Index Number:________________ SEC24/1.22m

L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

SECONDARY EDUCATION CERTIFICATE LEVEL
2022 MAIN SESSION

SUBJECT:	**Physics**
PAPER NUMBER:	I
DATE:	28th May 2022
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/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 $= \pi r^2$		

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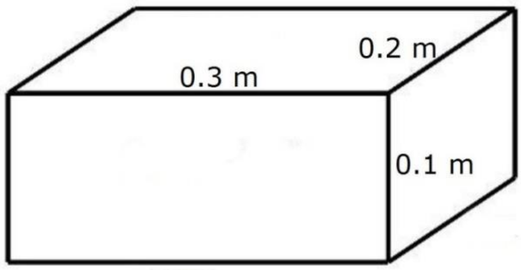
1. This question is about pressure.

a. The diagram shows a rectangular block made of stone having dimensions as shown. Calculate:



i. the volume of the block;

____

______________________________________ (1)

ii. the weight of the block given its density is 2500 kg/m^3.

____

____

______________________________________ (3)

b. A man holds the block horizontally under water such that its bottom side, having dimensions 0.3 m by 0.2 m, lies at a depth of 0.5 m.

i. When the block is fully immersed in the water, the level of the water rises because the block displaces the water. State the volume of water displaced in this case.

______________________________________ (1)

ii. Calculate the pressure at the bottom of the block, given that the density of water is 1000 kg/m^3.

____

____

______________________________________ (2)

iii. Circle the correct word in the following statements:

The pressure of the water at the bottom of the block is smaller / greater than that at the top. Therefore the force of the water acting upwards on the bottom of the block is smaller / greater than that acting downwards on the top of the block. (2)

iv. Using the result in b(iii), briefly explain why a person lifting a stone out of the water feels the stone lighter in the water than when it is completely out in air.

____

______________________________________ (1)

(Total: 10 marks)

10

2. This question is about waves.

a. Sound waves are longitudinal waves, which carry energy from one location to another.

i. Explain how longitudinal waves travel in terms of particle movement.

____

____ (1)

ii. Sound waves are mechanical waves. Explain.

____ (1)

b. Singing bowls are metal bowls used to produce sounds for meditation sessions. One bowl produces a sound of frequency 528 Hz. The speed of sound in air is 343 m/s.

i. Calculate the wavelength of this wave.

____

____ (2)

ii. If a different bowl produces a sound of lower frequency, what changes, if any, would occur in the pitch of the sound heard.

____ (1)

iii. If a louder sound is produced, which property of the wave would change?

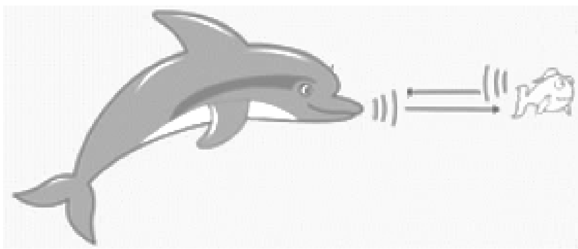
____ (1)

c. Dolphins use ultrasound and echoes to locate objects and surfaces around them.

i. State the frequency above which sound is considered as ultrasound.

____ (1)

ii. The figure, shows a dolphin emitting ultrasound waves, which are then reflected off a small fish. The speed of sound in water is about 1500 m/s. If the ultrasound takes 0.004 s to travel from the dolphin and back after bouncing off the small fish, how far is the fish from the dolphin?



(Source: springer.com)

____

____

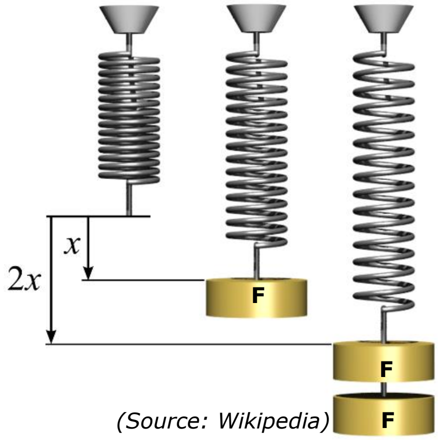
____ (3)

(Total: 10 marks)

10

3. This question is about springs.

a. A student hangs a spring from a support. The diagram shows the spring with no load, then with a load F and finally with a load 2F. The corresponding extensions are labelled as shown. Fill in the following:



(Source: Wikipedia)

These values show that for the spring, the extension is ______________________________ the load, thus the spring obeys ______________________ . (2)

b. State what happens to the length of the spring if it is loaded beyond its elastic limit and its length is measured after unloading.

____ (1)

c. State what happens to the relationship between extension and load if the elastic limit is exceeded.

____ (1)

d. A spring is 15.0 cm long and becomes 17.4 cm long when a load of 5 N is applied to it. Calculate its final length when a total load of 12.5 N is now applied to it. Assume the elastic limit is **not** exceeded in this case.

____

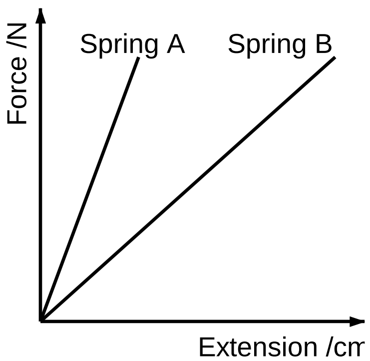
____

____ (4)

e. A group of students were given two springs of the same length and size but with one spring being stiffer than the other.

i. State whether the extension of the stiffer spring would be greater or smaller than the other one when they are loaded with the same load.

____ (1)



ii. With reference to the graph, state which of Spring A or Spring B is the stiffer spring.

____ (1)

(Total: 10 marks)

10

4. In 2016, a planet, which is very similar to planet Earth, was discovered in another solar system. This planet was named Proxima b. Proxima b is 4.2 light years away from Earth.

	Earth	**Proxima b**
Mass (kg)	5.972×10^{24}	7.763×10^{24}
Period of Orbit (days)	365.25	11.2
Density (g/cm^3)	5.51	56.8
Gravitational Acceleration (m/s^2)	9.81	12.75

(Source: https://nssdc.gsfc.nasa.gov/planetary/factsheet/)

a. With reference to Earth, briefly explain period of orbit.

(1)

b. By referring to the table:

i. Deduce whether Proxima b is a rocky or gaseous planet. Explain.

(2)

ii. The gravitational acceleration of Proxima b is greater than that of Earth. Explain.

(2)

c. Planet Earth is tilted on its own axis, while Proxima b is not. Explain how this will affect both planets in any way along the year.

(1)

d. During the night sky, Proxima b appears to be white. Explain.

(2)

e. Calculate the distance between Proxima b and Earth in meters if the speed of light is 3×10^8 m/s and one year is 365.25 days long.

(2)

(Total: 10 marks)

10

5. The figure shows a cyclist travelling along a straight, level road at constant speed.

(Source: https://www.shutterstock.com)

a. Complete the sentence:

The speed of the cyclist is constant when the work done by the cyclist is ____________ the work done against air resistance and friction. (1)

b. The table below shows how the speed of the cyclist changes as his power output changes. Plot a graph of speed of cyclist (m/s) on the y axis against power output (W) on the x axis. (4)

Speed (m/s)	0	7.0	9.5	11.0	12.0	12.5
Power output (W)	0	100	200	300	400	500

c. Calculate the work done by the cyclist when his power output is 200 W for 1800 s.

____

____

____ (2)

d. Calculate the percentage increase in speed of the cyclist when the power output changes from 200 W to 350 W.

____

____

____ (2)

e. When on a level road the cyclist reached a maximum speed of 14 m/s. He now cycles uphill. Explain why the maximum speed of the cyclist decreases.

____

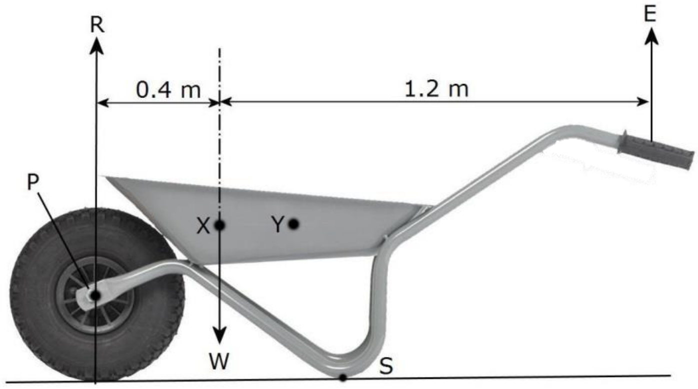
____ (1)

(Total: 10 marks)

10

10

6. This question is about moments.



The figure shows a wheelbarrow used to transport a stone of mass 20 kg. The stone is placed in the wheelbarrow such that its centre of mass is at point X; W indicates the weight of the stone. When at rest the wheelbarrow rests on its single front wheel and on its supports S at the back. The centre of the wheel P can be considered as the pivot of the system. The relative distances are as shown.

a. Calculate the clockwise moment of the weight of the stone W about the pivot P.

____

____ (2)

b. Calculate the force E needed to lift the supports S of the wheelbarrow off the ground.

____

____ (2)

c. The stone shifts its position during transport such that its centre of mass now lies at Y. What effect does this have on the force E needed? Explain.

____

____ (2)

d. In practice it is found that the actual force needed above in both cases is greater than that calculated. Explain.

____

____ (2)

e. Force R stands for the force exerted by the ground on the wheel.

i. Fill in the blank space.

This is commonly known as a ______________________ force. (1)

ii. Write an equation to show the relationship between forces R, W and E when an effort is applied to lift the supports S off the ground.

____

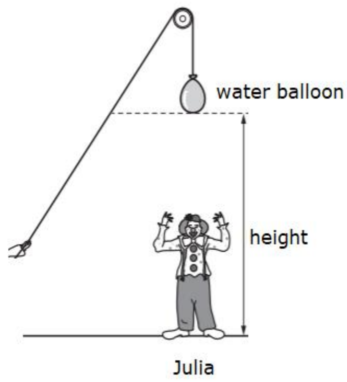
____ (1)

(Total: 10 marks)

10

7. Julia will be performing as a clown in the school's annual show.

a. In the first part of the show, water balloons will be dropped on her head from different heights.



i. If the first water balloon has a mass of 1.8 kg and hits Julia with a speed of 10 m/s, calculate the kinetic energy of this water balloon just before it hits Julia.

____

____

____ (3)

ii. The second water balloon has a mass of 2.4 kg. Determine the height, h, from which it is released, when it has a gravitational potential energy of 120 J.

____

____ (2)

iii. Find the work done in raising the second balloon to the height, h in part (a)ii.

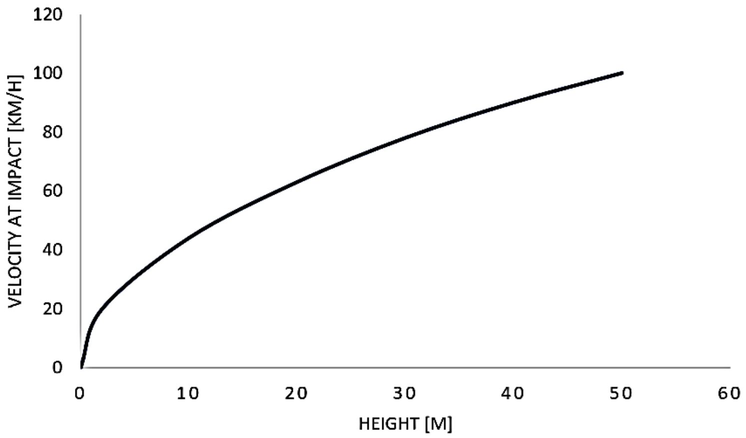
____ (1)

b. In the next part of the show, another student, acting as a clown, throws water balloons vertically upwards to different heights. Name:

i. a form of stored energy in the student before the balloon is thrown: _____________ (1)

ii. a form of mechanical energy while the balloon is in the air. _____________________ (1)

c. In the third part of the show, the water balloon is allowed to free fall in a vertical manner from different heights. The graph shows how the impact speed with the ground changes with different heights. With reference to the diagram above, explain how the impact speed changes with height of free fall.



____

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____

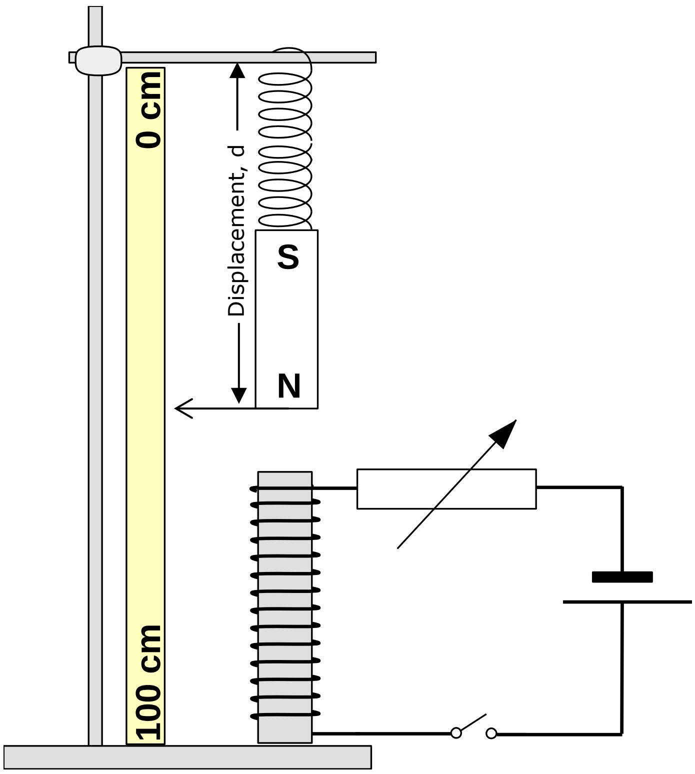
____

______________________________ (2)

(Total: 10 marks)

10

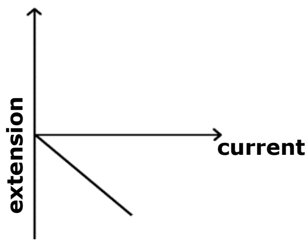
8. The diagram shows a bar magnet suspended by a helical spring from a wooden stand and clamp. A meter ruler is fixed parallel to the bar magnet. A non-magnetic pointer is attached to the bar magnet. A circuit including a solenoid, rheostat, switch and battery is placed in such a way that the solenoid is vertically aligned with the bar magnet.



a. Assume that the switch is closed. Indicate on the same diagram:

i. the direction of current in the circuit;
ii. the polarity of the solenoid;
iii. the fields present around both the solenoid and the bar magnet. (3)

b. The initial reading of displacement, d on the ruler is recorded. The switch is closed and the new position of the pointer is also recorded. The difference between the readings of displacement represents the negative extension (compression) of the spring. This procedure is repeated by decreasing resistance of the rheostat gradually, each time measuring displacement, d of the spring. Explain why the graph below is obtained.



____

____

____ (3)

c. In **each** scenario below, outline the result and give a reason for your answer:

i. A solenoid with less wire turns is used.

Result: ____________________________________ (1)

Reason: ____________________________________ (1)

ii. Rheostat is set at its lowest resistance.

Result: ____________________________________ (1)

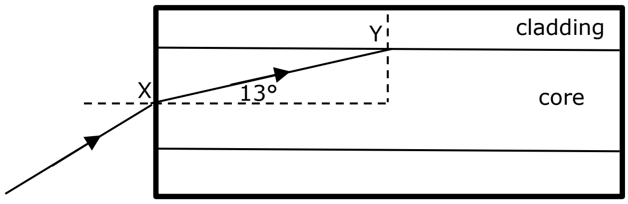
Reason: ____________________________________ (1)

(Total: 10 marks)

10

9. Optical fibres are made of thin rods of glass. They carry information in the form of light from one end to the other.

a. The diagram below shows an optical fibre consisting of a core of refractive index 1.55 surrounded by another material that is less dense, called cladding. The ray travelling at 3×10^8 m/s in air, is incident at point X and enters into the core.



i. Calculate the speed of light into the core.

____

____ (2)

ii. Explain this change in speed experienced by the ray of light.

____ (1)

iii. Due to this change in velocity, the ray bends towards the normal and the angle of refraction is 13°. Calculate the angle of incidence at Y.

____ (1)

iv. Explain the term critical angle.

____ (1)

v. The critical angle at Y is 71°. State and explain what will happen to the light ray when it reaches Y.

____

____ (2)

vi. Continue the path of the light ray at Y on figure above. (1)

b. Visible light forms part of the electromagnetic spectrum, which consists of different waves that can travel with the same speed in a vacuum.

i. Name the radiation with the lowest frequency. ____________________ (1)

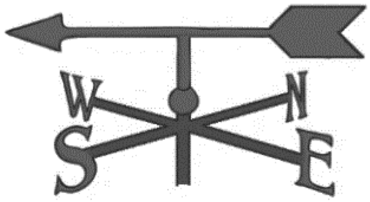
ii. State another similarity of electromagnetic waves.

____ (1)

(Total: 10 marks)

10

10. A wind vane is made up of a very light magnetised steel arrow, which can rotate freely on a frictionless support. When the wind blows, it rotates the arrow and the wind direction can be identified. However, it was noted that on days with no wind, the arrow always end up pointing in the north - south direction.



a. Outline the cause for the steel arrow to end up in this position on days with no wind.

____

____

____ (2)

b. Explain why this observation is not applicable for plastic wind vanes.

____

____ (1)

c. If one had to follow the North direction as indicated by the arrow of the wind vane, one would end up in Northern Canada, almost 500 km away from the geographical north pole of planet Earth. Explain.

____

____

____ (2)

d. Planet Earth is considered one giant bar-magnet. In the space provided, draw the field around a bar magnet.

(2)

e. By referring to your diagram above, explain why the arrow of the plotting compass changes its direction faster when it is placed at the sides of the bar magnet.

____

____

____ (2)

f. After a long hot summer, it was noticed that the wind vane was not aligning itself in a north-south direction. Give a possible explanation for this.

____

____ (1)

(Total: 10 marks)

10

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MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

SECONDARY EDUCATION CERTIFICATE LEVEL
2022 MAIN SESSION

SUBJECT:	**Physics**
PAPER NUMBER:	IIA
DATE:	28th May 2022
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 $= \pi r^2$		

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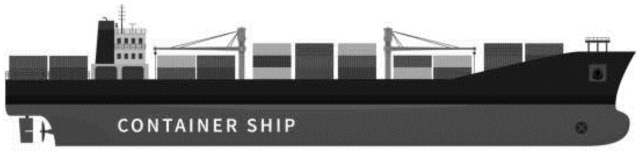
1. The figure below shows a large container ship travelling towards the Malta Freeport Terminal in Birzebbuga. The ship is travelling at a constant speed in a straight line.



(Source: https://images.app.goo.gl/Ln3wihmcDFfJwtTy7)

a. The ship has resistive forces acting on it.

i. Identify **TWO** factors that contribute to the resistive forces acting on the ship.

____

____(2)

ii. A growing awareness on climate change in the shipping industry has encouraged ship owners to lower speeds of large container ships. One advantage is that it reduces fuel consumption. Hence, give **TWO** other advantages of lowering speeds.

____

____(2)

iii. A container ship would take around 12 km to stop from when the engines are switched off. With reference to Newton's laws, explain whether this distance will change if less resistive forces are present.

____

____(2)

b. The mass of the ship is 2.2×10^8 kg. The engines are switched off and the resistive force/s causes the ship to decelerate.

i. Calculate the initial deceleration/acceleration of the ship if the resistive forces are 2.8×10^6 N.

____

____(2)

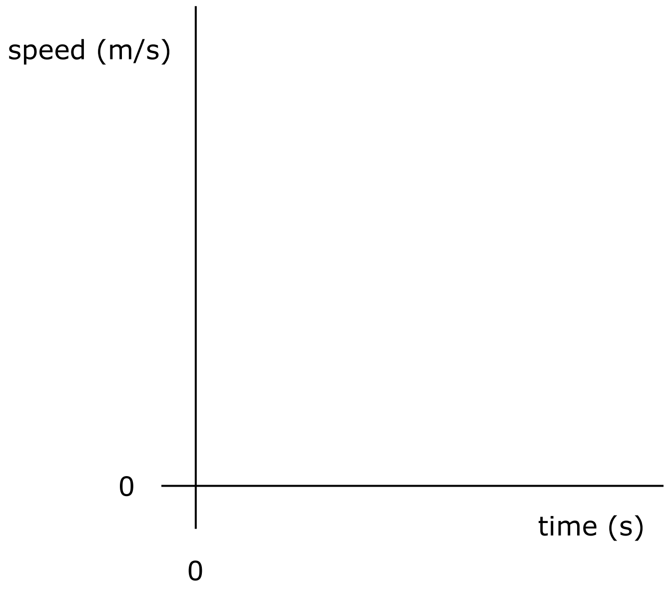
ii. Hence or otherwise, find the velocity of the ship at the time the engines were switched off if its velocity after 5 minutes was 2.1 m/s. Assume that the acceleration of the ship was constant during this time.

____

____

____(3)

iii. Sketch on the axes below, a speed-time graph for the situation described in part b(ii). (3)



iv. Explain how the distance travelled by the ship may be determined from the speed-time graph.

____

____ (1)

c. When the ship is travelling at a different speed, energy is being supplied to the engines at a rate of 33 MJ/s. The efficiency of the engines is 36%.

i. Define the term efficiency.

____

____(1)

ii. Name **TWO** main forms of energy loss of the onboard engines.

____

____(2)

iii. Calculate the rate at which energy is wasted in the engines.

____

____(2)

(Total: 20 marks)

20

2. This question is about heat.

a. Explain the following observations.

i. A metal spoon and a wooden spoon lying on the table in a room are both at a temperature of 20 ^{O}C but the metal spoon feels colder to the touch than the wooden one.

____

____(2)

ii. It is found that when 1 kg of sand and 1 kg of water absorb the same amount of heat energy, the temperature rise of the water is much less than that of the sand.

____

____

____(2)

iii. A person coming out of the sea on a hot day feels slightly cold while the water evaporates from his skin.

____

____

____(2)

iv. Light weight survival blankets are normally silvered and not black.

____

____

____(2)

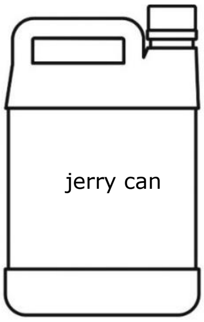
v. The temperature of the air inside a closed transparent glass container left in the sun for some time is higher than that of the air outside the bottle.

____

____

____(2)

b. You are asked to design an experiment to investigate which of two given materials is more efficient as lagging. This lagging is to be placed around a container as shown in the diagram which is filled to the top with hot water, so that it keeps the water inside hot for as long as possible.



The following items of apparatus are available:

- a plastic container as shown in the figure;
- a supply of hot water at 85 °C;
- two lagging materials, A and B, under investigation.

(Source: https://images.app.goo.gl/)

i. Measuring instruments are also needed to carry out this investigation. Name **TWO** of these instruments.

____

____ (2)

ii. Describe how you would carry out this investigation, including **ONE** precaution taken.

____

____

____

____

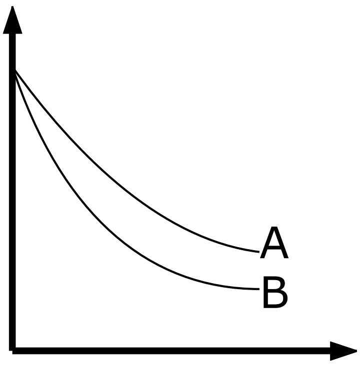
____

____ (4)

iii. The results are then put in a table. Fill in the other **TWO** headings of the table; one has already been done for you.

temperature of water using material A / °C					

(2)



iv. Two graphs on the same axis were plotted from the readings of this experiment and the resulting graphs are as shown.

Label both axes of this graph. (1)

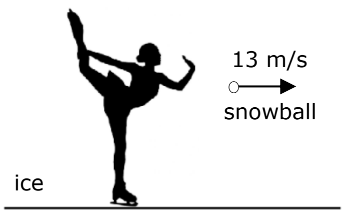
State which of the two materials A or B is the better insulator here.

____ (1)

(Total: 20 marks)

20

3. The figure shows Karen in a stationary position during skating practice.



a. She throws a snowball of mass 0.23 kg with a velocity of 13 m/s.

i. Calculate the initial momentum of the snowball.

____

____ (2)

ii. When Karen throws the snowball forward, she slides backwards on the ice. Explain why she moves in this direction.

____

____

____ (3)

iii. Karen wears soft knee pads that compress easily. Explain how the pads protect her knees when she falls on the ice.

____

____

____ (3)

iv. Karen throws another snowball which crashes into a garden fence nearby. State what happens to the momentum of the snowball.

____

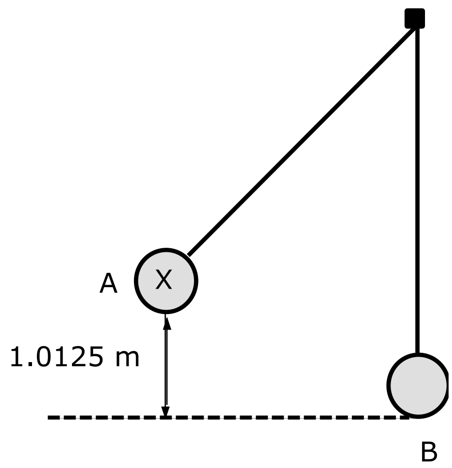
____ (2)

v. Describe what happens to the energy of the snowball when it hits the fence.

____

____ (2)

b. A ball X, is supported by a long solid rod of negligible mass. The rod is suspended from the other side from a support as shown in the diagram. There is also negligible friction between the rod and the support. The ball is released from position A and reaches position B when the rod is vertical.



i. Assuming there is no air resistance, state the energy in this system when ball X is at point A and when it is at point B.

____ (1)

ii. Hence or otherwise, calculate the speed of ball X at point B, if point A is 1.0125 m above point B.

____

____

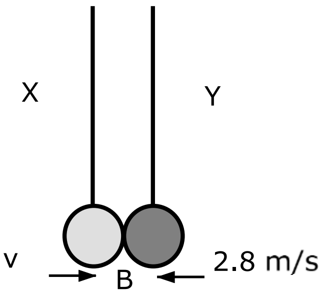
____ (2)

iii. Calculate the mass of ball X if its momentum at point B is 0.225 kgm/s.

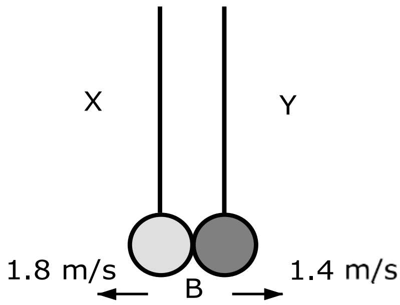
____

____ (2)

iv. At point B, ball X hits another ball, ball Y, which is travelling at a speed of 2.8 m/s in the opposite direction as shown in the diagram.



If after collision the velocities of both balls are as indicated on the diagram below, find the mass of ball Y.



____

____

____

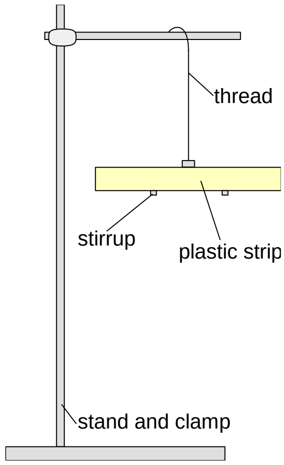
____ (3)

(Total: 20 marks)

20

4. This question is about electricity.

a. The figure shows a plastic strip hanging freely from a retort stand using a stirrup and an insulating thread.



An investigation is carried out to determine if the plastic strip is neutral or charged positively or negatively. A student is provided with another two plastic strips, X and Y. Strip X becomes negatively charged when rubbed with a cloth. Strip Y becomes positively charged when rubbed with an identical cloth.

i. Explain how the plastic strip X becomes negatively charged when rubbed.

____ (1)

ii. Explain how the plastic strip Y becomes positively charged when rubbed.

____ (1)

iii. Explain why the thread supporting the stirrup must be made from an insulating material.

____ (1)

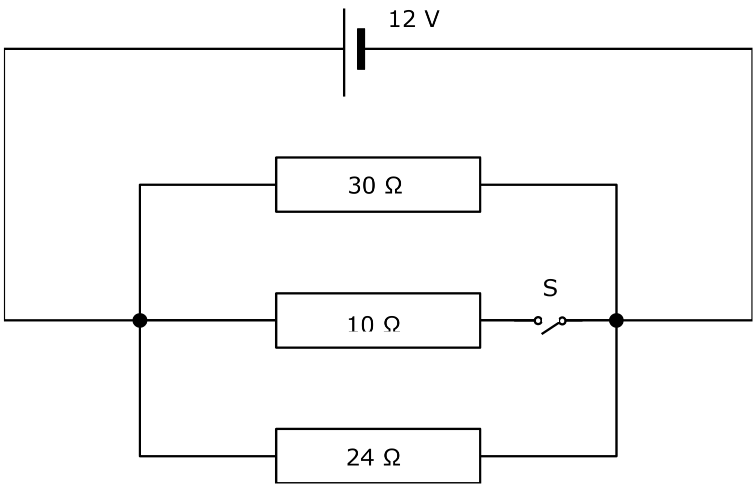
iv. Explain the difference between an electric conductor and insulator. Give an example of each.

____

____

____ (3)

b. The circuit in the figure below shows a 12 V direct current (D.C.) supply connected to three resistors in parallel. S is a switch connected in series to the 10 Ω resistor.



i. Define current.

____ (1)

ii. Calculate the total current in the circuit with switch S open.

____

____

____ (3)

Switch S is now closed.

iii. Calculate the power dissipated by the 10 Ω resistor.

____

____ (2)

iv. Calculate the total resistance in the circuit.

____

____ (2)

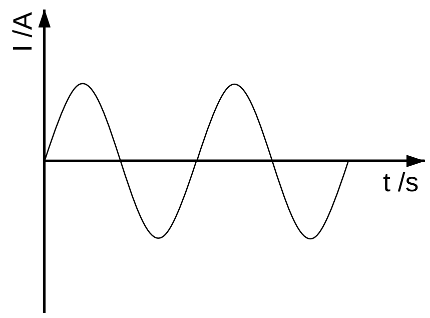
v. Calculate the total energy delivered by the battery in an hour.

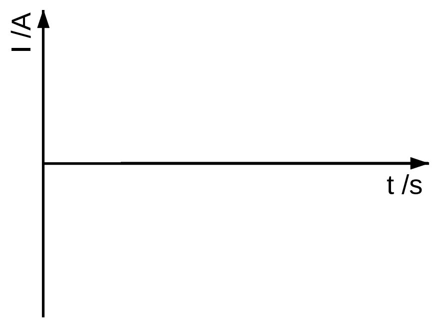
____

____

____ (3)

c. The graph in the figure below shows how current varies through a resistor when it is connected to an alternating current (A.C.) supply.





i. Name the component that can be used in an A.C. circuit to convert the current from A.C. to D.C.

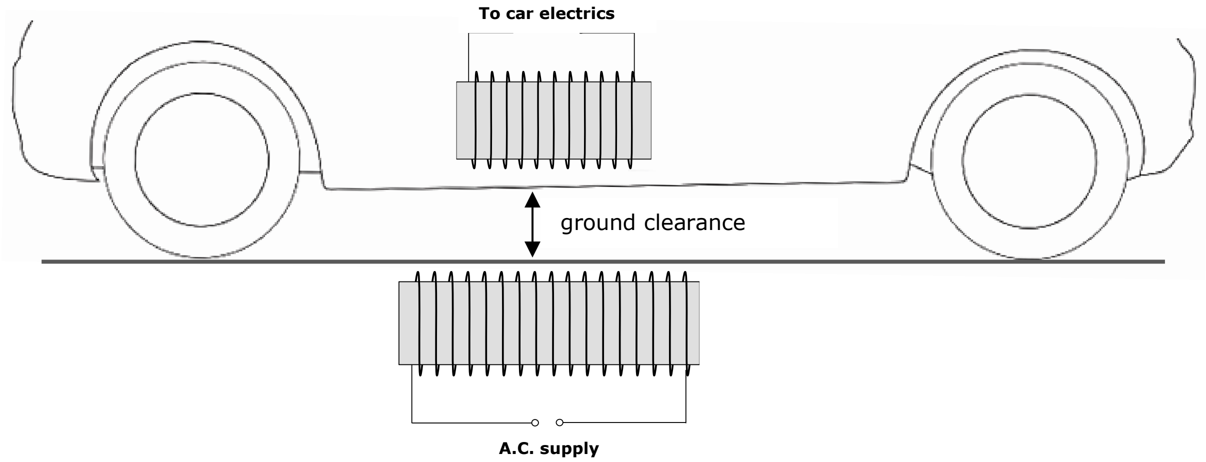
____ (1)

ii. On the axes above, sketch the resultant graph showing how current will vary with time when the component listed in part (i) is connected to an A.C. supply. (2)

(Total: 20 marks)

20

5. In recent years, the concept of dynamic wireless charging has been introduced in the car manufacturing industry. This concept enables drivers to charge their cars while driving, by having coils connected to an A.C. supply installed on the roads and another coil installed on the bottom of the car, connected to its battery.



a. Explain what happens when the car's coil is vertically aligned with the underground's coil, which is connected with an AC supply.

____

____

____ (3)

b. Identify **TWO** reasons why this setup is not 100% efficient.

____

____ (2)

c. This concept may **not** work for large trucks with high ground clearance. Suggest **TWO** ways how this setup can be modified to solve this problem.

____

____ (2)

d. During the trials, cars which were **not** vertically aligned with the underground's coil, still experienced some charging. Explain.

____

____ (1)

e. When roads are covered with rainwater, although water will get in the way between the two coils, the car would still be able to charge. Explain.

____

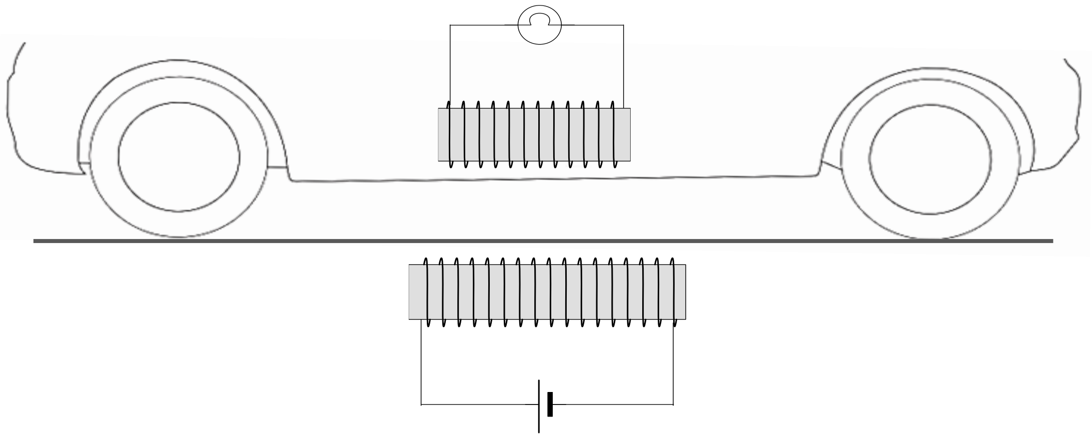
____ (1)

f. The underground's coil is connected with 240 V A.C. supply while the car's coil, having 200 turns, is connected with a 12 V storing battery. Calculate the number of wire turns that the underground's coil should have to ensure charging. Assume no energy losses.

____

____ (2)

Prior to trying this concept on cars, it was tested on a small-scale model as shown in the diagram. The toy car included a coil connected with a bulb. The toy car was moved on a cardboard paper, which had a coil underneath, connected to a battery.



g. The toy car was moved back and forth multiple times, and although a D.C. supply was being used, the bulb emitted light. Explain why.

____

____

____ (3)

h. When the toy car was moved at a faster rate, the light emitted was brighter. Explain.

____

____ (2)

i. State the Law being referred to in the previous question.

____

____ (2)

j. When the toy car was moved back and forth at the same speed, the brightness of the light being emitted was unchanged. However, when the bulb was replaced by a galvanometer, two different deflections were observed during the two different movements. Explain.

____

____ (2)

(Total: 20 marks)

20

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Index Number:________________ SEC24/2B.22m

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

SECONDARY EDUCATION CERTIFICATE LEVEL
2022 MAIN SESSION

SUBJECT:	**Physics**
PAPER NUMBER:	IIB
DATE:	28th May 2022
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/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 $= \pi r^2$		

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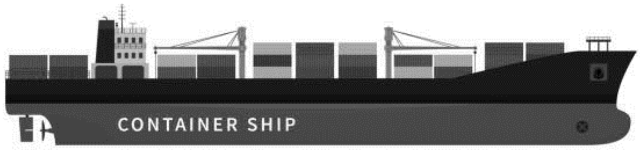
1. The figure below shows a large container ship travelling towards the Malta Freeport Terminal at Birzebbuga.



(Source: https://images.app.goo.gl/Ln3wihmcDFfJwtTy7)

a. The ship is travelling at a constant speed in a straight line.

i. The ship has a total of 2800 kN of resistive forces acting on it. Write down this value in Newtons.

______________________________ (1)

ii. Identify **ONE** of the resistive forces acting on the ship.

______________________________ (1)

iii. A growing awareness on climate change in the shipping industry has encouraged ship owners to lower speeds of large container ships. One advantage is that it reduces fuel consumption. Hence, give **TWO** other advantages of lowering speeds.

____

______________________________ (2)

iv. The steam engines are powered by oil. State the energy transfer that is taking place when the ship is travelling at constant speed.

____

______________________________ (2)

b. The mass of the ship is 2.2×10^8 kg. The engines are switched off and the resistive forces cause the ship to decelerate.

i. Calculate the initial deceleration/acceleration of the ship.

____

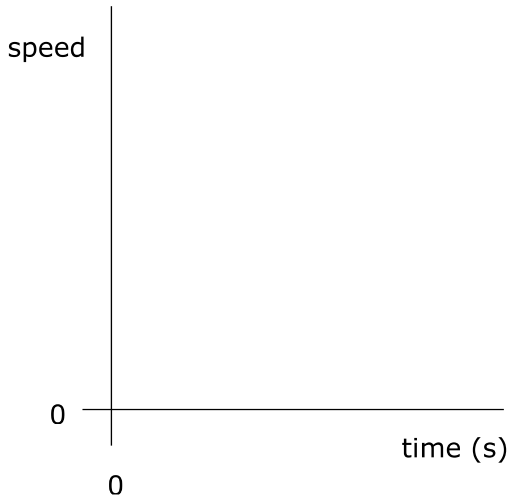
______________________________ (2)

ii. Hence or otherwise, find the velocity of the ship at the time the engines were switched off if its velocity after 300 s was 2.1 m/s. Assume that the acceleration of the ship was constant during this time.

____

______________________________ (2)

iii. Sketch on the axes below, a speed-time graph for the situation described in part b(ii).(3)



iv. Explain how the distance travelled by the ship may be determined from the speed-time graph.

____

____ (1)

c. When the ship is travelling at a different speed, energy is being supplied to the engines at a rate of 33 MJ/ s.

i. State the value of the energy per second supplied to the engines in Joules.

____ (1)

ii. Name **TWO** main forms of energy loss of the onboard machinery.

____ (2)

iii. Calculate the efficiency of the engines if their output energy is 11880000 J.

____

____ (2)

iv. Steam is generated by boilers in ships. Generally, the excess steam is wasted. Give one way how this excess steam can be utilised to produce useful energy.

____

____ (1)

(Total: 20 marks)

20

2. This question is about heat.

a. Circle the correct word in the following statements:

i. Heat transfer in a vacuum is only possible by convection / radiation. (1)

ii. Water is a good material for storing heat as it has a low / high value of specific heat capacity. (1)

iii. A hot air balloon rises because hot air is less / more dense than cold air. (1)

iv. As a liquid evaporates, the more energetic particles escape first from the liquid hence the temperature of the remaining liquid falls / rises. (1)

v. Gases expand more than solids when heated because the particles in solids are more / less tightly bound than those in gases. (1)

vi. Heat energy normally travels from a cold / hot place to a cold / hot place. (1)

b. Give a brief scientific explanation for the following.

i. The air inside a closed transparent glass bottle left in the sun is warmer than that of the air outside the bottle.

____

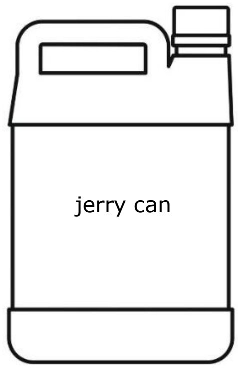
____ (2)

ii. Explain why light-weight survival blankets are normally silvered and not black.

____

____ (2)

c. You are asked to design an experiment to investigate which of two given materials is more efficient as lagging. This lagging is to be placed around a plastic container, shown here and filled to the top with hot water, in order to keep the water inside hot for a long time.



(Source: https://images.app.goo.gl/)

The following items of apparatus is available:

- a plastic container as shown in the figure;
- a supply of hot water at 85 °C;
- two lagging materials, A and B, under investigation.

i. Two measuring instruments are also needed to carry out this investigation. Name these instruments.

____ (2)

ii. The following are steps taken to carry out this investigation. Write down their correct sequence, numbered 1 to 5, by writing the correct number in the column on the right.

The experiment is repeated, this time using material B as lagging.	
Temperature readings are taken at regular intervals as the water cools.	
A graph is for both sets of readings is drawn from the table of results.	
The readings are put in a table of results.	
The container is surrounded by material A and filled to the top with hot water.	

(5)

iii. Why is the water stirred before taking the temperature readings?

____ (1)

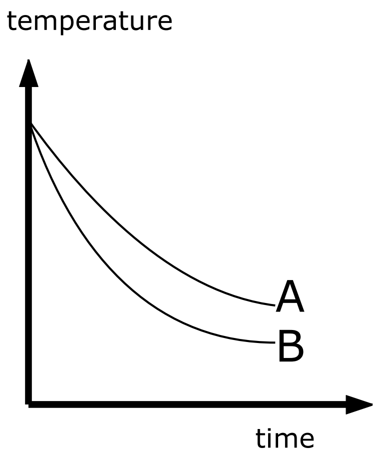
iv. The results are inputted in a table. In all, you should be taking readings of three variables. Complete the table by filling in the name of the other variable. The other two have already been done for you.

temperature of water using material A (°C)					
temperature of water using material B (°C)					

(1)

v. Two graphs were plotted on the same axis from the readings of this experiment and the resulting graphs are shown here.
State which of the two materials A or B is the better insulator in this case.

______________________________ (1)

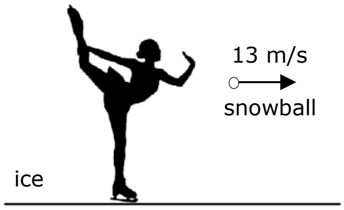


(Total: 20 marks)

20

3. The figure shows Karen in a stationary position during skating practice.

a. She throws a snowball of mass 0.23 kg with a velocity of 13 m/s.



i. Calculate the initial momentum of the snowball.

____

____ (2)

ii. Karen notices that when she throws the snowball forwards, she slides backwards on ice. Explain in terms of Newton's third law, why this happens.

____

____

____ (3)

iii. Karen wears soft knee pads that compress easily. Explain how the pads protect her knees when she falls on the ice.

____

____

____ (3)

iv. Karen throws another snowball which crashes into a garden wall nearby. Describe what happens to the energy of the snowball when it hits the wall.

____

____

____ (2)

b. After skating practice, Karen pulls her brother Darren, on a sledge.

i. The mass of Darren and the sledge is 38 kg. Determine their combined weight.

____ (1)

ii. Calculate the force needed by Karen if the sledge accelerates at 1.5 m/s^2.

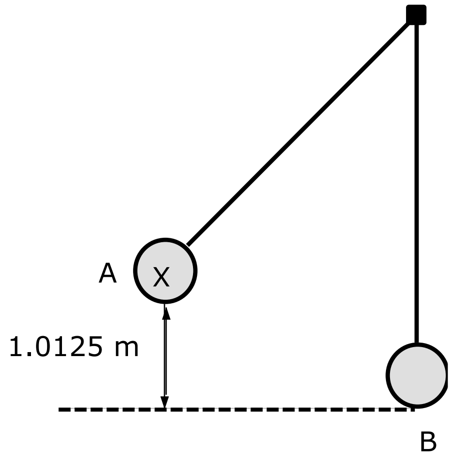
____

____ (2)

iii. Give a reason why the force exerted on the sledge by Karen must be in reality greater than the force calculated in part b(ii).

(1)

c. A Ball X, is supported by a long solid rod of negligible mass. The rod is suspended from the other side from a support as shown in the diagram. There is also negligible friction between the rod and the support. The ball is released from position A and reaches position B when the rod is vertical.



i. Assuming there is no air resistance, state the energy changes in this system when the ball is at point A and when it is at point B.

(1)

ii. Hence or otherwise, calculate the speed of the ball at point B, if point A is 1.0125 m above point B.

(2)

iii. Calculate the mass of Ball X, in grams, if its momentum at point B is 0.225 kgm/s.

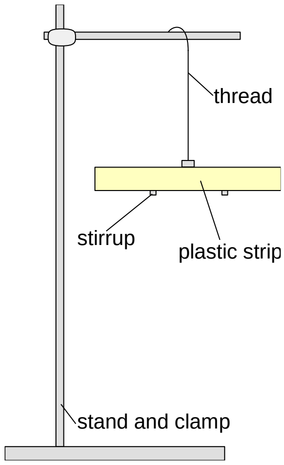
(3)

(Total: 20 marks)

20

4. This question is about electricity.

a. The figure shows a plastic strip hanging freely from a retort stand using a stirrup and an insulating thread.



An investigation is carried out to determine if the strip is charged positively or negatively. A student is provided with another two plastic strips, X and Y.

i. Strip X becomes negatively charged when rubbed with a cloth. Does this imply it has a surplus of electrons or protons?

____ (1)

ii. Strip Y becomes positively charged when rubbed with a cloth. Which charge does the cloth acquire? Explain.

____

____ (2)

iii. Explain why the thread supporting the stirrup must be made from an insulating material.

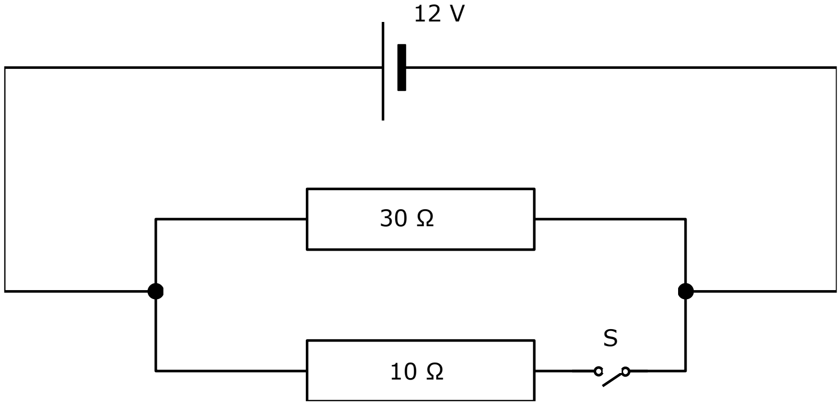
____ (1)

iv. The negatively charged strip X attracts the hanging strip, when brought close to it without making contact. What excess charge does the hanging strip carry? Explain.

____

____ (2)

b. The circuit in the figure below shows a 12 V direct current (D.C.) supply connected to two resistors in parallel. S is a switch connected in series with the 10 Ω resistor.



i. Use an arrow to show the direction of the current in the circuit above. (1)

ii. Calculate the current in the circuit with switch S open.

____

____ (2)

Switch S is now closed.

iii. Calculate the total resistance in the circuit.

____

____ (2)

iv. Calculate the new total current in the circuit.

____

____ (2)

v. Calculate the total power dissipated in the circuit.

____

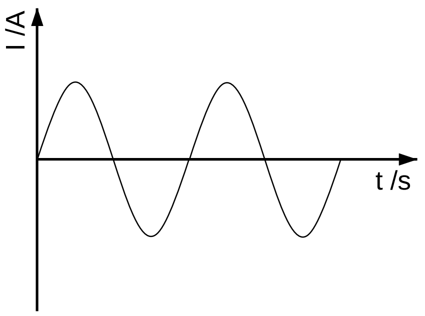
____ (2)

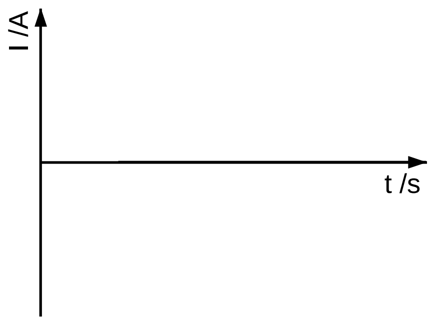
vi. Calculate the total energy delivered by the supply in 60 s.

____

____ (2)

c. The graph in figure below shows how current varies through a resistor when it is connected to an alternating current (A.C.) supply.





i. Complete the following statement.
An alternating current changes _________________ with every half a cycle. (1)

ii. A diode can be used in an A.C. circuit to convert the current from A.C. to D.C. Draw the symbol used in circuits for a diode.

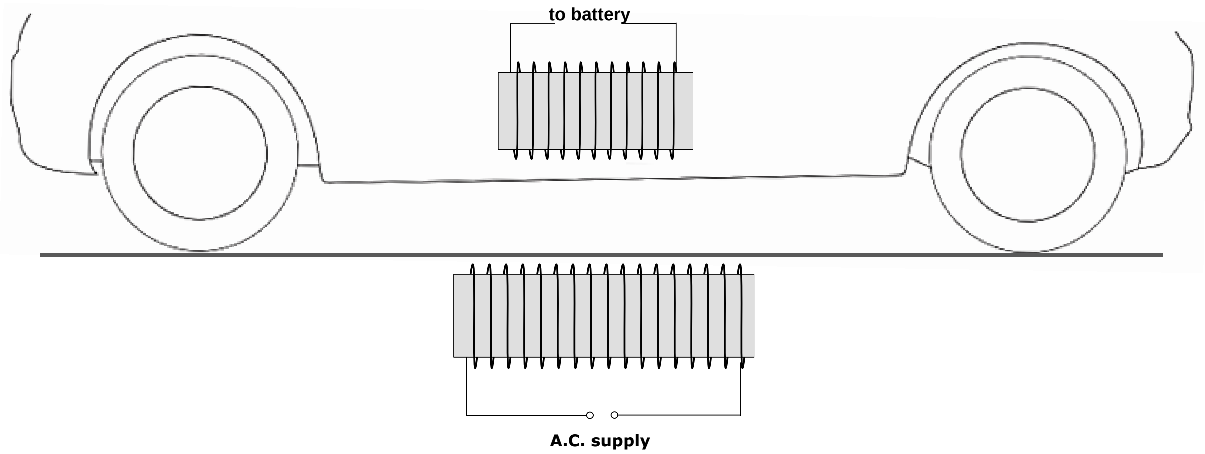
(1)

iii. When a diode is used as mentioned in part c(ii), half-wave rectification of the A.C supply is produced. Show the resultant half-wave rectification on the axes provided above. (1)

(Total: 20 marks)

20

5. In recent years, the concept of dynamic wireless charging has been introduced in the car manufacturing industry. This concept enables drivers to charge their cars while driving, by having coils connected to an A.C. supply installed on the roads and another coil installed on the bottom of the car, connected to its battery.



a. What is an electric transformer?

____ (1)

b. When current flows in the underground coil, a magnetic field is formed around it. Describe the shape of this field.

____

____ (2)

c. On the same diagram, draw the field around the underground's coil and mark with 'X' where the field is strongest and 'Y where the field is the weakest. (2)

d. Since the field direction changes with the current direction, the car's coil ends up continuously 'cutting' the field lines. What will be the result in the car's coil? Explain.

____

____ (2)

e. Identify **TWO** reasons why this setup is not 100% efficient.

____

____ (2)

f. This concept may not work with trucks that have high ground clearance. Suggest **TWO** ways how the field around the underground coil can be made stronger.

____

____

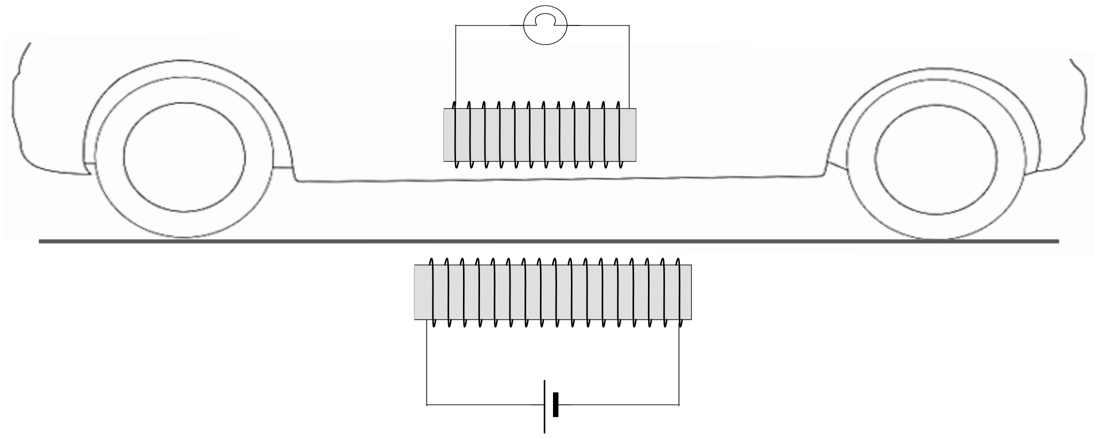
____ (2)

g. When it rains, water will get in the way between the two coils. Explain if the car would still be able to charge.

____

____ (1)

Prior trying this concept on cars, it was tested on a small-scale model as shown in the diagram. The toy car included a coil connected with a bulb. The toy car was moved on a cardboard paper, which had a coil underneath, connected to a battery.



h. Will the voltage in the bulb be higher or lower than that of the battery?

____ (1)

i. Compare the field formed around the underground coil in this case to the one in part (b).

____

____ (2)

j. Fill in the blanks.

When the toy car was not moved, the bulb did not light. This is because there was no 'cutting' of field lines and thus ______________________ was not being induced in the car's coil. If the toy car was moved back and forth, the bulb continued to light. The faster the toy car was moved, the ________________________ current was induced in the car's coil. This law is called __________________________________. (3)

k. State the Law being referred to in the previous question.

____

____ (2)

(Total: 20 marks)

20

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