BENENDEN

SIXTH FORM ENTRANCE 2023

PHYSICS

1 hour 30 minutes

Name: _____

School:_____

Date:_____

Instructions to Candidates:
Write all your answers in this booklet.
The number of points available is shown on each question.
Total marks for this paper = 100 points

QUESTIONS

Q1.
Scientific balloons are tested in a laboratory before they are used.

(a) In the first test the pressure of the air inside the balloon is 120 kPa.

The balloon is sealed and has a volume of 92 m^3.
(i) The pressure of the air inside the balloon is reduced to 64 kPa by reducing the external air pressure.
Calculate the new volume of the balloon.

(2)

volume = ... m^3

(ii) Give an assumption that is made in the calculation.

(1)

.....

(b) The pressure of the air in the balloon is returned to 120 kPa.

The temperature of the air inside the balloon is 290 K.
The balloon is tested again, changing the temperature of the air and keeping the volume of the balloon constant.
(i) Explain why the pressure of the air in the balloon decreases when the temperature of the air decreases.

(3)

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(ii) Calculate the temperature of the air when the pressure of the air in the balloon is 64 kPa.
Give your answer in kelvin.

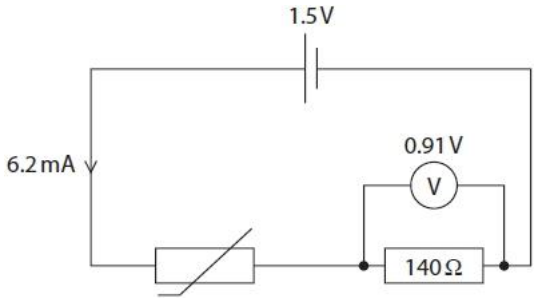
(3)

temperature = ... K

(Total for question = 9 marks)

Q2.

A teacher uses this circuit to investigate how the current in a circuit changes with the temperature of a room.



(a) (i) Calculate the voltage across the thermistor.

(2)

voltage = ... V

(ii) State the formula linking voltage, current and resistance.

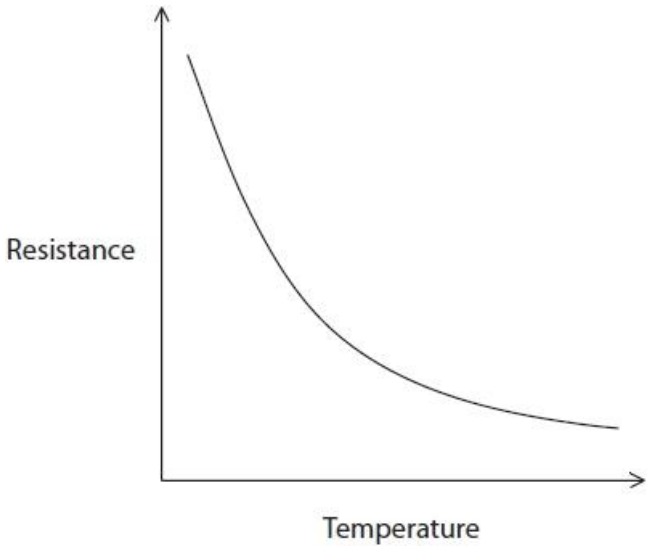
(1)

(iii) Calculate the resistance of the thermistor.

(3)

resistance = ... Ω

(b) The graph shows how the resistance of the thermistor changes with temperature.



(i) Describe the relationship between the temperature and the resistance of the thermistor.

(2)

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(ii) Explain how the reading on the voltmeter changes when the temperature of the room decreases.

(3)

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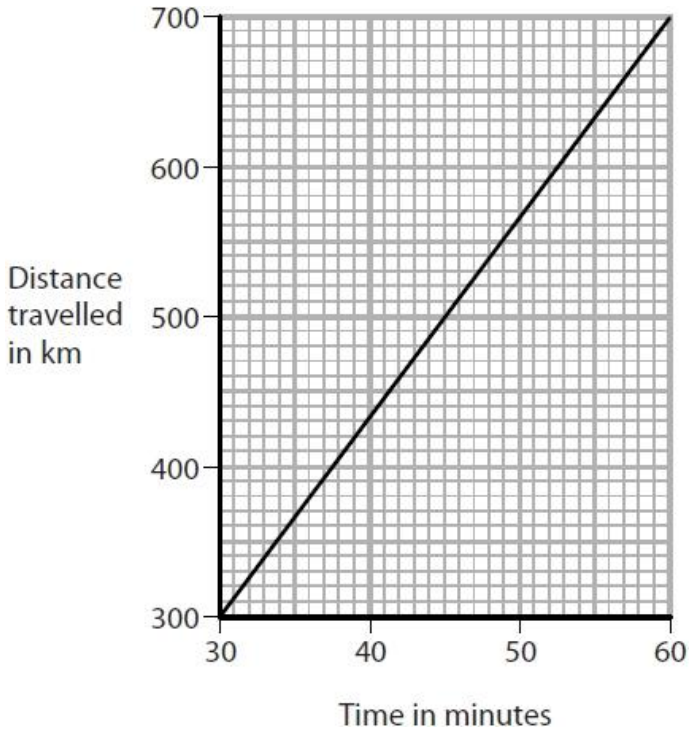
(Total for question = 11 marks)

Q3.

The graph shows how the distance travelled by an aeroplane changes during part of its journey.



(a) (i) State the formula linking average speed, distance moved and time taken.

(1)

(ii) Calculate the average speed of the aeroplane during this part of its journey.
Give a suitable unit.

(4)

average speed = ... unit .....

(b) During the flight, the height of the aeroplane decreases.

As the height of the aeroplane decreases, the temperature outside the aeroplane increases.
Explain how the air pressure outside the aeroplane changes as the height of the aeroplane decreases.

(3)

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(Total for question = 8 marks)

Q4.

X-rays and gamma rays are examples of ionising radiation.

(a) Which of these is another example of ionising radiation?

(1)

- ☒ **A** infrared
- ☒ **B** microwave
- ☒ **C** radio
- ☒ **D** ultraviolet

(b) Give one use of x-rays and one use of gamma rays.

(2)

x-rays

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gamma rays

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(c) (i) State the formula linking speed, frequency and wavelength of a wave.

(1)

(ii) Calculate the wavelength of a gamma ray with a frequency of 2.8×10^{19} Hz.
[speed of gamma ray = 3.0×10^{8} m/s]

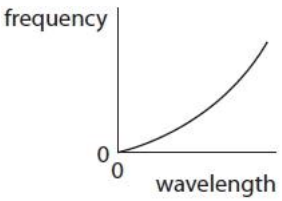
(3)

wavelength = ... m

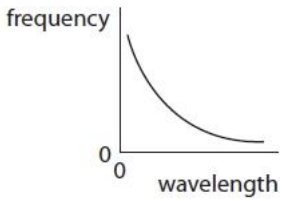
(d) X-rays and gamma rays are electromagnetic waves.

Which of these graphs is correct for waves travelling at a constant speed?

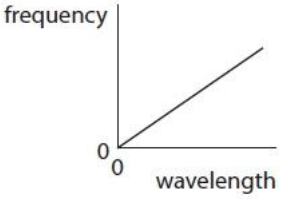
(1)



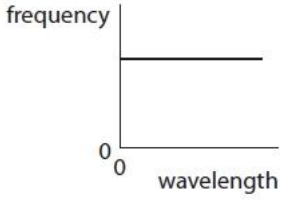
☐ **A**



☐ **B**



☐ **C**



☐ **D**

(Total for question = 8 marks)

Q5.

Sound travels as a wave.

(a) Which of these statements about sound waves is **incorrect**?

(1)

- ☒ **A** they can be reflected
- ☒ **B** they can travel through a vacuum
- ☒ **C** they can be refracted
- ☒ **D** they transfer energy

(b) Sound waves are a type of wave known as longitudinal waves.

(i) Name the other type of wave.

(1)

.....

(ii) Give **one** example of this other type of wave.

(1)

.....

(c) A buzzer produces a sound wave of frequency 2.9 kHz and wavelength 12 cm.

(i) State the equation relating wave speed, frequency and wavelength.

(1)

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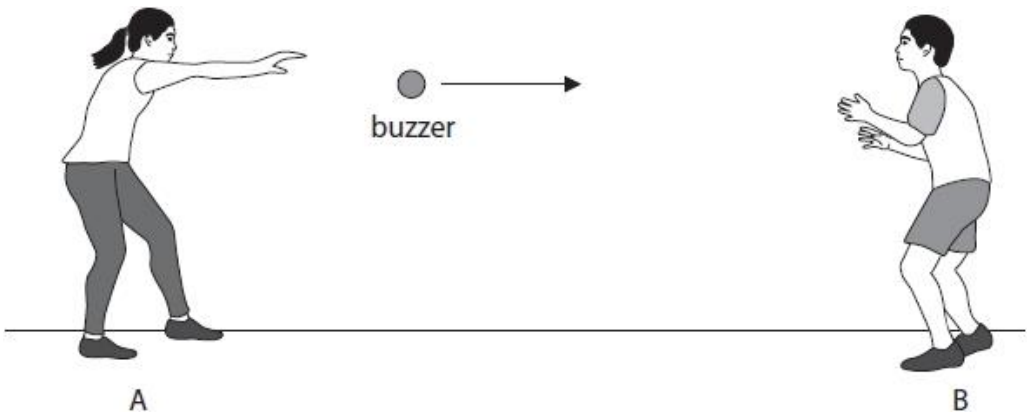
(ii) Calculate the speed of the sound wave.

(3)

speed = ...m/s

(d) Two students investigate the Doppler effect by throwing a buzzer to each other.

Student A throws the buzzer to student B.



When the buzzer is thrown, student A notices that the sound produced changes.
Explain how the sound heard by student A changes.
You may include a diagram in your answer.

(3)

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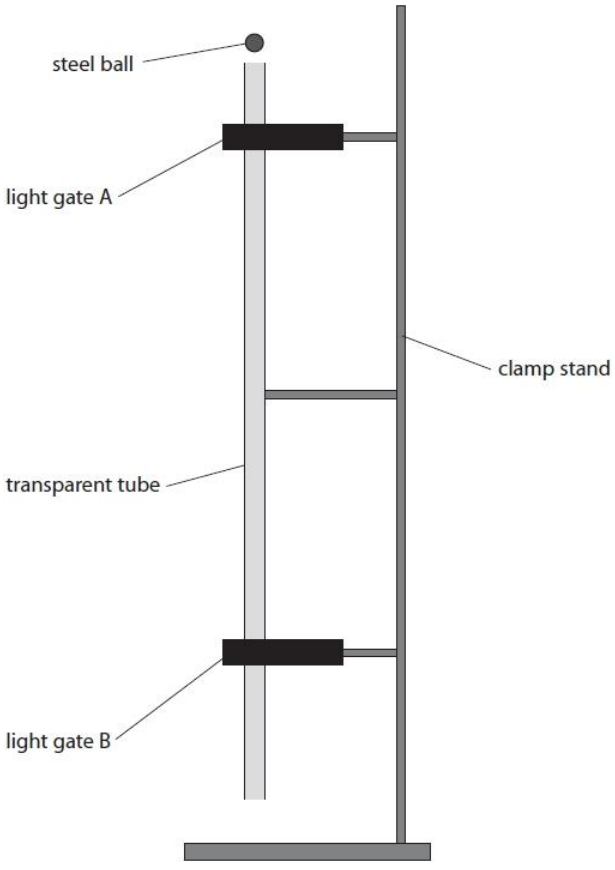
(Total for question = 10 marks)

Q6.

A student does an experiment to determine the acceleration due to gravity, *g*.

The diagram shows the apparatus used.



This is the student's method.

- connect both light gates to a data logger
- drop a steel ball from rest at the top of the transparent tube
- record the speed of the ball at each light gate
- record the time taken for the ball to fall from light gate A to light gate B

(a) The box shows the data recorded by the data logger.

speed at A = 1.45 m/s
speed at B = 4.20 m/s
time from A to B = 0.286 s

(i) Show that the acceleration of the steel ball is approximately 9.6 m/s^2 .

(2)

acceleration = ... m / s^2

(ii) Explain why the student's value for the acceleration of the steel ball is lower than the accepted value for the acceleration due to gravity, *g*.

(2)

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(iii) Calculate the distance between the light gates.

(3)

distance = ... m

(b) The student changes the distance between the light gates by varying the position of light gate B.

The student measures the time taken for the steel ball to fall from light gate A to light gate B when the light gates are different distances apart.
The table shows the student's results.

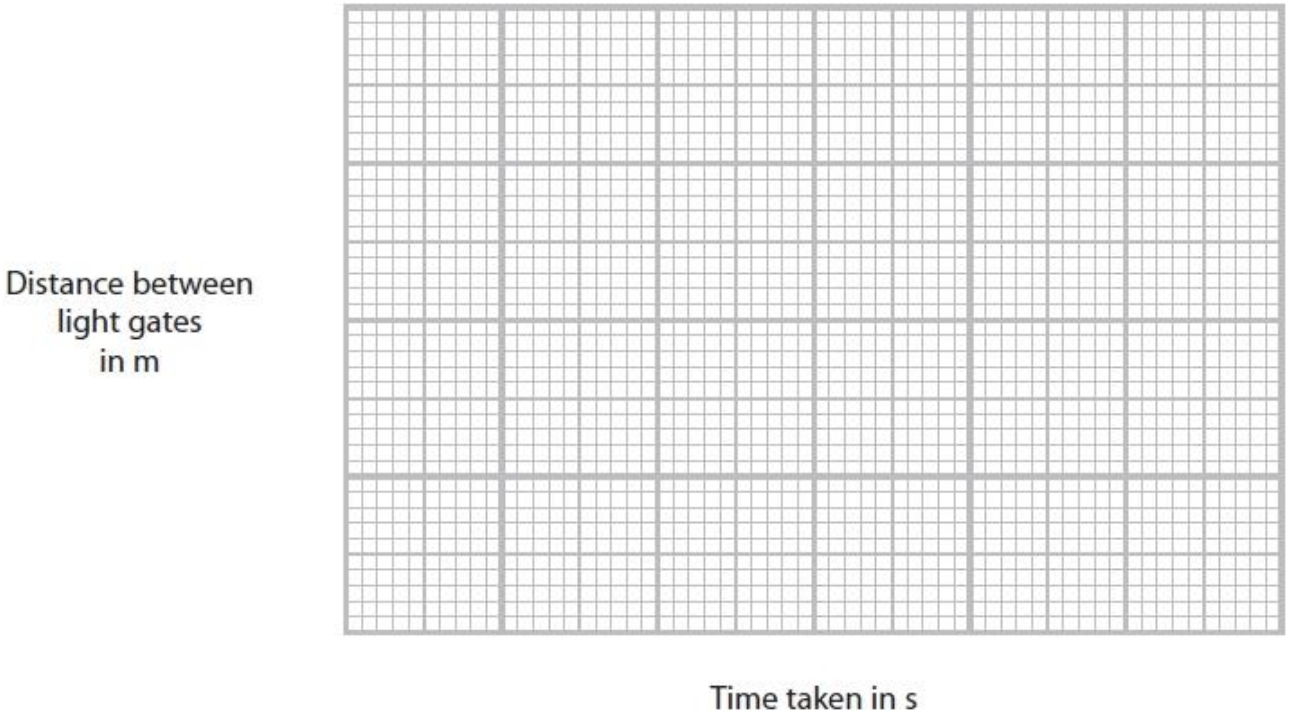
Distance between light gates in m	Time taken in s
0.10	0.058
0.20	0.103
0.30	0.141
0.40	0.175
0.50	0.205
0.60	0.233
0.70	0.260

(i) Plot a graph of the student's results on the grid.

(2)

(ii) Draw the curve of best fit.

(1)



(iii) Explain how the graph shows that the steel ball is accelerating as it falls.

(3)

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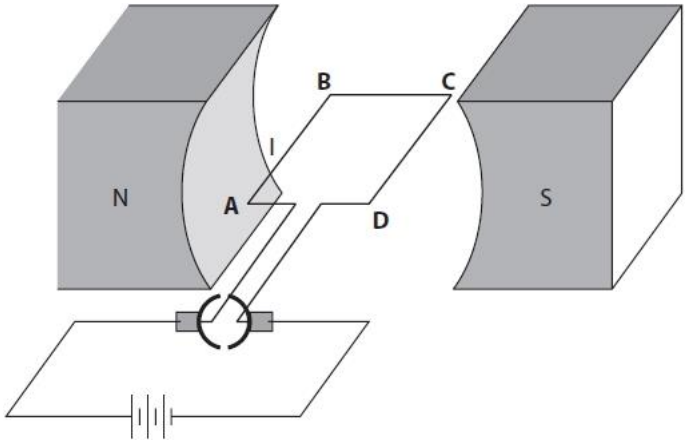
(Total for question = 13 marks)

Q7.

The diagram shows part of an electric motor connected to a battery.

The coil is shown as **ABCD**.
The direction of the current, I, is from **A** to **B**.



(a) Draw an arrow showing the direction of the force on side **CD** of the coil.

(1)

(b) Give **one** change that can be made to the equipment that will make the motor spin in the opposite direction.

(1)

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(c) Give **two** changes that can be made to the equipment that will make the motor spin slower.

(2)

1 .....

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2 .....

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(Total for question = 4 marks)

Q8.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

A student investigates four cars P, Q, R and S.

(a) How is energy transferred usefully from the engine of a car to its wheels?

(1)

- ☐ **A** by heating
- ☐ **B** by radiation
- ☐ **C** electrically
- ☐ **D** mechanically

(b) The engine of a car burns petrol, which transfers energy usefully from the chemical store of the petrol to the kinetic store of the car.
The useful power output of car P's engine is 47 kW.

(i) Calculate the useful energy output of car P's engine during a 15 minute period.

(3)

useful energy output = ... J

(ii) State the formula linking efficiency, useful energy output and total energy output.

(1)

(iii) During the 15 minute period, 2.0×10^8 J of energy is transferred from the chemical store of the petrol.
Calculate the efficiency of car P's engine.

(2)

efficiency = ...

(c) The student extends her investigation by collecting data for cars P, Q, R and S.

She records the useful power output of their engines, their masses and their maximum speeds.
The table shows her data.

Car	Engine useful power output in kW	Mass in kg	Maximum speed in m/s
P	47	721	41
Q	92	1143	51
R	194	915	62
S	198	1226	68

Using information from the table, discuss the relationships between useful power output, mass and maximum speed.

(4)

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(Total for question = 11 marks)

Q9.

A scientist wants to determine the half-life of a radioactive isotope.

The scientist measures the count rate from the radioactive isotope.

(a) State how the scientist should correct the count rate for background radiation.

(1)

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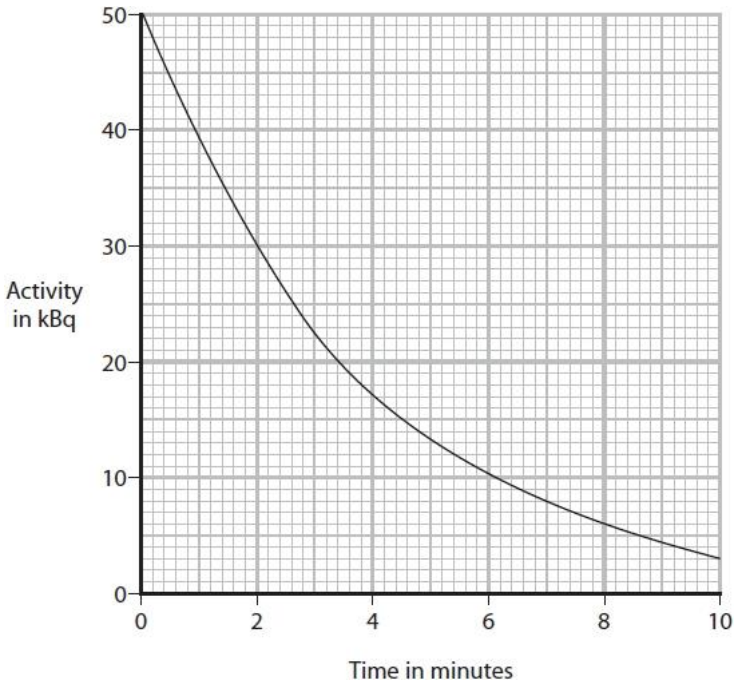
(b) The graph shows how the activity of the radioactive isotope varies with time.



(i) Explain what is meant by the term **half-life**.

(2)

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(ii) Use the graph to determine the half-life of this isotope.

(2)

half-life = ... minutes

(Total for question = 5 marks)

Q10.

(a) Bismuth-207 is a gamma emitter and is represented by the symbol

$$^{207}_{83}Bi$$

How many neutrons are in the nucleus of an atom of bismuth-207?

(1)

- ☒ **A** 83
- ☒ **B** 124
- ☒ **C** 207
- ☒ **D** 290

(b) Which of these gives the best description of gamma radiation?

(1)

- ☒ **A** a helium nucleus
- ☒ **B** a high energy electron
- ☒ **C** a high frequency electromagnetic wave
- ☒ **D** a subatomic particle with mass, but with no charge

(c) A technician uses this method to investigate the penetration power of gamma radiation.

- place a gamma emitting source at a fixed distance from a radiation detector
- measure the count using the detector, for a period of one minute
- place a thin sheet of lead between the source and the detector
- measure the new count using the detector, for a period of one minute
- increase the number of lead sheets between the source and detector and repeat this process

The table gives some of the variables from the technician's method.
Complete the table by placing a tick (Π) in each row to show whether each variable is an independent, a dependent or a control variable.

(3)

Variable	Independent variable	Dependent variable	Control variable
count measured using the detector			
distance between source and detector			
number of lead sheets			
time period for measuring the count			

(Total for question = 5 marks)

Q11.

(a) Which of these objects orbits a planet?

(1)

- ☒ **A** comet
- ☒ **B** dwarf star
- ☒ **C** galaxy
- ☒ **D** moon

(b) What is the correct name for our galaxy?

(1)

- ☒ **A** Crab Nebula
- ☒ **B** Milky Way
- ☒ **C** Solar System
- ☒ **D** Universe

(c) Which of these objects has the largest mass?

(1)

- ☒ **A** artificial satellite
- ☒ **B** comet
- ☒ **C** Earth
- ☒ **D** Sun

(d) Which of these stars is the coolest?

(1)

- ☒ **A** blue star
- ☒ **B** orange star
- ☒ **C** red star
- ☒ **D** yellow star

(Total for question = 4 marks)

Q12.

Diagram 1 shows a ray of violet light entering a prism.

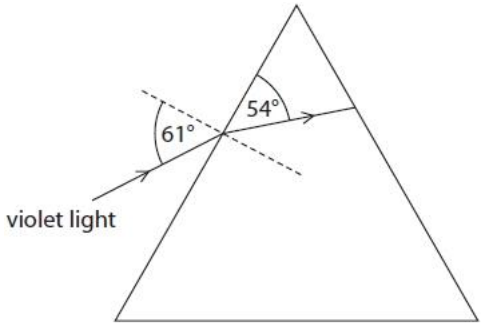

Diagram 1

(a) (i) Calculate the angle of refraction for the violet light.

(1)

angle of refraction = ... degrees

(ii) State the formula linking refractive index, angle of incidence and angle of refraction.

(1)

(iii) Calculate the refractive index of the prism for violet light.
Give your answer to 2 significant figures.

(3)

refractive index = ...

Diagram 2 shows rays of red light and violet light entering the same prism.

Red light has a longer wavelength than violet light.

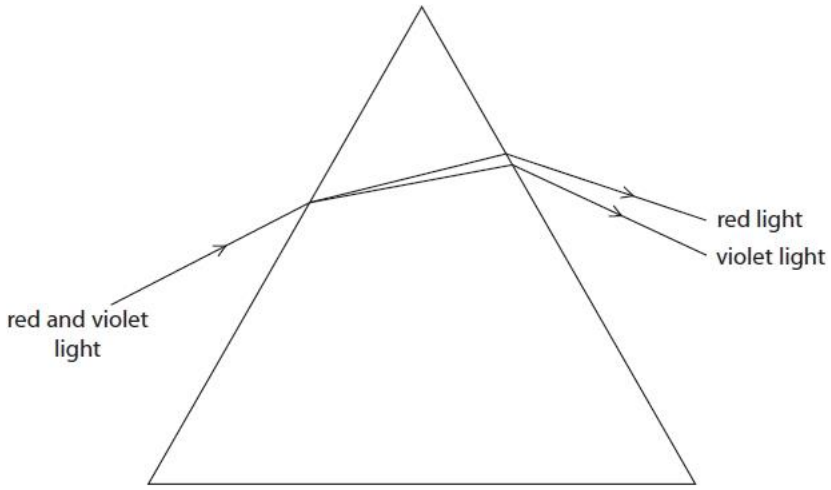

Diagram 2

(b) Deduce a possible relationship between the wavelength and the refractive index for colours of the visible spectrum.

(3)

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(Total for question = 8 marks)

Q13.

This question is about scalar quantities and vector quantities.

(a) Give a similarity and a difference for scalar quantities and vector quantities.

(2)

similarity

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difference

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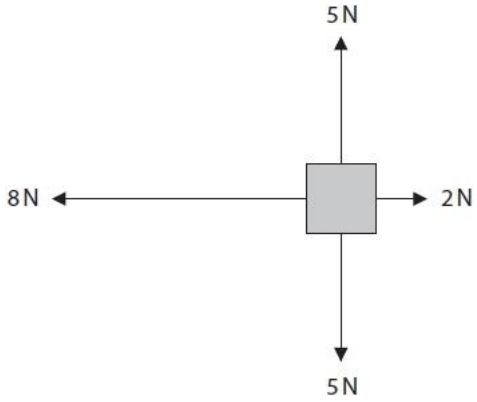
(b) The diagram shows four forces acting on an object.

Calculate the size and direction of the resultant force.

(2)



resultant force = ... N

direction = ...

(Total for question = 4 marks)

END OF TEST

TOTAL 100 MARKS