NEW TOWN SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2024
Secondary 4 Express

NAME _____

CLASS _____ **INDEX NO.** _____

PHYSICS 6091 [Revised]/02

Paper 2

22 Aug 2024

1 hour 45 minutes

Candidates answer on the Question Paper. 0800 – 0945

Additional Materials: NIL

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A (70 marks)
Answer **all** questions.

Section B (10 marks)
Candidates must answer only **one** out of the two questions.

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 Marker's Use	
Section A	
Section B	
Total	

Section A (70 marks)
Answer **all** the questions in the spaces provided.

1 A man stood at the edge of a vertical cliff and he threw a stone vertically upwards.
The stone reached its greatest height, fell past the man and hit the bottom of the cliff.

The motion of the stone is represented by the velocity-time graph shown in Fig. 1.1.

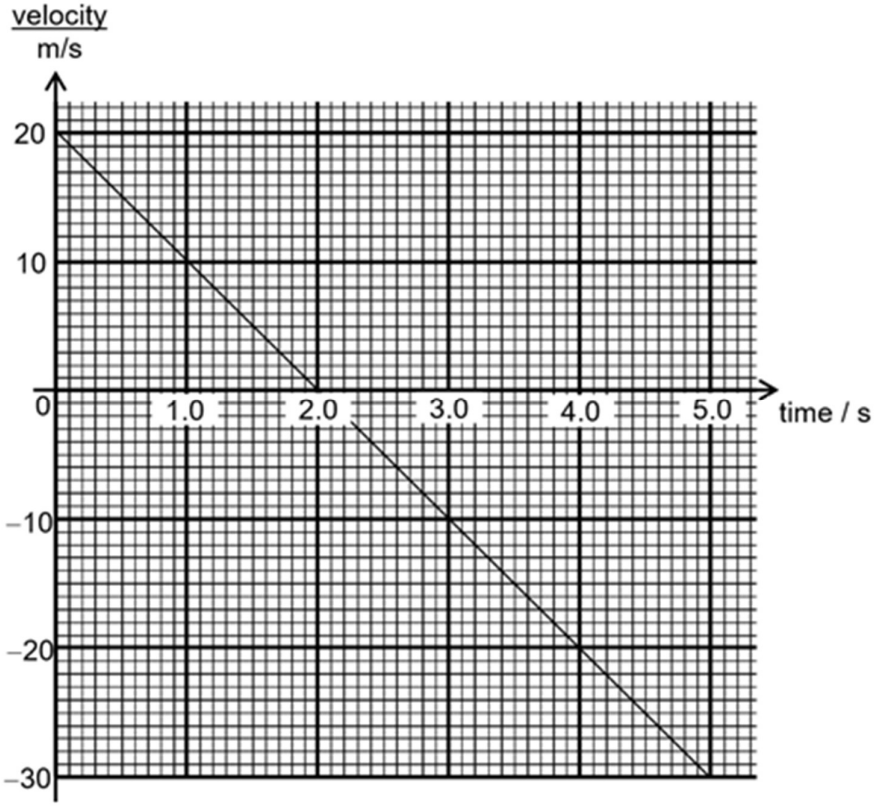

Fig. 1.1

(a) Explain how Fig. 1.1 shows that air resistance has negligible effect on the motion of the stone.

……

…… [1]

(b) Based on the data shown in Fig. 1.1, determine the greatest height achieved by the stone.

greatest height = …… [2]
[Total: 3 marks]

2 Fig. 2.1 shows the vertical forces acting on a weather balloon just after lift-off.

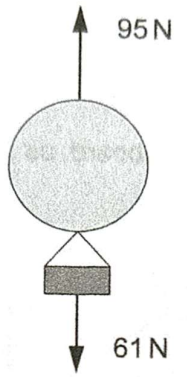

Fig. 2.1

The balloon experiences an upward force of 95 N. The total weight of the balloon and its contents is 61 N.

(a) Determine the total mass of the balloon and its contents.
The gravitational field strength *g* is 10 N/kg

total mass = ... [1]

(b) Calculate the initial vertical acceleration of the balloon.

acceleration = ... [1]

(c) As the balloon rises, it experiences air resistance. The upward force remains at 95 N.
Explain, in terms of forces acting, why the balloon will reach a constant maximum speed.

.....

.....

.....

..... [2]

[Total: 4 marks]

3 Fig. 3.1 shows a sphere of weight 6.5 N suspended by a wire from point X.
The sphere is pulled to one side by a horizontal force F so that the wire makes an angle of 30° with the vertical.

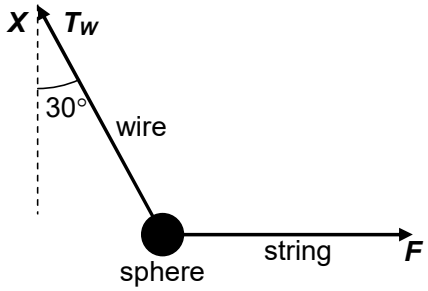

Fig. 3.1 (not to scale)

Use a scale of 1.0 cm to represent 0.50 N, draw a scale diagram in the space below to determine the magnitude of

(a) the tension (T_W) in the wire,

(b) the horizontal force F.

T_W = ……..

F = …….. [3]

[Total: 3 marks]

4 Fig 4.1 shows a sphygmanometer, a device used to measure blood pressure of a patient using mercury in a manometer.

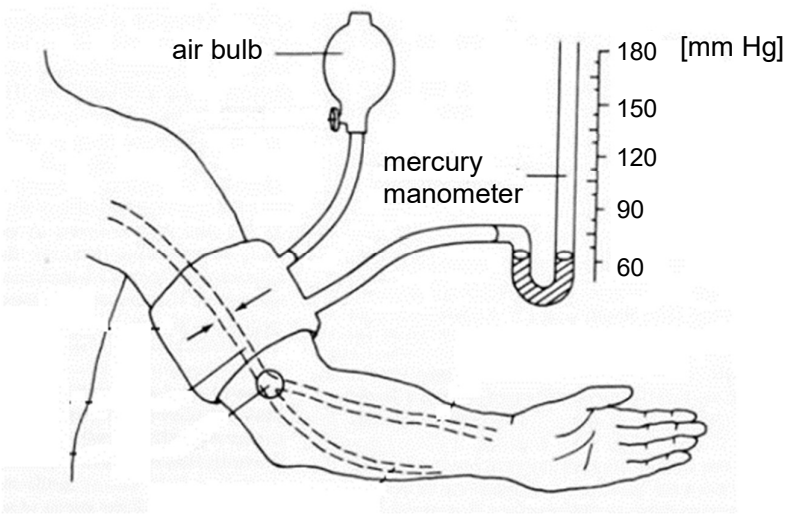

Fig. 4.1

After the doctor has depressed the air bulb, Fig 4.2 below shows an enlarged view of the manometer that is connected to the sphygmanometer.
The right arm of the manometer is open and exposed to atmospheric pressure.

P is the air pressure that is equal to the blood pressure of the patient.
P_0 = atmospheric pressure = 1.01×10^5 Pa.

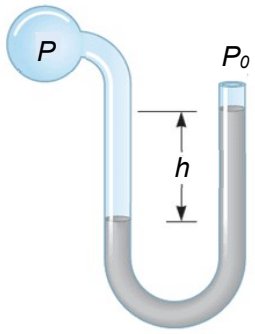

Fig 4.2

(a) The doctor observes that h = 115 mm. Calculate the blood pressure of the patient, in Pa. Assume the density of mercury to be 13600 kg/m^3.

pressure = …… [2]

(b) The doctor proceeds to draw a liquid vaccine from a bottle.
Fig. 4.3 shows a syringe with the vaccine in it.

The syringe has a piston A with cross-section area 0.80 cm^2 and a nozzle B with a cross sectional area of 0.13 cm^2.

The pressure of the liquid vaccine is 1.31×10^5 Pa.

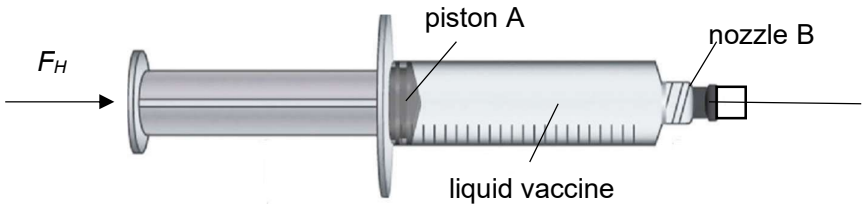

Fig 4.3

Calculate the force F_H required to just push in piston A.
Assume atmospheric pressure = 1.01×10^5 Pa.

Force F_H = …… [2]

(c) Explain, without calculation, how the magnitudes of the force at the piston A, F_A differs from the force at the nozzle B, F_B.

……

……

……

…… [2]

[Total: 6 marks]

5 Fig. 5.1 shows a roller coaster of weight 5000 N and initially at rest at a height of 15.0 m above the ground.
It is then released from rest and it rolls along the track for 50.0 m before it comes to a momentary rest at point X which is 11.0 m above the ground.
The track feels warm after the roller coaster rolls past.

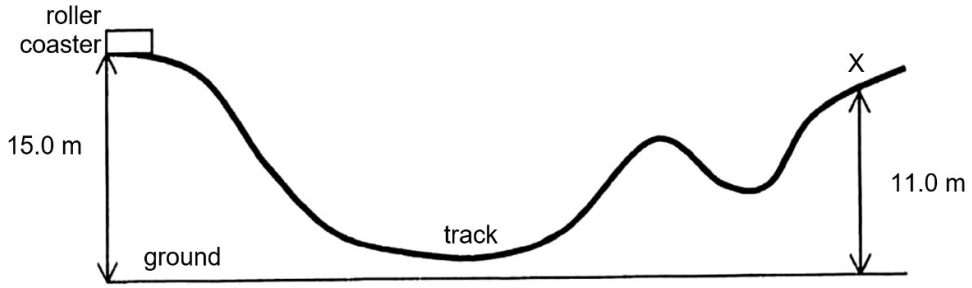

Fig. 5.1

(a) Ignoring loss of energy to the surroundings through other means, determine the work done against friction as it rolls from its initial rest position to point X.

work done against friction = ……. [2]

(b) Determine the frictional force (assumed constant throughout) that acts between the roller coaster and the track.

frictional force = ……. [2]

(c) A motor (not shown in Fig. 5.1) was used to raise the roller coaster from ground level to its initial rest position 15 m above ground level.
Given that the motor takes 30 s to do so, what is the power dissipated by the motor? (Ignore energy lost to the surroundings as heat or sound).

Power = …….. [2]
[Total: 6 marks]

6 **(a)** Table 6.1 shows the wavelength of four electromagnetic waves.

Type of wave	wavelength
infrared wave	0.18 mm
A	0.5 μm
B	10 cm
C	1100 m

Table 6.1

Which of the waves, A, B or C, is visible light?

……..…….……..... [1]

(b) A television station broadcasts its programmes at 5 x 10^3 kHz.

(i) Name the electromagnetic wave used for television broadcast.

…….. [1]

(ii) Calculate the wavelength of the wave.

wavelength = …….. [2]

(c) Stars emit all types of electromagnetic waves. Telescopes that monitor X-rays are mounted on satellites in space.

Suggest why would an X-ray telescope based on Earth not be able to detect X-rays emitted from distant stars.

……………………………………………………………………………………………………

…………………………………………………………………………………………………… [1]

[Total: 5 marks]

7 Fig. 7.1 shows an object placed in front of a converging lens.

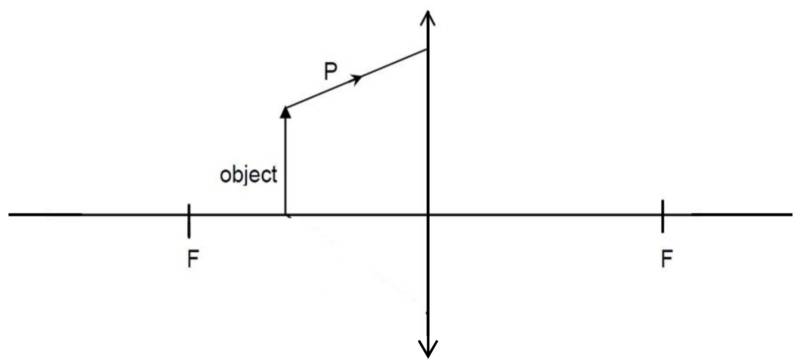

Fig. 7.1

(a) On Fig. 7.1, draw two rays from the top of the object to locate and label the position of the image I. Hence, complete the path for ray P. [3]

(b) Describe two changes to the new image if the object is shifted closer to the lens.

……………………………………………………………………………………………………

…………………………………………………………………………………………………… [1]

[Total: 4 marks]

8 Fig. 8.1 shows a solenoid connected to a galvanometer. A bar magnet is placed on the left of the solenoid.

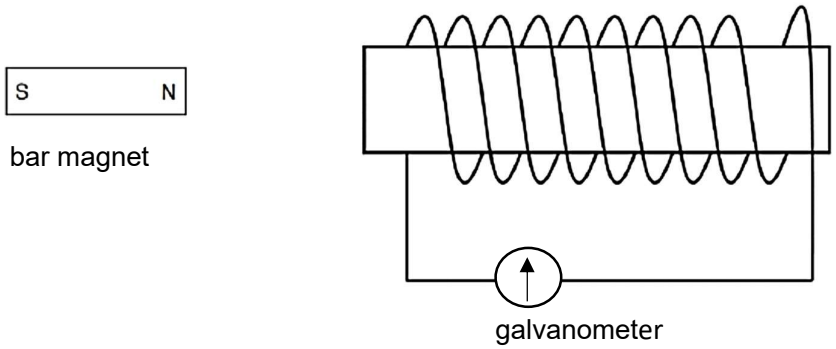

Fig. 8.1

(a) Draw in Fig. 8.1 the magnetic field around the stationary bar magnet. [2]

(b) The bar magnet moves to the right, towards the solenoid.
State the direction of deflection of the galvanometer and give a reason for this.

……..……..

……..……..

……..……..

……..…….. [2]

[Total: 4 marks]

9 A student builds a motor which consists of a coil ABCD, two metal rings and two magnets. The two ends of the coil are soldered to the two metal rings as shown in Fig. 9.1.

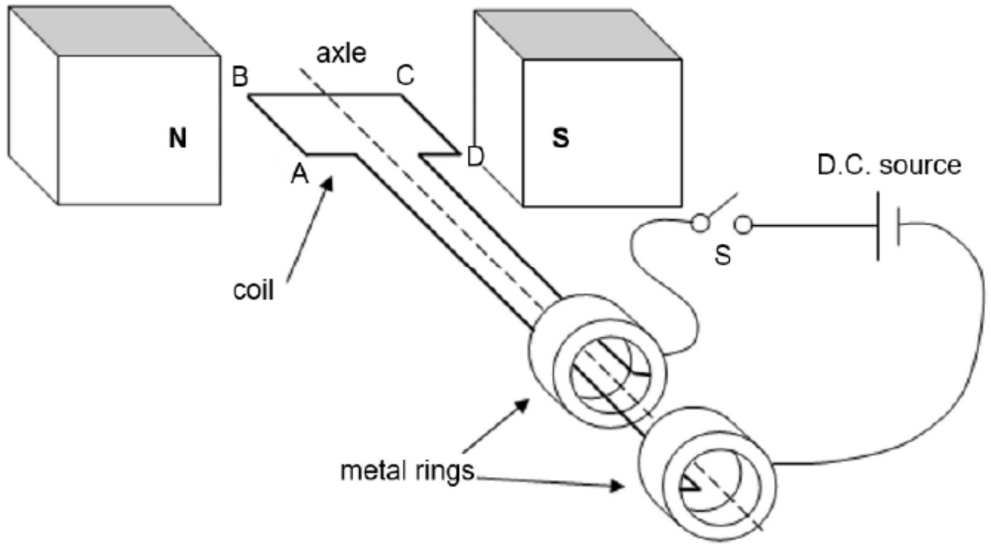

Fig. 9.1

(a) Fig. 9.2 shows the front view of the design of the motor.
On Fig. 9.2, draw the direction of the force acting on the sides AB and CD of the coil when switch S is closed. [1]

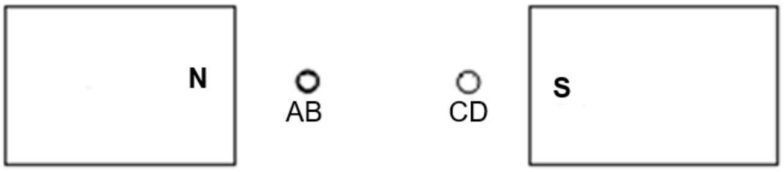

Fig. 9.2

(b) There is a fault with the design of this motor set up by the student.
Explain what is wrong with the set up.

……

…… [1]

(c) State a solution and explain briefly how it can help to rectify the motor's design.

……

……

……

…… [2]

[Total: 4 marks]

10 **(a)** Fig.10.1 shows a transformer.

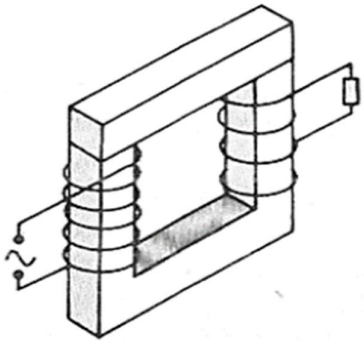

Fig. 10.1

The primary coil has 250 turns and the secondary coil has 150 turns.

Given that the primary coil is connected to a 230 V a.c. mains and that the primary current and the secondary current are 3.00 A and 4.00 A respectively, calculate

(i) the secondary voltage, Vs ,

Vs = …….. [2]

(ii) the efficiency of the transformer.

efficiency = …….. [2]

(b) Transformers are often used during the transmission of power from power stations to houses.
In the transmission of power over a longer distance using cables, explain the need to step up voltage along the transmission cables.

……..……...

……..……... [1]

[Total: 5 marks]

11 In a laboratory at a nuclear power station, a radiation detector is connected to a computer. The readings recorded are displayed on the computer screen. The detector is switched on.

Ten minutes later, at time t = 10 minutes, a small sample of radioactive material is removed from a nuclear reactor and placed near to the detector.
Readings are recorded for a further 40 minutes.
Fig. 11.1 shows the display on the computer screen.

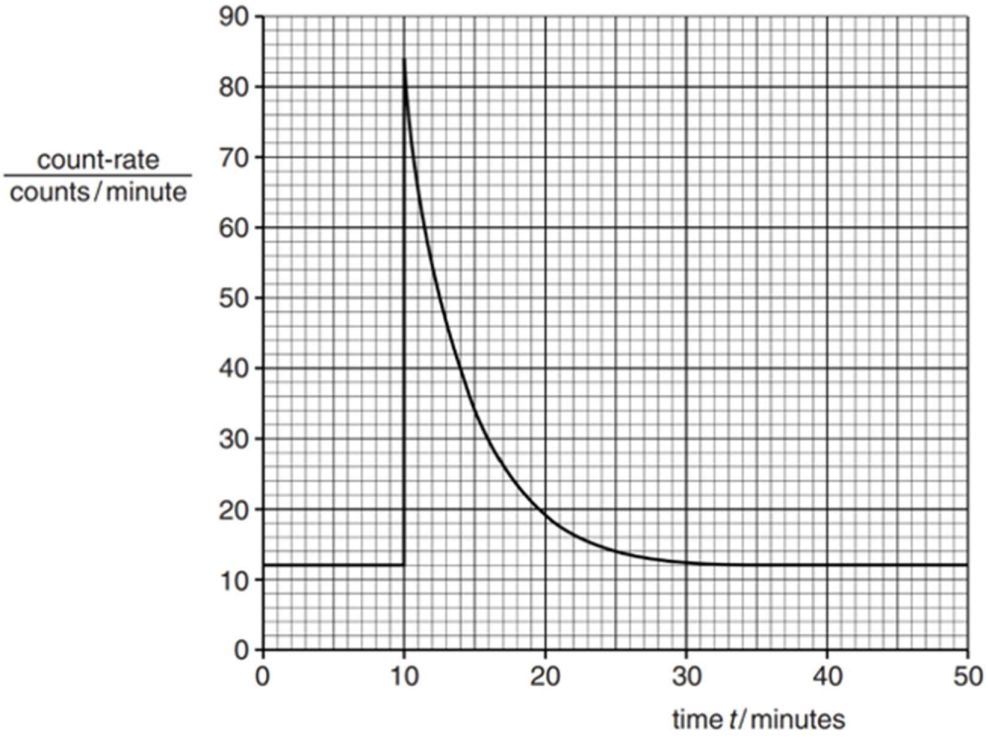

Fig. 11.1

(a) Use the graph to determine the background count rate in the laboratory.

background count rate = …….. [1]

(b) Suggest one source of this background radiation.

…….....

……... [1]

(c) Using Fig. 11.1, determine the count rate due to the radioactive sample at the following times.

(i) t = 10 minutes,

count rate = …….. [1]

(ii) t = 19 minutes.

count rate = …….. [1]

(d) Using your answers in (c), calculate the half-life of the radioactive sample.

count rate = ……. [2]

[Total: 6 marks]

12 **(a)** Fig. 12.1 shows part of a household electrical installation where an electric kettle is used to heat the water.

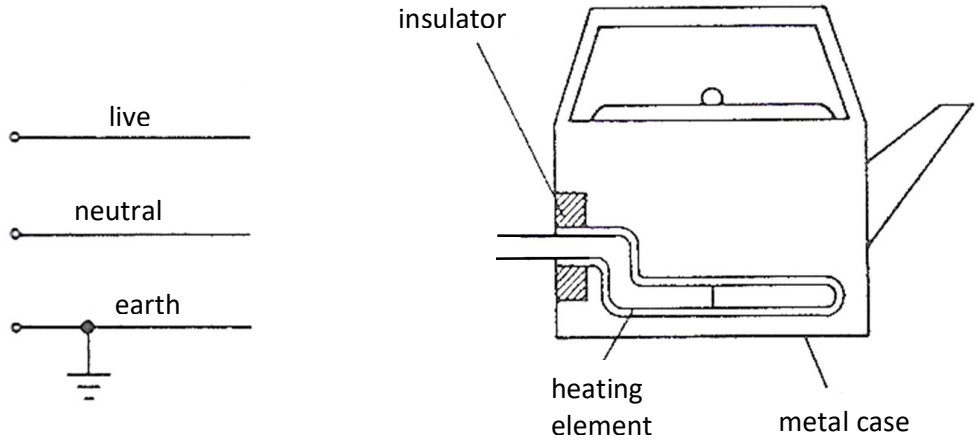

Fig. 12.1

(i) On Fig 12.1, complete the electric circuit by connecting the live, neutral and earth wires to the electric kettle.
Include a fuse and a switch in the circuit diagram. [3]

The electric kettle is rated 240 V, 2.5 kW.
Calculate

(ii) the operating current for the kettle;

current = ... [1]

(iii) the total energy used in 6 hours;

total energy = ... [1]

(iv) the cost of electricity at the rate 30 cents per kWh for 7 days if the kettle is used for 6 hours a day.

Cost = ... [2]

(b) Fig. 12.2 shows a relay used to switch on a car headlamp.

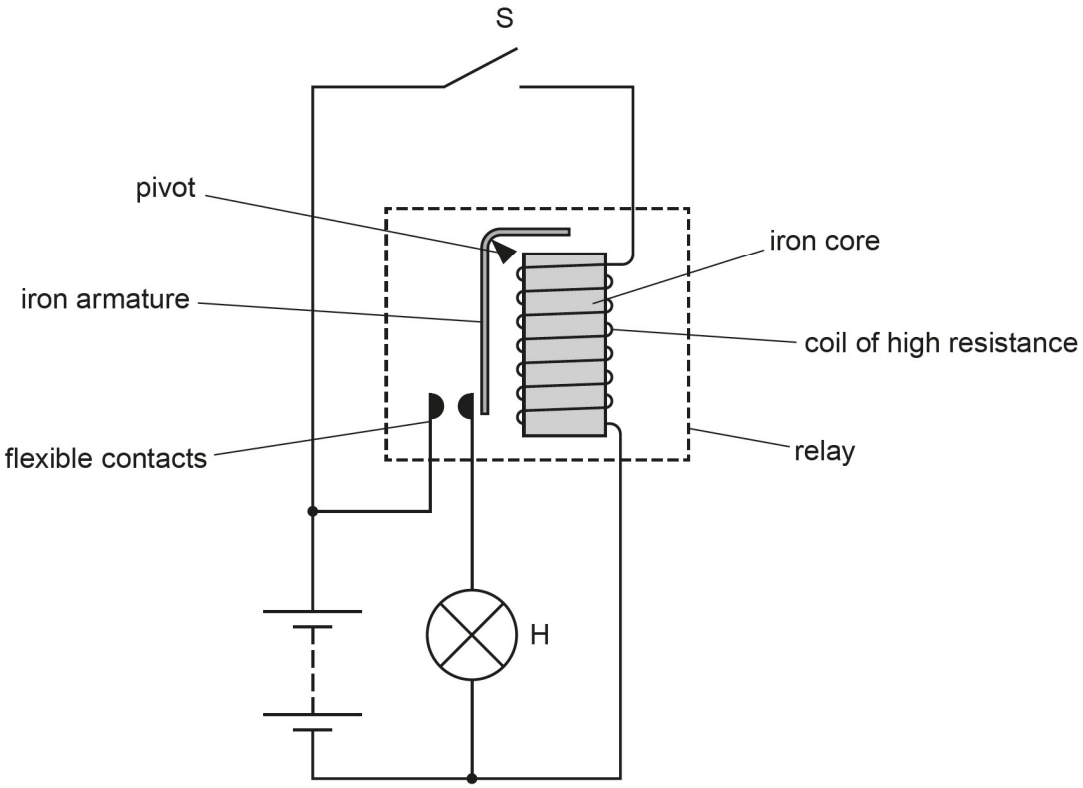

Fig. 12.2

Explain why headlamp H lights up when switch S is closed.

……

……

……

……

……

…… [3]

[Total: 10 marks]

13 Fig. 13.1 shows a vacuum flask cooker. It comprises of an outer pot and an inner pot.

The inner pot is a single-layered steel container with a shiny and silvery exterior.
The outer pot is a double-layered steel container with vacuum in between the layers.
Both pots come with their own lids. The inner pot can fit into the outer pot.

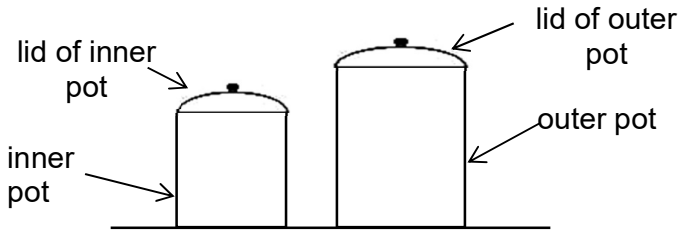

Fig. 13.1

Student A used the vacuum cooker to cook some soup by doing the following:

- The soup was placed into the inner pot over an electric stove.
- The stove is set at high power setting and the soup was cooked for 20 minutes.
- The inner pot, containing the soup, was transferred immediately into the outer pot.
- The outer pot was then covered up with lid and left alone for 3 hours.
- The inner pot containing the soup was taken out of the outer pot and placed over the electric heater again. The soup was heated up at high power setting for 2 minutes.

Student B is not impressed by student A's way of cooking the soup.
He devised his own way of cooking the same mass of soup by doing the following:

- The soup was placed into the inner pot over an electric stove.
- The stove is set at high power setting and the soup was cooked for 20 minutes.
- The stove is then set at low power setting and the soup was cooked for 100 minutes.

Other details pertaining to the electric stove and the soup are shown in Table 13.2.

Table 13.2

power rating of electric stove (high power setting)	2.2 kW
power rating of electric stove (low power setting)	1.1 kW
mass of soup	4.0 kg
specific heat capacity of soup	4400 $Jkg^{-1}°C^{-1}$
temperature of soup (before inner pot is placed inside outer pot)	97.0 °C
temperature of soup (after 3 hours)	85.0 °C

(a) Explain what is meant by *the specific heat capacity of the soup is 4400 $Jkg^{-1}{}^{\circ}C^{-1}$*.

……

…… [1]

(b) Determine the rate of heat loss from the soup when it was placed inside the outer pot for 3 hours. Express your answer in SI units.

rate of heat loss = …….. [2]

(c) Explain how the inner pot keep the soup warm when it was placed inside the outer pot for 3 hours.

……

……

……

…… [3]

(d) Determine the amount of energy supplied by the stove using student A's method as well as student B's method.
Hence, deduce whose method is more energy efficient.

energy supplied (A's method) = ……

energy supplied (B's method) = ……

whose method is more energy efficient: …… [3]

(e) When cooking water-based food, we must exercise caution not to be scalded by steam.
Explain why scalding by steam at 100°C is more severe than being scalded by the same mass of boiling water at 100°C.

……

…… [1]

[Total: 10 marks]

Section B (10 marks)

Answer any **one** question in this section.
Write your answers in the spaces provided.

14 **(a)** A clarinet contains a thin strip of material, known as the reed. A musical note is produced when the reed vibrates, causing molecules in the air nearby to vibrate at the same frequency.

Fig. 14.1 shows the clarinet and an audience in a concert room.

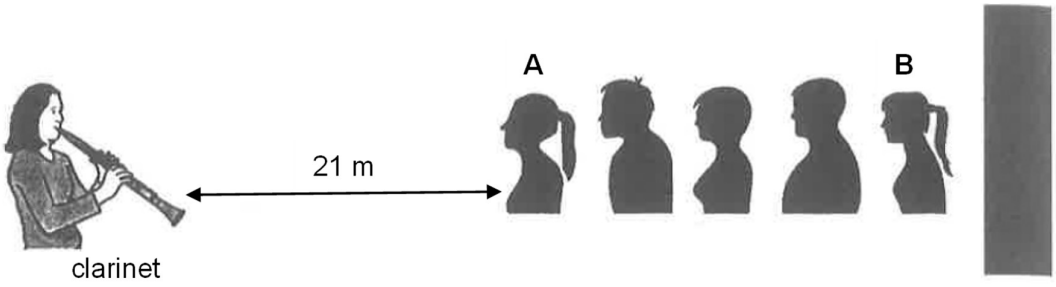

Fig. 14.1

A sound is heard by a listener at A, who is 21 m from the clarinet. The clarinet is making a note of frequency 220 Hz.

(i) Explain how the sound is transmitted from the clarinet to the audience.

……..

……..

……..

…….. [2]

(ii) Calculate how many vibrations the reed makes before the sound reaches the listener at A. The speed of sound in air is 330 m/s.

number of vibrations = ……. [3]

(iii) Another listener at B is further away from the clarinet as shown in Fig. 14.1. She hears a sound of frequency 220 Hz but with a lower amplitude.

Describe, using ideas about the vibration of molecules in air, what is meant by

1. a frequency of 220 Hz,

……

…… [1]

2. a lower amplitude.

……

…… [1]

(b) Line X in Fig. 14.2 represents the position of molecules in the wall of the concert room.

Line Y represents the position of the same molecules at time t as a sound wave passes through the wall.

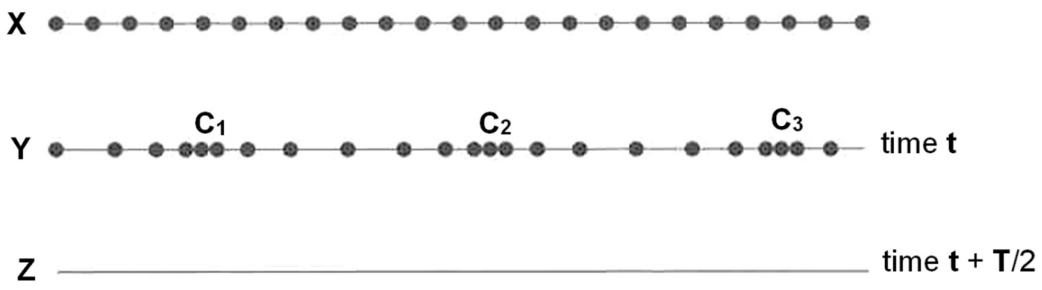

Fig. 14.2

(i) On line **Y** in Fig. 14.2, mark a distance equal to the wavelength of the sound wave. Label it as λ. [1]

(ii) Describe how Fig. 14.2 show that sound is a longitudinal wave.

……..

…….. [1]

(iii) Line **Y** in Fig. 14.2 shows a number of compressions.

The time taken for one complete vibration of a molecule is T.

On line **Z** in Fig. 14.2, mark the new positions of C_1 and C_2 at time t + T/2. [1]

[Total: 10 marks]

15 A thermistor is part of an electrical set-up shown in Fig. 15.1.
The resistance of R1 is 50 Ω.

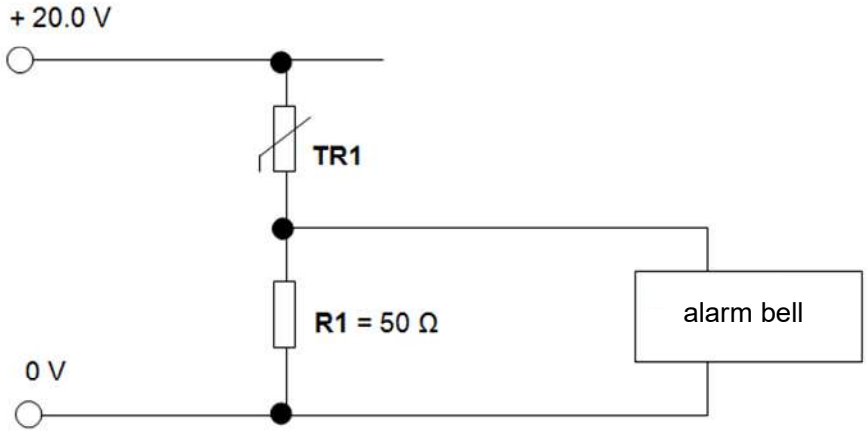

Fig. 15.1

The alarm bell will be activated only when the potential difference across it is 5.0 V and above.
Assume that the alarm bell takes in negligible current.

The characteristic of thermistors TR1 and TR2 are shown in Fig.15.2.

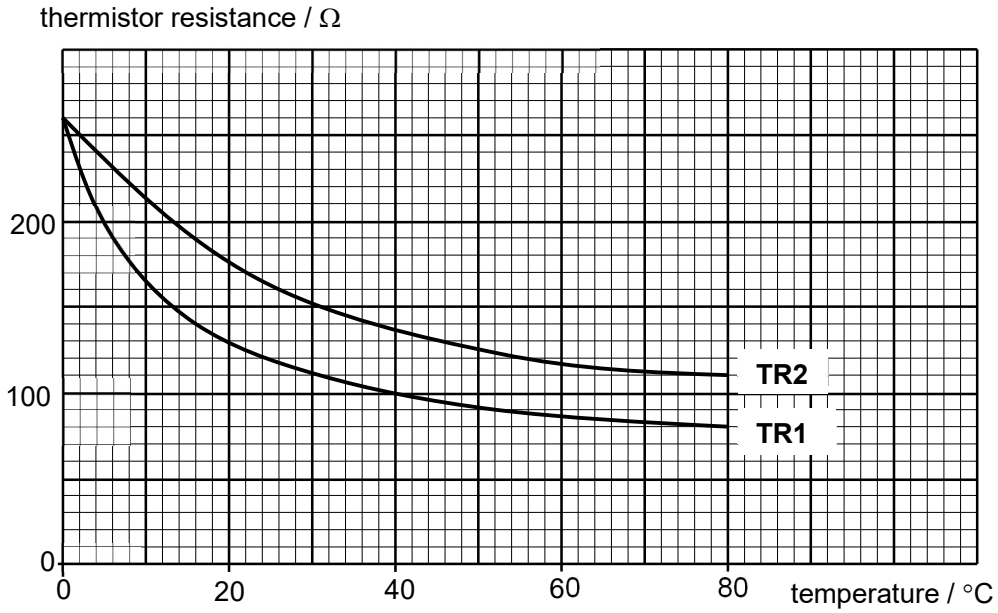

Fig. 15.2

(a) Using Fig. 15.2, describe the relationship between the resistance of the thermistor and temperature.

……

…… [1]

(b) State the resistance of TR1 when the temperature is 45 °C.

resistance of TR1 = ……. [1]

(c) Hence, calculate

(i) the current flowing through TR1 at 45°C,

current flowing through TR1 = ……. [2]

(ii) the potential difference across TR1 at 45°C.

potential difference across TR1 = ……. [2]

(d) Calculate the minimum temperature that will activate the alarm.

minimum temperature = ……. [3]

(e) The characteristics of another thermistor TR2 is shown in Fig.15.2.

With the same operating condition, predict what will happen to the minimum temperature required to activate the alarm if TR1 is replaced by TR2.

……..……..……...

……..……..……... [1]

[Total: 10 marks]

END OF PAPER