UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

0158322318

PHYSICS **5054/21**

Paper 2 Theory **October/November 2011**

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 soft 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.

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.

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Section A

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

1 Fig. 1.1 shows an ice cube at 0 °C.

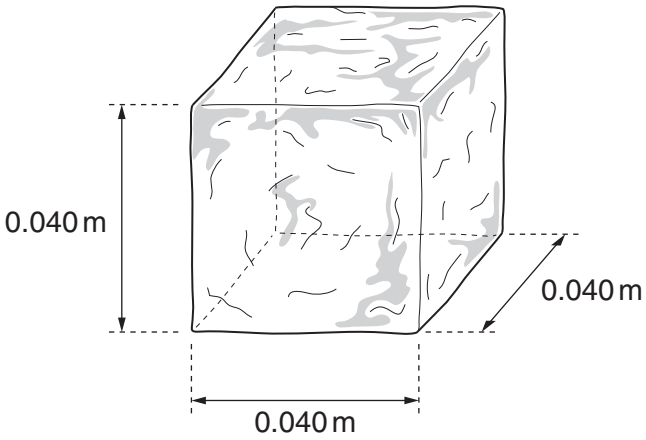


Fig. 1.1

The sides of the cube are of length 0.040 m. Ice at 0 °C has a density of 920 kg / m^3.

(a) Calculate

(i) the mass of the ice cube,

mass = ...[3]

(ii) the weight of the ice cube.

weight = ...[1]

(b) The specific latent heat of fusion of ice is 3.4×10^5 J / kg. Calculate the thermal energy (heat) absorbed by the ice cube as it melts.

thermal energy = ...[2]

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2 Fig. 2.1 shows an elevator (lift) that is supported by a cable.

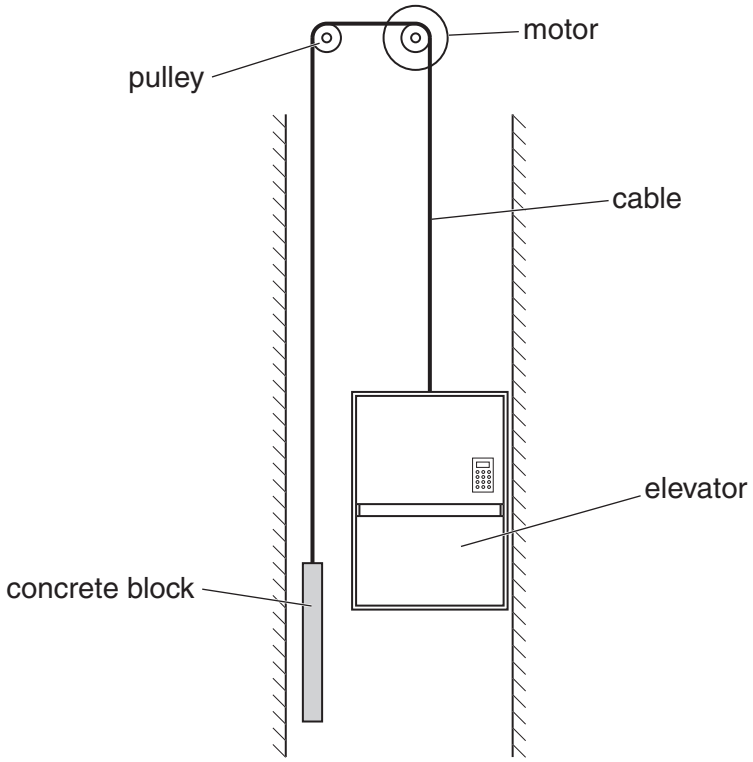


Fig. 2.1 (not to scale)

The cable passes around the axle of an electric motor and over a pulley. The cable is then attached to a concrete block that has the same mass as the empty elevator. As the elevator moves up, the concrete block moves down.

(a) Explain why very little work is done by the electric motor when lifting up the empty elevator.

.....

.....

.....[2]

(b) Several people of total weight 4900 N are travelling upwards at constant speed in the elevator. They rise through a distance of 24 m in 28 s.

Calculate the minimum power output of the electric motor.

power = ...[3]

3 Fig. 3.1 shows the flame of a Bunsen burner.

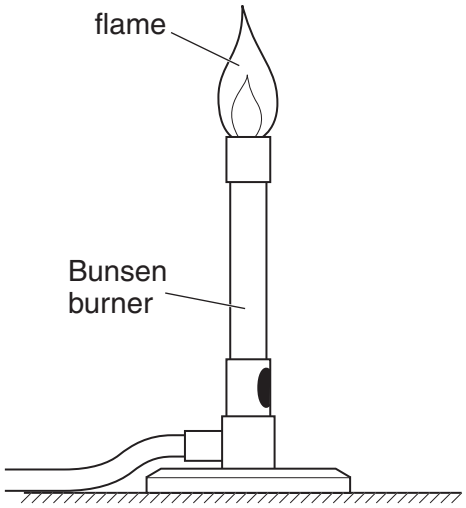


Fig. 3.1

(a) A thermocouple thermometer contains a voltmeter. It is used to measure the temperature in the flame of the Bunsen burner.

(i) On Fig. 3.1, draw a labelled diagram of the structure of the thermocouple thermometer as it measures the temperature in the flame. [2]

(ii) Describe how the fixed points and the reading of the voltmeter are used to determine the value of the temperature in the flame.

.....

.....

.....

.....[2]

(b) The thermocouple thermometer is used to measure the temperature in the flame because it can measure very high temperatures. State and explain one other advantage of using a thermocouple thermometer to determine temperature.

.....

.....

.....[2]

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4 Fig. 4.1 shows a glass lens in air and its two focal points F_1 and F_2.

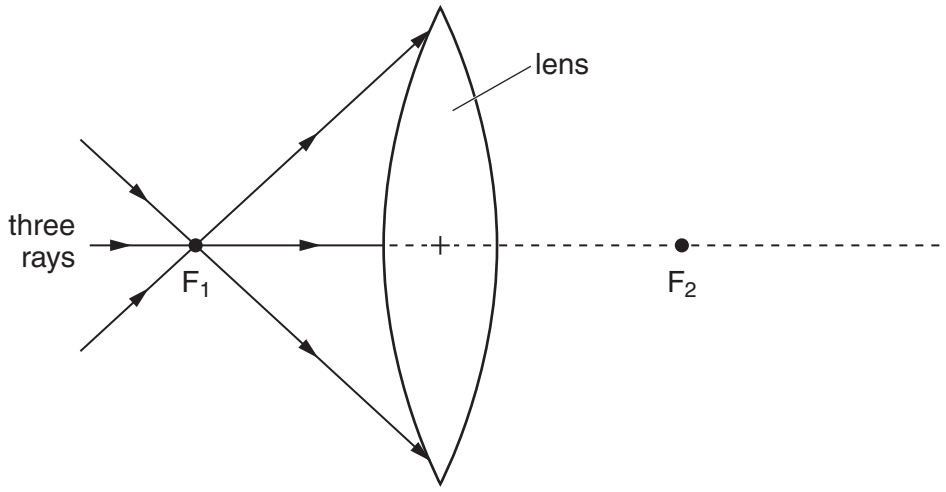


Fig. 4.1

Three rays of light pass through F_1 to the lens.

(a) On Fig. 4.1, continue the three rays through the lens and into the air. [2]

(b) State what happens to the speed of light on

(i) entering the glass lens from air,

.....[1]

(ii) leaving the lens and returning to the air.

.....[1]

(c) Light of wavelength 6.0×10^{-7} m travels in air at a speed of 3.0×10^{8} m/s.

(i) Calculate the frequency of this light.

frequency = ...[2]

(ii) State the effect, if any, on the frequency as the light enters the glass from air.

.....[1]

5 Fig. 5.1 shows a nylon rod being rubbed with a woollen cloth.



Fig. 5.1

The rod becomes negatively charged.

(a) (i) Explain how rubbing the nylon rod makes it negatively charged.

.....

.....[1]

(ii) State what happens to the cloth as the rod becomes negatively charged.

.....

.....[1]

(b) Fig. 5.2 shows the negatively-charged rod placed near to a conducting sphere. The sphere is suspended by an insulating thread.

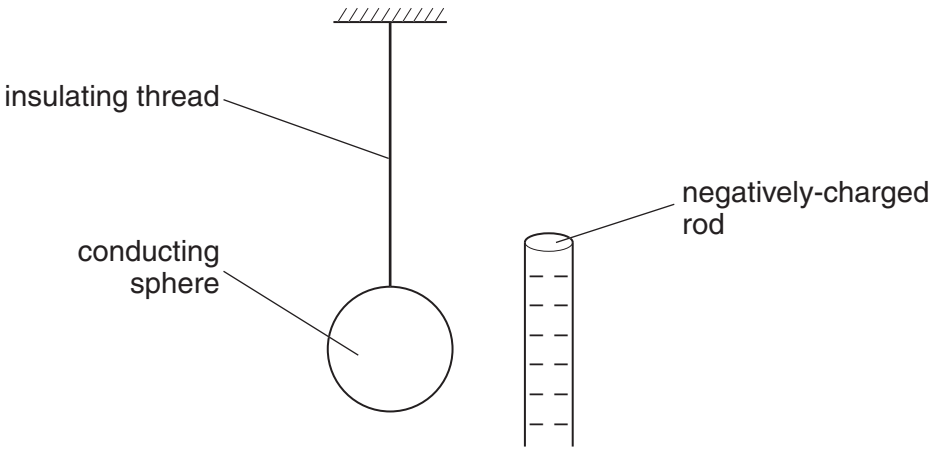


Fig. 5.2

(i) On Fig. 5.2, draw the distribution of positive and negative charges on the sphere. [2]

(ii) Explain why the sphere is attracted to the rod.

.....

.....

.....[2]

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6 When a car is moving, its electrical equipment is powered by an a.c. generator.

(a) The coil of the a.c. generator is rotated by the car engine.

(i) On the axes in Fig. 6.1, sketch a graph of the output voltage of the coil against time for two rotations of the coil of the generator.



[1]

Fig. 6.1

(ii) The speed of the car increases and so does the speed of rotation of the coil.

State two changes that this causes to the output voltage.

change 1 .....

.....

change 2 .....

.....

[2]

(b) When the car engine is off, the current in a lamp from a 12V battery is 0.50A. Calculate the resistance of the lamp.

resistance = ...[2]

7 Fig. 7.1 is the circuit diagram for the volume control of a loudspeaker.

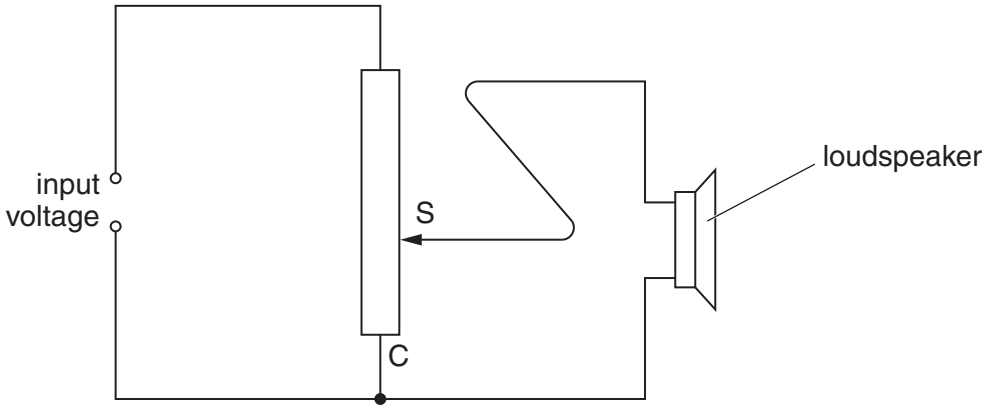


Fig. 7.1

The circuit includes a variable potential divider (potentiometer). The input voltage is connected across the ends of the potential divider. The loudspeaker is connected between the sliding contact S and the terminal C.

(a) The sliding contact S is moved towards C. State and explain the effect on the sound produced.

.....

.....

.....[2]

(b) The loudspeaker emits a sound of constant pitch. Over a period of time, this sound becomes louder and louder. State the effect, if any, on the amplitude and on the frequency of the sound wave during this time.

the amplitude .....

the frequency .....
[2]

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8 **(a)** One radioactive isotope of iodine is $^{131}_{53}\mathrm{I}$. As a nucleus of this isotope decays, it emits a beta-particle (symbol: β) and it becomes a nucleus of an isotope of xenon (symbol: Xe).

Complete the equation in nuclide form, for this decay.

$$^{131}_{53}\mathrm{I} \rightarrow {}^{\ldots\ldots}_{\ldots\ldots}\mathrm{Xe} + {}^{\ldots\ldots}_{\ldots\ldots}\beta$$

[2]

(b) A sample of a radioactive isotope emits both beta-particles and gamma-rays.

Fig. 8.1 shows these two types of radiation entering a magnetic field.



Fig. 8.1

The direction of the magnetic field is into the page.

On Fig. 8.1, mark **and** label the path taken by

(i) the beta-particles, [1]

(ii) the gamma-rays. [1]

(c) Emission from a radioactive source is a random process.

State two ways in which the process is random.

1. .....

2. .....

[2]

Section B

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

9 Fig. 9.1 is the speed-time graph for a rocket from the moment that the fuel starts to burn at time $t = 0$.

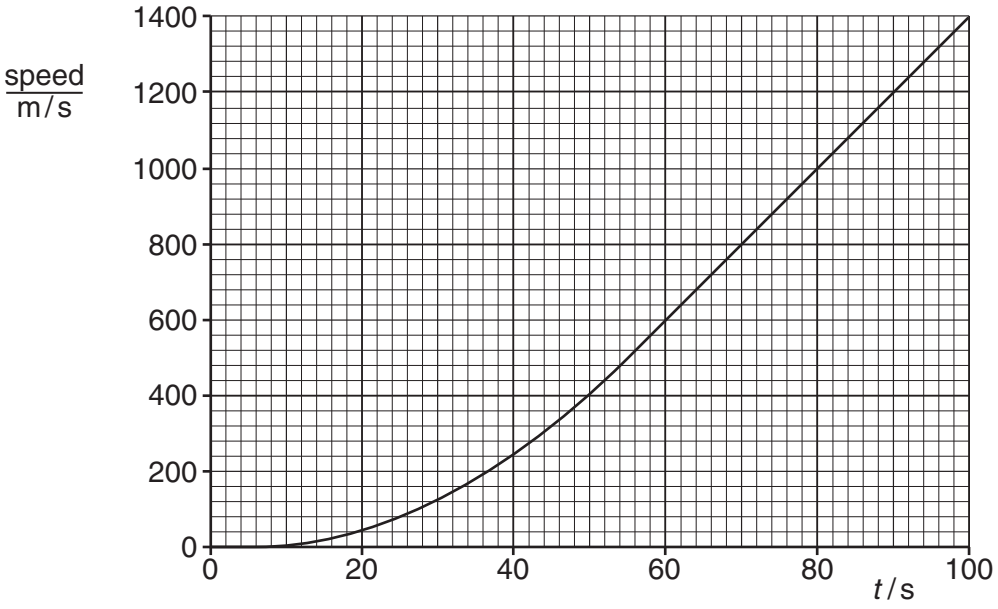


Fig. 9.1

(a) State the principal energy changes taking place as the rocket accelerates upwards.

.....

.....

.....

.....[4]

(b) **(i)** State the size of the acceleration of the rocket at $t = 0$.

.....[1]

(ii) State what happens to the acceleration of the rocket between $t = 5\,s$ and $t = 80\,s$.

.....

.....[2]

(iii) Calculate the acceleration of the rocket at $t = 80\,s$.

acceleration = ...[2]

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(iv) The total mass of the rocket at $t = 80\,s$ is $1.6 \times 10^6\,kg$. Calculate the resultant force on the rocket at this time.

resultant force = ...[2]

(v) The total weight of the rocket at $t = 80\,s$ is $1.6 \times 10^7\,N$. Calculate the upward force on the rocket at this time, caused by the burning fuel.

upward force = ...[1]

(c) As the rocket burns fuel, it ejects hot gas downwards.

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

.....

.....[1]

(ii) Explain how Newton's third law of motion applies to the upward force on the rocket and to the force on the hot gas.

.....

.....

.....[2]

10 Fig. 10.1 is the circuit diagram of a fan oven that works from a 230 V a.c. mains supply.

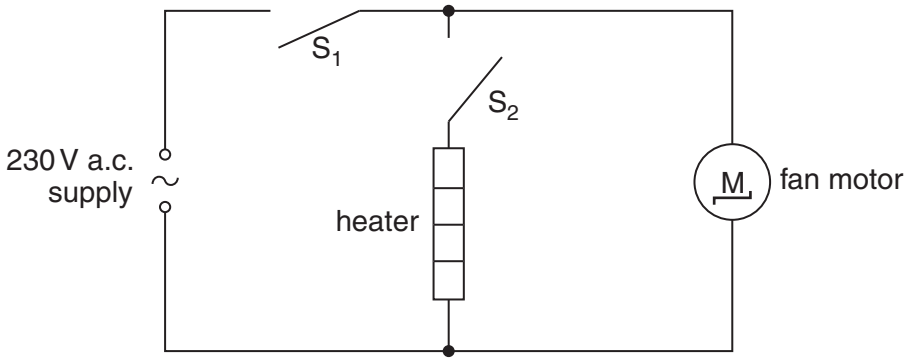


Fig. 10.1

The oven contains a 3500 W electric heater, an electric fan operated by a 200 W fan motor and two switches S_1 and S_2.

(a) (i) When switches S_1 and S_2 are open, both the heater and the fan motor are off, as shown in Fig. 10.2.

S_1	S_2	heater	fan motor
open	open	off	off
		off	on
		on	on

Fig. 10.2

Complete Fig. 10.2 by writing "open" or "closed" in the boxes. [2]

(ii) Explain how the circuit represented by Fig. 10.1 ensures that the heater cannot be switched on when the fan motor is off.

.....

.....

.....[2]

(iii) Suggest one reason why the circuit is designed so that the heater cannot be switched on when the fan motor is off.

.....

.....[1]

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(b) (i) The heater and the fan motor are both switched on. Calculate the current supplied to the oven.

current = ...[2]

(ii) 1. Suggest a suitable rating for the fuse to be used with this oven.

.....[1]

2. The fuse is placed in one of the three wires in the mains lead. State the wire in which it is placed.

.....[1]

(iii) Explain how earthing the metal case of the oven makes it safer.

.....

.....

.....

.....[3]

(c) The cost of 1 kW h of electrical energy is 35 cents. Calculate the cost of leaving just the fan motor switched on for 12 hours.

cost = ...[3]

11 A crankshaft is a shaped metal bar that is part of a car engine. It is free to rotate about an axis, as shown in Fig. 11.1.

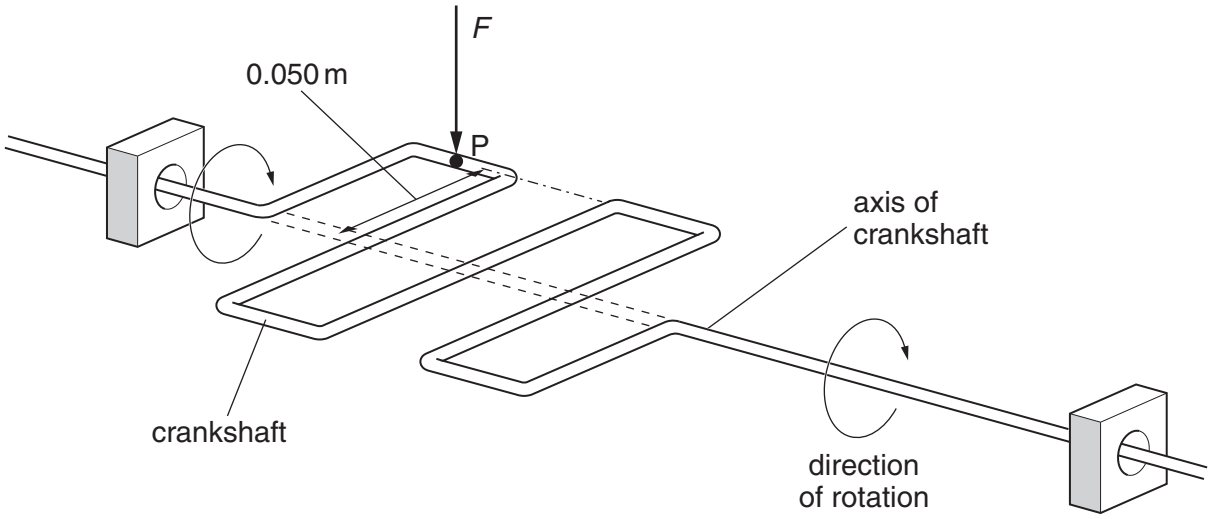


Fig. 11.1

When the crankshaft is horizontal, a vertical force *F* of 8200 N acts downwards on the crankshaft at P. This causes the crankshaft to rotate. The distance between P and the axis of the crankshaft is 0.050 m.

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

.....

.....[2]

(ii) The crankshaft is horizontal. Calculate the moment of *F* about the axis of the crankshaft.

moment = ...[2]

(iii) The size and direction of the vertical force *F*, acting on the crankshaft at P, remain constant. Explain why the moment of *F* decreases as the crankshaft rotates through a small angle.

.....

.....[1]

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(b) The force *F* on the crankshaft at P is exerted by a metal rod connected to a piston. The piston traps high-pressure gas in a cylinder, as shown in Fig. 11.2.

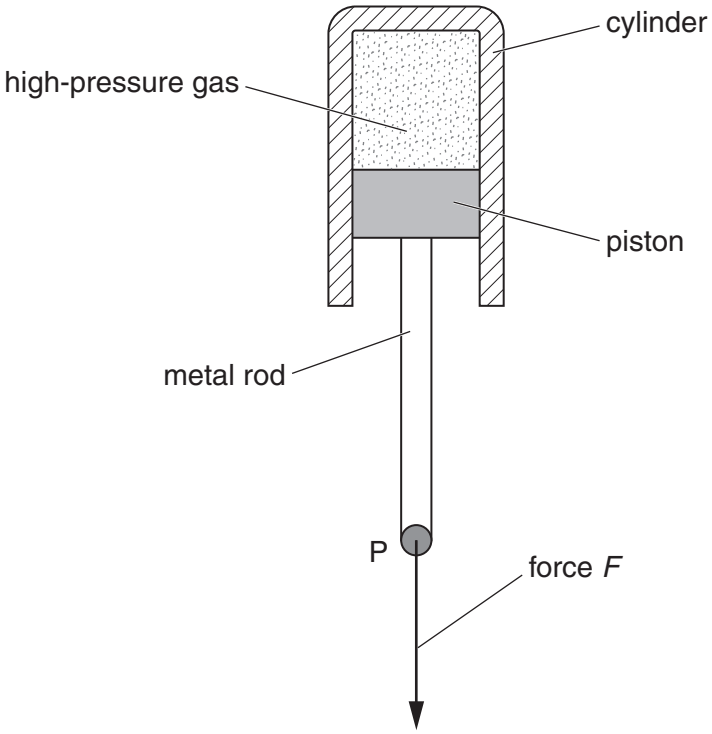


Fig. 11.2

The force *F*, of 8200 N, acts because the high-pressure gas pushes down on the piston. The air pressure outside the cylinder is 1.0×10^5 Pa and the cross-sectional area of the piston is $0.0067\,m^2$.

(i) Calculate the minimum value of the pressure of the gas in the cylinder.

pressure = ...[3]

(ii) Suggest why, in practice, the pressure of the gas in the cylinder is greater than the value calculated in **(i)**.

.....

.....

.....[2]

Question 11 continues on the next page.

(c) The piston moves in the cylinder and the gas expands. State and explain what happens to the force *F*.

.....[1]

(d) Explain, in molecular terms, why heating a gas at constant volume causes its pressure to increase.

.....

.....

.....

.....

.....[4]

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