Index Number:_____ SEC24/1.23m

L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

SECONDARY EDUCATION CERTIFICATE LEVEL
2023 MAIN SESSION

SUBJECT:	**Physics**
PAPER NUMBER:	I
DATE:	20th May 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		

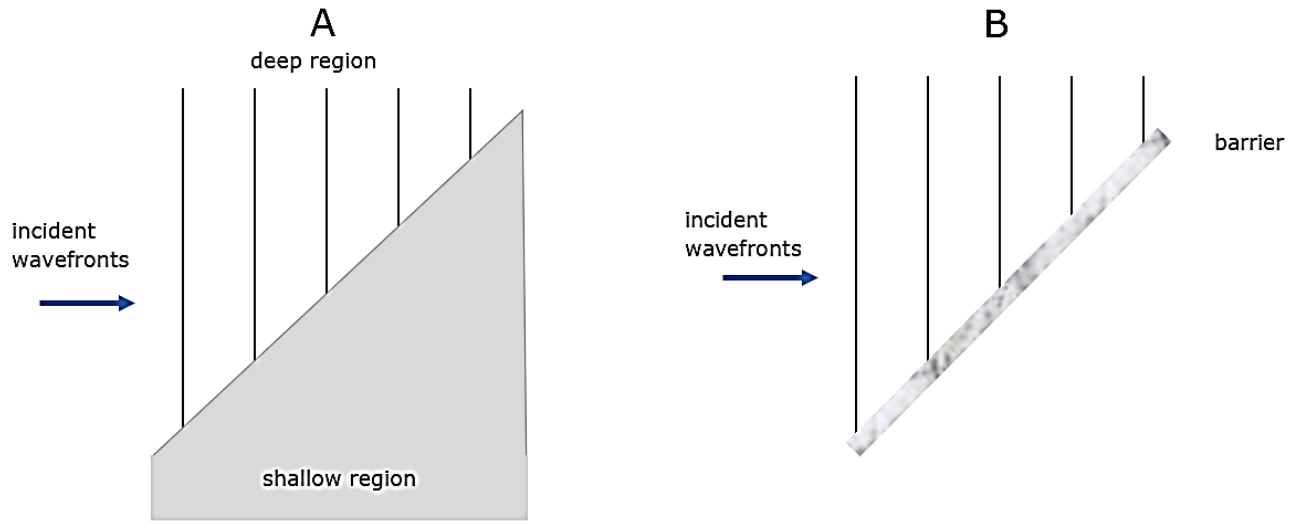
1. Some waves are longitudinal waves while others are transverse waves.

a. Explain **ONE** difference between longitudinal and transverse waves.

_____

_____ (2)

b. Sally uses a vibrating rod to produce straight wavefronts in a ripple tank as shown in the figures below.



i. Complete diagram A to show how incident wavefronts are refracted as they pass from deep to shallow water. (2)

ii. Complete diagram B to show how incident wavefronts are reflected after they hit the barrier. The barrier rests on the base of the ripple tank and protrudes above the water level (2)

iii. In the deep water, the wavelength of the waves is 0.019 m. If the waves travel at 0.17 m/s, calculate the frequency of the waves.

_____

_____ (2)

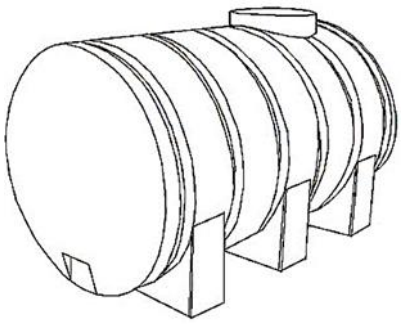
iv. State what happens to the frequency and speed of the waves as they pass from deep to shallow water.

_____

_____ (2)

(Total: 10 marks)

2. A fresh water tank was installed on the roof of a two-storey house which has a bathroom on each floor. It was noted that the water pressure at ground floor level is greater than that in the first-floor bathroom. (Density of fresh water: 1 g/cm^3)



a. Briefly explain the difference in water pressure in both bathrooms.

_____

_____(2)

b. The pressure in the kitchen tap which is at ground floor level is similar to that of the bathroom on the same level. Give a reason for this.

_____

_____ (1)

c. It was noted that if the water tank is filled up with salt water instead of fresh water, the water pressure in both bathrooms slightly increases. Explain. (Density of salt water: 1.03 g/cm^3)

_____

_____ (2)

d. If the water tank is filled up with 50 m^3 of fresh water, calculate the mass of the water in kg, when the tank is full.

_____

_____ (2)

e. The water tank may damage the roof due to the large pressure being exerted when sitting on its three legs. It is common practice that a thick wooden plank is placed between the tank and the roof. Explain.

_____

_____ (1)

f. During the installation of the water tank, a hydraulic lifter was used. Give **TWO** reasons why hydraulic machines manage to lift heavy loads.

_____

_____ (2)

(Total: 10 marks)

3. A spring balance is used to measure the mass of an object. It consists of a helical spring fixed at one end and a hook to attach the object at the other end. When no object is attached to the hook, the reading on the spring balance would read 0 kg and the spring length would be 35 mm.

a. Fill in the blanks:

When the spring is loaded, the _____ in length is called the extension.

A spring obeys Hooke's Law if the extension and the _____ are

_____ proportional. (3)

b. An object of mass 400 g was attached to the spring balance hook. The spring length increased to 42 mm. Assume that the elastic limit has **not** been exceeded. Calculate the new length of the spring if another 200 g are added with the object.

_____

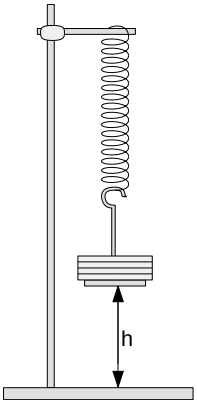
_____ (2)

c. Identify **TWO** changes in the behaviour of the spring if the elastic limit is exceeded.

_____

_____ (2)

d. Two helical springs were investigated by loading different masses gradually at different intervals. The apparatus used for this investigation is shown in the diagram. The results obtained were tabulated.



Spring 1						
mass (kg)	0	0.1	0.2	0.3	0.4	0.5
height 'h' (m)	0.8	0.75	0.7	0.65	0.6	0.55

Spring 2						
mass (kg)	0	0.1	0.2	0.3	0.4	0.5
height 'h' (m)	0.8	0.78	0.76	0.74	0.72	0.70

By referring to the results in the tables above, compare the relationship between force and extension of the springs.

_____

_____ (2)

e. Give **ONE** precaution when loading springs.

_____ (1)

(Total: 10 marks)

4. An athlete participating in a race, accelerated constantly from rest for 4 s to reach his maximum velocity of 10 m/s. The athlete then continued at constant velocity for 7 s and finally came to rest back on the starting line in a further 2 s.

a. Use the axes provided below to sketch a speed-time graph showing the athlete's motion. Include any known information. (3)

b. Calculate the deceleration in the final 2 s of the race.

_____

_____ (2)

c. Using the graph, or otherwise, find the total distance covered by the athlete.

_____

_____ (2)

d. Calculate the athlete's average speed.

_____

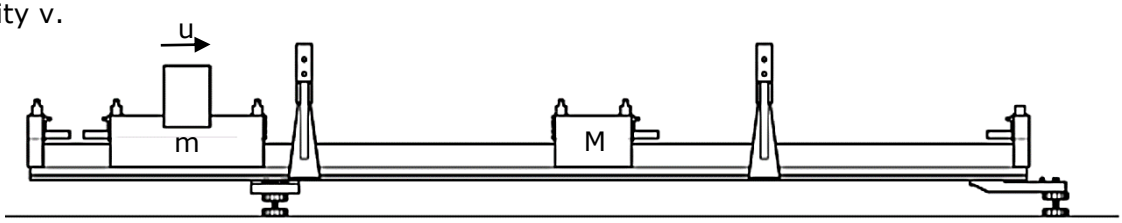
_____ (2)

e. State the athlete's displacement at the end of the race.

_____ (1)

(Total: 10 marks)

5. A glider of mass m is released with different initial velocities u, and made to collide with a stationary glider of mass M, using an air track. They then move together with a common velocity v.



a. The table shows the initial velocity u of the glider of mass m and the final common velocity v of the gliders. Complete the table by calculating the initial momentum mu of the first glider, given that its mass, m is 0.25 kg. Give your answers to 2 decimal places. (1)

initial velocity u (m/s)	**initial momentum mu (kg m/s)**	**final common velocity v (m/s)**
2.0		0.83
2.5		1.05
3.0		1.25
3.5		1.47
4.0		1.67
4.5		1.88

b. On the graph paper provided, plot a graph of initial momentum, mu (kg m/s) on the y-axis against final common velocity, v (m/s) on the x-axis. (4)

c. State the law of conservation of momentum.

_____

_____ (2)

d. Calculate the gradient of the graph.

_____

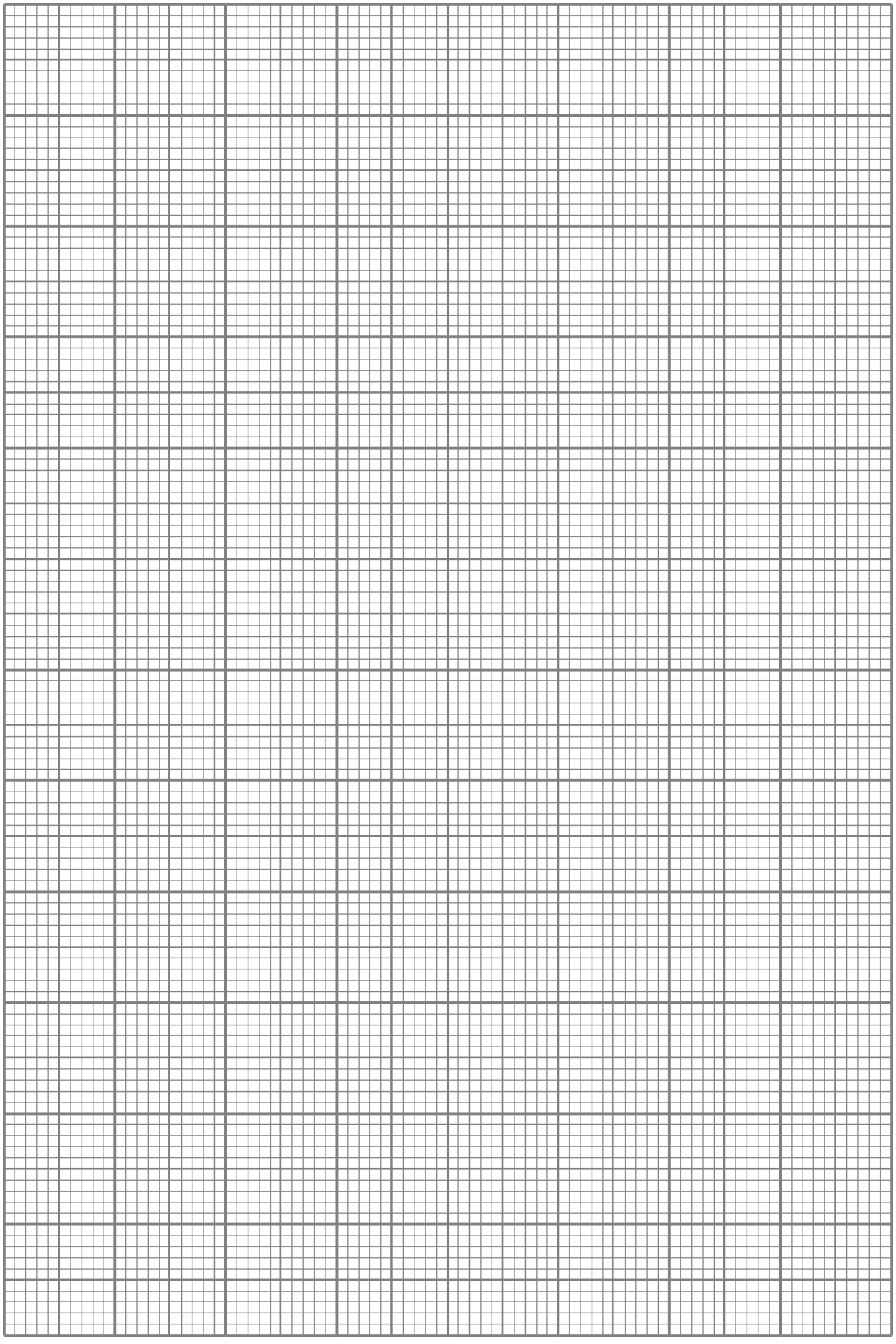
_____ (2)

e. Use the gradient to calculate the mass M of the glider that was initially at rest, given that the gradient represents the combined mass.

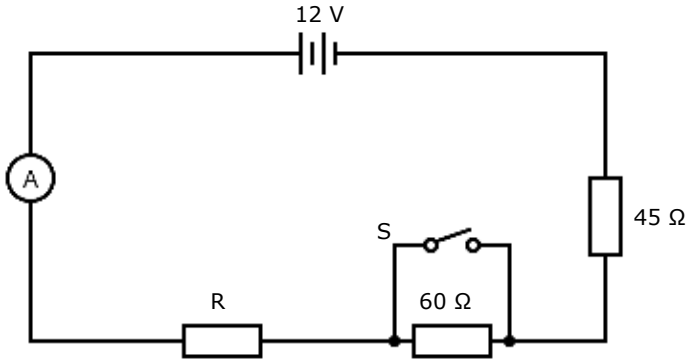
_____

_____ (1)

(Total: 10 marks)



6. Isabel sets up the electrical circuit as shown in figure below.



a. She notices that the ammeter reads 0.1 A.

i. On the diagram, draw a voltmeter which reads the voltage across the 45 Ω resistor. (1)

ii. Calculate the voltage across the 45 Ω resistor.

_____

_____ (2)

iii. Calculate the resistance of the resistor R.

_____

_____ (2)

iv. Explain what happens to the total resistance and the current through the circuit when switch S is closed.

_____

_____ (2)

b. Isabel opened a three-pin plug and found a brown, blue and a green-yellow wire. Identify and explain the function of each wire.

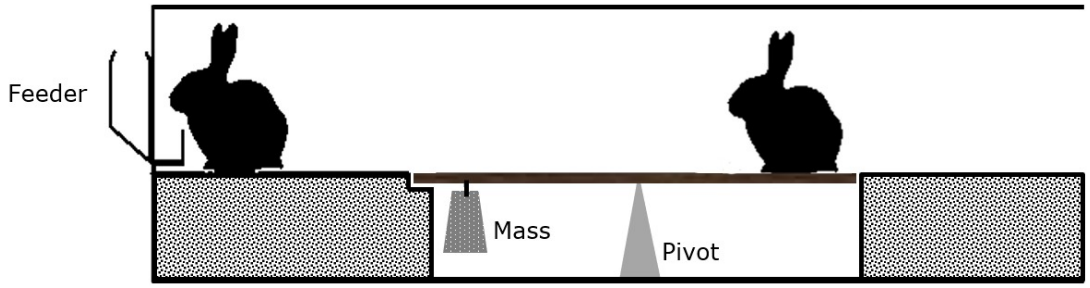
_____

_____

_____ (3)

(Total: 10 marks)

7. The device shown in the diagram is used to feed extra vitamins only to small rabbits. The device contains a trap door where rabbits which have a mass greater than 400 g would not be able to access the feeder.



a. State **TWO** conditions for equilibrium of a body.

_____

_____

_____ (2)

b. A rabbit of mass of 0.15 kg enters the device and sits 0.4 m away from the pivot. The device remains in equilibrium. If the distance from the mass to the pivot is 0.3 m, calculate the value of the mass.

_____

_____

_____ (3)

c. Explain in terms of moments, what happens when:
   i. a rabbit of mass 500 g enters the device;

_____

_____ (2)

   ii. a rabbit of mass 150 g sits on the pivot.

_____

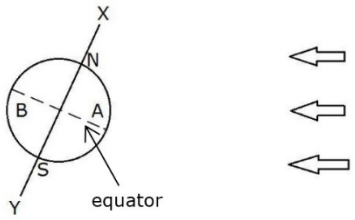
_____ (2)

d. Suggest **ONE** way how the same device can be used to make the device to feed rabbits with a mass less than 200 g instead of 400 g.

_____(1)

(Total: 10 marks)

8. The diagram shows the Earth at a particular point in its orbit round the sun.



a. Line XY represents the axis of rotation of the Earth which passes through the geographic North and South poles as shown. The three arrows on the right represent light coming from the sun.

i. How long does the Earth take to make one complete rotation about axis XY?

_____ (1)

ii. Which part of the Earth, A or B, is during night time in the position shown? _____ (1)

iii. Is it the northern or the southern hemisphere which is experiencing summer with the Earth in the position shown?

_____ (1)

iv. How long does the Earth take to make one complete revolution round the sun?

_____ (1)

v. The position of Earth is such that, light from the sun is coming from the right as shown. From which direction would light be incident on the Earth six months later?

_____ (1)

b. Travelling at 3×10^8 m/s, light from the sun takes 8 min 20 seconds to reach us on Earth. Calculate the distance of the Sun from Earth.

_____

_____ (2)

c. Observations from Earth of the sky are carried out by specific instruments. Name **TWO** instruments used to make these observations.

_____

_____ (2)

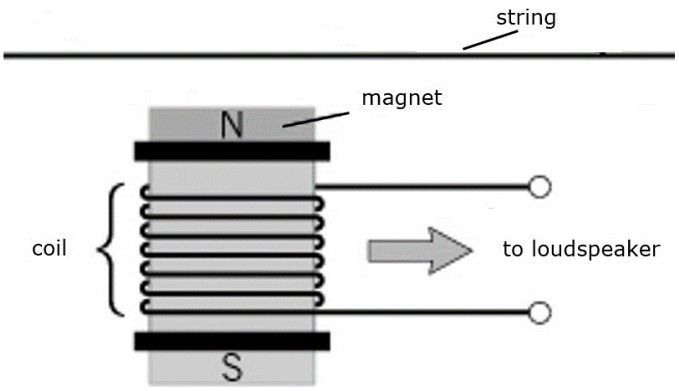
d. Pluto orbits the sun like other planets, however it is classified as a dwarf planet. Explain.

_____

_____ (1)

(Total: 10 marks)

9. The strings of an electric guitar are made of a magnetic material and pass close to devices, known as pick-ups, which consist of a coil of wire wound around a permanent magnet.



a. Sketch on the diagram some lines of flux to show the magnetic field around the magnet, indicating also its direction. (2)

b. Since the string lies in the magnetic field mentioned in part (a), the region of the string above the pick-up is magnetised. Explain why such strings cannot be made of nylon.

_____ (1)

c. When the magnetised string is plucked or hit by the guitar player, it vibrates to and fro. This causes a voltage to be induced in the coil.

i. Explain how this voltage is induced.

_____

_____ (2)

ii. Explain what happens to the size of the induced voltage if the strings are hit with a greater force.

_____

_____ (2)

d. Complete the following.

A loudspeaker changes _____ energy to _____ energy. (1)

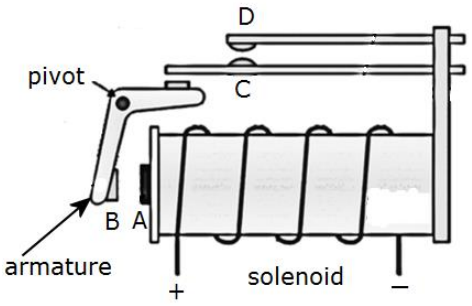
e. An ordinary guitar normally produces sounds between the range 100 Hz to 2000 Hz while a bass guitar produces sounds ranging from 40 Hz to 400 Hz. Explain which guitar produces sound having the longest wavelength.

_____

_____ (2)

(Total: 10 marks)

10. The figure shows one type of electromagnetic relay. The solenoid consists of a coil of wire wrapped round a core. When the ends of the solenoid are connected to a d.c. supply, the solenoid is magnetised and attracts the armature to it, thus causing the armature to rotate about the pivot.



a. Suggest a suitable material to use for the following:

i. solenoid core A _____ (1)

ii. end B of armature _____ (1)

b. The ends of the solenoid are connected to a d.c. supply with the polarity as shown. Identify which magnetic poles are induced at end A of the solenoid and at end B of the armature.

A: _____ B: _____ (2)

c. State **TWO** changes which can be made to the solenoid to produce a stronger magnetic field.

_____

_____ (2)

d. Contacts C and D are connected in series with a battery and a bulb in a second circuit (not shown). State what happens to the following when the armature is attracted to the solenoid.

i. contacts C and D _____ (1)

ii. bulb in the second circuit _____ (1)

e. This relay arrangement still works when the d.c. supply of the solenoid is replaced by an a.c. one. Explain.

_____

_____

_____ (2)

(Total: 10 marks)

Index Number:_____ SEC24/2A.23m

L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

SECONDARY EDUCATION CERTIFICATE LEVEL
2023 MAIN SESSION

SUBJECT:	**Physics**
PAPER NUMBER:	IIA
DATE:	20th May 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 = πr^2		

1. This question is on Newton's laws of motion.

a. A student places a small, light box on a horizontal, frictionless part of a bus floor to test Newton's first law of motion.

i. State Newton's first law of motion.

_____

_____ (2)

ii. For each of these **THREE** situations, predict and explain what will be observed in the box's behaviour when:

- The bus starts accelerating from rest.

_____

_____

_____ (2)

- The bus is moving at constant velocity.

_____

_____

_____ (2)

- The bus suddenly decelerates to rest.

_____

_____

_____ (2)

b. The bus has a mass of 6500 kg when full. It has an acceleration of 2.8 m/s^2 when the resistive forces acting on it are 200 N.

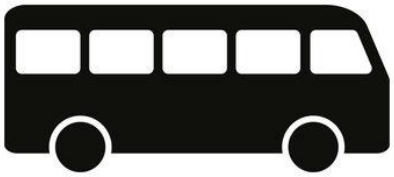
i. Calculate the forward engine force at this instant.

_____

_____

_____ (3)

ii. On the diagram below draw and name the forces acting on the bus. (2)



iii. Calculate the force that the ground exerts on the bus.

_____

_____

_____ (2)

iv. Name and state the law used for this calculation.

_____

_____

_____ (2)

c. A box containing glass bottles is loaded in the storage booth. Each bottle is protected with bubble wrap.

i. Explain why bubble wrap protects the bottles.

_____

_____ (1)

ii. Calculate the change in momentum experienced by a bottle if it experiences a force of 2.7 N in 0.5 s.

_____

_____

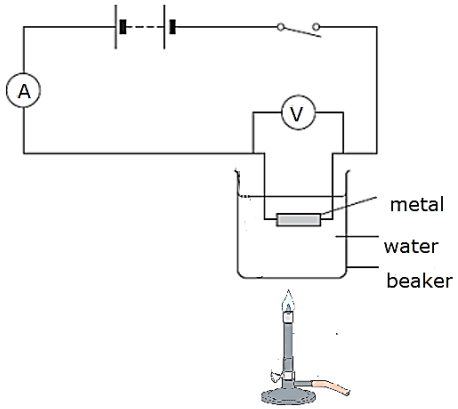
_____ (2)

(Total: 20 marks)

20

2. This question is on resistance and heat.

a. Tristan uses the apparatus below to investigate how the resistance of a piece of a metal varies with temperature.



i. Which additional piece of apparatus is required to carry out the investigation?

_____ (1)

ii. Describe how Tristan should use this apparatus to carry out the investigation.

_____

_____

_____

_____(4)

iii. List the quantities that Tristan should take readings of.

_____

_____

_____ (3)

iv. Explain how the values of some of the quantities measured may be used to find the resistance.

_____

_____ (2)

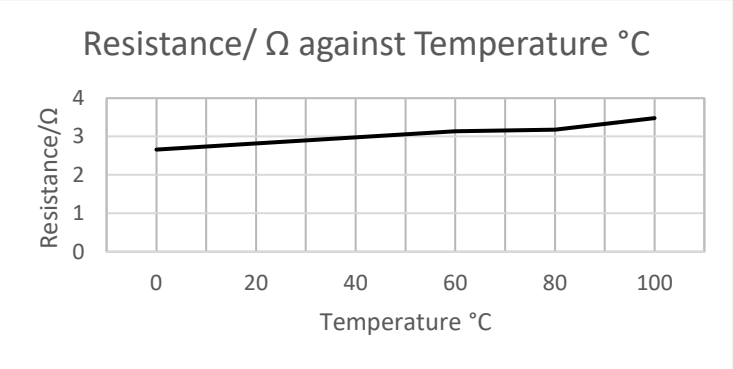
v. Suggest **TWO** possible sources of error in this experiment.

_____

_____ (2)

b. The table shows some data obtained for four metals, A, B, C and D. The metal samples all have the same cross-sectional area and length. A graph of the results of one of the metal samples is also shown.

Metal	Resistance/Ω at 0°C	Resistance/ Ω at 100°C
A	4.05	5.67
B	2.65	3.48
C	6.00	9.17
D	1.70	2.23



i. Why did the metal samples all have the same cross-sectional area and length?

_____ (1)

ii. Which metal A, B, C or D is represented in the graph?

_____ (1)

iii. On the graph sketch the graph that would be obtained if a thicker piece of metal is used. Explain your reasoning.

_____ (2)

c. Tristan is replacing an old instant electric water heater. The charge that flows in the new instant water heater in 300 s is 18000 C. The heating element of the water heater has a power rating of 13.8 kW.

i. Calculate the current flowing in the water heater.

_____

_____ (2)

ii. Hence, calculate the resistance of the heating element of the water heater.

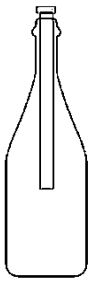
_____

_____ (2)

(Total: 20 marks)

20

3. This question is about energy



Drink chiller sticks are used to lower the temperature of a drink in its own bottle. The sticks are left in a freezer overnight. Then, once a drink bottle is opened, the stick is inserted in the bottle and the drink gets colder after some minutes.

a. Describe the molecular structure and the motion of the particles of:
   i. the stick at 20 ^{o}C;

_____

_____ (2)

   ii. the drink at 20 ^{o}C.

_____

_____ (2)

b. Fill in the blanks.

When a stick at 0 ^{o}C is inserted in the drink bottle containing the drink at 20 ^{o}C, heat is transferred from the _____ to the _____ until thermal _____ is reached. (2)

c. "Unless the drink bottle is shaken, only the liquid near the chiller stick gets cold." In terms of particles and heat transfer, explain why this statement is incorrect.

_____

_____

_____

_____ (3)

d. A steel chiller stick is inserted in the bottle containing warm water. If the steel chiller stick has a mass of 200 g and gains 840 J from the water, calculate the change in temperature in the chiller stick. [specific heat capacity of steel: 420 J/kg^{o}C]

_____

_____

_____

_____ (3)

e. A designer is considering the use of different materials to manufacture these chiller sticks. The choice is between three materials: steel, ceramic and glass. The designer wants a material that has a very low specific heat capacity.

i. In the space provided below, draw a labelled diagram of the set-up required to find out which material is best to be used for the chiller sticks. (3)

ii. Outline the method of an experiment that the designer can conduct to find out which material is best to be used for the chiller sticks.

_____

_____

_____

_____

_____

_____ (3)

iii. State **TWO** precautions that should be taken during this experiment.

_____

_____

_____

_____ (2)

(Total: 20 marks)

4. This question is about radioactivity.

One of the greatest nuclear disasters occurred at a nuclear power station in Chernobyl in 1986. An explosion in this plant released huge amounts of radiation and radioactive material which contaminated large surrounding areas and neighbouring countries.

a. Fill in the blanks with the most appropriate words.

The main energy change taking place in such a power station is from

_____ energy to _____ energy. (1)

b. As a result, the background radiation recorded in several places was higher than usual. State **TWO** sources of background radiation.

_____

_____ (2)

c. One of the dangerous radioactive materials released was $^{131}_{53}\mathrm{I}$, an isotope of Iodine.

i. What is an isotope?

_____ (1)

ii. What do the numbers 53 and 131 represent?

53 _____

131 _____ (2)

iii. $^{131}_{53}\mathrm{I}$ decays and emits mostly beta radiation and some gamma radiation. What do beta and gamma radiation consist of?

beta radiation _____ (1)

gamma radiation _____ (1)

iv. $^{131}_{53}\mathrm{I}$ has a half-life of 8 days. A nuclear scientist in a laboratory has 20 mg of $^{131}_{53}\mathrm{I}$. How much of it will remain after a period of 24 days?

_____

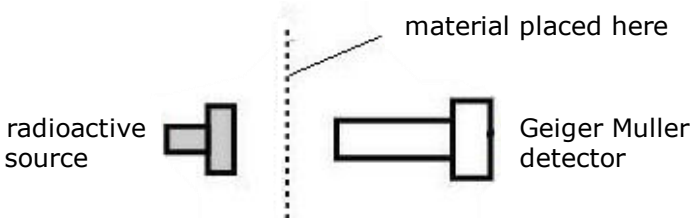
_____ (2)

v. Give **TWO** uses of radioactive isotopes.

_____

_____ (2)

d. A researcher in a nuclear laboratory has an unknown radioactive source and wants to determine what types of radiation this source emits. She carries out the following investigation:



- The apparatus was set up as shown in the diagram.
- The unknown radioactive source was placed close to a Geiger Muller (GM) detector. A reading of the count rate was taken.
- This was repeated for three times, each time placing a different material acting as a radiation absorber between the source and GM detector as shown in the diagram. The different radiation absorbing materials were a sheet of paper, an aluminium sheet and a lead sheet.
- The radioactive source was taken well away from the GM detector and a reading of the background count rate was taken.
- The results obtained were tabulated.

Material between sources and GM detector	Ratemeter reading (counts/min)
none	1200
paper	750
aluminium sheet	750
lead sheet	35

Background count rate	18

From these readings determine if alpha, beta and gamma radiations were emitted or **not** from the radioactive source, giving a reason for your answer.

Alpha: _____

_____ (2)

Beta: _____

_____ (2)

Gamma: _____

_____ (2)

e. State **TWO** precautions which need to be taken when handling radioactive sources.

_____

_____(2)

(Total: 20 marks)

20

5. This question is about energy.

a. In a hydroelectric power station, the turbine used is 90% efficient and can generate an electrical power output of 2.25×10^6 W.

i. Calculate the power input at the turbine.

_____

_____

_____ (3)

ii. Assuming this power input is all due to the kinetic energy of the water, state the kinetic energy input per second.

_____ (1)

iii. If 5000 kg of water fall towards the turbine every second, calculate the velocity with which the water must reach the turbine.

_____

_____

_____

_____ (3)

iv. Assuming that all the water is at the same level before it falls towards the turbine, calculate the height through which this mass of water must fall and explain any other assumptions made.

_____

_____

_____

_____

_____

_____ (4)

v. State **TWO** forms of possible energy losses in the turbine.

_____

_____ (2)

b. Sources of energy can be classified as renewable or non-renewable.

i. Is hydroelectric energy a renewable or a non-renewable source of energy? Explain.

_____

_____

_____ (2)

ii. The best fossil fuel power stations can have an efficiency of 60%. Apart from being less efficient than some other sources of energy, mention **TWO** other disadvantages of using fossil fuels to generate electricity.

_____

_____

_____ (2)

iii. A car uses fuel to gain a kinetic energy of 2000 J from rest. Assuming no energy losses, calculate the constant forward force required to achieve this energy gain over 25 m.

_____

_____

_____

_____ (3)

(Total: 20 marks)

Blank Page

Index Number:_____ SEC24/2B.23m

L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

SECONDARY EDUCATION CERTIFICATE LEVEL
2023 MAIN SESSION

SUBJECT:	**Physics**
PAPER NUMBER:	IIB
DATE:	20th May 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 10m/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. This question is about Newton's laws of motion.

a. A student places a small, light box on a horizontal, frictionless part of a bus floor to test Newton's first law of motion.

i. Complete the following statement for Newton's first law of motion.

If an object is at rest, it will remain at rest and if it is moving at constant velocity, it _____

_____,

provided that _____ (2)

ii. The student made the following observations of the box in each of these **THREE** different situations. Explain the box's behaviour using Newton's first law.

- The bus starts accelerating forward from rest and the box is seen to slide towards the back of the bus.

_____

_____ (2)

- The bus is moving at constant velocity and so is the box.

_____

_____ (2)

- The bus suddenly decelerates to rest and the box is seen to slide towards the front area of the bus.

_____

_____ (2)

b. The bus has a mass of 6500 kg when full.

i. At a particular instant when the bus is moving at constant velocity, the force of friction acting against its motion is 200 N. State the forward engine force at this instant.

_____ (1)

ii. The bus then accelerates to an acceleration of 2.8 m/s^2. Calculate the resultant force acting on the bus at this instant.

_____

_____ (2)

iii. The frictional force acting against the motion of the bus at this instant is 300 N. Calculate the forward engine force.

_____

_____ (2)

iv. Calculate the upward reaction force that the ground exerts on the bus.

_____

_____ (2)

v. The answer to part (iv) follows from Newton's third law of motion. State this law.

_____

_____ (2)

c. A box containing glass bottles is loaded in the storage booth. Each bottle is protected with soft bubble wrap.

i. Explain why this bubble wrap protects the bottles.

_____

_____ (1)

ii. A 2 kg bottle's speed is reduced from 16 m/s to 0 m/s in 0.5 s. Calculate the force acting on the bottle.

_____

_____

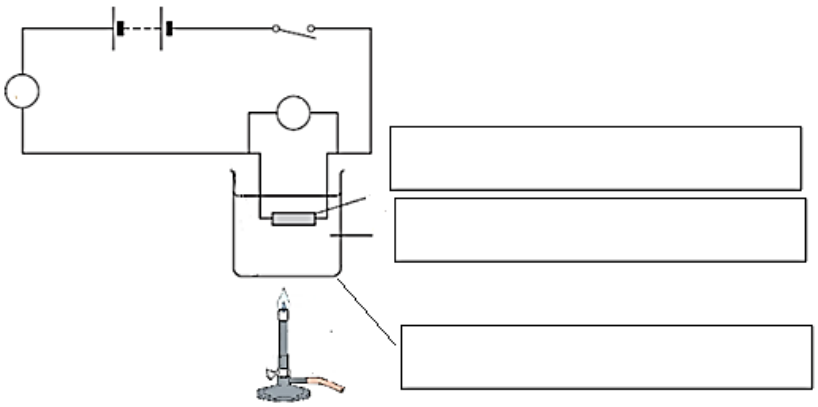
_____ (2)

(Total: 20 marks)

20

2. This question is on resistance and heat.

a. Tristan uses the apparatus below to investigate how the resistance of a piece of a metal varies with temperature.



i. Label the apparatus in the boxes provided. (3)

ii. Mark the ammeter and voltmeter with an A and V respectively. (2)

iii. A thermometer is needed for this investigation. Draw a thermometer in the setup to indicate where it should be placed. (1)

iv. Mark with numbers 1 to 4 to describe the method that Tristan should use to carry out the investigation. (2)

Take ammeter and voltmeter readings when there is a 10 °C water increase until the water boils.	
Light the Bunsen Burner to start heating the water.	
Read the initial temperature from the thermometer.	
Take the initial readings of the ammeter and voltmeter at the initial temperature.	

v. Explain how the values of some of the quantities measured may be used to find the resistance.

_____

_____ (2)

vi. Suggest a possible source of error in this experiment.

_____ (1)

b. The table shows some data obtained for four metals, A, B, C and D. The metal samples all have the same cross-sectional area and length.

Metal	Resistance/Ω at 0°C	Resistance/ Ω at 100°C
A	4.05	5.67
B	2.65	3.48
C	6.00	9.17
D	1.70	2.23

i. Why did the metal samples all have the same cross-sectional area and length?

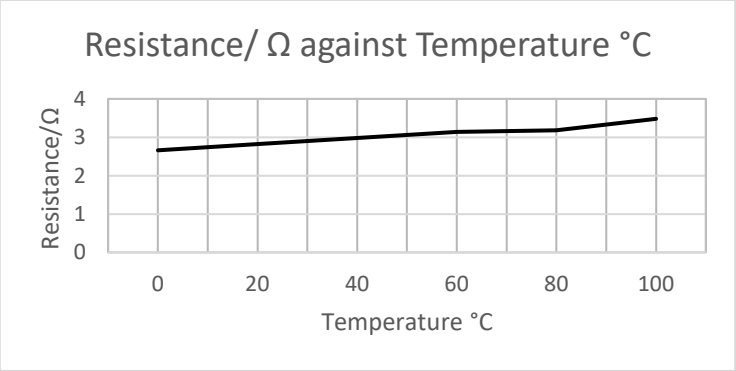
_____ (1)

ii. Which metal is the better conductor? Explain your reasoning.

_____

_____ (2)

The graph above represents the change in resistance with temperature of one the metals.



iii. Which metal A, B, C or D is represented in the graph? _____ (1)

iv. On the graph, sketch the graph obtained if a thicker piece of metal is used. (1)

c. Tristan is replacing an old instant electric water heater. The charge that flows in the new shower in 300 s is 18000 C.

i. Calculate the current flowing in the water heater.

_____

_____ (2)

ii. The water heater has a power rating of 13800 W. Calculate the resistance of the heating element of the water heater.

_____

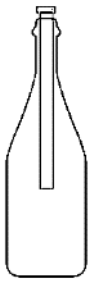
_____ (2)

(Total: 20 marks)

20

3. This question is about energy.

Drink chiller sticks are used to lower the temperature of a drink in its own bottle. The sticks are left in a freezer overnight. Then, once a drink bottle is opened, the stick is inserted in the bottle and the drink gets colder after some minutes.



a. Describe the molecular structure and the motion of the particles of:
   i. the stick at 20 °C;

_____

_____ (2)

   ii. the drink at 20 °C.

_____

_____ (2)

b. Fill in the blanks.
When a stick at 0 °C is inserted in the drink bottle containing the drink at 20 °C, heat is transferred from the _____ to the _____ until thermal _____ is reached. (2)

c. After some time, all the drink in the bottle reaches a lower temperature due to the convection currents. Explain, with the help of a diagram, the term convection current in terms of particles and heat transfer.

_____

_____

_____ (3)

d. A steel chiller stick at 0 °C is inserted in the bottle containing water. If the steel chiller stick has a mass of 0.2 kg, calculate the heat energy lost by the chiller stick if the final temperature of the chiller stick is 10 °C. Assume there are no heat losses. [specific heat capacity of steel: 420 J/kg°C]

_____

_____

_____ (2)

A designer is considering the use of different materials to manufacture these chiller sticks. The choice is between three materials: steel, ceramic and glass. The designer wants a material that has a very low specific heat capacity.

e. The procedure used by the designer to see which of these three is the best material is listed below. Put them in the correct order by writing the sequence numbers near each sentence. (3)

Switch on the power supply and simultaneously start the stopwatch. Record the current and voltage values.	
After the temperature of the block rises by 10°C, switch off the power supply and the stop-watch. Record the time from the stopwatch.	
Connect the power supply, ammeter, electric heater in series using connecting wires. Connect the voltmeter in parallel to the power supply.	
Record the initial temperature of the block.	
Use the equation $Energy = V\ I\ t$ and $Energy = m\ c\ \Delta\theta$ to work out the value for specific heat capacity.	
Insert the thermometer in one of the holes and the heater in the other hole of the block and surround the block with an insulator.	

f. Outline **ONE** precaution that should be used during this experiment.

_____

_____ (1)

g. In the space provided below, draw a labelled diagram of the experiment outlined in part (e).

(2)

h. The initial temperature of the block was 20 °C and after 6 minutes, the temperature reached 30 °C. If the voltage was 10 V and the current was 0.8 A, calculate the specific heat capacity of the block if the mass of the block is 0.6 kg.

_____

_____

_____ (3)

(Total: 20 marks)

20

4. This question is about radioactivity.

One of the greatest nuclear disasters occurred at a nuclear power station in Chernobyl in 1986. An explosion in this plant released huge amounts of radiation and radioactive material and contaminated large surrounding areas and neighbouring countries.

a. Fill in the blanks with the most appropriate terms.

The main energy change taking place in such a power station is from

_____ energy to electrical energy. (1)

b. As a result, the background radiation recorded in several places was higher than usual. State **TWO** sources of background radiation.

_____

_____ (2)

c. One of the dangerous radioactive materials released was $^{131}_{53}\mathrm{I}$, an isotope of Iodine.

i. What is an isotope?

_____ (1)

ii. How many protons and neutrons are there in the nucleus of $^{131}_{53}\mathrm{I}$?

protons _____, neutrons_____ (2)

iii. $^{131}_{53}\mathrm{I}$ decays and emits beta radiation and gamma radiation. What do beta and gamma radiation consist of?

beta radiation _____ (1)

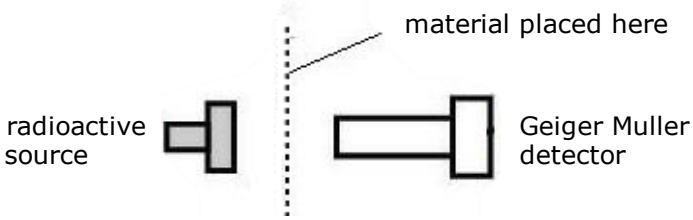
gamma radiation _____ (1)

iv. $^{131}_{53}\mathrm{I}$ has a half-life of 8 days. A nuclear scientist in a laboratory has 20 mg of $^{131}_{53}\mathrm{I}$. Fill in the two missing values in the following table, showing how it will decay over a period of 24 days.

time	amount of $^{131}_{53}\mathrm{I}$ present (mg)
at the beginning	20
after 8 days	
after 16 days	5
after 24 days	

(2)

d. A researcher in a nuclear laboratory has an unknown radioactive source and she wants to determine what types of radiation this source emits. She carries out the following investigation:



- The apparatus was set up as shown in the diagram.
- The unknown radioactive source was placed close to a Geiger Muller (GM) detector and a reading of the count rate was taken.
- This was repeated for three times, each time placing a different material acting as a radiation absorber between the source and GM detector as shown in the diagram. The different radiation absorbing materials were a sheet of paper, an aluminium sheet and a lead sheet.
- The results obtained were tabulated.

Material between sources and GM detector	Ratemeter reading (counts/min)
none	1200
paper	750
aluminium sheet	750
lead sheet	35

i. Fill in the following with **ONE** absorbing material mentioned above. Each material can only be mentioned once.

Alpha particles are absorbed by _____ (1)

Beta particles are absorbed by _____ (1)

Gamma radiation is absorbed by _____ (1)

ii. By refering to the table above, write a **Yes** if the radiation mentioned is emitted or a **No** if it is not emitted:

alpha _____; beta _____; gamma _____. (3)

e. State **TWO** precautions which need to be taken when handling radioactive sources.

_____

_____ (2)

f. Give **TWO** uses of radioactive isotopes.

_____

_____ (2)

(Total: 20 marks)

20

5. This question is about energy.

a. In a hydroelectric power station, 5000 kg of water is held by a dam 50 m above a turbine.

i. Calculate the potential energy of the water at this height. [Assume that the water is all at the same level.]

_____

_____

_____(2)

ii. When released, the water reaches the turbine at a velocity of 31.6 m/s. Calculate the kinetic energy of the water at this point.

_____

_____

_____(2)

iii. The answers to parts (i) and (ii) are approximately equal and confirm that the law of conservation of energy is obeyed. Complete the following statement for this law.

Energy cannot _____, but it

_____ (2)

iv. Water reaches the turbine with the kinetic energy calculated above in 1 s. State the power input at the turbine.

_____ (1)

v. The power station is 90 % efficient. Calculate the electrical power output obtained.

_____

_____

_____ (3)

vi. State **TWO** main form of possible energy loss at the turbine.

_____

_____ (2)

b. Sources of energy can be classified as renewable or non-renewable.

i. Hydroelectric energy is a renewable source of energy. Explain.

_____ (1)

ii. State **TWO** other source of renewable energy.

_____

_____ (2)

iii. Fossil fuels are a non-renewable source of energy. State **ONE** advantage and **ONE** disadvantage of using fossil fuel-run cars.

Advantage:

_____ (1)

Disadvantage:

_____ (1)

iv. A car uses fuel to achieve 2000 J of mechanical work and gain kinetic energy. What distance would the car travel if 80 N of mechanical forward force were produced by the engine.

_____

_____

_____ (3)

(Total: 20 marks)

Blank Page