Index Number:________________ SEC24/1.23s

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

L-Università ta' Malta

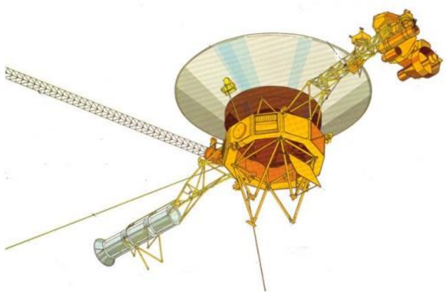
SECONDARY EDUCATION CERTIFICATE LEVEL
2023 SUPPLEMENTARY SESSION

SUBJECT:	**Physics**
PAPER NUMBER:	I
DATE:	29th August 2023
TIME:	9:00 a.m. to 11:05 a.m.

Answer all questions.
You are requested to show your working and to write the units where necessary.
When necessary, take g, acceleration due to gravity, as 10 m/s².

Density	$m = \rho V$		
Pressure	$F = p A$	$p = \rho g h$	
Moments	Moment = F × perpendicular distance		
Energy and Work	$PE = m g h$	$KE = \frac{1}{2} m v^2$	$W = F s$
	Work Done = energy converted		$E = p t$
Force and Motion	$m a$ = unbalanced force	$W = m g$	$v = u + a t$
	average speed = $\frac{\text{total distance}}{\text{total time}}$		$s = (u + v)\frac{t}{2}$
	$v^2 = u^2 + 2 a s$	$s = u t + \frac{1}{2} a t^2$	momentum = $m v$
Waves	$\eta = \frac{\text{speed of light in air}}{\text{speed of light in medium}}$		$v = f\lambda$
	$\eta = \frac{\text{real depth}}{\text{apparent depth}}$	Magnification = $\frac{\text{image distance}}{\text{object distance}}$	
	Magnification = $\frac{\text{image height}}{\text{object height}}$		$T = \frac{1}{f}$
Electricity	$Q = I t$	$V = I R$	$E = Q V$
	$P = I V$	$R \propto \frac{1}{A}$	$E = I V t$
	$R_{total} = R_1 + R_2 + R_3$	$\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2}$	
Electromagnetism	$\frac{V_p}{V_s} = \frac{N_p}{N_s}$	$V_p I_p = V_s I_s$	
Heat	$Q = m c \Delta\theta$		
Radioactivity	$A = Z + N$		
Other equations	Area of a triangle = $\frac{1}{2} b h$	Area of a trapezium = $\frac{1}{2}(a + b) h$	
	Area of a circle = πr^2		

1. Several spacecraft have been launched from Earth and landed on the moon, Venus and Mars. Others have passed by other planets and their moons and sent back useful data about them using electromagnetic waves.



(Source: https://voyager.jpl.nasa.gov)

a. Name the force responsible for keeping planets in orbit around the sun.

____ (1)

b. Would this force increase, decrease or remain the same if:

i. the planet has a smaller mass;

____ (1)

ii. the planet is closer to the sun.

____ (1)

c. Why is Pluto known as a dwarf planet?

____ (1)

d. State the number of major planets in our solar system.

____ (1)

e. The spacecraft Voyager 1 launched in 1977 is speeding away from Earth and is currently at the outer fringes of our solar system at a distance of 2.4×10^{10} km away, making it the most distant man-made object from Earth. It is still making contact with us using electromagnetic waves.

i. Which electromagnetic wave is used for this communication?

____ (1)

ii. How long do these electromagnetic waves, travelling at 3×10^{8} m/s, take to travel from Voyager 1 to Earth?

____

____ (2)

iii. Without making any calculations, state how long electromagnetic waves take to travel a distance of 1 light-year.

____ (1)

f. Name **ONE** benefit obtained from space exploration.

____ (1)

(Total: 10 marks)

10

2. A tennis ball is thrown upwards with an initial velocity of 8 m/s as shown.

a. State the final speed of the ball at its maximum height.

____ (1)

b. State the value of the acceleration of the ball as it moves upward.

____ (1)

c. Hence, calculate the maximum height reached.

____

____ (2)

d. Calculate the time it takes to reach this maximum height.

____

____ (2)

e. The same tennis ball is now dropped from rest from a height of 30 m. It is observed that initially the ball accelerates but then it reaches a constant velocity, with which it continues falling towards the ground.

i. Name the **TWO** forces acting on the ball as it is falling downwards.

____ (2)

ii. State the value of the resultant force acting on the ball when it is falling at constant speed.

____ (1)

f. Why does a ball thrown in space never reaches a constant speed but keeps on accelerating?

____ (1)

(Total: 10 marks)

10

3. In 1998, the first inflatable water walking ball was introduced to the public. A person is enclosed in a plastic ball and the ball is inflated with air. The density of water is 1000 kg/m^3 and density of air is 1.2 kg/m^3.

a. Explain, in terms of particles, how the air inside the ball keeps it inflated.

____

____ (2)

b. Define density.

____

____ (1)

c. Briefly explain, in terms of density, how the ball can float on water.

____

____ (2)

d. If the wall of the inflatable ball is made of thin glass instead of plastic, explain why the ball still floats even though the ball is now heavier.

____

____ (2)

e. The safety instructions on the ball state that the ball may burst if left in extreme hot temperatures. Explain in terms of particles.

____

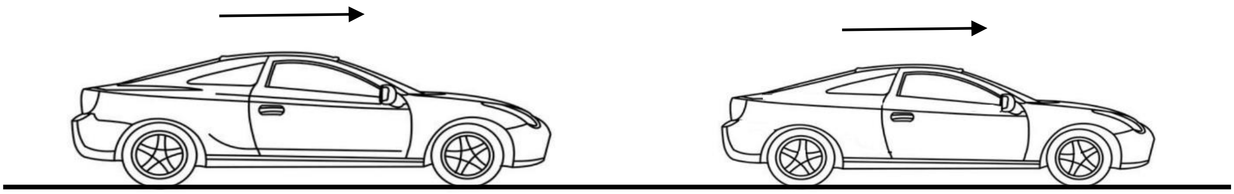
____

____ (3)

(Total: 10 marks)

10

4. Two cars are travelling in the same direction. Car A of mass 1600 kg skids into the back of car B, of mass 1200 kg. After impact, the cars keep moving together in the same direction with a common velocity of 14 m/s.



Car A **Car B**

a. State the law of conservation of momentum.

____

____(2)

b. Calculate the momentum of the cars after impact.

____

____(2)

c. Car A was moving at 22 m/s before impact. Calculate the initial velocity of Car B before impact.

____

____

____(3)

d. The driver's air bag in car A inflates on impact but that in car B doesn't.

i. Which driver will feel the larger force?

____(1)

ii. Explain your answer in terms of time of impact.

____

____(1)

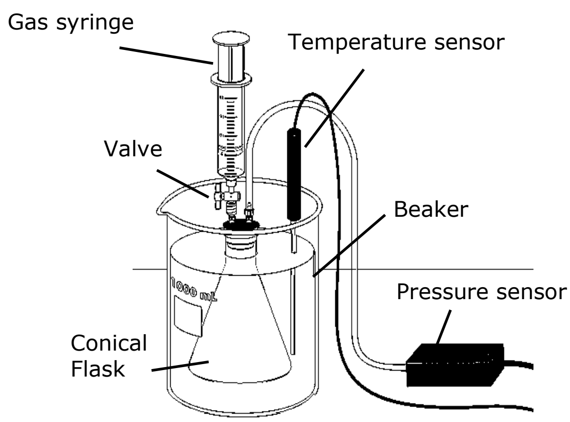
iii. Name the law used to justify your answer in part (ii).

____(1)

(Total: 10 marks)

10

5. During an investigation, a fixed mass of gas was enclosed in a conical flask which was then submerged under 1 kg of water within a large beaker. The conical flask is connected to a pressure sensor and to a gas syringe (through a valve which can be opened and closed). The temperature of the water in the beaker can be recorded with the temperature sensor. The valve was closed. An electric water immersion heater was placed in the beaker and turned on. The temperature and pressure were recorded simultaneously at each increase of 1 °C interval. The values were tabulated below.



Temperature (°C)	17	18	19	20	21	22	23	24
Pressure (kPa)	98	99	101	102	104	105	107	108

a. Plot a graph of Pressure (kPa) on y-axis against Temperature (°C) on x-axis. (4)

b. Calculate the gradient of the graph.

____

____(2)

c. If the power of the electric water immersion heater is 145 W, calculate the time required to transfer 30885 J of energy from the heater to the water to raise its temperature from 17 °C to 24 °C.

____

____(2)

d. Hence or otherwise, calculate the specific heat capacity of the water.

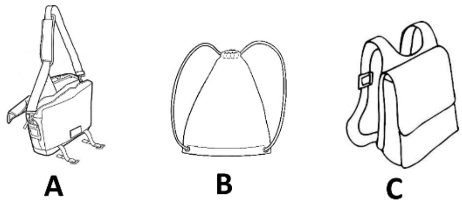
____

____(2)

(Total: 10 marks)

10

6. The school management team were reviewing different school bags to decide which is the best bag for their students. The aim was to find a school bag which exerts the least amount of pressure on the students.



a. Define pressure.

____(1)

b. Assume all three bags have the same mass and are filled with identical books. Briefly explain which bag will exert the least amount of pressure on the students.

____

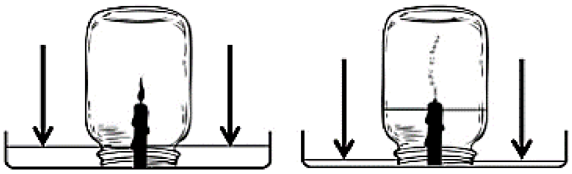
____(2)

c. Once a bag is chosen, it is still recommended that students carry the least amount of books as possible. Briefly explain why changing the mass of the bag will affect the pressure exerted by the bag on the students.

____

____(2)

The students are given a demonstration in class where a candle is placed in a shallow container with water. An empty glass container is inverted on the candle. Once the lit candle is enclosed by the glass container, the candle is extinguished after some time and the water level within the inverted glass container is observed to rise.



d. What do the arrows in the diagram represent?

____(1)

e. While the candle is burning, the pressure inside the glass container decreases. Briefly explain why the water level rises.

____

____(2)

f. The air trapped in the inverted glass container is then used to investigate the properties of a gas. Explain how would the level of the water inside the glass container be affected if the fixed mass of gas inside the inverted container:

   i. is heated;

____(1)

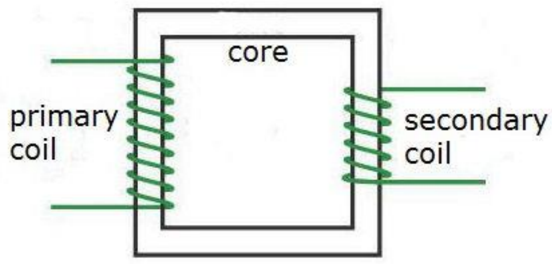
   ii. is placed in a smaller inverted glass container.

____(1)

(Total: 10 marks)

10

7. The diagram shows a transformer used in welding. Welding is a process which requires a large current in order to heat and melt metal. When operating normally from a 230 V a.c. supply, this particular transformer supplies an output of 25 V.



a. Is this a step-up or step-down transformer?

____ (1)

b. Explain why an a.c. and not a steady d.c. supply is needed in a transformer.

____

____(2)

c. During a particular welding operation, a current of 200 A is taken from the 25 V output. Assuming the transformer to be ideal, calculate the current taken from the 230 V a.c. supply by the transformer during this operation.

____

____

____(3)

d. Hence, which of the two transformer coils would you expect to be made of thinner wire? Explain.

____

____(2)

e. One source of energy loss in a transformer is heat in the core. To reduce this, the core is not solid but made of thin separate strips held together. What is such a core construction called and explain how it helps to reduce energy loss.

____

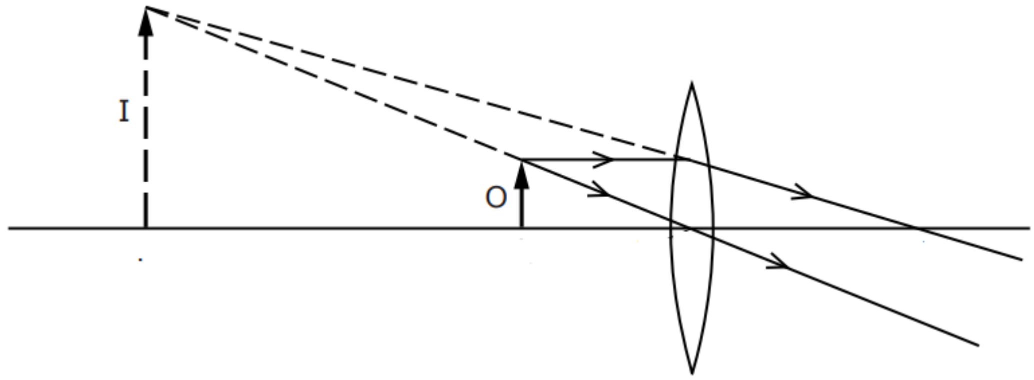
____(2)

(Total: 10 marks)

10

8. Converging lenses have many uses and applications.

a. The figure represents an object O placed in front of a converging lens.



i. State **THREE** properties of the image I.

____

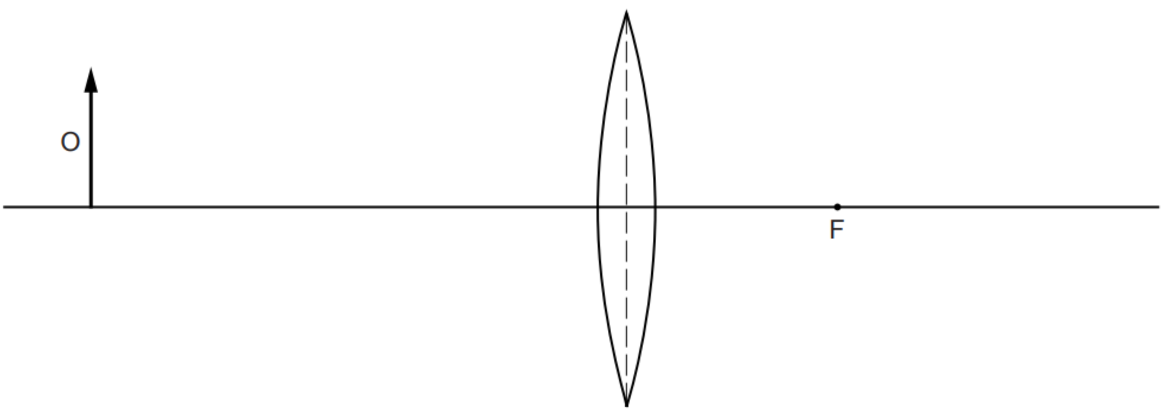
____

____ (3)

ii. On the diagram mark the focal length, f, of the converging lens. (1)

iii. Draw an eye placed such that the image I can be viewed. (1)

b. The figure below shows an object O in front of a converging lens.



i. Draw **TWO** rays to locate the image and mark the image with an I. (3)

ii. Calculate the magnification of the image.

____

____ (2)

(Total: 10 marks)

10

9. Mariella is supplied with the following apparatus: A d.c. power supply, a voltmeter, an ammeter, a variable resistor, a switch, a fixed resistor, and some connecting wires.

a. Draw a circuit diagram to show the set-up that she should use to obtain an average value for the resistance of a fixed resistor. (2)

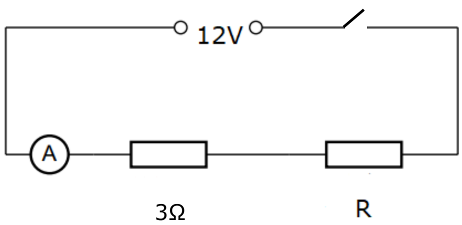
b. Explain how she can use the circuit to obtain an average value for the resistance of the fixed resistor.

____

____

____(3)

c. She then assembles the circuit below.



i. When the circuit is switched on the ammeter reads 1.0 A. Calculate the resistance of resistor R.

____

____(2)

ii. Calculate the total resistance if resistor R was connected in parallel instead of in series.

____

____(2)

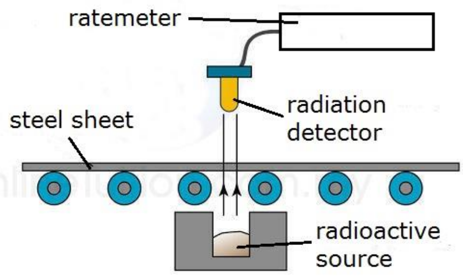
iii. Hence calculate the total current in the circuit with the resistors connected in parallel.

____(1)

(Total: 10 marks)

10

10. The diagram shows the set-up of one type of apparatus using a radioactive source and used in industry to determine whether steel sheet being manufactured is of uniform thickness or not. The sheet passes over rollers between a gamma emitting radioactive source placed beneath it and a radiation detector placed above it as shown.



(Source: http://spmphysics.onlinetuition.com)

a. Name **ONE** radiation detector which may be used here.

____ (1)

b. Radiation from the source passes through the steel sheet and reaches the detector. Would you expect the ratemeter readings of the count rate to increase, decrease of remain the same, if the sheet thickness:

i. remains uniform;

____ (1)

ii. decreases;

____ (1)

iii. increases.

____ (1)

c. Explain what would happen if an alpha or beta source are used instead of gamma.

____

____ (2)

d. State **ONE** suitable safety precaution for workers in the room when using a gamma emitter.

____ (1)

e. The physicist in charge of this set-up had two options of radioactive source to use: one having a half-life of 3 days and the other of 3 years. Explain, giving a reason, which one would be more suitable here.

____

____ (2)

f. Write down, in order of increasing ionising ability (starting from the least ionising), the three radiations alpha, beta and gamma.

____ (1)

(Total: 10 marks)

10

L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

SECONDARY EDUCATION CERTIFICATE LEVEL
2023 SUPPLEMENTARY SESSION

SUBJECT:	**Physics**
PAPER NUMBER:	IIB
DATE:	29th August 2023
TIME:	4:00 p.m. to 6:05 p.m.

Answer all questions.
You are requested to show your working and to write the units where necessary.
When necessary, take g, acceleration due to gravity, as $10 m/s^2$.

Density	$m = \rho V$		
Pressure	$F = p A$	$p = \rho g h$	
Moments	Moment = F × perpendicular distance		
Energy and Work	$PE = m g h$	$KE = \frac{1}{2} m v^2$	$W = F s$
	Work Done=energy converted		$E = p t$
Force and Motion	$m a$ = unbalanced force	$W = m g$	$v = u + a t$
	average speed $= \frac{\text{total distance}}{\text{total time}}$		$s = (u + v)\frac{t}{2}$
	$v^2 = u^2 + 2 a s$	$s = u t + \frac{1}{2} a t^2$	momentum $= m v$
Waves	$\eta = \frac{\text{speed of light in air}}{\text{speed of light in medium}}$		$v = f\lambda$
	$\eta = \frac{\text{real depth}}{\text{apparent depth}}$	Magnification $= \frac{\text{image distance}}{\text{object distance}}$	
	Magnification $= \frac{\text{image height}}{\text{object height}}$		$T = \frac{1}{f}$
Electricity	$Q = I t$	$V = I R$	$E = Q V$
	$P = I V$	$R \propto \frac{1}{A}$	$E = I V t$
	$R_{total} = R_1 + R_2 + R_3$	$\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2}$	
Electromagnetism	$\frac{V_p}{V_s} = \frac{N_p}{N_s}$	$V_p I_p = V_s I_s$	
Heat	$Q = m c \Delta\theta$		
Radioactivity	$A = Z + N$		
Other equations	Area of a triangle $= \frac{1}{2} b h$	Area of a trapezium $= \frac{1}{2} (a + b) h$	
	Area of a circle $= \pi r^2$		

1. This question is about power.

a. A student is late for a lesson and runs up the stairs to reach the classroom in a shorter time.

i. Is the work done when running up the stairs smaller than, equal to, or larger than the work done when walking up the same flight of stairs?

____(1)

ii. Explain your answer.

____

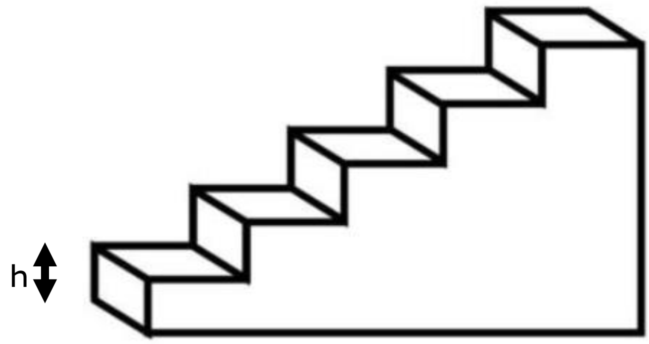
____(2)

iii. Explain the difference, if any, in the power developed by the student when walking and running up the stairs.

____

____(2)

b. The student wants to calculate the work done to climb a flight of stairs consisting of 15 steps, each having approximately the same height, h. The apparatus provided consists of a metre ruler and a weighing scale.



i. Describe in detail how an accurate value of the total height climbed can be obtained.

____

____

____(2)

ii. Explain in detail how the force done by the student can be calculated.

____

____

____(2)

iii. State how the work done can be calculated.

____(1)

c. The student now wants to investigate the difference, if any, in the power developed when walking or running up this flight of stairs. A stopwatch is now added to the apparatus.
   i. Explain in detail how the power developed can be calculated in both cases.

____

____(2)

   ii. State **ONE** main source of error in this experiment.

____(1)

d. The average height of one step was found to be 0.19 m, and the flight of stairs contained 15 steps.
   i. Calculate the total vertical height climbed by the student.

____(1)

   ii. Calculate the weight of the student if the mass recorded was 65 kg.

____(1)

   iii. Hence calculate the work done when climbing the whole flight of stairs.

____

____(2)

   iv. Calculate the power developed when the stairs are climbed in 18 s.

____

____(2)

   v. Explain whether the power developed will change if, the student will now climb the same flight of stairs in 18 s carrying a also backpack.

____(1)

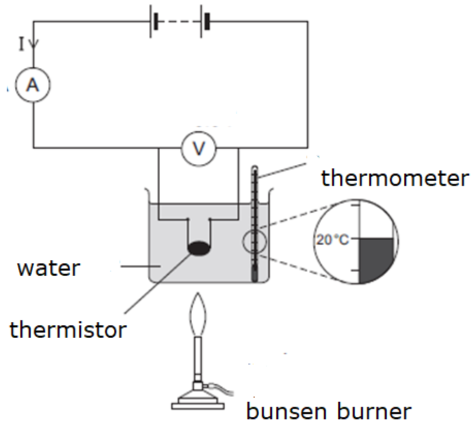
(Total: 20 marks)

Please turn the page.

20

2. This question is about heat.

a. Trevor wants to calculate the resistance of a thermistor at different temperatures. He uses the apparatus below.



i. In the space below, draw the circuit symbol for the thermistor. (1)

ii. At 20 °C, the voltmeter reads 9 V while the ammeter reads 0.025 A. Using this data, calculate the resistance of the thermistor at 20 °C.

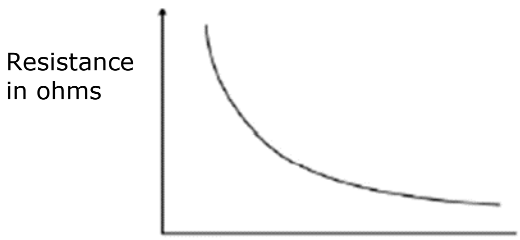
____

____ (2)

iii. The ammeter used in the circuit has very low resistance. Explain why this is important.

____ (1)

iv. Trevor obtained the graph shown for resistance and temperature for the thermistor. Explain the relationship between resistance and temperature for this thermistor.



____

____ (2)

v. Explain whether the thermistor can be considered as an ohmic conductor.

____

____(2)

vi. Give a reason why the thermometer should **not** be placed directly above the Bunsen burner.

____(1)

vii. Suggest **ONE** way how Trevor can take readings of resistance at a lower temperature.

____

____(2)

vii. Tick the circuit/s which include a thermistor. (2)

Circuit	Tick (√) if thermistor is included
Automatic circuit to switch a plant watering system on and off.	
Automatic circuit to switch on a fire alarm.	
Automatic circuit to switch an outside light on when it is dark.	
Automatic circuit to switch a heating system on and off	

b. Trevor plans to investigate how the resistance of an LDR varies with light intensity.

i. What do the letters LDR stand for?

____(1)

ii. In the space provided, draw the circuit symbol for the LDR. (1)

iii. Describe **THREE** changes which Trevor must make to the apparatus in part (a).

____

____

____(3)

iv. Give **TWO** examples where the LDR is used.

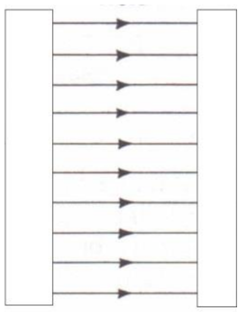
____

____(2)

(Total: 20 marks)

20

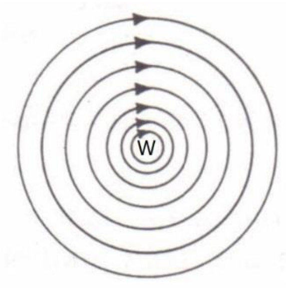
3. This question is about magnetism.



a. The figure shows the magnetic field between two magnetic poles of a magnet.
   i. Label on the diagram the north [N] and south [S] poles. (1)

   ii. How can you tell that the field strength between the poles is uniform?

____(1)



b. The figure shows the magnetic field around a current carrying conductor placed at W.
   i. State whether the direction of the current is into or out of the paper and name the rule you used to decide this.

____

____ (2)

   ii. When the current carrying conductor is put in the magnetic field as shown in part(a), it experiences a force. State the direction of this force and name the rule you used to decide this.

____

____(2)

   iii. State **TWO** ways by which the force mentioned in part b(ii) may be increased.

____

____(2)

   iv. What would happen if the conductor is turned so that the current is now parallel to the field between the magnet poles?

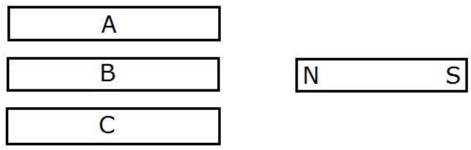
____(1)

   v. The effect in part b(ii) above is sometimes known as the motor effect. Name **ONE** application which works on this effect and state the main energy change taking place here.

____

____(2)

c. A student was given a task by her teacher. She was given three bars A, B and C, and a known bar magnet as shown. She was told that one of the three bars was made of a non-magnetic material, the second was a permanent magnet while the third was made of an unmagnetised magnetic material (in no particular order).



i. Suggest a material which could be used for each of the three bars:

Non-magnetic material ____ (1)

Permanent magnet ____ (1)

Unmagnetised magnetic material ____ (1)

ii. She was asked to identify each of the three bars A, B and C. The method she employed was to bring the north pole of the known bar magnet near each of the three bars in turn and observe the result when the magnet is placed close to one end and then close to the other end of each bar. She tabulated the results and obtained the following table showing what she observed.

Bar	N pole brought close to one end of bar	N pole brought close to the other end of bar
A	attraction	repulsion
B	no effect	no effect
C	attraction	attraction

Identify whether bars A, B and C are non-magnetic, magnetic or unmagnetised, giving a reason for your choice.

A ____

____ (2)

B ____

____ (2)

C ____

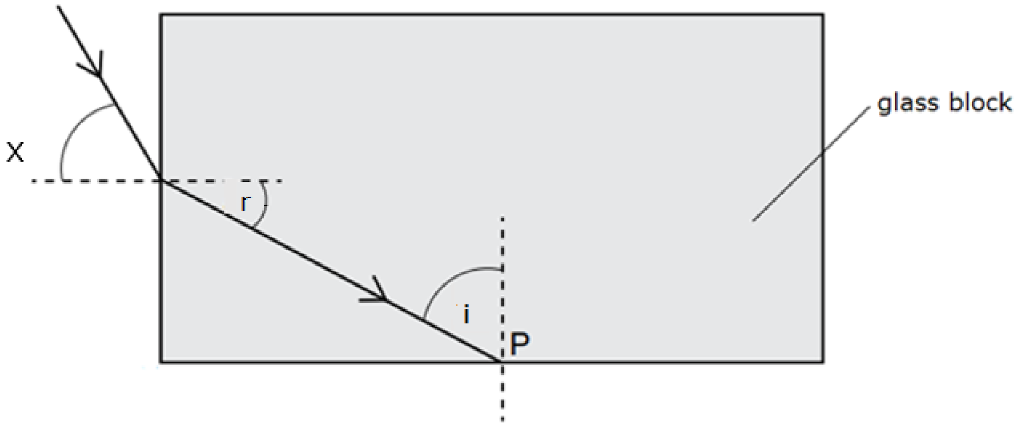
____ (2)

(Total: 20 marks)

20

4. This question is about light.

a. The figure shows a ray of light incident on one side of a rectangular glass block.



i. Circle the correct word.

A light wave is a (longitudinal, transverse) wave. It is also described as being (radioactive, electromagnetic). When a light wave passes from air into glass the speed of the wave (increases, decreases). This is because glass is (less dense, more dense) than air. (4)

ii. Name the angle marked as X.

____(1)

iii. Continue the path of the ray incident at P to show how it emerges into air. (2)

iv. The glass block is made from flint glass which has a refractive index of 1.6. Calculate the speed of light in glass if the speed of light in air is 3×10^8 m/s.

____

____(2)

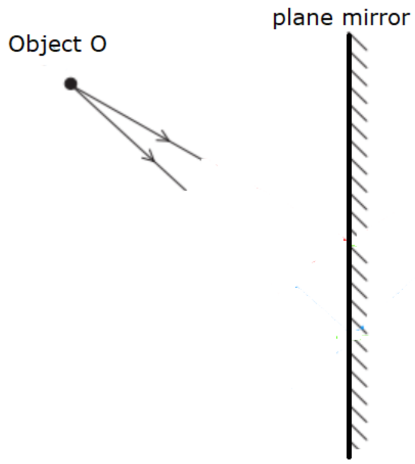
v. Name the phenomenon occurring if light is incident at an angle greater than the critical angle.

____(1)

vi. Optical fibres make use of the phenomenon mentioned in part a(v). State **ONE** advantage of using optical fibres rather than wires to transmit data.

____(1)

b. The figure below shows an object, O in front of a plane mirror.



i. Complete the rays from object O to show how the image is formed by a plane mirror. Mark the image with the letter I. Mark also the angle of incidence and the angle of reflection. (3)

ii. State the relationship between the angle of incidence and the angle of reflection.

____(1)

iii. One characteristic of the image formed by the mirror is that it is virtual. Explain what is meant by a virtual image.

____

____(2)

iv. State **THREE** other characteristics of an image formed by a plane mirror.

____

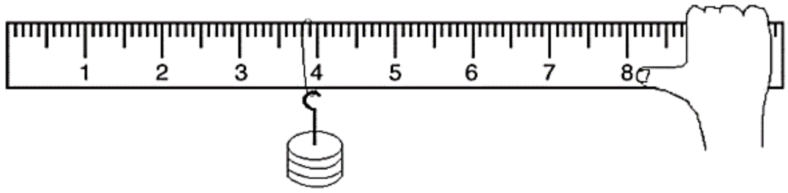
____(3)

(Total: 20 marks)

20

5. This question is about moments.

A long ruler is held from one of its ends as shown in the diagram. A small load was hung using a string, and was placed along the ruler.



a. Circle the correct term.

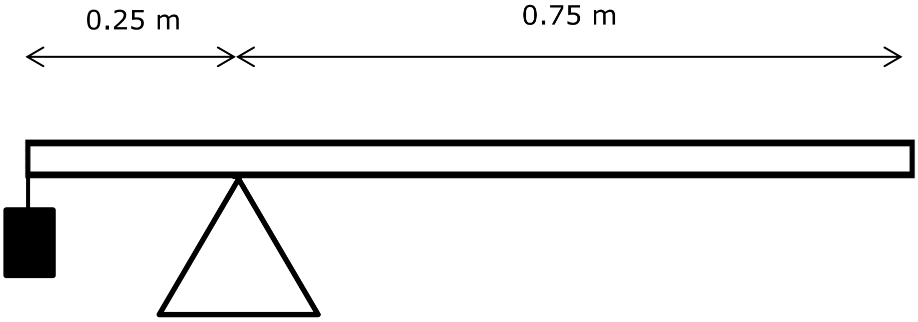
The load is moved away from the hand. The turning effect (increases, decreases, stays the same).

The load is then kept in the same position, but more masses are added. The turning effect (increases, decreases, stays the same). (2)

b. Fill in the blanks.

In equilibrium, the total ______________________ moment would be ______________________ to the total ______________________ moment. (3)

A uniform rod is placed on a pivot and a box of mass 500 g is hanging from one of its sides as shown in the diagram. The rod is in equilibrium.



c. Calculate the moment produced by the box.

____

____ (2)

d. In terms of moment, explain briefly how the rod is in equilibrium, despite there is only one box placed on one of the sides of the pivot.

____

____ (2)

e. On the diagram, draw **TWO** arrows to identify the clockwise and the anti-clockwise moments about the pivot. Label as CM and ACM respectively. (2)

f. Calculate the mass of the uniform rod.

____

____ (2)

g. Another object of mass 200 g was added on the uniform rod, at 0.35 m from the pivot. Calculate the increase in mass of the box to keep the rod in equilibrium.

____

____

____ (3)

h. Explain why the uniform rod remains in equilibrium when an object is added exactly on the pivot.

____

____

____ (2)

i. The rod used in this setup was uniform. Explain whether the same behaviour will be observed if a non-uniform rod of the same length is used.

____

____

____ (2)

(Total: 20 marks)

20

Blank Page