Index Number: _______________ SEC24/1.17s

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

SECONDARY EDUCATION CERTIFICATE LEVEL

SEPTEMBER 2017 SESSION

SUBJECT:	**Physics**
PAPER NUMBER:	I
DATE:	30th August 2017
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	$\text{Moment} = F \times \text{perpendicular distance}$		
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. Georg Ohm (1789 – 1854) was a German physicist and mathematician. He was a school teacher who was interested in research about the relationship between current, voltage and resistance.

Source: https://en.wikipedia.org

a. From the following, choose the correct physical quantity, to match its explanation:

Voltage	**Current**	**Resistance**
i.		the rate at which charge flows
ii.		the tendency of a material to oppose the flow of charge
iii.		the difference in energy per unit charge between two points

(3)

b. Ohm found that "there is a direct proportionality between the voltage applied across a conductor and the electric current flowing through that conductor." This is called Ohm's Law.

i. State **ONE** condition made for this law to hold.

____ (1)

ii. Sketch the I-V graph for a filament lamp in the space provided. (2)

iii. Comment on the shape of the graph.

____

____

____ (2)

c. What current flows through an electric guitar plugged into a 240 V supply if it has a resistance of 0.05 kΩ?

____

____

____ (2)

(Total: 10 marks)

10

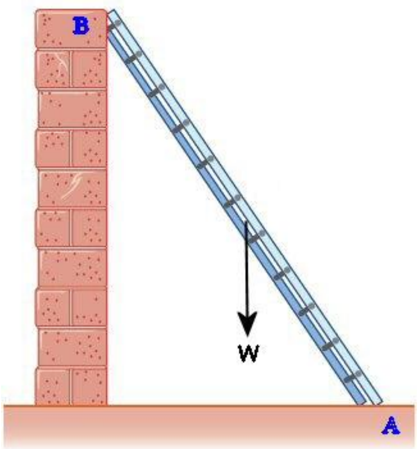
2. A force is defined as a pull or a push that one object exerts on another. There are various types of forces. The ladder, shown in the diagram below is resting against a wall. This question is about the several forces acting on the ladder.

a. Underline the correct word (scalar or vector) and fill in the **TWO** blank spaces in the following sentence:

A force is a (scalar / vector) quantity because it has both ______________________________ and

______________________________ . (3)

b. Lisa wants to hang a picture up a wall and uses a ladder AB of mass 12 kg to do so. The ladder is standing on rough ground and resting against the wall. There are several forces acting on the ladder. One of them is the pull of the earth on the ladder, commonly known as weight. This force is labelled W in the diagram.



Source: http://cnx.org

i. Calculate the size of this force W.

____ (2)

ii. Draw on the diagram an arrow, labelled R, showing the vertical reaction force of the ground on the ladder at A. (1)

iii. Lisa now starts to climb up the ladder. How would this affect the size of force R?

____(1)

c. The base of the ladder does not slip and move away from the wall because of the frictional force between the ladder and the ground at A.

i. On the diagram draw an arrow, labelled F, showing this force on the ladder. (1)

ii. Circle the correct answer:

If the ground was smooth and not rough, the size of this frictional force would have been

smaller / the same / greater. (1)

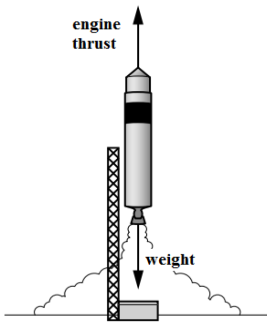
iii. For the same ladder and type of ground, name **ONE** way of reducing the chance of the ladder slipping away from the wall.

____(1)

(Total: 10 marks)

10

3. Apollo 11 was the spaceflight that landed the first two humans on the Moon. The rocket and fuel used to launch the spacecraft had a total mass of 2.3×10^6 kg. The resultant force acting upwards on the rocket was 9×10^7 N. The figure shows the rocket as it takes off.



Source: https://en.wikipedia.org/

a. State the total weight of the rocket and fuel.

____(1)

b. Hence find the upward thrust produced by the rocket engine.

____(1)

c. Calculate the acceleration of the rocket.

____

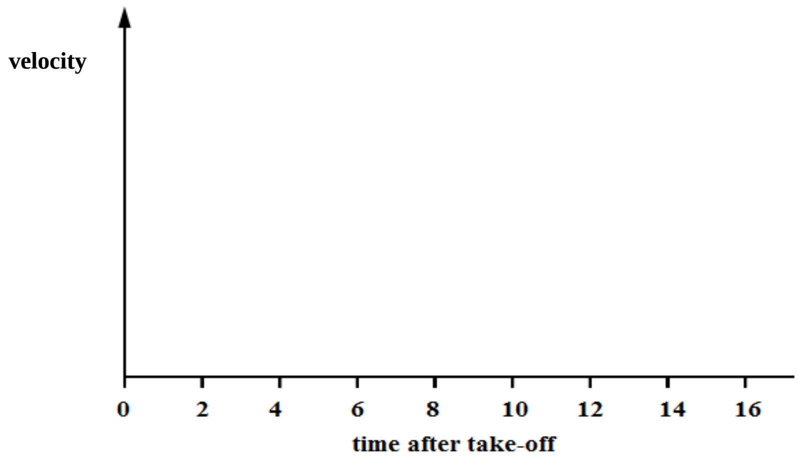
____(2)

d. After 15 minutes from take-off, the rocket stops accelerating. Explain why the rocket stops accelerating.

____(1)

e. The table below describes the motion of the rocket in the first 16 minutes. Use it to sketch the velocity-time graph of the rocket for the first 16 minutes. You do not need to give values for velocity. (Assume that the rocket is moving in one direction) (4)

Time in minutes	**Motion of rocket**
0 to 4	Uniform acceleration
4 to 8	Increasing acceleration
8 to 13	Decreasing acceleration
13 to 16	Constant velocity



f. State how the velocity-time graph in part (e) can be used to find the distance travelled by the rocket.

____(1)

(Total: 10 marks)

10

4. Solar energy is a renewable energy source used to generate electricity.

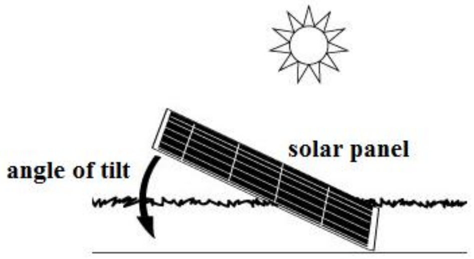
a. What is meant by renewable energy source?

____(1)

b. Name **TWO** other renewable energy sources used to generate electricity.

____(2)

c. A householder uses panels of solar cells to generate electricity for his home. The solar panels can be tilted to receive maximum energy input from the Sun.



Month	Angle of tilt		
	15°	**30°**	**55°**
January	460	550	430
April	600	630	600
August	650	660	570
December	430	440	410

i. The table gives the energy received from the sun each second (in J/s) onto a 1 m^2 area of solar cells for different angles of tilt during different months of the year.
Use the data in the table to describe how the average energy received by the panels depends on the angle of tilt.

____

____(2)

ii. The total area of the solar cell panels used by the householder is 6 m^2 and these are considered to have an efficiency of 22%. Use the data in the table to calculate the maximum electrical energy available from the solar panels each second in August.

____

____

____(4)

d. Most of the electricity in our homes is still generated from a fossil fuel power station. Give **ONE** advantage of using solar cells to generate electricity compared to using fossil fuels.

____(1)

(Total: 10 marks)

10

5. Carbon-14 is a radioactive isotope. A small amount of radioactive carbon-14 is found in all living organisms because it enters the food chain. An estimated time since an organism died can be found by measuring the amount of carbon-14 left in its remains. Carbon-14 decays over a long period of time.

Source: https://www.dreamstime.com

a. What is an isotope?

____

____ (2)

b. The following table shows the percentage of carbon-14 remaining in a dead body over time.

Percentage of Carbon – 14 remaining in a dead body (%)	100.00	50.00	25.00	12.50	6.75
Time (years)	0	5730	11460	17190	22920

i. Draw a graph of the percentage of carbon-14 (y-axis) against time (x-axis). (4)

ii. What is the half-life of carbon-14? Explain.

____

____ (2)

iii. After how many years would 75% of the original carbon-14 remain in a dead body?

____ (1)

iv. What would be the percentage of carbon-14 in a dead body after 34,380 years?

____ (1)

(Total: 10 marks)

10

10

6. A full supermarket trolley was rolled with a velocity of 6 m/s towards five stationary empty trolleys.

a. After colliding and linking to them, the six trolleys now moved together with half the initial velocity of the full trolley. Each trolley has a mass of 8 kg when empty.

i. State the law of conservation of momentum.

____

____(2)

ii. State the initial momentum of the five empty trolleys.

____(1)

iii. Given that the mass of the moving trolley when full is M, give the total initial momentum in terms M.

____(1)

iv. Use the law stated in part (i) to calculate the value of the mass M.

____

____

____(3)

v. Hence calculate the mass of the goods placed in the trolley.

____(1)

b. The trolleys come to rest immediately after colliding with a wall.

i. State Newton's second law of motion.

____(1)

ii. Use this law to explain why after the impact some fragile goods within the trolley might have been damaged.

____(1)

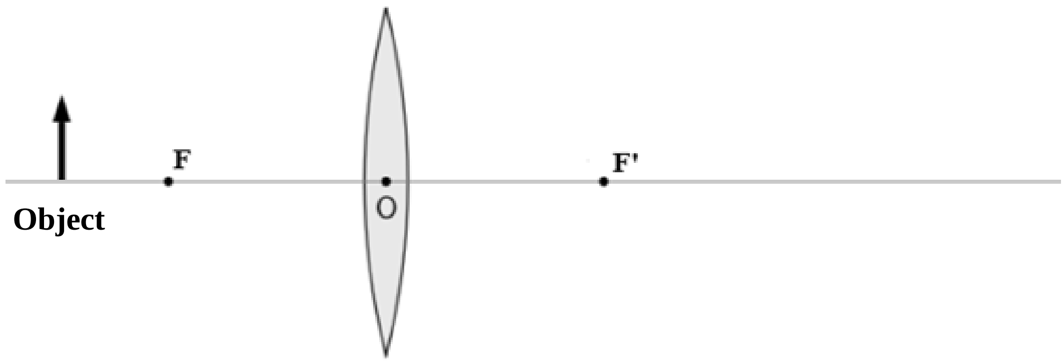
(Total: 10 marks)

10

7. Lenses can be converging or diverging.

a. The diagram below shows an object, represented by an arrow placed next to a converging lens. F represents the focal point of the lens.

  i. Complete the diagram by using **TWO** rays emerging from the tip of the arrow representing the object, to show the position of the image formed. Illustrate your image using an arrow and label it as ‘**I**’. (3)



  ii. Is the image real or virtual?

____(1)

  iii. State a practical use for when the object is placed in this position.

____(1)

  iv. Use a ruler and measure the size of the object and the image, in cm.

Height of object = ___________ cm Height of image = ___________ cm

(2)

  v. Calculate the magnification of the lens used.

____(1)

b. As the rays of light enter the convergent lens, their direction will change.

  i. State the name of this phenomenon.

____(1)

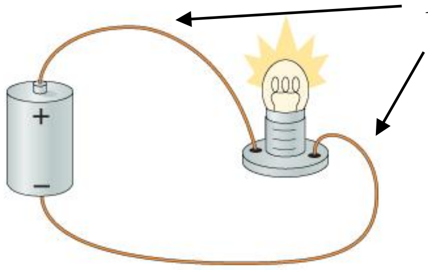
  ii. State the changes, if any, in the direction of the rays if instead of a converging lens, they entered a diverging lens.

____(1)

(Total: 10 marks)

10

8. Consider the following circuit.



Source: http://www.bulbs.com

a. Complete the following energy flow diagram. (4)

___________ energy in the battery	→	Electrical energy in the _________	→	_____________ energy and ___________ energy in the bulb

b. Explain what happens if the insulated copper wire is replaced with pieces of rubber band.

____

____ (2)

c. A 14.4 W bulb was connected to a 240 V mains supply.

i. Calculate the amount of current passing through the bulb.

____

____ (2)

ii. What is the amount of electrical energy used if the bulb is on for 12 hours?

____

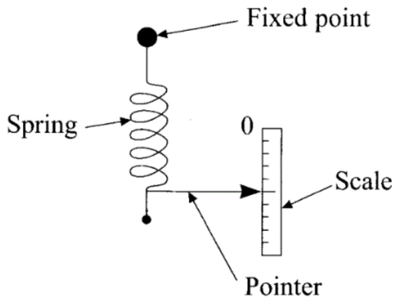
____ (2)

(Total: 10 marks)

10

9. Luca and Lorraine are investigating the behaviour of a spring.

a. They suspend it from a fixed point and use a pointer and a vertical scale to find the extension produced when loads are hung from the lower end of the spring. They find that with every 1 N of added load the spring extends by 10 mm. They make sure that throughout the whole experiment the load does not exceed the elastic limit of the spring.



i. State Hooke's Law.

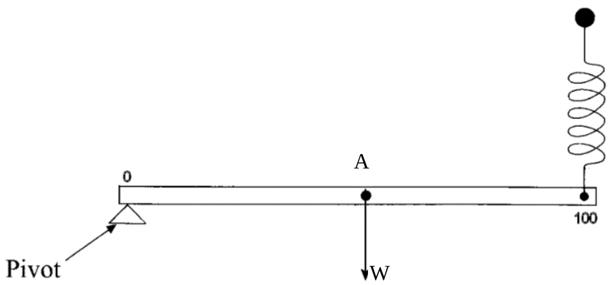
____

____(2)

ii. State the changes that would occur to the following if the elastic limit is exceeded:

- the extension for every 1 N added ______________________________ (1)
- the length of the unloaded spring ______________________________ (1)

b. Lorraine removes the load from the spring and Luca attaches a uniform meter ruler at the 100 cm mark to the spring. The other end of the ruler is placed on a pivot at the 0 cm mark. They measure the extension produced using the vertical scale as above.



i. W represents the weight of the ruler. What is the name usually given to point A?

____(1)

ii. How do we know that in this case point A lies at the midpoint of the ruler?

____(1)

iii. The extension of the spring produced in this case was measured to be 5 mm. Calculate the force acting on the spring by the ruler. (Assume that the ruler is horizontal.)

____(1)

iv. The force just calculated in part (iii) is equal to the upward force on the ruler by the spring. Taking moments about the pivot, calculate the weight of the ruler.

____

____

____(3)

(Total: 10 marks)

10

10. The following table shows the distance of various objects from planet Earth.

Object	Distance
Space observation satellite	300 km
Weather satellite	36,000 km
The moon	384,000 km
The sun	150,000,000 km
Centre of Milky Way Galaxy	25,000 light years
Andromeda Galaxy	2 million light years

a. State which object is farthest from Earth.

____ (1)

b. Calculate the distance travelled by light in a year. (speed of light in a vacuum is 3×10^8 m/s)

____

____ (2)

c. What kind of instrument can be used to observe the sky from planet Earth?

____ (1)

d. One common factor between the sun and the moon is that both can be seen from planet Earth. Mention **TWO** differences between the sun and the moon.

____

____ (2)

e. Explain what keeps a weather satellite orbiting around the Earth.

____

____ (2)

f. Space exploration leads the way for advanced technology. Mention another **TWO** benefits of space research.

____

____ (2)

(Total: 10 marks)

10

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

SECONDARY EDUCATION CERTIFICATE LEVEL

SEPTEMBER 2017 SESSION

SUBJECT:	**Physics**
PAPER NUMBER:	IIB
DATE:	30th August 2017
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	$\text{Moment} = F \times \text{perpendicular distance}$		
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	$\text{Area of a triangle} = \frac{1}{2} b h$	$\text{Area of a trapezium} = \frac{1}{2}(a + b) h$	
	$\text{Area of a circle} = \pi r^2$		

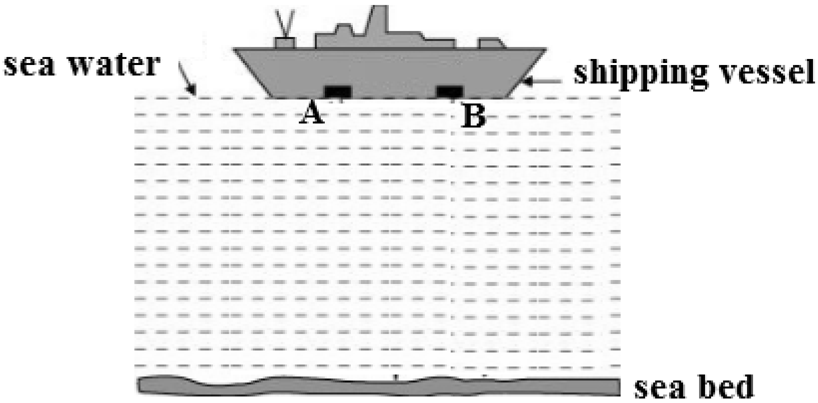
1. This question is about waves.

a. Fill in the missing blanks using the given words.

longitudinal **parallel** **energy** **transverse** **perpendicular**

Water waves are _______________ waves, since the particles vibrate _______________ to the direction of travel of the wave. Waves carry _______________ in the process. On the other hand, sound waves are _______________ waves and the particles vibrate _______________ to the direction of travel of the wave. (5)

b. A fishing vessel uses ultrasonic sound pulses to detect the depth of the water. The diagram below shows a vessel with an ultrasound transmitter at point A and a detector at point B.



i. Use lines to show the path of the ultrasound as it is emitted at A and received at B. (2)

ii. Calculate the time taken for a pulse to travel from point A to point B, if the depth of the water at this instant is 40 m. The speed of ultrasound in sea water is 1500 m/s.

____

____ (2)

iii. Give another use of ultrasonic sound pulses by fishing vessels.

____ (1)

iv. Circle the correct value above which the longitudinal wave would be considered as ultrasound.

20 Hz 200 Hz 2000 Hz 20000 Hz

(1)

c. Ocean waves, which travel in the open sea at 5 m/s, arrive at a beach once every 4 s. Calculate the distance between the peak of crest and the peak of a trough in open sea.

____

____

____

____ (4)

d. The diagram below shows two musical instruments; the drum and the violin, together with a description of the sound they produce.

Underline the correct word (High or Low) to describe the frequency and amplitude of both the drum and the violin.

Musical instrument	**Sound produced**	**Frequency**	**Amplitude**
 Drum	Very loud Low pitch	High OR Low	High OR Low
 Violin	Not very loud High pitch	High OR Low	High OR Low

(4)

e. The diagram below shows a speaker which is switched on close to a human ear. On the diagram, draw the air particles to show their motion as the sound wave travels towards the ear.

(1)

speaker

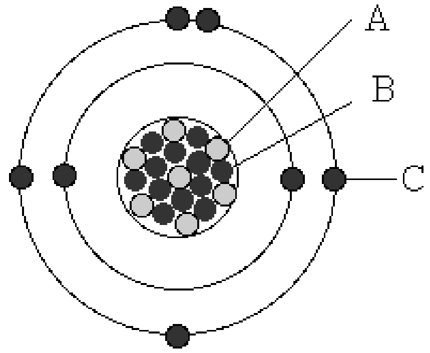
ear

(Total: 20 marks)

20

2. This question is about radioactivity.

a. The following diagram represents an atom. Particles A and C are charged.



Source: http://www.bbc.co.uk

i. Name particles:

A: ______________________

B: ______________________

C: ______________________

(3)

ii. The central part of the atom is called the ____________________________________ (1)

iii. Particles C are found in the atom's ____________________________________ (1)

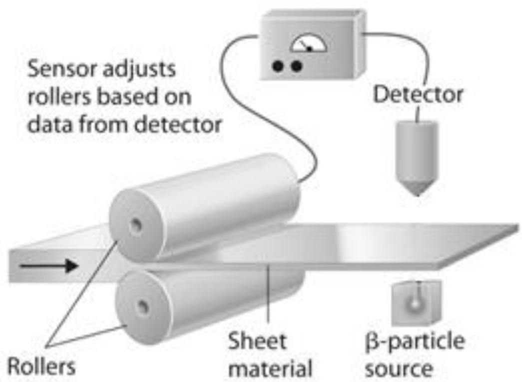
b. Mark the following statements as True (T) or False (F).

i. Radiation can be measured using a GM Tube. ____________ (1)

ii. The count rate of the GM Tube always starts from zero. ____________ (1)

iii. Radioactive substances should never be handled with bare hands. ____________ (1)

c. The diagram below shows how a beta emitting radioactive isotope can be used to ensure that the material is produced with the same thickness.



Source: https://saylordotorg.github.io

i. Explain how the equipment above can be used to show whether the material is too thick or thin.

____

____

____

____ (2)

ii. How will the detector note that the material is too thick? Explain.

____

____ (2)

iii. If the material is found to be thinner than it should be, how will any adjustment be made in the equipment?

____

____ (2)

iv. Give reasons why alpha or gamma sources will not be suitable to be used as radioactive sources in such an equipment.

____

____

____ (2)

v. Give **TWO** reasons why a beta emitter with a half-life of many years should be used.

____

____ (2)

vi. Name **ONE** material that may have its thickness measured using this setup.

____ (1)

d. Mention **ONE** other use of radioactivity where a source with a short half-life may be used.

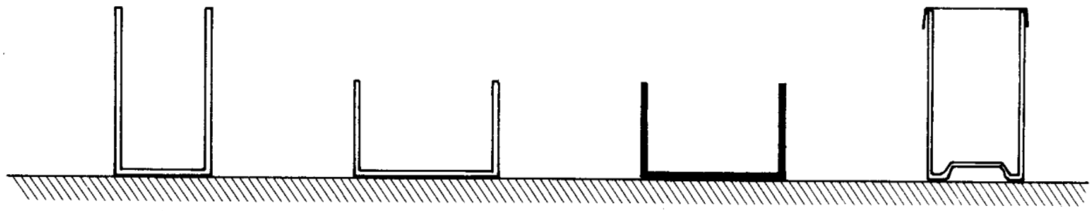
____ (1)

(Total: 20 marks)

20

3. This question is about heat and heat transfer.

It is common knowledge that a cup of hot drink left on a table cools down and so warms its surroundings.
Sarah works for a company which manufactures plastic cups used to hold a drink of hot coffee. The company has four different cup designs as shown in the following figure.



Cup C is made from dark plastic while cups A, B and D are made from white plastic. The base of cup D is elevated at the center, leaving an air space between the cup and the surface; this cup is also fitted with a lid. All 4 cups have the same volume. The manufacturer wants to know which cup can keep the coffee hot for the longest time. He asks Sarah to design an experiment to find this out. Sarah fills the cups with hot water and measures the temperature of the water in each cup at one minute intervals.

a. To prepare the hot water needed for this experiment, Sarah fills an electric kettle with 1.5 kg of cold water at a temperature of 15 ^{o}C and switches on the kettle until the water boils at 100 ^{o}C. The specific heat capacity of water is 4200 J/kg^{o}C.

   i. Calculate the energy required to bring the water to the boil.

____

____

____ (3)

   ii. Calculate the time it takes for the water to boil if the power of the kettle is 2000 W.

____

____ (2)

   iii. Explain why in practice the time taken is longer.

____

____ (2)

b. Having obtained the hot water, Sarah then carries out the experiment. The steps needed in the method she used are shown below but are not in order. In the space on the right hand side, write down the numbers 1 to 5 to show the correct order. 1 being the first step whilst 5 is the last step.

The results are recorded in a table	
Each cup is filled with the same volume of hot water	
A graph of temperature against time for each cup is plotted	
The four empty cups are placed on the same surface	
The temperature of the water in each cup is taken at regular intervals	

(5)

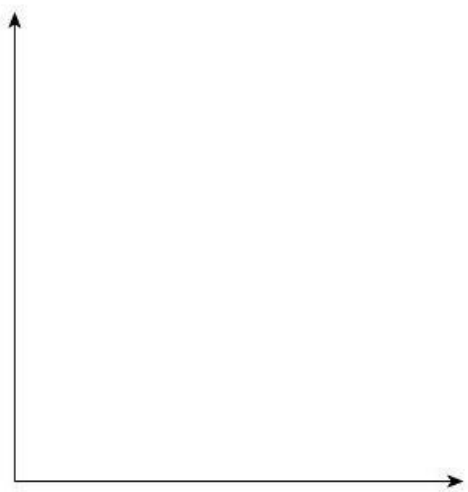
c. State **ONE** precaution that needs to be taken before taking each temperature and briefly explain why this is necessary.

____

____

______________________________________ (2)

d. Draw a rough sketch of the graph you would expect to obtain for any one of the cups. It is important to label both axes with the quantities. (2)



e. Give a reason why:

i. the water in cup B is found to remain hotter than in cup C.

____ (1)

ii. the water in cup A is found to remain hotter than in cup B.

____ (1)

iii. Give **TWO** reasons why the water in cup D is expected to remain hotter than in cup A.

____

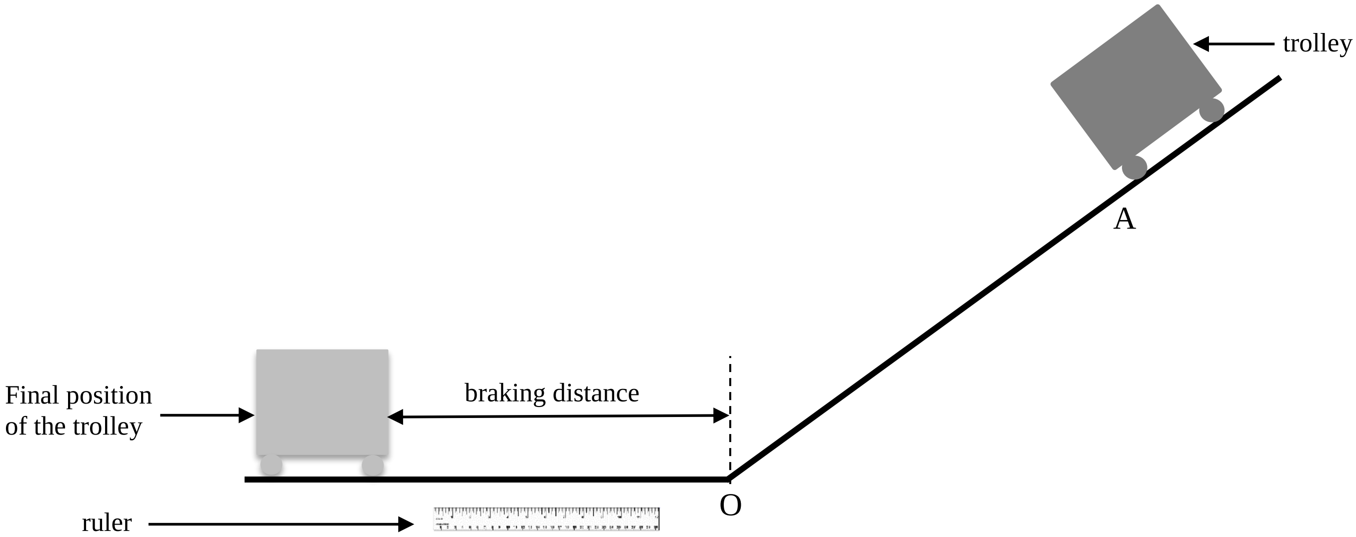
____ (2)

(Total: 20 marks)

20

4. This question is about braking distance.

Malcolm was given the apparatus as shown in the diagram below. Malcolm was asked to investigate the relationship between speed and braking distance.



a. State **TWO** factors, apart from speed and opposing forces that may affect the braking distance of such a trolley in the setup above.

____

____ (2)

b. If the trolley of mass m is let go at point A, explain the relationship between the potential energy of the trolley at point A and its kinetic energy at point O.

____

____ (2)

c. Hence or otherwise, express the velocity of the trolley at point O in terms of the vertical height at which the trolley was before it was let go.

____

____ (2)

d. List **FOUR** steps that Malcolm had to follow to do the experiment.

____

____

(4)

e. Why is it important that the trolley is let go and not pushed?

(2)

f. Malcolm obtained the results below during the experiment

Speed [m/s]	0.62	1.04	1.38	1.78
Braking Distance [m]	0.15	0.43	0.83	1.28

i. From the readings above, write a possible conclusion to the experiment.

(2)

ii. Work out the kinetic energy of the trolley at O when the braking distance was 0.83 m if the mass of the trolley is 0.21 kg.

(2)

iii. Hence or otherwise find the height at which the trolley was let go.

(3)

g. Suggest, giving reasons, **ONE** possible improvement to this investigation.

(1)

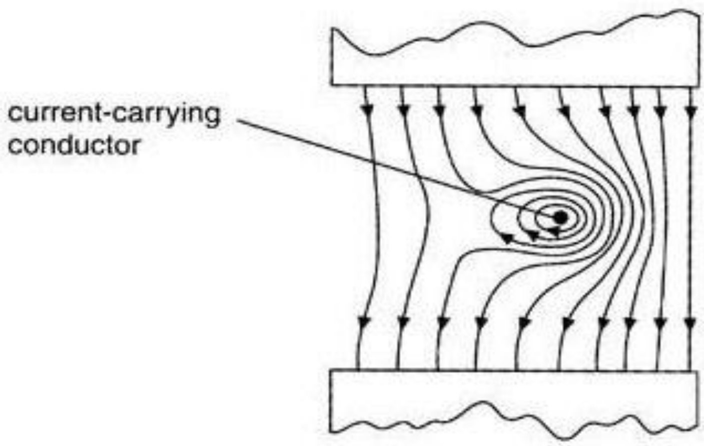
(Total: 20 marks)

20

5. This question is about electromagnetism and electromagnetic induction.

a. The diagram on the right shows the magnetic field pattern obtained when a conductor carrying a current is placed between the poles of a permanent magnet.

   i. Name a material which can be used to make such a magnet and clearly explain your choice.



Source: https://www.electrical4u.com

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______________________________ (2)

   ii. Label on the diagram, with the letters N and S respectively, the north and south poles of the magnet. (2)

   iii. Is the direction of the current in the conductor into the paper or out of the paper?

______________________________ (1)

   iv. Name the rule used to obtain the answer in part (iii).

______________________________ (1)

The conductor in the diagram above experiences a force. On the diagram, draw an arrow to show the direction of the force on the wire and label it F.

   v. Name the rule which can be used to determine the direction of this force.

______________________________ (2)

   vi. State **TWO** ways by which the size of the force F on the conductor can be increased.

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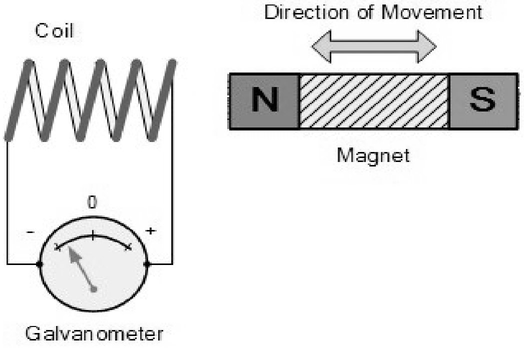
______________________________ (2)

   vii. Name **ONE** device which makes use of this force for its operation.

______________________________ (1)

b. The diagram shows a bar magnet near a coil of wire whose terminals are connected to a galvanometer.

i. The needle of the galvanometer is seen to deflect when the bar magnet is moved towards the coil. Explain clearly why this happens.



Source: *https://en.wikipedia.org*

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____(2)

ii. State **TWO** ways by which the size of this deflection can be increased.

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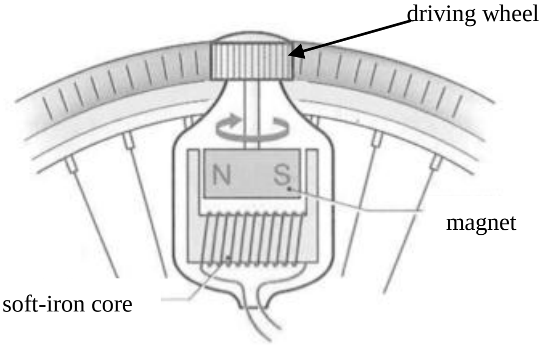
____(2)

iii. It is observed that when the north pole of the magnet is moved towards the coil, the needle of the galvanometer deflects to the left as shown in the diagram. Complete the table below to show what is observed in all the following situations. (3)

N pole of magnet moved towards the coil	needle deflects to the left
S pole of magnet moved towards the coil	
S pole of magnet moved away from the coil	
magnet stationary near the coil	

c. A bicycle dynamo operates using the effect shown. As the bicycle wheel turns, the driving wheel rotates; this in turn causes the magnet to rotate near the stationary coil. The terminals of this coil are connected to a lamp. Explain why the lamp lights as the bicycle moves.



Source: *http://sizo.adlerka.sk*

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____ (2)

(Total: 20 marks)

20

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