Cambridge
O Level

Cambridge International Examinations
Cambridge Ordinary Level

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER			

7349126980

PHYSICS **5054/22**

Paper 2 Theory **October/November 2016**

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 **18** printed pages and **2** blank pages.

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Section A

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

1 A skier sets off from rest and accelerates uniformly at 3.4 m/s^2 in a straight line for 5.0 s.

(a) Calculate the speed of the skier after 5.0 s.

speed = ...[2]

(b) At 5.0 s, the skier stops accelerating and travels on for a further 10.0 s at a constant speed.

(i) State the size of the resultant force acting on the skier during these 10.0 s.

.....[1]

(ii) On Fig. 1.1, sketch a speed-time graph for the skier during the whole 15.0 s. [3]

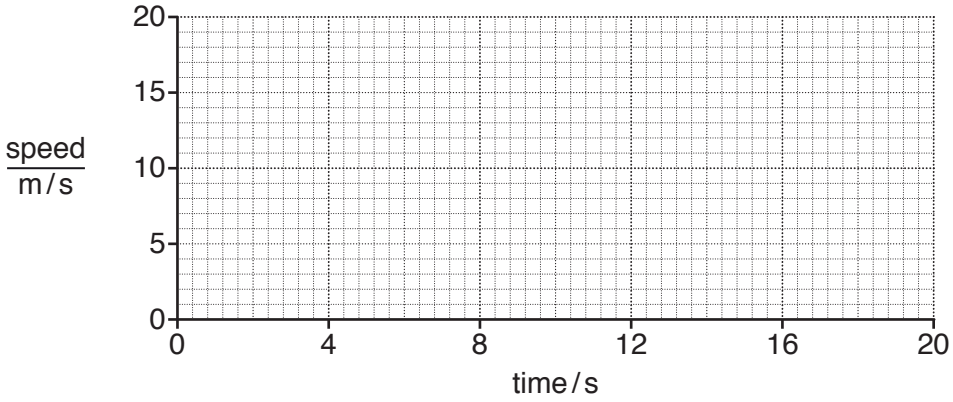


Fig. 1.1

(iii) State how the distance travelled by the skier can be determined using the speed-time graph.

.....

.....[1]

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2 A skateboarder of mass 45 kg is at the top of a ramp.

Fig. 2.1 shows the skateboarder and the ramp.

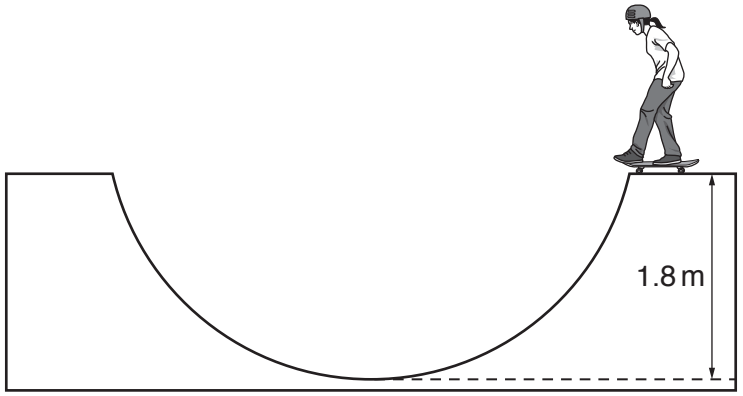


Fig. 2.1 (not to scale)

(a) The skateboarder moves off and she descends vertically through 1.8 m. The gravitational field strength *g* is 10 N / kg.

(i) Calculate the change in gravitational potential energy of the skateboarder.

energy change = ...[2]

(ii) State the name of two forms of energy that increase as she descends.

1. .....

2. .....
[2]

(b) At the lowest point on the ramp, the skateboarder is travelling at a constant speed along a path which is part of a vertical circle.

State

(i) the direction of the resultant force on the skateboarder at this point,

.....[1]

(ii) how the weight of the skateboarder compares with the upward force that the ramp exerts on her.

.....

.....

.....[1]

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[Turn over

3 When the lid of a freezer is opened, it pivots about the hinge at the back of the freezer. The handle is at the front.

Fig. 3.1 is a side view of the freezer.

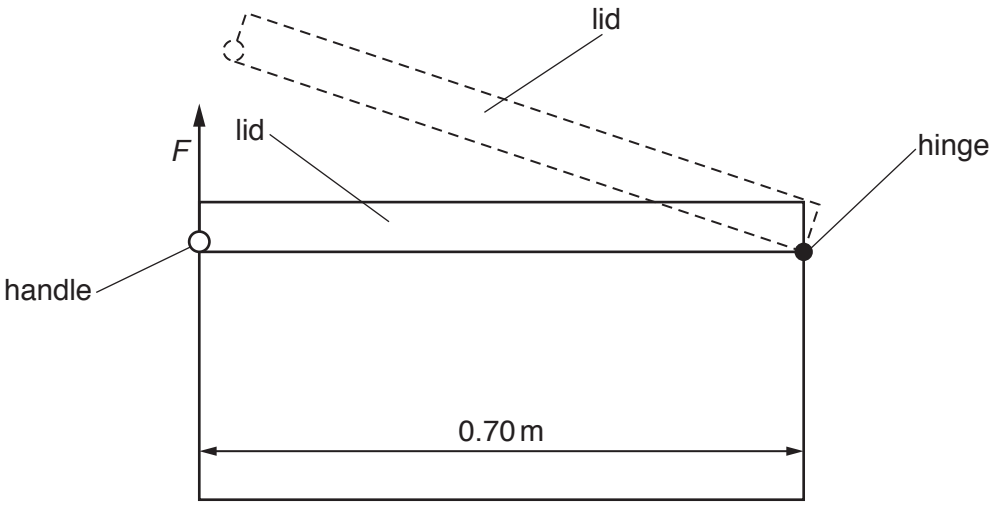


Fig. 3.1

The handle is 0.70 m from the hinge. The lid has a mass of 2.0 kg.

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

(i) Calculate the weight of the lid.

weight = ...[1]

(ii) The lid is uniform and its centre of mass is at its centre. The weight of the lid produces a moment about the hinge.

1. Calculate the moment about the hinge when the lid is closed.

moment = ...[2]

2. The moment required to open the lid is greater than the value calculated in **(a)(ii)1.**

Suggest one reason for this.

.....

.....[1]

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(b) The lid is closed. To open the lid, a force *F* is applied to the handle as shown in Fig. 3.1.

The direction of *F* is vertically upwards and *F* is the smallest possible force that opens the lid.

A force on the handle in any other direction must be larger than *F* in order to open the lid. Explain why.

.....

.....

.....[1]

4 Fig. 4.1 shows a kettle containing water placed on the burner of a gas cooker.



Fig. 4.1

The gas burner is lit at time $t = 0$. At $t = 250$ s the temperature of the water is 100 °C, the boiling point of water.

(a) State what is meant by *boiling point*.

.....

.....[1]

(b) Fig. 4.2 shows how the temperature of the water changes with time *t*.

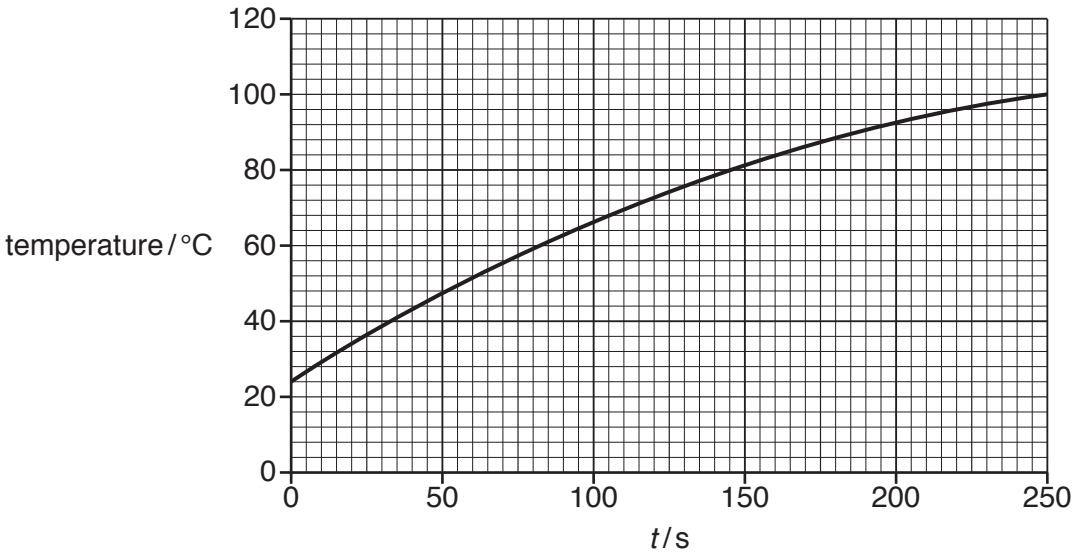


Fig. 4.2

(i) The kettle contains 1.5 kg of water which has a specific heat capacity of 4200 J / (kg °C).

Using Fig. 4.2, determine the increase in the internal energy of the water between $t = 0$ and $t = 250$ s.

increase in internal energy = ...[3]

(ii) Thermal energy (heat) is transferred to the water at a constant rate but the temperature of the water increases at a rate that is not constant, as shown in Fig. 4.2.

Explain why the temperature increases in this way.

.....

.....

.....

.....

.....[2]

(c) When the temperature reaches 100 °C, the kettle is left on the burner. Thermal energy is still supplied to the water. The water boils as the molecules form bubbles and rise to the surface.

(i) State what happens to the temperature of the water.

.....

.....[1]

(ii) Explain, in terms of the molecules, why it is necessary to supply thermal energy in order to keep the water boiling.

.....

.....

.....

.....

.....[2]

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[Turn over

5 Gas is trapped in a syringe by a piston. Fig. 5.1 shows that the narrow end of the syringe is sealed.

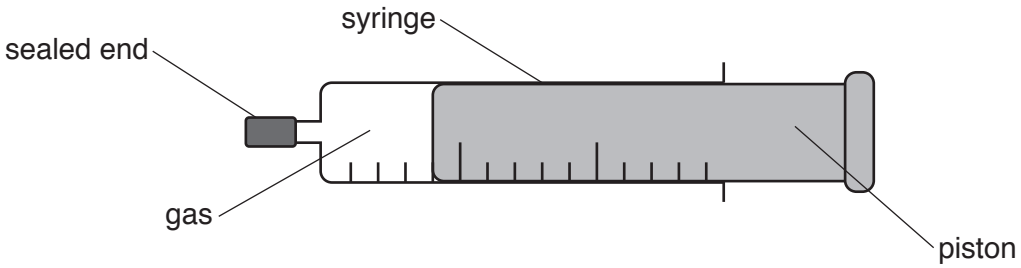


Fig. 5.1

When the gas is at a pressure of 1.1×10^5 Pa, it occupies a volume of 40 cm^3.

(a) Explain, in terms of the molecules, how the gas exerts a pressure on the inside of the syringe.

.....

.....

.....

.....

.....

.....[3]

(b) The piston is slowly pulled to the right until the volume occupied by the gas is 110 cm^3. The temperature of the gas does not change.

Calculate the new pressure of the gas.

pressure = ...[2]

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6 In a cathode-ray oscilloscope (c.r.o.), a beam of electrons is produced by a filament at one end of an evacuated glass tube. The electrons are then accelerated and strike a screen at the other end of the tube.

(a) Describe how the electrons are produced by the filament and how they are then accelerated.

.....

.....

.....

.....

.....

.....[3]

(b) Explain why the glass tube is evacuated.

.....

.....

.....[1]

(c) The instruction booklet for a c.r.o. states that strong magnets must not be placed close to the c.r.o.

Explain why a strong magnet close to the c.r.o. deflects the electron beam.

.....

.....

.....

.....

.....

.....[2]

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[Turn over

7 Plutonium-238 is a radioactive isotope that decays by alpha-particle emission. It also emits gamma-rays.

(a) The nuclide notation for plutonium-238 is $^{238}_{94}Pu$.

Describe the structure and composition of a neutral atom of plutonium-238.

.....

.....

.....

.....[3]

(b) Alpha-particles, beta-particles and gamma-rays all cause ionisation. The ionisation of substances in the human body can be hazardous.

(i) State how the ionising effect of beta-particles compares with

1. the ionising effect of alpha-particles,

.....[1]

2. the ionising effect of gamma-rays.

.....[1]

(ii) State two precautions that are taken when radioactive substances are moved in a safe way.

1. .....

.....

2. .....

.....

[2]

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Section B

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

8 A spring is taken from a drawer in a physics laboratory.

(a) Fig. 8.1 is the extension-load graph for the spring.

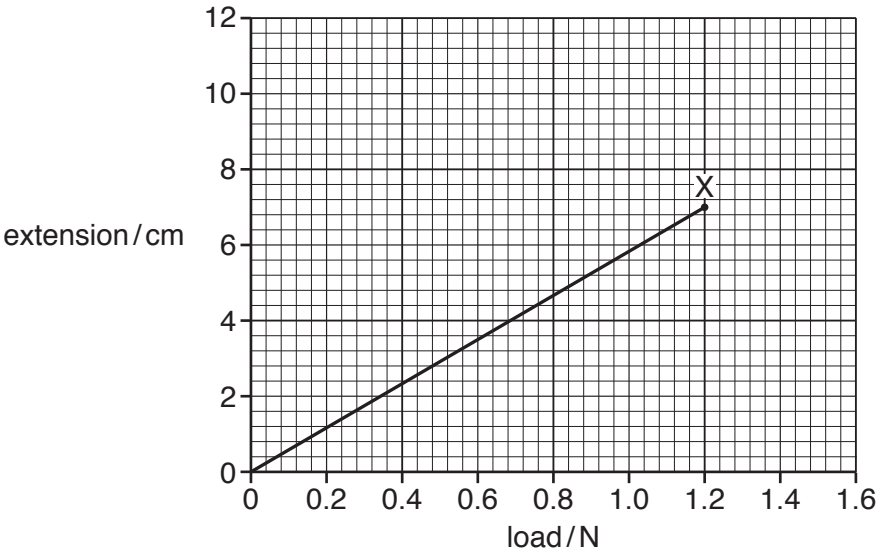


Fig. 8.1

(i) Using Fig. 8.1, determine the load on the spring when its extension is 4.9 cm.

load = ...[1]

(ii) The point X on Fig. 8.1 is the limit of proportionality for the spring.

On Fig. 8.1, sketch a line to show how the extension-load graph might continue after X. [2]

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[Turn over

(b) A rectangular, plastic block is suspended from the lower end of the spring. Fig. 8.2 shows that the bottom 3.5 cm of the plastic block is in the water in a beaker.

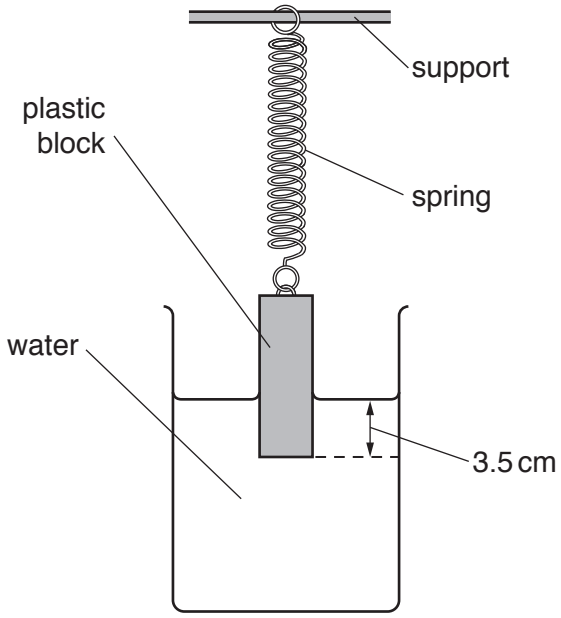


Fig. 8.2 (not to scale)

The density of water is 1000 kg / m^3 and the gravitational field strength g is 10 N / kg. The base of the plastic block is a square with sides of 4.0 cm.

(i) Calculate the pressure due to the water at a depth of 3.5 cm below the surface of the water.

pressure = ...[3]

(ii) Calculate the upward force on the base of the block due to the pressure of the water.

force = ...[2]

(iii) In Fig. 8.2, the extension of the spring is 4.9 cm.

Using the answer from **(a)(i)** and the answer from **(b)(ii)**, determine the weight of the block.

weight = ...[1]

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(c) In the equipment shown in Fig. 8.2, the pressure of the atmosphere is transmitted through the water. The total pressure in the water at a depth of 3.5 cm is larger than the pressure due to the water alone.

(i) Explain why, in this experiment, atmospheric pressure does not affect the position of the plastic block in the water.

.....

.....

.....

.....[2]

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

State how a *vector* quantity differs from a *scalar* quantity.

.....

.....[1]

(d) The beaker in Fig. 8.2 is gradually moved upwards so that more of the plastic block is in the water.

Explain what happens to the forces that act on the block.

.....

.....

.....

.....

.....

.....

.....[3]

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[Turn over

9 A vertical solenoid (long coil) with an iron core is held in a wooden clamp above a laboratory bench.

The solenoid is connected in series with a battery, a switch S, an ammeter and a variable resistor. There is a voltmeter in parallel with the solenoid.

Fig. 9.1 represents this apparatus.

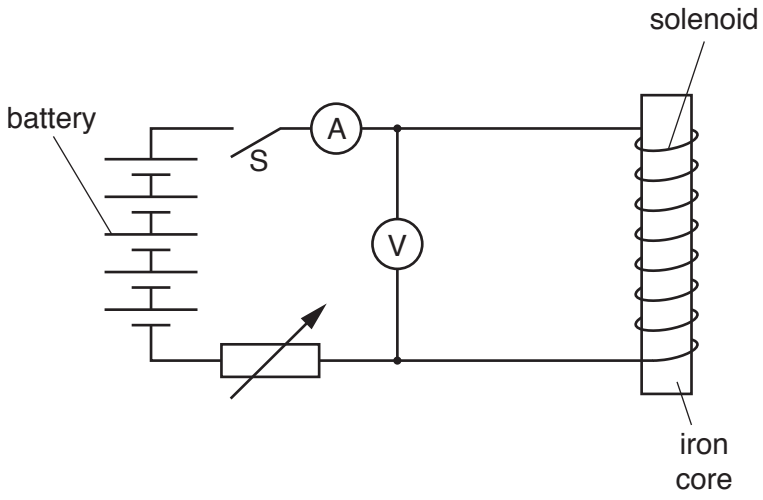


Fig. 9.1

A student closes switch S and a current in the circuit produces a reading on the ammeter.

(a) State what is meant by *current*.

.....

.....[1]

(b) The battery consists of five 1.5 V cells in series. The reading on the ammeter is 4.0 A.

(i) State the size of the electromotive force (e.m.f.) of the battery.

.....[1]

(ii) Calculate the total resistance of the series circuit.

resistance = ...[2]

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(iii) The reading on the voltmeter is 6.5 V.

Calculate the power dissipated in the solenoid.

power = ...[2]

(iv) The solenoid is made of copper and the student notices that, as time passes, the solenoid becomes extremely warm.

State and explain the effect of this temperature increase on the ammeter reading.

.....

.....

.....[2]

(c) (i) The current in the solenoid magnetises the iron core so that the lower end of the core is an N-pole.

On Fig. 9.1, draw the pattern and indicate the direction of the magnetic field in the region surrounding the iron core. [3]

(ii) The student holds an iron cylinder against the bottom surface of the iron core in the solenoid. When he releases the iron cylinder, it stays in contact with the iron core.

1. Explain why the iron cylinder does not fall.

.....

.....

.....

.....

.....[3]

2. The switch S is opened.

State and explain whether the iron cylinder remains in contact with the iron core.

.....

.....

.....[1]

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[Turn over

10 A laser produces a beam of red light.

(a) The red light from the laser has a frequency of 4.3×10^{14} Hz.

(i) State the speed of light in air.

.....[1]

(ii) Calculate the wavelength of this red light in air.

wavelength = ...[2]

(b) Red light from the laser strikes one side of a glass prism at an angle of incidence *i*. The light refracts towards the normal as it enters the prism.

Fig. 10.1 shows the prism, the light and a screen.

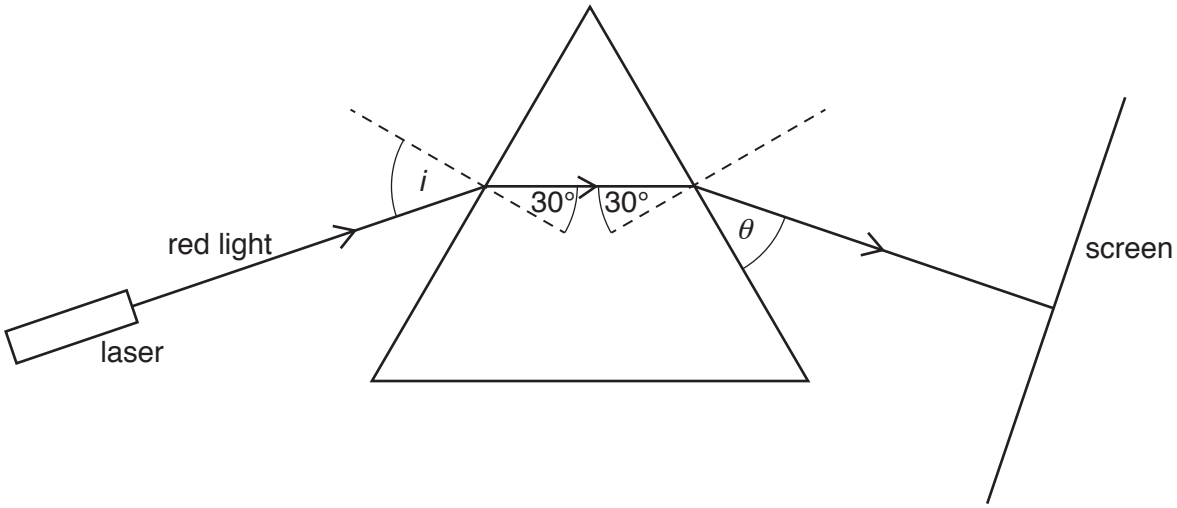


Fig. 10.1 (not to scale)

(i) State what happens to the speed of light as it enters the glass.

.....[1]

(ii) The refractive index of the glass is 1.5. The angle of refraction in the glass, where the light enters the prism, is 30°.

Calculate the angle of incidence *i*.

i = ...[2]

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(iii) The light then passes back into the air and strikes the front of the white screen, as shown in Fig. 10.1.

Calculate θ, the angle between the ray in air and the side of the prism.

θ = ...[1]

(c) The laser in **(b)** is replaced with a filament lamp and a slit, as shown in Fig. 10.2.

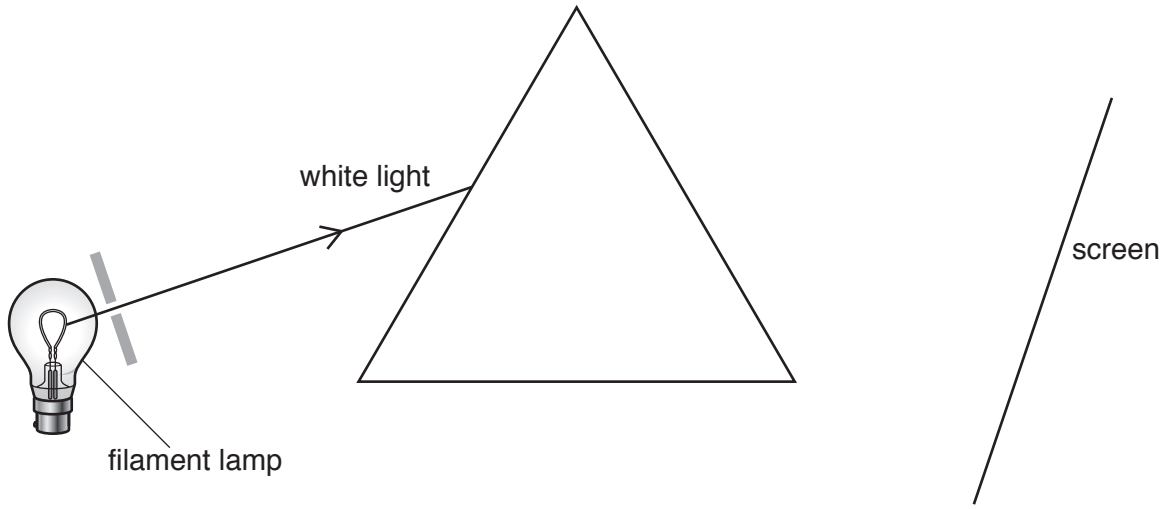


Fig. 10.2 (not to scale)

A ray of white light now strikes the prism.

(i) On Fig. 10.2, draw what happens to the light as it passes through the prism and strikes the screen. [2]

(ii) Describe what is seen on the screen.

.....

.....

.....

.....[2]

(iii) In addition to visible light, the filament lamp also emits some infra-red radiation. This infra-red radiation is able to pass through glass.

1. On the screen in Fig. 10.2, mark an X to indicate a place where infra-red radiation strikes the screen. [1]

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2. Infra-red radiation is often detected by using a sensitive thermometer with a bulb that has been painted black.

Explain why the blackened bulb makes the thermometer a good detector of infra-red radiation.

.....

.....[1]

(d) Explain the role played by infra-red radiation in intruder alarms.

.....

.....

.....

.....

.....[2]

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