Anglican High School
Secondary Four
Preliminary Examination
2024

S4

CANDIDATE NAME

CLASS 4

INDEX NUMBER

PHYSICS
Paper 2 Theory

6091/02
27 Aug 2024
1 hour 45 min

Candidates answer on the Question Paper.

No additional Materials are required.

	Marks
Section A	
Section B	
s.f. error	
Total (80)	

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all your work.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction tape.

Assessment noted by :

_____

Name of Parent/Guardian

_____

Signature of Parent/Guardian

Date : _____

Section A
Answer **all** questions.
Write your answers in the spaces provided.

Section B
Answer **one** question.
Write your answers in the spaces provided.

Candidates are reminded that **all** quantitative answers should be given to appropriate units and rounded off to the appropriate number of significant figures.
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.

This Question Paper consists of **16** printed pages including this cover page.

Section A [70 marks]

Answer **all** questions.

1 Fig. 1.1 shows a cricket ball as it comes into contact with a cricket bat.

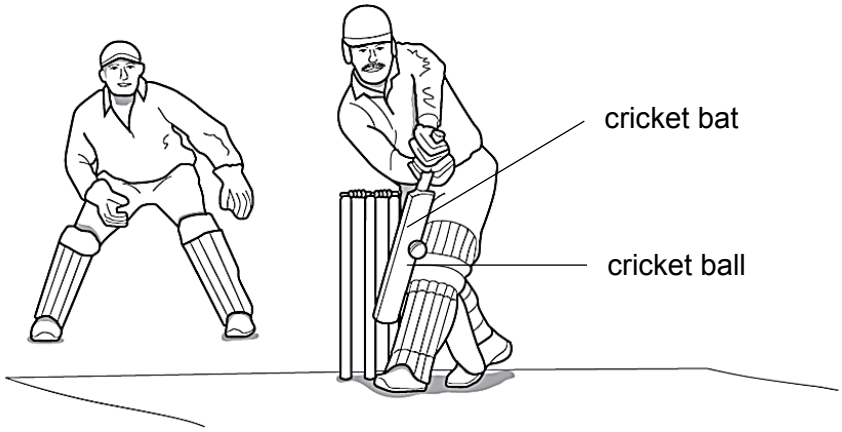

Fig. 1.1

The cricket ball has a mass of 0.16 kg and it hits the bat with a speed of 25 m/s. After being in contact with the bat for 0.0013 s, the ball rebounds with a speed of 22 m/s in the direction exactly opposite to its original direction.

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

……..……...

……..……..…… [1]

(b) Determine

(i) the change in speed of the cricket ball,

change in speed = …….. [1]

(ii) the change in velocity of the cricket ball.

change in velocity = …….. [1]

(c) During the time whilst the ball is in contact with the bat, calculate

(i) the average acceleration of the ball,

average acceleration = …….. [1]

(ii) the average force acting on the ball.

average force = …….. [2]

[Total: 6]

2 Fig. 2.1 shows a gas-filled shock absorber for each of its four wheels of a car.

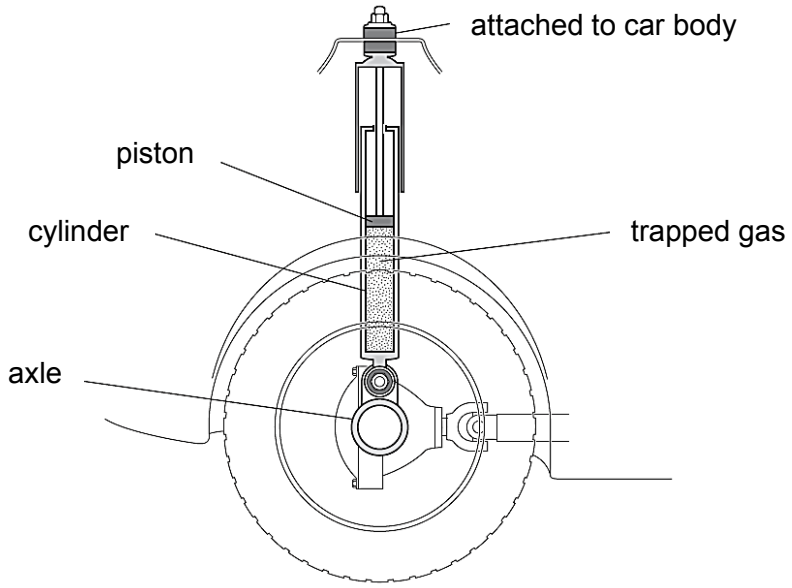

Fig. 2.1

The axles are attached to the cylinders. The body of the car is supported by the four pistons, which can move up and down inside the cylinders. Each piston has a cross-sectional area of 35 cm^2.

(a) A driver of weight 800 N gets into the car.

Calculate the increase in the pressure of the gas in each of the cylinders in SI unit.

pressure increase = ... [2]

(b) Using ideas about molecules, explain how the molecules of the gas inside the cylinder create a pressure.

……

…… [1]

(c) At the end of a long journey, the temperature of the trapped gas in the shock absorbers has increased.

Explain why this increases the pressure of the gas.

……

……

……

…… [2]

[Total: 5]

3 Fig. 3.1 shows the path of a baseball after being hit by a baseball bat at point A, which is 2.0 m above the ground. The highest point reached by the ball is point B, 10 m above the ground. Air resistance has a negligible effect on the motion of the ball.

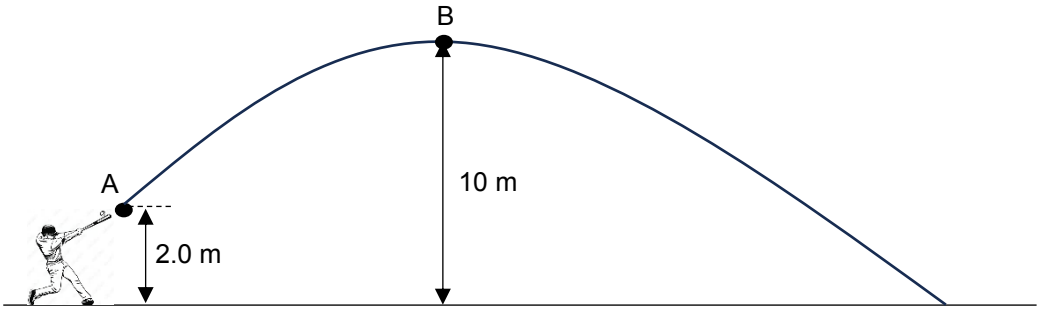

Fig. 3.1

When the bat hits the ball, work is done by the bat.

(a) State what is meant by *work done*.

……

…… [2]

(b) The baseball has a mass of 0.15 kg. The kinetic energy of the ball at B is 170 J.

The gravitational field strength *g* is 10 N / kg.

Calculate

(i) the gain in energy in the gravitational potential store of the ball as it moves from A to B,

gain in energy = …… [2]

(ii) the speed of the ball at A.

speed = …… [2]

(c) State the pathway for the transfer of energy from A to B.

…… [1]

[Total: 7]

4 Fig. 4.1 shows the displacement-distance graph of a sound wave travelling through a wall. Fig. 4.2 shows how the displacement of a wall particle from its equilibrium position varies with time.

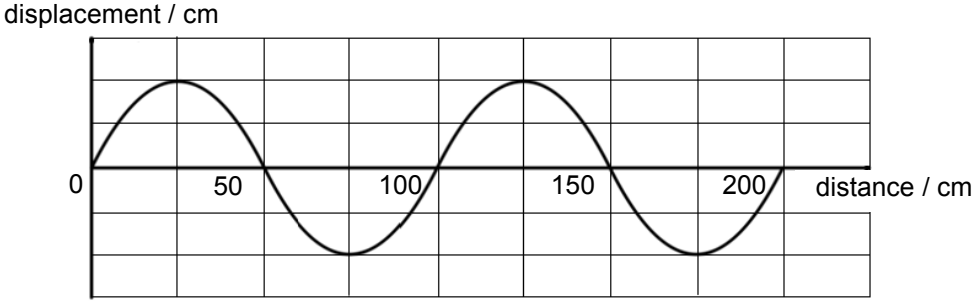

Fig. 4.1

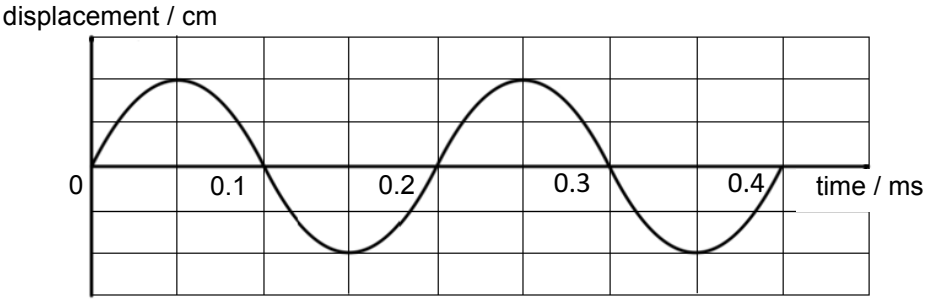

Fig. 4.2

(a) Explain how sound energy is transferred through the wall without transferring matter.

……

……

…… [2]

(b) From Fig. 4.1 and Fig. 4.2, determine

(i) the wavelength of the wave,

wavelength = …….. [1]

(ii) the frequency of the wave,

frequency = …….. [1]

(iii) the speed of the wave.

speed = …….. [1]

(c) The sound's loudness and pitch are now both halved. On Fig. 4.2, sketch another graph to show how the displacement of the particle varies with time from 0 to 0.4 ms. [2]

[Total: 7]

5 **(a)** Fig. 5.1 shows the lens of a simple camera being used to photograph an object.

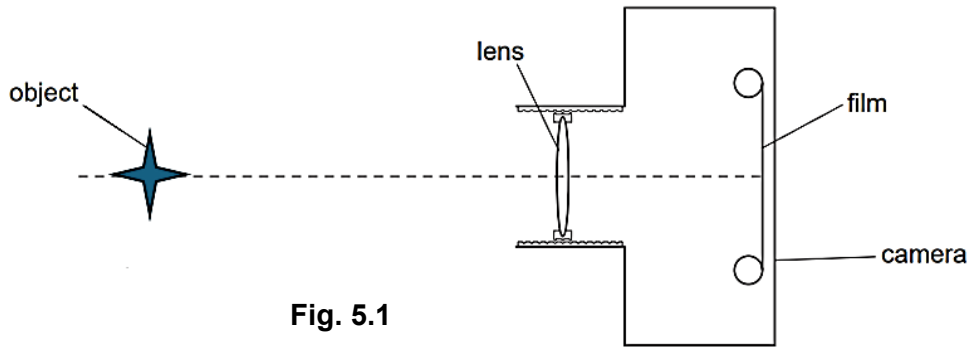

Fig. 5.1

The lens forms a focused image of the object on the film.

(i) Draw two rays from the bottom of the object to show how the lens forms the image. [2]

(ii) The object moves away from the camera. State how the lens is moved to keep the image in focus.

..... [1]

(b) Fig. 5.2 shows part of an optical fibre.

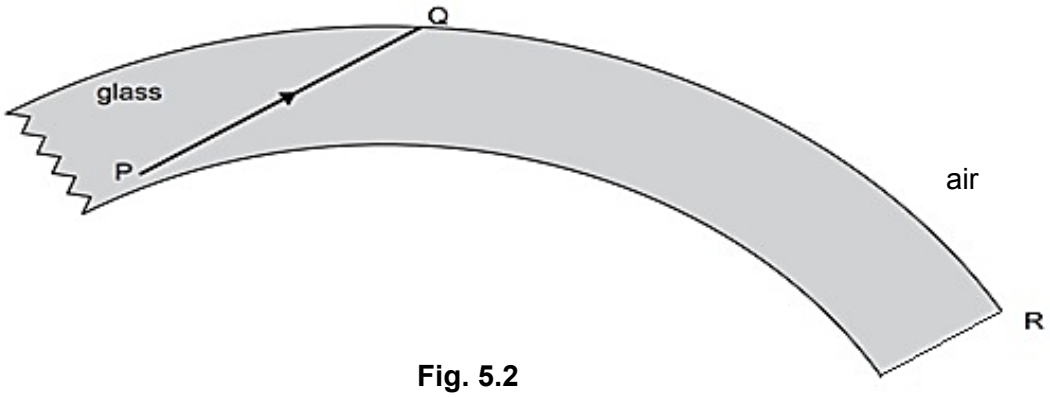

Fig. 5.2

The ray PQ undergoes total internal reflection in the optical fibre.

(i) Explain what is meant by *total internal reflection*.

.....

..... [1]

(ii) On Fig. 5.2, continue the path of ray PQ until it emerges from end R into air. [2]

(iii) If the critical angle for light in glass is 42°, calculate the speed of ray PQ in the glass.

speed = ... [2]

[Total: 8]

6 Fig. 6.1 shows an electrostatic paint spray.

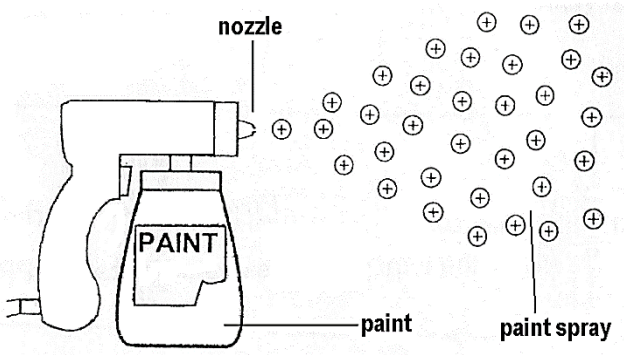

Fig. 6.1

This method is used to apply paint to a grounded metal gate.

(a) Explain why the droplets are attracted to the gate.

……

……

……

…… [2]

(b) State and explain one advantage of this method as compared to the non-electrostatic method.

……

……

……

…… [2]

(c) Explain why this method is not effective for painting non-conductive materials.

……

……

……

…… [2]

[Total: 6]

7 Two identical lamps in a room are connected in parallel to the 240 V mains supply.

(a) On Fig. 7.1, use circuit symbols to draw the two lamps and their switches connected to the 240 V mains supply.

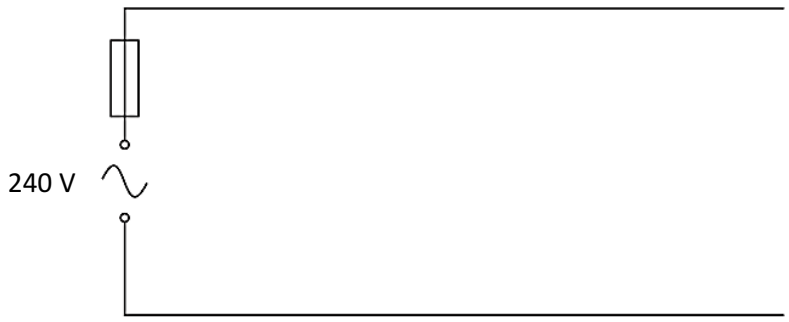

Fig. 7.1 [2]

(b) 1.4 A of current flows in one lamp when it is operating correctly.

(i) Calculate the current from the mains supply when the two lamps are switched on.

current = ... [1]

(ii) State the potential difference across one lamp. Assume that the fuse has negligible resistance.

potential difference = ... [1]

(iii) State a suitable fuse rating for the above circuit.

fuse rating = ... [1]

(c) The house owner wants to use an LDR to control the brightness of the lamps. He connected the LDR in parallel to the lamps. Explain why the LDR cannot control the brightness of the lamps when connected in this way.

……..……..……..

……..…… [1]

[Total: 6]

8 **(a)** Fig. 8.1 shows a simple loudspeaker that uses a coil attached to a paper cone.

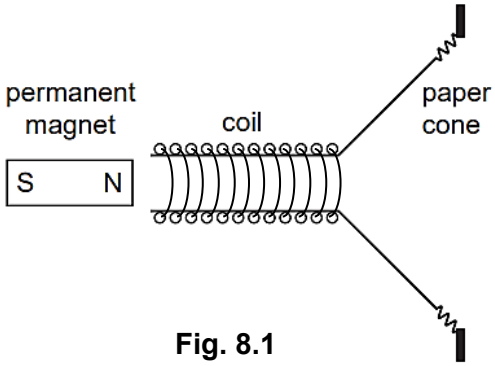

Fig. 8.1

The coil is connected to a signal generator. There is an alternating current in the coil.

Describe and explain the movement of the coil.

……

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……

……

……

……

…… [3]

(b) Fig. 8.2 shows the circuit diagram for the volume control of a loudspeaker.

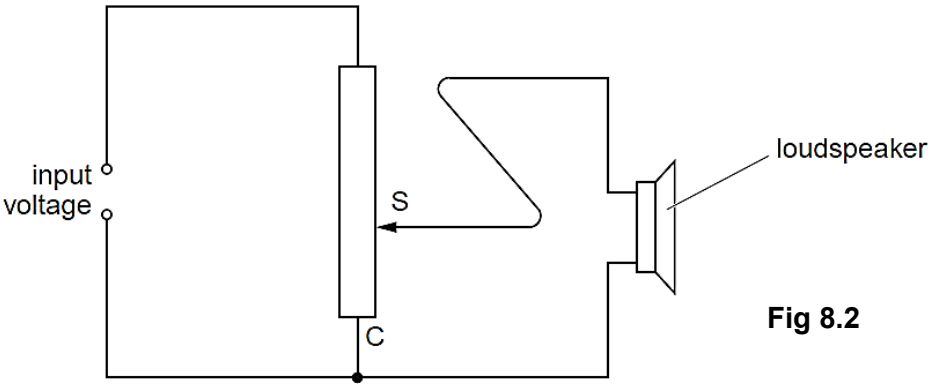

Fig 8.2

The circuit includes a variable potential divider. 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. The sliding contact S is moved towards C. State and explain the effect on the sound produced.

.....

.....

..... [2]

[Total: 5]

9 A student compares the efficiency of two electric water heaters in the kitchen. Each heater consists of a tank to contain the water and an electrical heating element to heat the water.

The two tanks are different, but each tank contains the same amount of water and is heated by the same type of electrical heating element.

Fig. 9.1 shows part of the tank from the heater A that is less efficient, and Fig. 9.2 shows the heater B that is more efficient.

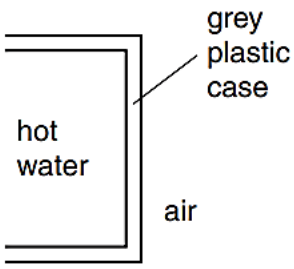

Fig. 9.1 (heater A)

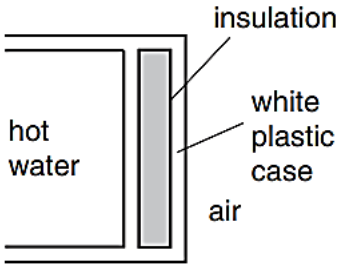

Fig. 9.2 (heater B)

(a) Define *specific heat capacity*.

……

……

…….. [1]

(b) Data about the heaters is given in Table 9.3

Table 9.3

rating of both the electrical heaters: 4.0 kW, 230 V specific heat capacity of water: 4200 J / (kg °C) mass of water in each heater: 20 kg initial temperature of water in each heater: 15 °C efficiency of energy transfer from the electrical heating element: • to water in heater A = 70% • to water in heater B = 90%

(i) Explain two features of heater B that allows it to have higher efficiency than heater A.

……...

……...

……...

……..…… [3]

(ii) Heater B is heated for 15 minutes.

Calculate the increase in energy in the internal store of the water in heater B,

increase in energy = …….. [2]

(iii) Calculate the final temperature of the water in heater B after 15 minutes,

final temperature = …….. [2]

(iv) Electrical heater A is now used to raise the temperature of water to the same temperature in (**biii**). Calculate the input energy supplied by the electrical heater A.

input energy supplied = …….. [2]

[Total: 10]

10 (a) Some atoms that undergo radioactive decay have a half-life of 6 hours. The count rate near a sample of these atoms is initially 838 counts / minute. Background radiation near the sample is 18 counts / minute.

(i) State what is meant by nuclear decay. State clearly which part of the atom decays.

……

……

…… [2]

(ii) State what is meant by background radiation.

……

…… [1]

(iii) The equipment is left undisturbed for 12 hours. Calculate the count rate due to the sample of atoms alone after this time.

count rate = …… [2]

(b) Fig. 10.1 shows a radioactive series. Atom A emits a beta-particle and becomes atom B. Atom B then emits a particle to become atom C.

atom	proton number (atomic number)	nucleon number (mass number)	radiation emitted
A	83	214	beta-particle
B	X	214	Y
C	82	210	none

Fig. 10.1

(i) Calculate the proton number X of atom B and show how you calculated it.

X = …… [2]

(ii) State the name of radiation Y and describe the changes that occur in the atom when this radiation is emitted.

……..

……..

……..… [2]

(iii) Using information from the table, explain why atoms A and C are not isotopes of the same element.

……..… [1]

[Total: 10]

Section B [10 marks]

Answer **one** question from this section.

11 Fig. 11.1 shows the main parts of an electric grill.

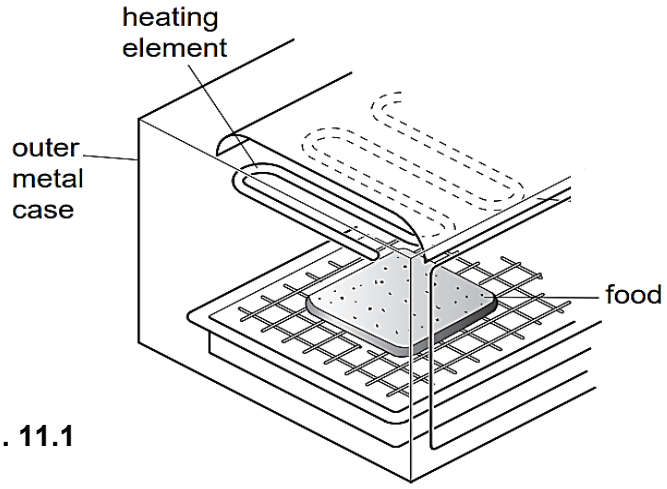

Fig. 11.1

(a) Infra-red radiation is part of the electromagnetic spectrum. In Table 11.2, write the names of the other 3 components of the electromagnetic spectrum that are not ionising radiations in order of increasing wavelength. [2]

Increasing wavelength →

Table 11.2

(b) For safety, the electric grill is fitted with an earth wire. State where the earth wire is connected to the electric grill and explain how it acts as a safety device.

……

……

……

……

……

…… [3]

(c) The current in the heating element is 8.3 A when it is connected to the 230 V mains supply.

(i) Calculate the power of the heating element when it is working correctly.

power = …….. [1]

(ii) It costs \$0.30 for 1 kW h of energy.

Calculate the cost to run the electric grill for 20 minutes.

cost = …….. [2]

(iii) A student thinks that if the heating element is connected to a mains supply of 115 V then the power produced is halved. Explain why the student is wrong.

……..

……..

…….. [2]

[Total: 10]

12 **(a)** State the *principle of moments*.

……

…… [2]

(b) Fig. 12.1 shows two forces acting on a stationary stool. The force *F* keeps the stool balanced. Point P acts as the pivot.

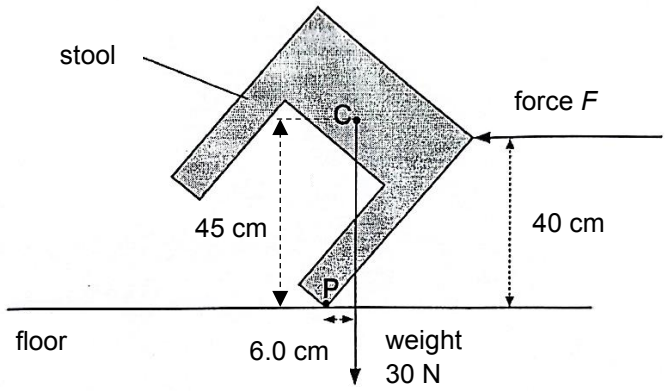

Fig. 12.1

(i) On Fig. 12.1, mark and label another force *N* acting on the stool. [1]

(ii) By taking moments, determine the force *F*.

force = …… [2]

(iii) State the value of the force *N*.

force = …… [1]

(iv) Describe the force *N*.

……

……

…… [2]

(c) Explain why the stool topples if force *F* is removed.

……

……

…… [2]

[Total: 10]