Index No: _______________ SEC24/1.13s

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD
UNIVERSITY OF MALTA, MSIDA

SECONDARY EDUCATION CERTIFICATE LEVEL

SEPTEMBER 2013 SESSION

SUBJECT:	**Physics**
PAPER NUMBER:	I
DATE:	5th September 2013
TIME:	9:00 a.m. to 11:00 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 $10 m/s^2$.

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

1. A boy and a girl were out at sea on a paddle boat. They jumped overboard and dived together.

a. Explain the changes in pressure of the sea on the children in the following situations:

i. The girl dived vertically down a couple of metres and then swam underwater horizontally.

____

____

[2]

ii. The boy dived vertically down until he reached the bottom of the sea.

____

____

[2]

b. The boy has a mass of 65 kg and the girl has a mass of 45 kg. They stand on the paddle boat. Find the total pressure exerted by the children on the boat if the average area of one foot is 64 cm^2.

____

____

____

____

[3]

c. On the paddle boat, the children had an inflated swimming ring. Explain what happens to the pressure inside the ring after it is left in the sun for an hour.

____

____

____

____

[3]

2. Light travels in air at 3×10^{8} m/s. The table shows the refractive index of three media.

Medium	**Refractive index**
Air	1.00
Water	1.33
Glass	1.52

a. State in which medium does light travel:

i. fastest; ____ [1]

ii. slowest. ____ [1]

b. Calculate the speed of light in water?

____

____

____

[3]

c. Would total internal reflection occur if light were to pass from water to glass? Why?

____

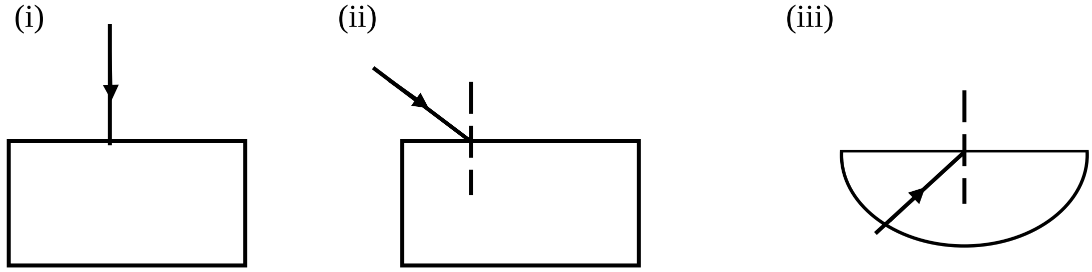
____

[2]

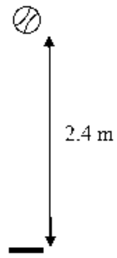
d. Complete the diagrams below to show the path of the rays through and out of the glass blocks.
In diagram (i) the incident ray is perpendicular to the glass block.
In diagram (ii) the angle of incidence is smaller than the critical angle at each boundary.
In diagram (iii) the angle of incidence is greater than the critical angle.

[3]

(i) (ii) (iii)



3. A tennis ball of mass 59.4 g is dropped from a height of 2.4 m.



a. Calculate the gravitational potential energy of the ball before it is released.

[2]

b. What is the kinetic energy of ball just before it is released?

[1]

c. What is the kinetic energy of the ball just before it touches the ground? State any assumptions.

[2]

d. Hence calculate the maximum velocity reached by the ball.

[2]

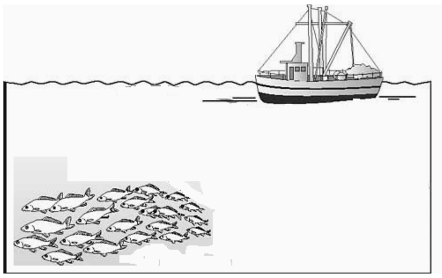
e. If the ball bounces back from the floor a height of 2 m calculate the difference in potential energy from when the ball was released.

[2]

f. State a reason why the ball did not reach the original height.

[1]

4. The diagram shows a trawler using a sonar to detect a shoal of fish. The sonar sends pulses of sound from the trawler which travel at 1500 m/s in sea water and the echo is then received.



a. State whether sound waves are transverse or longitudinal.

___

[1]

b. A sound pulse is emitted from the trawler and an echo is received from the sea-bed 0.3 s later.

i. How deep is the sea-bed beneath the trawler?

___

___

[2]

ii. What will the captain notice in the sonar when a shoal of fish swims under the trawler?

___

[1]

iii. If a shoal of fish passes underneath the trawler at a depth of 75 m, what will be the time from when the pulse is emitted to when the echo is received?

___

___

___

[3]

iv. If the frequency of the sound produced is 22000 Hz, what is its wavelength?

___

___

[2]

c. The sonar uses sound of a very high frequency. What is this sound known as?

___

[1]

5. In an experiment, the velocity of an object was measured, every second, for 12 seconds. The values recorded are reported in the table below.

Time (s)	0	1	2	3	4	5	6	7	8	9	10	11	12
Velocity (m/s)	0.0	1.5	3.0	4.5	6.0	6.0	6.0	5.0	4.0	3.0	2.0	1.0	0.0

a. Plot a graph of velocity (on the y-axis) against time (on the x-axis). [4]

b. From the graph, and without using the equations of motion, find:

i. the acceleration of the object in the first 4 seconds;

[2]

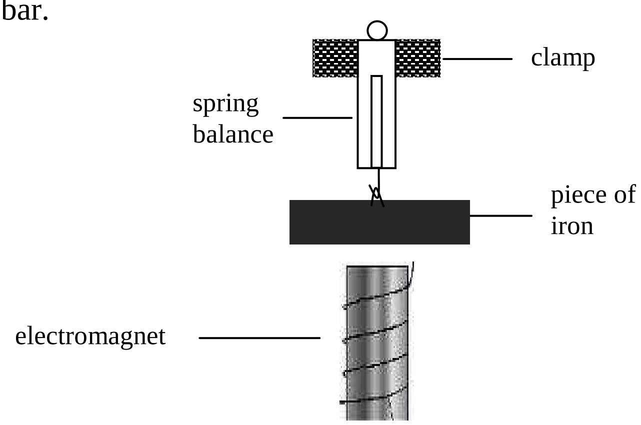
ii. the deceleration of the object in the last 6 seconds of its journey;

[2]

iii. the total distance travelled by the object.

[2]

6. The diagram below shows a piece of iron on a spring balance. An electromagnet is brought close to the iron bar.



a. The electromagnet is swithched on. Briefly explain why the piece of iron comes to be attracted to the electromagnet.

[3]

b. Describe how the force of attraction between the electromagnet and the piece of iron can be measured.

[3]

c. State **two** ways of increasing this force of attraction.

[2]

d. State what would happen if a steel bar was used instead of an iron bar.

[1]

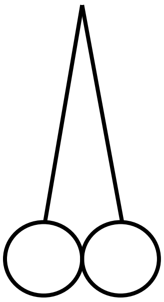
e. Would the strength of the magnetic force change if the direction of current is reversed?

[1]

7. Two very light conducting spheres are suspended close to each other so that their surfaces just touch. The two spheres are given a positive charge.

a. A body is said to be ____________________ charged if it has more positive charges than ____________________ charges. [2]

neutral spheres **charged spheres**



b. In the space provided, draw the spheres as they would appear after being charged. Mark the charges on the sphere. [2]

c. Explain your reasoning to part (b).

____

____ [2]

d. What would happen if the positive charge on the spheres is increased?

____

____ [1]

e. Had the spheres been charged negatively, in what way, if any, would your answer to (b) be different?

____ [1]

f. State two reasons why a lightning conductor/rod is most likely to be struck by lightning.

____

____ [2]

8.a. Hannah poured 150 g of water at 15^{o}C in a beaker. A block of metal, of mass 100 g and at a temperature of 80^{o}C, was placed in the water. The final temperature of both water and metal block was 20^{o}C.

i. Given that the specific heat capacity of water is 4200 J/kg^{o}C, calculate the heat energy received by the water.

[3]

ii. Assuming that all the heat lost by the metal is received by the water, and that there are no heat losses, calculate the specific heat capacity of the metal.

[2]

iii. Suggest **two** precautions that can be carried out in order to reduce heat losses in this experiment.

[2]

iv. Apart from the assumptions mentioned in part (ii), state another assumption that is considered in the above calculations.

[1]

b. The saying "hot air rises" is frequently used in common everyday conversation. Explain briefly why "hot air rises".

[2]

9. A filament lamp rated at 60 W is replaced with an energy saver lamp that emits the same amount of light energy but is rated at 11 W.

a. In the space below draw a flow diagram to show the energy change/s that take place in a filament lamp. [2]

b. Estimate the amount of energy that is converted by the filament lamp per second.

[1]

c. How much energy in kWh is consumed by the energy saver lamp in 3500 hours?

[2]

d. How much **more** energy in kWh is consumed by the filament lamp in 3500 hours?

[2]

e. If 1 unit of electricity costs 18 cents. How much is the extra cost if a filament lamp was used?

[2]

f. Give a reason why an energy saver lamp is considered more environmental friendly.

[1]

10. John, Kevin and Debbie were playing in a play ground. John and Kevin went onto a see-saw which is 2.2 m long and pivoted at the centre. They sat on opposite sides such that the see-saw was in equilibrium.

a. What is the resultant moment about the pivot?

[1]

b. What is the resultant force on the see-saw?

[1]

c. Why is the moment of a force considered to be a vector quantity?

[1]

d. If John has a mass of 60 kg and sat 70 cm from the pivot, calculate his moment about it.

[2]

e. Where did Kevin of mass 50 kg sit for the see saw to balance?

[3]

f. If Debbie joined the boys on the see-saw but sat exactly at the middle, would she affect the equilibrium of the see-saw? Explain you answer.

[2]

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SECONDARY EDUCATION CERTIFICATE LEVEL

SEPTEMBER 2013 SESSION

SUBJECT:	**Physics**
PAPER NUMBER:	IIB
DATE:	5^{th} September 2013
TIME:	4:00 p.m. to 6:00 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/s^2.

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

1. ***This question is about Ohm's law.***

a. A team of three students were assigned the task to determine whether an unknown electrical component may be considered as one which obeys Ohm's Law or not.

i. Ohm's law states that the ________________________ in a given component is directly ________________________ to the ________________________ applied across it provided the temperature remains constant. [3]

ii. Put the following statements in the correct sequence to describe the method used for the experiment to verify Ohm's law. Use numbers 1 to 4 in the number column. [4]

Number	**Method**
	The variable resistor setting is changed a number of times and the above steps repeated.
	Current and p.d. across component are read from the ammeter and voltmeter respectively.
	Measurements are tabulated.
	The variable resistor is set at a particular value.

iii. Draw a circuit which may be suitable to use in this experiment. [2]

iv. How would you conclude whether the component obeys Ohm's Law or not?

[1]

b. A circuit consists of a 6 Ω and a 12 Ω resistor connected in parallel across a 3V battery.

i. Calculate the resistance of the parallel branch.

[2]

ii. Calculate the total current in the circuit.

[2]

iii. What is the power of the battery?

[2]

iv. What happens to the energy dissipated in the circuit?

[2]

v. Will the current in the circuit be the same, greater or smaller if the resistors were connected in series? Explain.

[2]

20

2. ***This question is about density.***

Sarah and Maria bought a number of rings, all of which have irregular shapes. They wanted to investigate what metal they were made of.

a. i. Outline a method how one can find the volume of one of these rings. Include a labelled diagram.

[6]

ii. Suggest **two** precautions that need to be taken in order to obtain a more accurate result.

[2]

b. For each of the five rings bought, they measured the mass in g and the volume in cm^3. The values of mass and volume for each of the rings are recorded in the table. Calculate the density for each ring, and write the values in the spaces in table below. In each case, show also the working in the space provided.

[5]

	Mass (g)	Volume (cm^3)	Working	Density (g/cm^3)
Ring 1	81.9	7.8		
Ring 2	33.2	4.2		
Ring 3	68.3	6.5		
Ring 4	30.3	3.4		
Ring 5	44.5	5.0		

c. At this stage, Sarah and Maria went to the school library and found a table of densities in g/cm^3 for a number of metals in a Physics book.

Metal	Density (g/cm^3)
Gold	19.29
Lead	11.35
Nickel	8.9
Rhodium	12.9
Silver	10.5

In the same book, they also found the following information: *"The mass of 1 cm^3 of iron metal was found to be 0.00787 kg."*

i. Calculate the density of iron in g/cm^3.

____

____

____

[2]

ii. According to the information above, indicate the metal for each of the rings in the table below.

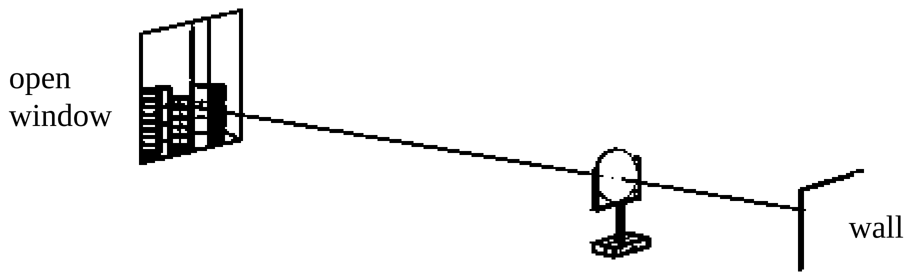
	Metal
Ring 1	
Ring 2	
Ring 3	
Ring 4	
Ring 5	

[5]

20

3. ***This question is on lenses.***

a. When Victoria and Josephine went in a dark room, they noticed that there was a small image of the buildings opposite the school, on the wall of the room. There was a lens on the bench in front of the image.



i. What type of lens was used?

[1]

ii. Give **two** properties of the image produced, other than that of being smaller than the actual buildings.

[2]

iii. What is this distance between the lens and the wall called?

[1]

iv. Draw a ray diagram (not to scale) to show how the image was formed. [3]

b. Our eyes have a number of different parts, each with a different function. One of the parts is a convex lens. Why is it unwise to look directly at the sun?

[1]

c. Indicate whether the statements below are [T]rue or [F]alse. [8]

		T or **F**
i	When a convex lens is placed nearly touching the object, no image is formed on the screen.	
ii	The distance between the lens and the image is known as the object distance.	
iii	An object at the focus forms an image at infinity.	
iv	The image of an object placed at infinity is virtual.	
v	A convex lens is a diverging lens.	
vi	Images produced by a convex lens are always real and inverted.	
vii	The image formed by an object placed between F and 2F is real, inverted and larger than the object.	
viii	When the object distance equals the image distance, they are at 2F from the lens.	

d. i. Sketch a ray diagram to show a ray of light reflected by a plane mirror. Indicate clearly the angles of incidence and reflection. [2]

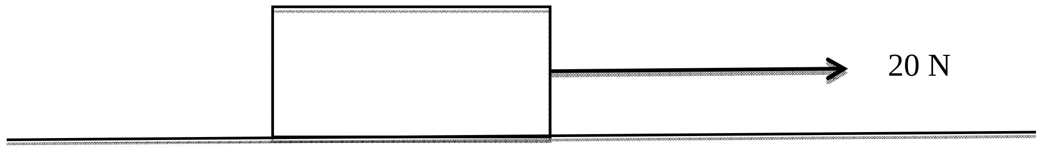
ii. State two characteristics of images formed by plane mirrors.

[2]

20

4. ***This question is about force and acceleration.***

An object of mass 5 kg is originally at rest. It is pulled along a horizontal, frictionless surface with a force of 20 N.



a. i. What is the velocity of the object when it is "originally at rest"?

[1]

ii. Calculate the acceleration of the object.

[3]

iii. The body reaches a velocity of 6 m/s. Calculate the distance travelled by the object to reach this velocity.

[4]

iv. Calculate the time taken for the object to reach a velocity of 6 m/s.

[3]

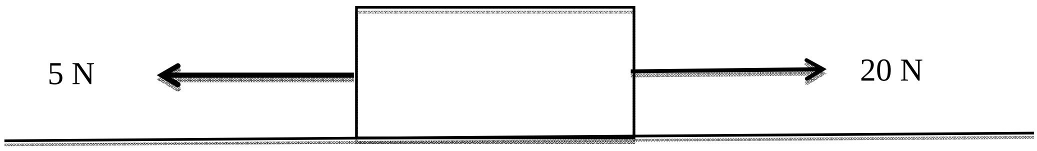
v. Calculate the work done in moving the object.

[3]

vi. Calculate the power.

[3]

b. While being pulled forward by a force of 20 N, the object is pulled backwards by a force of 5 N.



i. Calculate the resultant force on the object.

[1]

ii. Calculate the new acceleration of the object.

[2]

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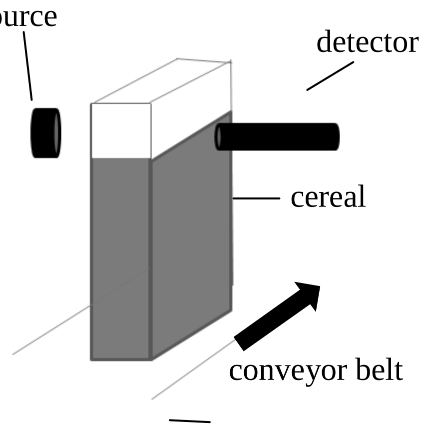


5. ***This question is on radioactivity*.**

A company which manufactures **cereal** wants to check the level of cereal in the boxes. It proposes to place a radioactive source on one side and a Geiger counter on the other side of a conveyor belt which carries the cereal boxes, as shown in the diagram.

The company was given the information below:

Source	**Radiation**	**Half-life Period**
A	α	4500 million years
B	α and γ	1600 years
C	β	5 days
D	γ	20 minutes
E	γ	19 years

Use the information above to answer the following questions.

a. Which source in the list above would you recommend? Explain.

\[3\]

b. Give **one** reason why the half-life of the source should not be too short.

\[1\]

c. Explain how the system above will allow the correct level of cereal in the packet to be checked.

\[3\]

d. This procedure can also be used to check if the thickness of aluminum sheets is more than 1 cm.

i. State the type of radiation that one should use in such a case. Explain.

\[2\]

ii. State which source from the list above would be ideal? Explain.

\[2\]

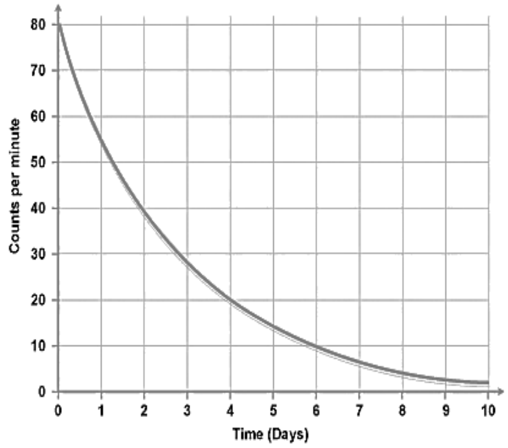
e. Mention **one** precaution companies should take to protect their employees from the radiation of the source?

[1]

f. Will Geiger counters give readings even in the absence of any radioactive source? Explain.

[2]

g. The graph below represents the decay curve of a radioactive element.



i. What is the initial activity of the element?

[1]

ii. Define half-life.

[2]

iii. Use the graph above to determine the half-life of the element.

[2]

iv. What is the activity after 6 days?

[1]

20

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