UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CANDIDATE NAME

CENTRE NUMBER | | | | | |

CANDIDATE NUMBER | | | | |

6297016693

PHYSICS **5054/21**

Paper 2 Theory **October/November 2013**

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 a pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, 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 **16** printed pages.

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Section A

For Examiner's Use

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

1 A swimming pool is filled with 450 m^3 of water at 12 °C.

The density of water is 1000 kg/m^3 and its specific heat capacity is 4.2 J/(g °C).

(a) Calculate the mass of water in the swimming pool.

mass = ...[2]

(b) (i) Calculate the thermal energy (heat) needed to raise the temperature of the water to 27 °C.

thermal energy = ...[3]

(ii) Suggest one reason why the thermal energy supplied to the water by the heating system, when raising the temperature of the water to 27 °C, differs from the value calculated in **(i)**.

.....

.....[1]

2 A girl of weight 550 N is playing on a see-saw with her brother. Fig. 2.1 shows her brother of weight *W* sitting 1.1 m to the right of the balance point.

For Examiner's Use

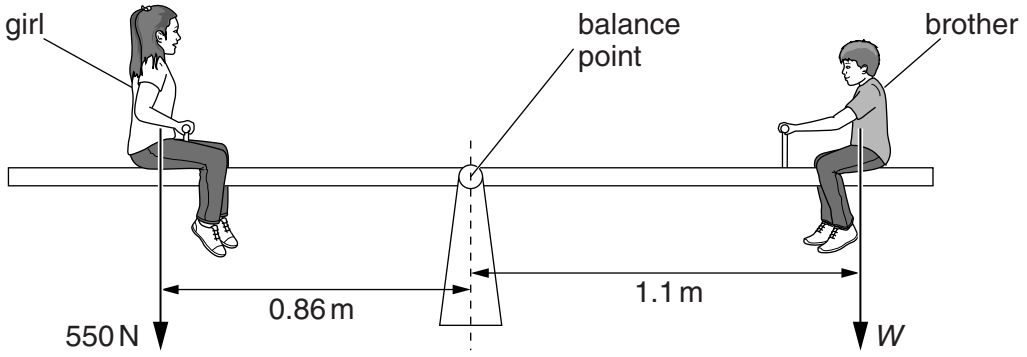


Fig. 2.1 (not to scale)

The see-saw is balanced when the girl sits 0.86 m to the left of the balance point.

(a) Calculate *W*.

W = ...[2]

(b) The girl and her brother slide equal distances along the see-saw away from each other.

Describe and explain what happens.

.....

.....

.....

.....[3]

For Examiner's Use

3 A schoolboy tries to inflate a bicycle tyre using a bicycle pump.

(a) Explain how the air molecules inside the pump produce a pressure.

.....

.....

.....[2]

(b) The opening at the end of the pump is blocked with a small amount of dried earth, as shown in Fig. 3.1.

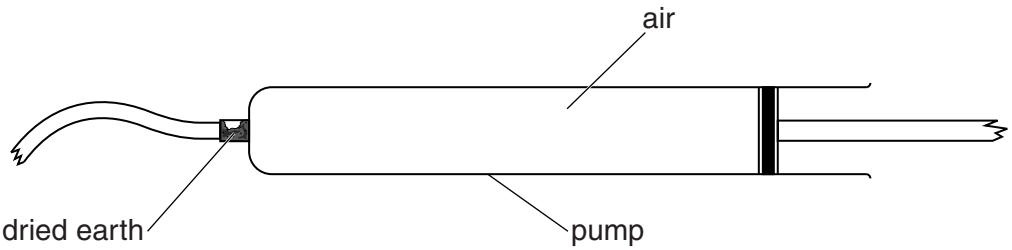


Fig. 3.1

The air is initially at a pressure of 100 kPa. During one stroke of the pump, the volume of air in the pump is reduced from 120 cm^3 to 16 cm^3.

(i) Assuming that the temperature of the air remains constant, calculate the pressure of the compressed air.

pressure = ...[2]

(ii) Compressed air in the pump at this pressure exerts a force on the dried earth. The cross-sectional area of the opening at the end of the pump is $1.2 \times 10^{-5}\,m^2$.

Calculate the size of this force.

force = ...[2]

(iii) In fact, the temperature of the air in the pump increases as its volume decreases.

The actual pressure of the 16 cm^3 of air differs from the pressure calculated in **(i)**.

Using ideas about molecules, state and explain this difference.

.....

.....

.....

.....[3]

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4 Fig. 4.1 shows food being cooked in an electric grill.

For Examiner's Use

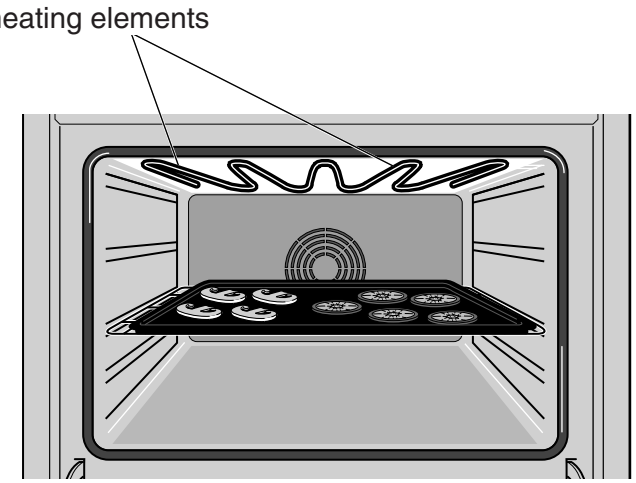


Fig. 4.1

There are red-hot heating elements above the food and thermal energy (heat) is transmitted to the food by radiation.

(a) Explain what is meant, in this case, by *radiation*.

.....

.....

.....[2]

(b) Explain why very little thermal energy is transmitted to the food by

(i) conduction,

.....

.....[1]

(ii) convection.

.....

.....[1]

5 **(a)** Draw a labelled diagram to show the structure of a liquid-in-glass clinical thermometer.

For Examiner's Use

[2]

(b) A clinical thermometer is used to measure the temperature of a patient. When removed, the thermometer cools but it continues to show the maximum temperature reached.

Explain how this happens.

.....

.....

.....[2]

For Examiner's Use

6 **(a)** Suggest a material that is used to make a permanent magnet.

.....[1]

(b) When there are no other magnetic fields present, the needle of a plotting compass points due north in the Earth's magnetic field. This is shown in Fig. 6.1.

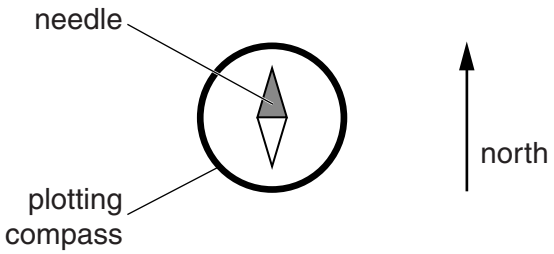


Fig. 6.1

The plotting compass is placed close to a permanent magnet, first at position A and then at position B, as shown in Fig. 6.2.

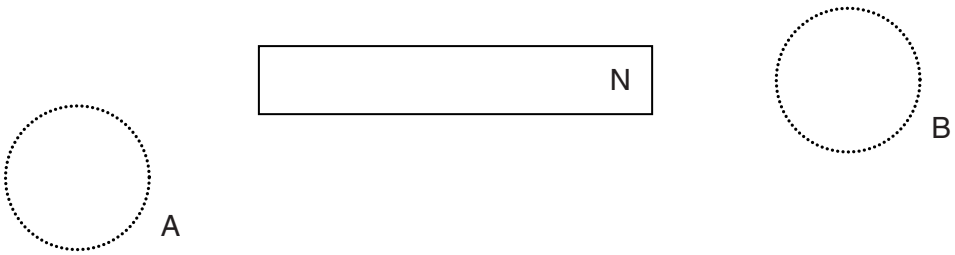


Fig. 6.2

The magnetic field close to the permanent magnet is very much larger than the magnetic field of the Earth.

On Fig. 6.2, draw needles in the two circles to show the direction in which the compass needle points when the compass is at A and at B. [2]

(c) Describe an electrical method that is used to demagnetise a permanent magnet. You may include a diagram in your answer.

.....

.....

.....

.....[3]

7 A 9.6 kW electric shower is powered by a 240 V mains supply.

For Examiner's Use

(a) (i) Calculate the electric current in the heating element of the shower.

current = ...[3]

(ii) Suggest an appropriate rating for the circuit breaker in the circuit for the shower.

.....[1]

(b) A family uses the shower for a total time of 25 minutes every day. The cost of 1 kW h of electrical energy is 21 cents.

Calculate the daily cost of using the shower.

cost = ...[2]

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8 A radioactive sample emits only beta-particles and gamma-rays.

For Examiner's Use

(a) Describe, with the aid of a labelled diagram, an experiment that shows that the sample does **not** emit alpha-particles.

.....

.....

.....

.....

.....[3]

(b) State two safety precautions that must be taken when working with the radioactive sample.

1. .....

2. .....
[2]

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[Turn over

Section B

For Examiner's Use

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

9 Fig. 9.1 shows a skydiver, of mass 70 kg, falling towards the Earth at constant speed, a long time after jumping from an aeroplane.



Fig. 9.1

At time $t = 0$, he receives a radio signal. He opens his parachute 12 s later. Fig. 9.2 is the speed-time graph for the skydiver.

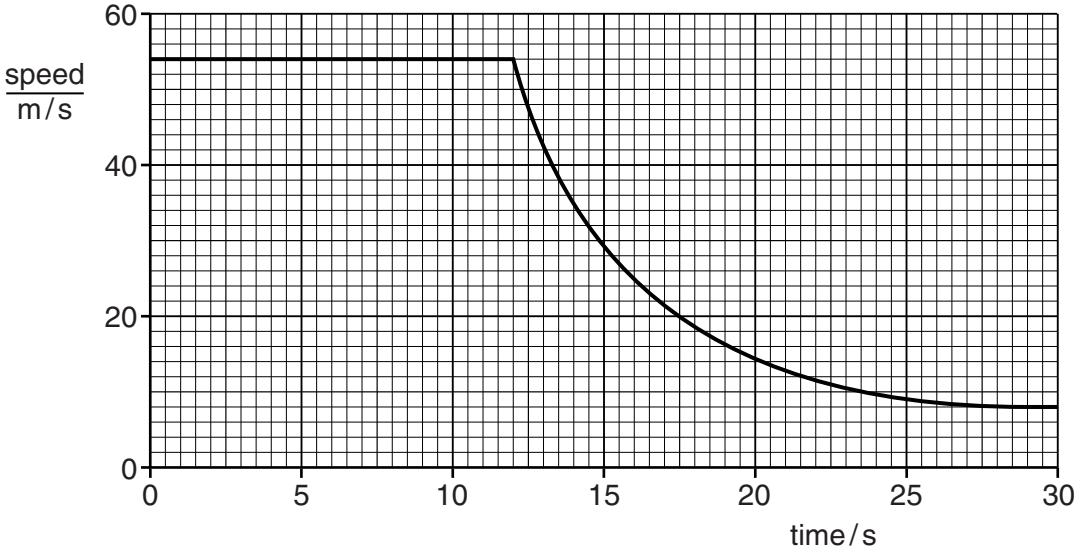


Fig. 9.2

(a) State the difference between *speed* and *velocity*.

.....

.....[1]

(b) The gravitational field strength g is 10 N/kg.

(i) Calculate the weight of the skydiver.

weight = ...[1]

(ii) State the size of the air resistance acting on the skydiver between $t = 0$ and $t = 12\,s$.

For Examiner's Use

air resistance = ...[1]

(c) For the period between $t = 0$ and $t = 12\,s$, determine

(i) the speed of the skydiver,

speed = ...[1]

(ii) the distance fallen by the skydiver,

distance = ...[2]

(iii) the change in the gravitational potential energy of the skydiver.

change in energy = ...[2]

(d) As he falls at constant speed, his gravitational potential energy changes into another form. State the name of this other form of energy.

.....[1]

(e) **(i)** State and explain what happens to the air resistance as the skydiver opens his parachute.

.....

.....

.....[2]

(ii) State and explain the effect on the motion of the skydiver of opening the parachute.

.....

.....

.....[2]

(f) By $t = 15\,s$, his parachute is fully open.

State and explain what happens to the air resistance after $t = 15\,s$.

.....

.....

.....[2]

10 A student goes for a walk in the mountains. During a storm, she sees lightning strike a hillside in the distance. Several seconds later, she hears the thunder caused by the lightning.

For Examiner's Use

(a) (i) Explain why she hears the thunder several seconds after she sees the lightning.

.....

.....[1]

(ii) The student knows the distance to the hillside. She waits for lightning to strike the hillside again. Describe how she can determine a value for the speed of sound in air.

.....

.....

.....

.....[2]

(b) After the storm, the student sees a rainbow.

(i) State the speed of light in air.

speed = ...[1]

(ii) Calculate the wavelength in air of light of frequency 7.5×10^{14} Hz.

wavelength = ...[2]

(iii) State the colours of the spectrum in order of increasing wavelength.

.....

.....[2]

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(c) In the laboratory, the student sends blue light into a glass prism placed on a sheet of paper. The arrangement is shown in Fig. 10.1.

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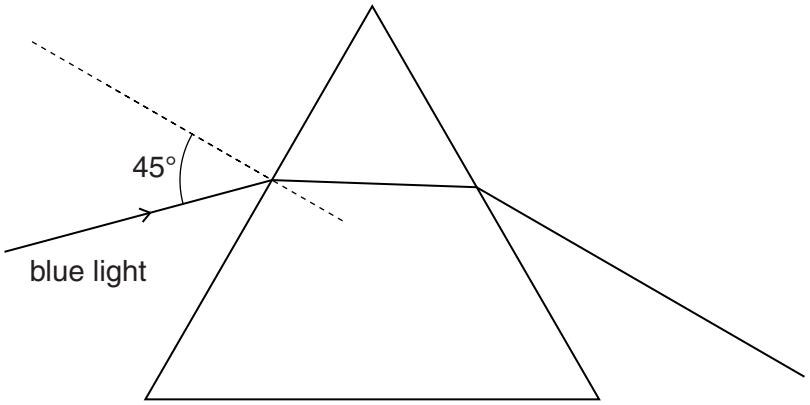


Fig. 10.1

The blue light enters the prism with an angle of incidence of 45°.

(i) On Fig. 10.1, mark the angle of refraction in the glass and label it *r*. [1]

(ii) The student wishes to determine the angle of refraction. On the sheet of paper, she draws the path the ray takes in the glass. Describe how she could do this.

.....

.....

.....[2]

(iii) **1.** State the formula that relates the angle of incidence *i*, the angle of refraction *r* and the refractive index *n*.

.....

.....[1]

2. The angle of refraction in the glass is 28°.

Calculate the refractive index of the glass.

refractive index = ...[1]

(iv) The student sends a ray of red light to the glass prism along the same path as the blue light.

On Fig. 10.1, mark the path taken by the red light after it enters the prism. [2]

11 An ammeter, a variable resistor and a 4.0Ω resistor are connected in series with a 6.0V battery. A cathode-ray oscilloscope (c.r.o.) is connected in parallel with the 4.0Ω resistor through a switch. Fig. 11.1 is the circuit diagram.

For Examiner's Use

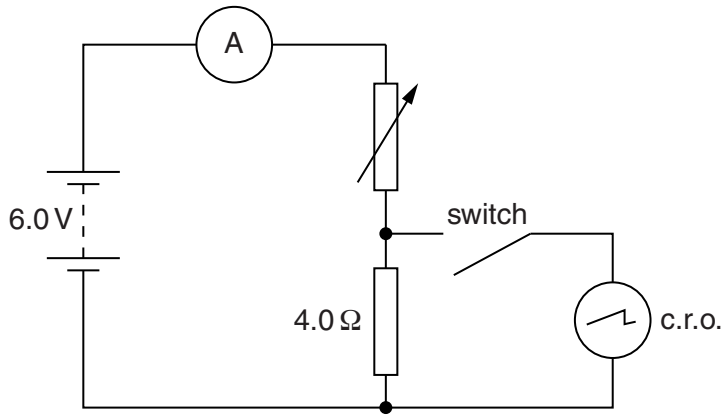


Fig. 11.1

The switch is open.

(a) The variable resistor is adjusted so that it has a resistance of 8.0Ω.

Calculate

(i) the current measured by the ammeter,

current = ...[2]

(ii) the potential difference (p.d.) across the 4.0Ω resistor.

p.d. = ...[1]

(b) The resistance of the variable resistor is adjusted until the p.d. across the 4.0Ω resistor is 5.0V.

State the effect that this adjustment has on

(i) the current measured by the ammeter,

.....[1]

(ii) the resistance of the variable resistor.

.....[1]

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(c) The trace on the c.r.o. is a horizontal line across the middle of the screen and the p.d. across the 4.0Ω resistor is still 5.0V.

The Y-gain control is set at 2.0V/cm and the switch is closed.

State the effect on the trace of closing the switch.

.....

.....

.....[2]

(d) Fig. 11.2 shows, in outline, the basic structure of a c.r.o. viewed from the side.

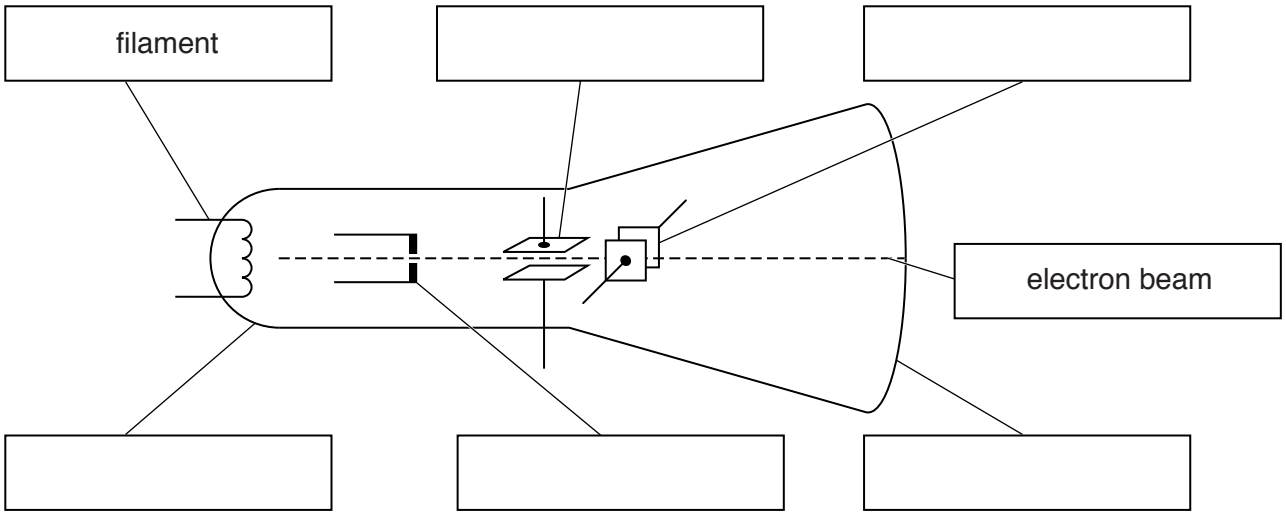


Fig. 11.2

(i) On Fig. 11.2 write, in the **five** empty boxes, the names of the parts of the c.r.o. indicated. [3]

(ii) Explain how the electron beam is produced.

.....

.....

.....[2]

(iii) Explain why the tube of the c.r.o. must be evacuated.

.....

.....[1]

Question 11 continues on page 16.

(iv) In the c.r.o. shown in Fig. 11.2, the electrons travel from left to right.

For Examiner's Use

1. Explain why the flow of electrons is an electric current.

.....

.....[1]

2. State the direction of the conventional current due to the electrons.

.....

.....[1]

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