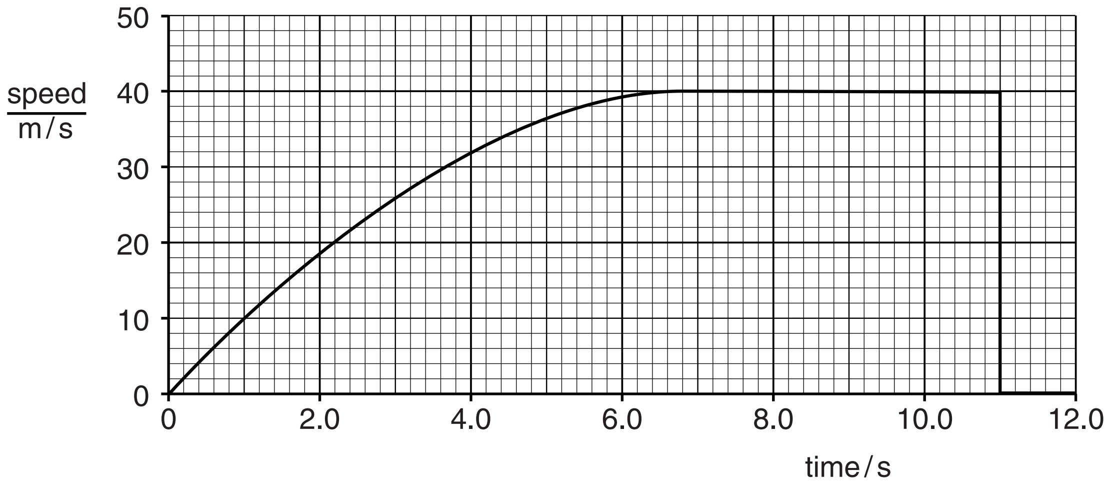

Fig. 9.2

At first, the acceleration of the block of ice is equal to the acceleration of free-fall. The acceleration of the block then decreases to zero as the block reaches terminal velocity.

(i) As the block of ice falls, the force F of air resistance acting on the block changes.

1. State the value of F at time = 0.

F = ... [1]

2. State the value of F at time = 10.0 s.

F = ... [1]

3. Explain why F changes.

....

....

.... [1]

(ii) State the energy change that takes place when the block is falling at terminal velocity.

....

.... [1]

(iii) Using information from Fig. 9.2, determine the maximum kinetic energy of the block when it is falling to the ground with terminal velocity.

maximum kinetic energy = ... [3]

(c) The block strikes the ground and it stops moving. This impact causes some of the ice to melt.

(i) The specific latent heat of fusion of ice is 330 J / g.

Calculate the maximum possible mass of ice that melts as a result of the impact.

mass = ... [2]

(ii) In practice, the mass of ice that melts on impact is less than the value calculated in **(c)(i)**.

Suggest two reasons for this.

1. ....

....

2. ....

.... [2]

(d) As the solid ice melts, it changes into liquid water.

Describe, in terms of molecules, how ice differs from liquid water.

....

....

....

....

....

.... [3]

Please turn over for Question 10

10 Thin wire, covered in plastic insulation, is used to make a solenoid (long coil). The solenoid is connected to a sensitive ammeter. Fig. 10.1 shows the N-pole of a steel magnet placed next to the solenoid.

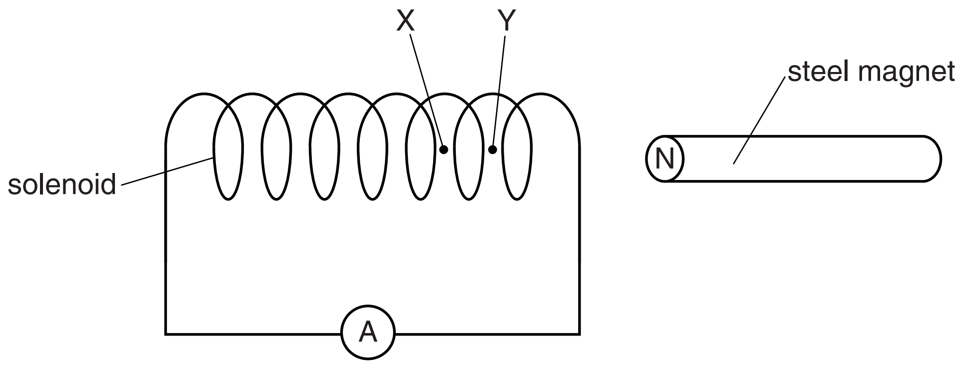

Fig. 10.1

Point X and point Y are on the axis of the solenoid.

(a) **(i)** Explain why plastic is an electrical insulator.

....

....

.... [1]

(ii) Explain why the magnet is **not** made from

1. aluminium,

.... [1]

2. iron.

.... [1]

(b) In one experiment, the magnet in Fig. 10.1 is moved to the left and passes into the solenoid. The N-pole of the magnet travels from Y to X at a constant speed. As it moves, the ammeter shows a small current.

(i) Explain why there is a current in the solenoid when the magnet is moving.

....

....

....

....

....

.... [3]

(ii) The N-pole travels from Y to X in 0.14 s. As it moves, the current shown on the ammeter is 0.045 mA. The resistance of the solenoid is 1.2 Ω.

Calculate

1. the potential difference (p.d.) across the solenoid,

potential difference = ... [2]

2. the charge that passes through the solenoid as the N-pole moves from Y to X.

charge = ... [2]

(c) In a second experiment, the speed of the N-pole is greater than its speed in the first experiment. It now takes only 0.070 s to travel from Y to X.

A current in the same direction is shown on the ammeter.

(i) State and explain how the size of this current compares with the size of the current in the first experiment.

....

....

.... [2]

(ii) The same quantity of charge passes through the coil in both the first and second experiments.

Explain why this is the case.

....

....

.... [1]

(d) State two ways in which the equipment shown in Fig. 10.1 can be used to produce a current in the solenoid that is in the opposite direction.

1. ....

2. ....

[2]

11 The proton number (atomic number) of the element lead is 82. The isotope lead-209 ($^{209}_{82}$Pb) is radioactive and decays by the emission of beta-particles.

(a) Describe the composition and structure of a neutral atom of lead-209.

....

....

....

.... [3]

(b) A nucleus of lead-209 emits a beta-particle.

(i) State how the composition of the nucleus produced differs from the original nucleus.

....

.... [2]

(ii) Complete the table in Fig. 11.1 to show the relative ionising effects of the three types of ionising radiation produced by radioactive decay.

least strongly ionising ⟶ most strongly ionising		

[2]

Fig. 11.1

(iii) A sample containing lead-209 nuclei is used to produce a beam of beta-particles. The beta-particles enter a magnetic field. The magnetic field is perpendicular to the direction of travel of the beta-particles.

The beta-particles travel from left to right. Fig. 11.2 shows that the direction of the magnetic field is out of the page.

Fig. 11.2

On Fig. 11.2, sketch the path of the beta-particles in the magnetic field. [2]

(c) An industrial technician uses a detector to measure the background count rate in a laboratory.

(i) State what is meant by *background radiation*.

....

.... [1]

(ii) Suggest two major sources of background radiation.

1. ....

2. ....

[2]

(iii) The average reading for the background count measured by the technician is 16 counts / minute.

He then brings a sample that contains a radioactive isotope of lead close to the detector and he finds that the new count rate is 92 counts / minute. The half-life of this isotope is 3.3 hours.

Determine the count rate measured using the detector after 6.6 hours.

count rate = ... [3]

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