Paper 2A	☐ s.f. ☐ formula	50

Name:		Index Number:		Class:	

CATHOLIC HIGH SCHOOL
Preliminary Examination
Secondary 4 (O-Level Programme)

PHYSICS **6091/02**

Paper 2 Theory

14 September 2022
1 hour 45 minutes

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all the work you hand in.
Write in dark blue or black link.
You may use a HB pencil for any diagrams or graphs.
Do not use paper clips, glue or correction fluid.

Section A
Answer **all** questions.

Section B
Answer **all** questions. Question 13 has a choice of parts to answer.

Candidates are reminded that **all** quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.
Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

The number of marks is given in brackets [ ] at the end of each question or part question.

For examiner's use only:

Section A	/ 50
Section B	/ 30
Total	**/ 80**

Overall	**Marks**	**%**
Paper 1	40	30%
Paper 2A	50	50%
Paper 2B	30	
Paper 3	40	20%

Section A

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

1 Fig. 1.1 shows three forces acting on an object on a horizontal surface.

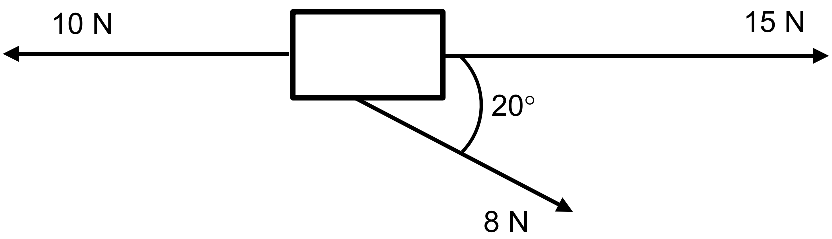

Fig. 1.1

By considering the resultant of the 10 N and 15 N forces, draw a scale diagram in the space below to determine the magnitude of a fourth force that is needed to keep the object in equilibrium.

force = ... [4]

2 Fig. 2.1 shows a cycle track.

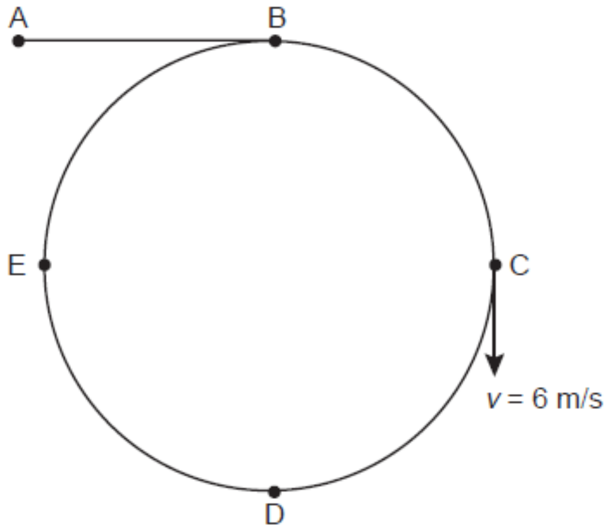

Fig. 2.1

A cyclist starts at A and follows the path ABCDEB.

The speed-time graph of the cyclist is shown in Fig. 2.2.

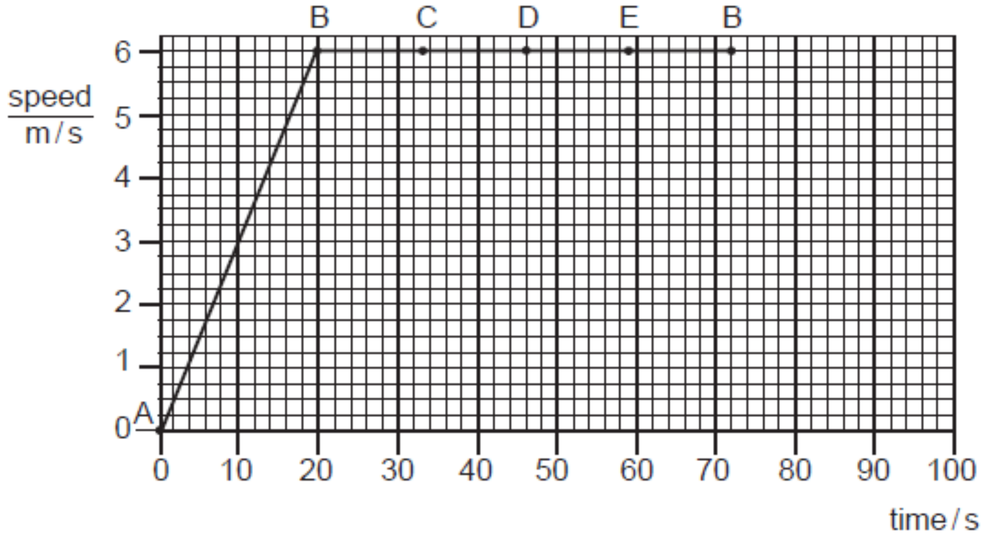

Fig. 2.2

(a) Using the information from **both** Fig. 2.1 and Fig. 2.2, describe the motion of the cyclist

(i) along AB,

....

.... [1]

(ii) along BCDEB.

....

.... [1]

(b) The velocity *v* of the cyclist at C is shown in Fig. 2.1.

State one similarity and one difference between the velocity at C and the velocity at E.

similarity ....

....

difference ....

.... [2]

(c) Calculate

(i) the distance along the cycle track from A to B,

distance = ... [1]

(ii) the circumference of the circular part of the track.

circumference = ... [1]

3 **(a)** For a special parade, the guest of honour is to sit on a chair while the parade passes by. Unfortunately, the ground beneath the chair is soft, so the parade organisers placed the chair on a large flat board, as shown in Fig. 3.1.

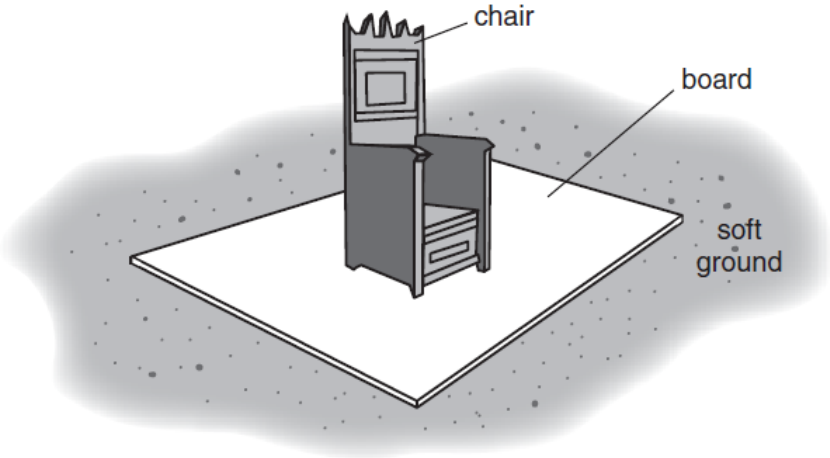

Fig. 3.1

(i) Using ideas about pressure, explain why the board prevents the chair from sinking into the ground.

....

....

.... [2]

(ii) The mass of the chair is 10 kg, and its base area is 0.75 m^2. The base area of the board is twice as large.

Calculate the pressure acting on the soft ground due to the weight of the chair. The gravitational field strength g is 10 N / kg.

pressure = ... [2]

(b) During the parade, some air-filled balloons are used as decorations, as shown in Fig. 3.2.

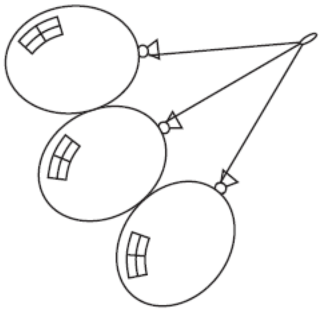

Fig. 3.2

(i) State what happens to the balloons when the Sun makes them hotter.

.... [1]

(ii) Explain, in terms of molecules, your answer to **(b) (i)**.

....

....

.... [2]

(c) A pump is used to pump up the balloons in **(b)**. A valve in the pump becomes blocked and cannot be repaired, as shown in Fig. 3.3.

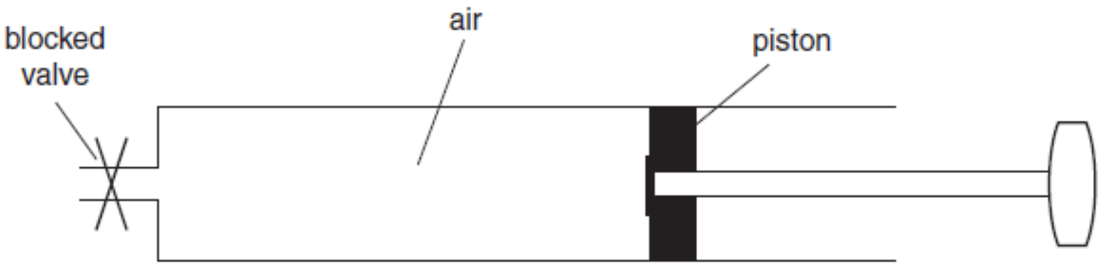

Fig. 3.3

State how the pressure of the trapped air in the same pump can be reduced.

....

.... [1]

4 **(a)** State what will happen to the kinetic and potential energies of the molecules of a solid when it is heated during a change of state.

kinetic energy ....

....

potential energy ....

.... [2]

(b) Most substances expand when they are heated.

(i) Suggest one example where such expansion is useful.

....

.... [1]

(ii) State one example where such expansion could be a nuisance and hence must be considered.

....

.... [1]

5 Fig. 5.1 shows a section through a series of waves on water.

Fig. 5.1

(a) The waves enter a region of **deeper** water.

On Fig. 5.1, carefully mark and label

(i) the wavelength of the waves in the **deeper** water, [1]

(ii) the amplitude of the waves in the **deeper** water. [1]

(b) Describe how the frequency of the waves can be found using a stopwatch.

....

....

....

.... [2]

6 **(a)** Fig. 6.1 shows a lens which forms the image of an object on a screen.

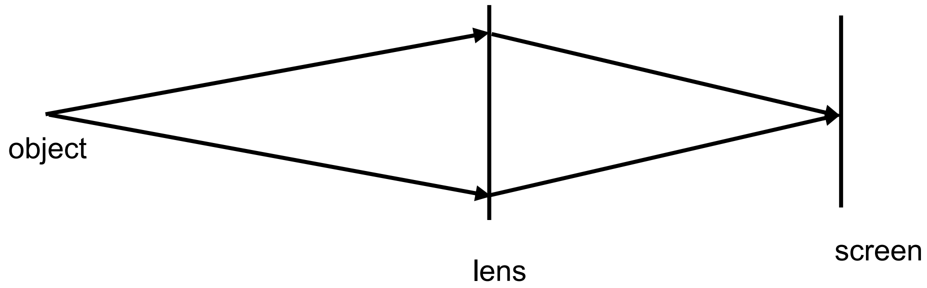

Fig. 6.1

By drawing on Fig. 6.1, locate and mark the focal point of the lens with a 'F'. [2]

(b) Fig. 6.2 shows another lens that is placed in front of an object.

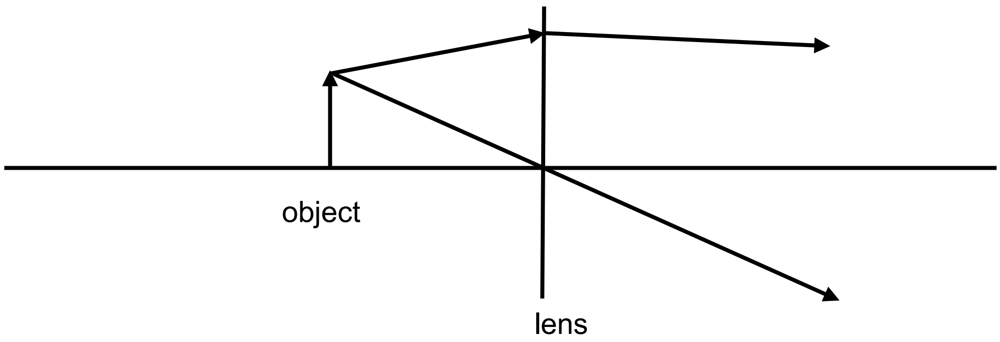

Fig. 6.2

(i) State and explain the type of lens that is shown in Fig. 6.2.

....

....

.... [2]

(ii) By drawing on Fig. 6.2, locate and mark the image with a 'I'. [2]

7 Fig. 7.1 shows a light, positively charged conducting sphere, which is hanging from an insulating thread.

The sphere is deflected when a metal plate on an insulating stand is brought near the sphere.

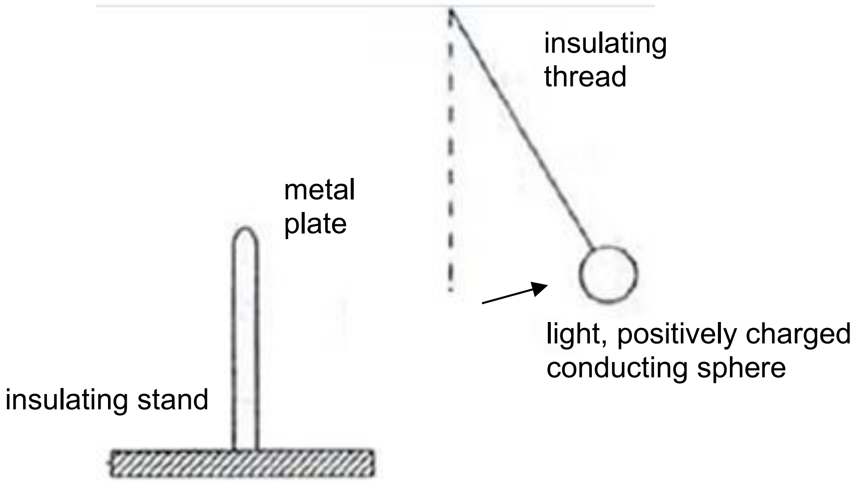

Fig. 7.1

(a) When the metal plate is touched by a finger as shown below, the sphere falls, as shown in Fig. 7.2 below.

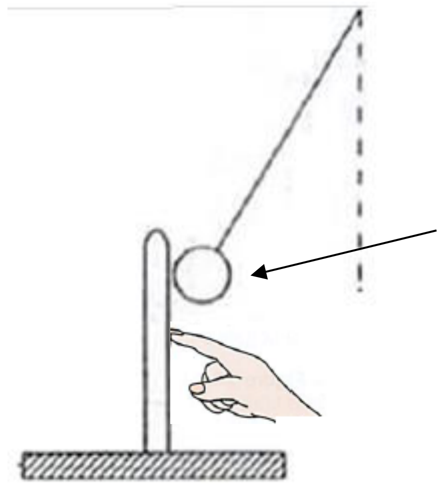

Fig. 7.2

Explain why the sphere falls.

....

....

.... [2]

(b) The movement of the ball shows the meaning of *electric field*.

(i) Define *electric field*.

....

.... [1]

(ii) Explain how the movement of the ball shows the meaning of the term *electric field*.

....

.... [1]

8 **(a)** Fig. 8.1 shows a circuit containing a lamp and a variable resistor.

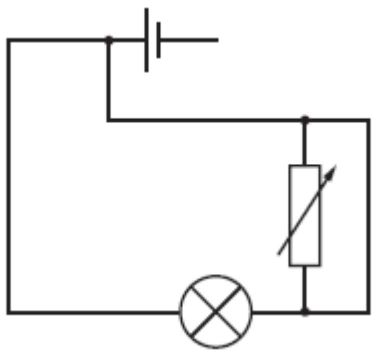

Fig. 8.1

The circuit does not work. The lamp does not light up and altering the variable resistor makes no difference.

In the space below, re-draw the diagram, showing a circuit in which the variable resistor may be used to change the brightness of the lamp.

[2]

(b) Fig. 8.2 shows another circuit, with a wire AB which acts as an one metre resistance wire.

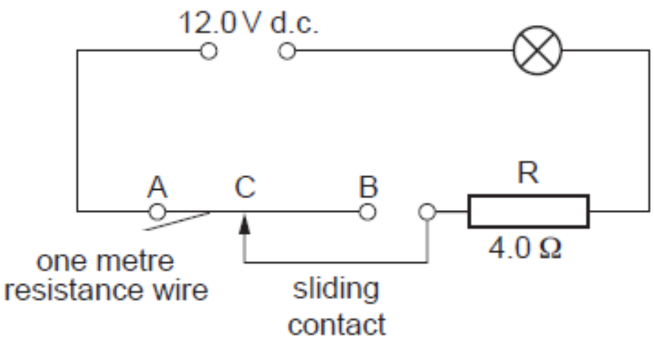

Fig. 8.2

The resistance of the lamp is 4.0 Ω when it is at its normal brightness.

(i) The lamp is rated at 6.0 V, 9.0 W.

Calculate the current in the lamp when it is at its normal brightness.

current = ... [1]

(ii) The sliding contact C is moved to A. The lamp lights up at its normal brightness.

Calculate the total resistance in the circuit.

resistance = ... [1]

(iii) The sliding contact C is moved from A to B.

State and explain any change to the brightness of the lamp.

....

....

.... [3]

9 Fig. 9.1 shows an electromagnetic relay being used to operate a motor.

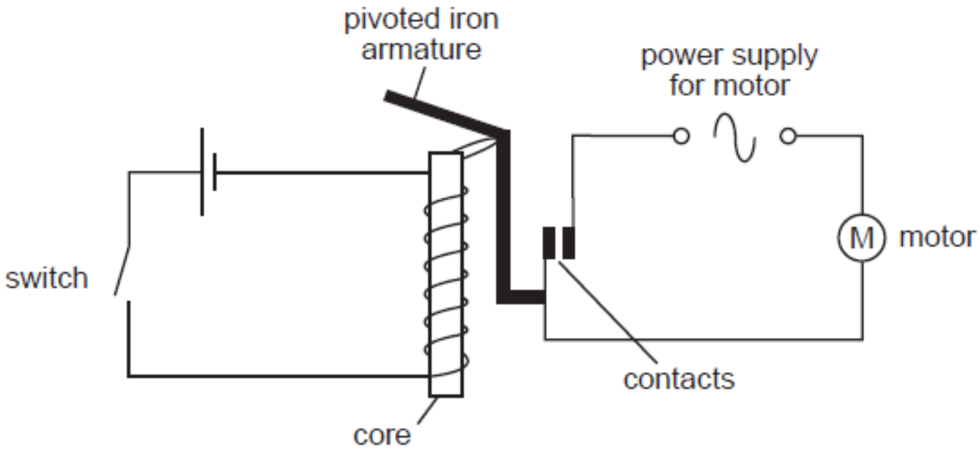

Fig. 9.1

Describe briefly how the electromagnetic relay works for the motor to operate.

....

....

....

....

.... [3]

10 **(a)** One coil of a transformer is connected to a toy train set. The other coil is connected to a 240 V a.c. mains supply, as shown in Fig. 10.1.

The transformer has an efficiency of 90%.

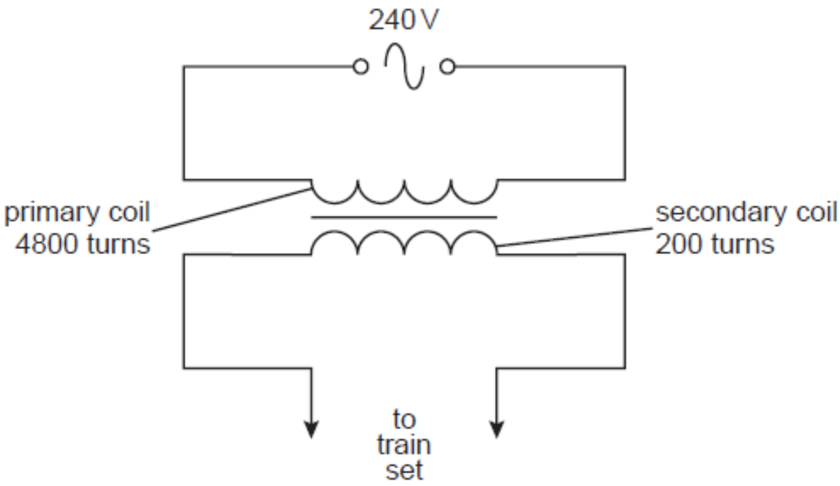

Fig. 10.1

(i) State what is meant by *240 V a.c.*

....

.... [1]

(ii) Calculate the voltage at which the toy train operates.

voltage = ... [1]

(b) Another transformer has the same number of turns for the primary and secondary coils but is 100% efficient.

Compared to this 100% efficient transformer, state and explain the effect on the secondary current for the transformer in **(a)**.

....

....

.... [2]

Paper 2B	☐ s.f. ☐ formula	30

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PHYSICS **6091/02**

Paper 2 Theory

14 September 2022
1 hour 45 minutes

Candidates answer on the Question Paper.
No Additional Materials are required.

Section B

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

Answer only one of the two alternative questions in **Question 13**.

11 Fig. 11.1 shows the specifications of an electric bike.

The motor provides a force *F* to move the electric bike so that a cyclist does not have to pedal.

model of electric bike	65 cm diameter wheel
mass of electric bike	30 kg
maximum carrying load of electric bike	120 kg
operating resistance of motor	12 Ω
operating voltage of motor	40 V
output power of motor	120 W

Fig. 11.1

A 70 kg cyclist rides the electric bike (without pedaling) and travels on a long straight lane.

During the ride, the cyclist experiences a constant resistive force that is equivalent to 0.02 times of the combined mass of the cyclist and the electric bike. The gravitational field strength *g* is 10 N / kg.

(a) **(i)** Calculate the efficiency of the motor.

efficiency = ... [2]

(ii) Electric bikes are much more efficient than electric or conventional cars, which can have an efficiency of as low as 20%.

State and explain why electric bikes are much more efficient.

....

....

.... [1]

(b) **(i)** Calculate the constant resistive force experienced by the cyclist.

force = ______________________ [1]

(ii) Hence, based on the output power of the motor, calculate the maximum constant velocity that could be obtained by the cyclist.

velocity = ______________________ [2]

(c) At a particular instant, the cyclist is moving with a forward force of 120 N.

(i) In the space below, draw a free-body diagram to illustrate the forces acting on the cyclist.

[2]

(ii) Calculate the acceleration of the cyclist at this instant.

acceleration = ______________________ [2]

(d)

Newspaper article 1

"Fire in Bukit Merah flat linked to electric bike that was charging"

SINGAPORE - A fire broke out at a flat in Bukit Merah on Friday morning (April 8) that gutted the entire flat and damaged part of the corridor.

The Singapore Civil Defence Force (SCDF), which responded to the fire at about 8.15am, said preliminary investigation indicated that the fire originated from the battery pack of an electric bike that was charging in the living room…

Re: The Straits Times, 8 April 2022
https://www.straitstimes.com/singapore/fire-in-bukit-merah-flat-linked-to-power-assisted-bike-that-was-charging

Newspaper article 2

"Man riding e-bike illegally on footpath jailed after woman, 74, fractures shoulder in accident"

SINGAPORE - A 74-year-old woman fell and fractured her shoulder after her umbrella got hooked on the power-assisted bicycle (PAB) of a man who was riding illegally on the footpath…

Re: The Straits Times, 19 May 2022
https://www.straitstimes.com/singapore/courts-crime/man-riding-e-bike-illegally-on-footpath-jailed-after-woman-74-fractures-shoulder-in-accident

In real life, there are safety concerns with regards to the use of electric bikes.

Based on the two newspaper articles above, suggest and explain how the use of electric bikes can be made safer.

Newspaper article 1 ....

....

....

Newspaper article 2 ....

....

.... [2]

12 Fig. 12.1 shows coil A connected to an ammeter, a cell and a switch S.
Coil B is connected to a galvanometer.

Coils A and B are placed close together.

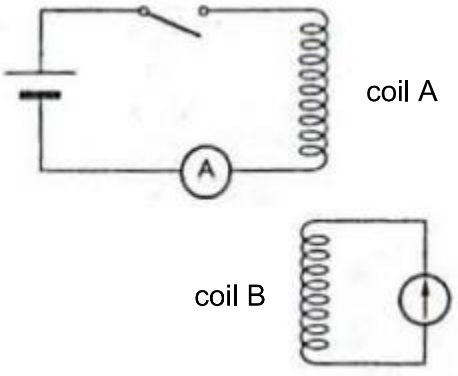

Fig. 12.1

(a) State and explain what is observed when

(i) switch S is closed and remains closed,

....

....

....

.... [3]

(ii) switch S is opened again.

....

....

.... [1]

(b) **(i)** The experiment in **(a)** is repeated with soft iron rods placed in both coils.

State and explain one difference in what is observed.

....

....

.... [2]

(ii) Fig. 12.2 shows the soft iron rods in **(b) (i)** removed, and a sheet of soft iron is placed between the two coils, at right angles to the line joining coils A and B.

State and explain one difference in in what is observed.

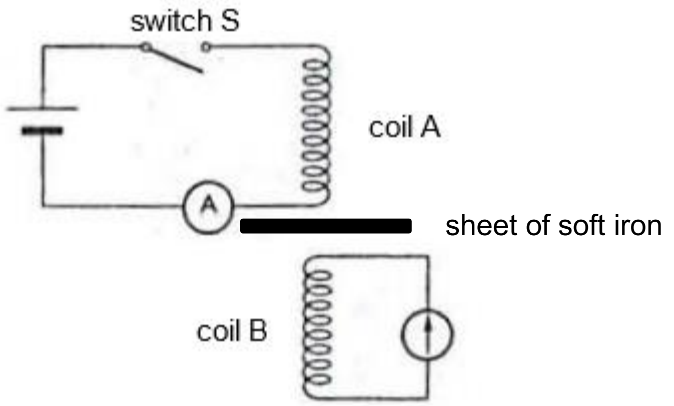

Fig. 12.2

....

....

.... [2]

13 EITHER

Fig. 13.1 shows the speed-time graph of a stone thrown vertically downwards.

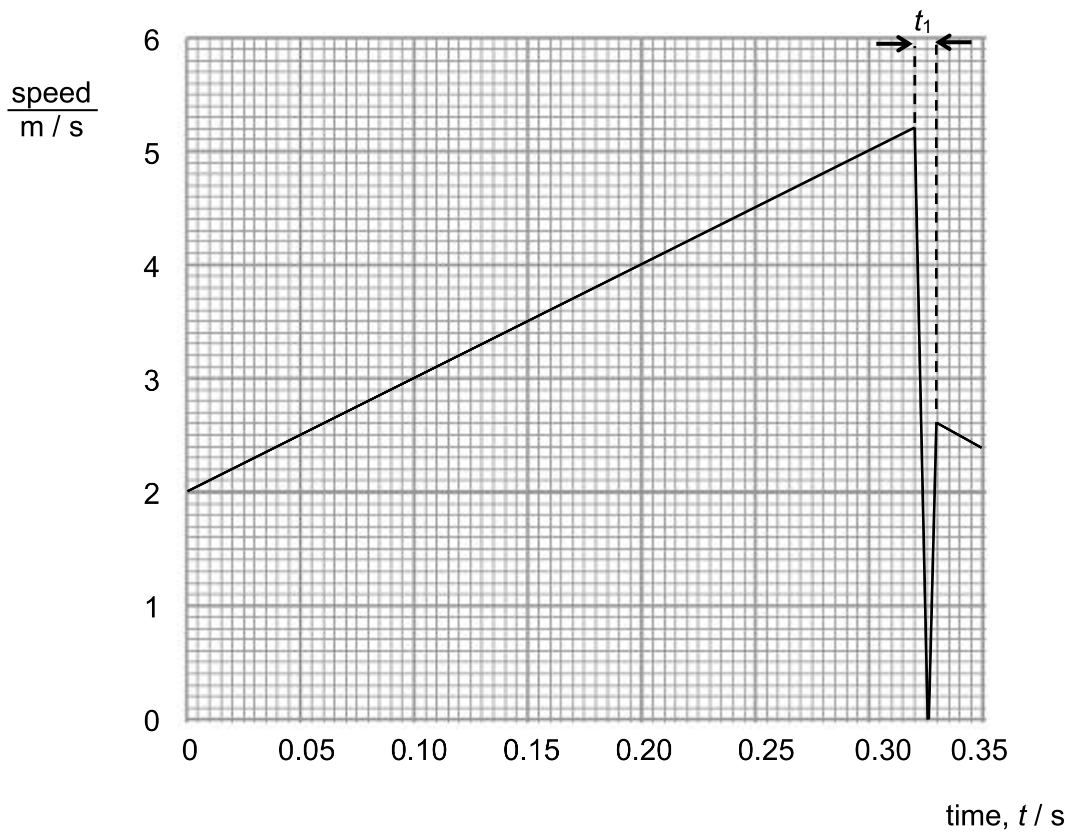

Fig. 13.1

The stone has a mass of 230 g and leaves the thrower's hand at $t = 0$ s.

It hits the ground at $t = 0.320$ s and rebounds with 50% of the speed with which it hits the ground.

(a) Using ideas about forces, explain without using any calculations, how Fig. 13.1 shows that the stone is falling with a constant acceleration g due to free fall.

....

....

.... [2]

(b) **(i)** Determine the speed of the stone just after it rebounds.

speed = ... [1]

(ii) Calculate the loss of kinetic energy of the stone as it hits the ground and rebounds.

loss = ... [2]

(c) **(i)** The acceleration of the stone is always positive, but sometimes the velocity is negative.

Explain this statement.

....

....

.... [2]

(ii) On Fig. 13.2 below, sketch the velocity-time graph of the stone for the entire duration until t = 0.35 s.
(The values on the axes need not be labelled.)

[2]

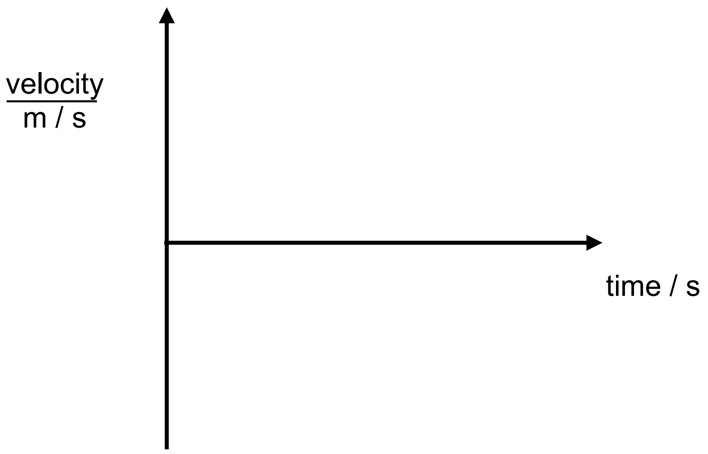

Fig. 13.2

(d) State the energy changes during the time interval labelled t_1 on Fig. 13.1.

....

.... [1]

OR

(a) Fig. 13.3 shows how ultrasound is used to produce an image of the heart.

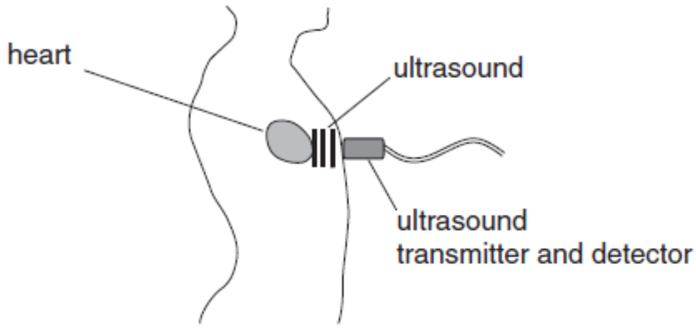

Fig. 13.3

(i) Describe briefly how the transmitter and detector work together to produce an image of the heart.

....

....

.... [2]

(ii) The ultrasound has a wavelength of 1.2 μm. The speed of the ultrasound in the human body is 1500 m / s.

Calculate the frequency of the ultrasound.

frequency = ... [2]

(iii) Fig. 13.4 shows the positions of the particles in the body all spaced equally apart on the vertical lines drawn, before the ultrasound arrived in the body.

The dots represent the positions of the particles at a particular instant, when the ultrasound passes through the body.

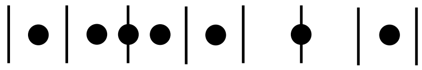

Fig. 13.4

1. On Fig. 13.5 below, sketch the corresponding pressure-distance graph of the particles

[2]

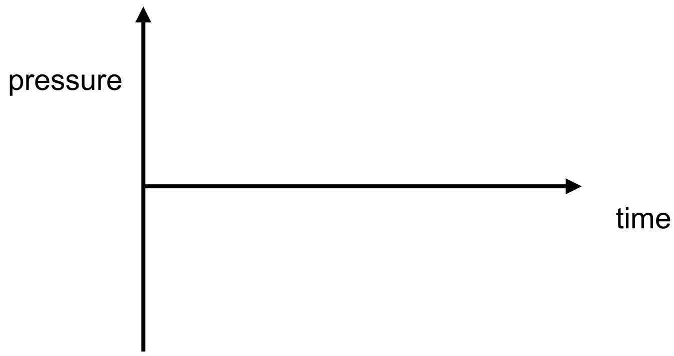

Fig. 13.5

2. In the space above Fig. 13.4, draw the positions of the particles after half a period.

[1]

(b) Fig. 13.6 shows a graph of the relative power of the thermal radiation emitted by objects at different temperatures against the wavelengths of the thermal radiation.

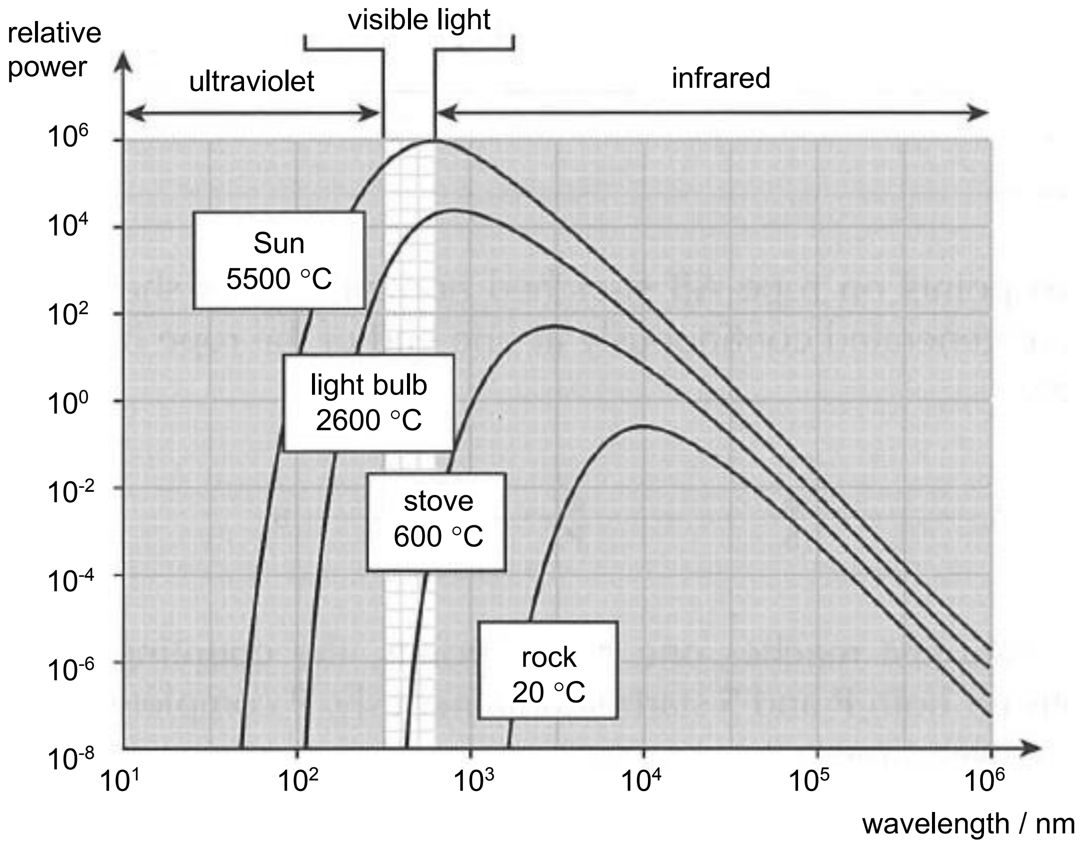

Fig. 13.6

Both the stove and the rock emit thermal radiation.

The colour of the thermal radiation emitted by the stove can be seen. However, the thermal radiation emitted by the rock cannot be seen.

Using Fig. 13.6, explain why this is so.

....

....

....

.... [3]