



L-Università
ta' Malta

MATSEC
Examinations Board



Marking Scheme

SEC Physics

Main Session 2021

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Paper 1

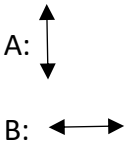
Question		Suggested Answer	Marks Distribution	Marks
1	a	Density is the mass per unit volume of a substance.	Do not accept the equation	1
	b	kg/m ³	Do not accept g/m ³	1
	c	Foam concrete has pockets of air / spaces / holes. OR Concrete has more compact particles. These decrease the mass per unit volume.	1 1	2
		d i	$V = 1.5 \times 1.2 \times 0.98$ $V = 1.764 \text{ m}^3$	1 1 Deduct 1 mark if the height is in cm
	ii	$\rho = \frac{m}{V} = \frac{1040}{1.764}$ $\rho = 589.57 \text{ kg/m}^3$	1 1	2
iii	Mixture X will float and Porous clay brick will sink.	Award 1 mark if answer states that they will both float or both sink	2	
			Total:	10
2	a	$a = \frac{v - u}{t} = \frac{53.61 - 26.67}{2.5}$ $a = 10.776 \text{ m/s}^2$	1 1	2
		b i	Newton's first law or Law of inertia. A body in motion will remain in constant motion unless acted upon by an external force (there is no need to state that an object at rest remains at rest, as it does not apply in this situation).	1 1
	ii	Increase the time of impact. Reducing the force on the driver.	1 1	2
	iii	Air Bag, Crumple Zones, Headrest, Cushioned Interior, Tempered Glass.	1 mark each for any two	2
	iv	$s = \frac{(u + v)t}{2}$ $s = \frac{(53.61 + 0) 0.18}{2}$ $s = 4.82 \text{ m}$	1 1	2
			Total:	10

3	a		kgm/s		1
	b		$p = mv$ $p = 0.45 \times 14$ $p = 6.3 \text{ kgm/s}$	1 1 Deduct 1 mark if mass is not converted	2
	c		$p = mv$ $p = 0.45 \times -8$ $p = -3.6 \text{ kgm/s}$	1 1 Deduct 1 mark if the answer is not negative	2
	d		$\Delta p = \text{final } p - \text{initial } p$ $\Delta p = -3.6 - 6.3$ $\Delta p = -9.9 \text{ kgm/s}$	Accept also 9.9 kgm/s	1
	e		$F = \Delta \frac{p}{t} = \frac{(-9.9)}{0.12}$ $= -82.5 \text{ N}$	1 1 Deduct 1 mark if the answer is not negative	2
	f		Larger force. Force is directly proportional to the mass or it has a larger momentum.	1 1 Do not accept 'the force is larger because the mass is larger'	2
Total:					10
4	a	i	$\text{Area} = 0.03 \times 0.02 = 0.0006 \text{ m}^2$ $P = \frac{F}{A} = \frac{2.4}{0.0006}$ $= 4000 \text{ Pa}$	1 1 1 Deduct 1 mark if the area is in cm^2	3
		ii	Yes, it will be lower. This is because the force is acting over a larger area and so less pressure is exerted since pressure is inversely proportional to area.	1 1	2

b			Pressure Increases	Pressure Decreases	No change in pressure		
		Lowering the block further down into the water.	✓			1	3
		Lowering a block of the same material, but larger mass at the same depth.			✓	1	
	Using a liquid of lower density than that of water but keeping the block at the same depth.		✓		1		
c	Yes. Atmospheric pressure, or Air particles colliding with block. OR Weight of air column above it.					1 1	2

Total: 10

5	a	<p>The diagram shows a horizontal beam AB pivoted at a point 0.3 m from A. A force F is applied downwards at a point 1.5 m from the pivot and 0.2 m from B.</p>		1
	b	<p>The graph shows Moment (Nm) on the y-axis (0 to 1000) and Distance (m) on the x-axis (0 to 1.5). A straight line is drawn through the origin and the points (0.2, 200), (0.4, 400), (0.6, 600), (0.8, 800), (1.0, 1000), (1.2, 1200), and (1.4, 1400).</p>	<p>1 mark for equally spaced scale and graph occupy page</p> <p>1 mark for axes</p> <p>1 mark for plotting</p> <p>1 mark for title</p> <p>Deduct 1 mark if axes are inverted</p>	4

	c	The weight of diver can be obtained either from the gradient or by using a single coordinate. $Mom = F \times d$ $310 = F \times 0.5$ $F = 310 / 0.5 = 620N$ $Mass = 620 / 10 = 62 \text{ kg}$	Allow for the use of any point from the graph 1 1	2	
	d	i	0.7 m from pivot.	1	
		ii	Moment of diver at 1.7m from pivot = $620 \times 1.7 = 1054 \text{ Nm}$ Moment of weight of diving board = $65 \times 0.7 = 45.5 \text{ Nm}$ Total clockwise moment = $1054 + 45.5 = 1099.5 \text{ Nm}$	1 1 Assign 1 mark if only one moment is calculated	2
				Total:	10
6	a		1 1	2	
	b	Wave A: Transverse Wave B: Longitudinal	1 1	2	
	c	Number of waves /oscillations /vibrations /cycles per second.		1	
	d	Accurate labeling from rest position to crest /trough.		1	
	e	$c = f \times \lambda$ $f = v/\lambda = 0.5/0.25$ $= 2 \text{ Hz}$	1 1 Deduct 1 mark if unit is missing or incorrect	2	
	f	Periodic time. $T = 1/f = 1/2 = 0.5 \text{ s}$	1 1 Deduct 1 mark if unit is missing or incorrect	2	
				Total:	10

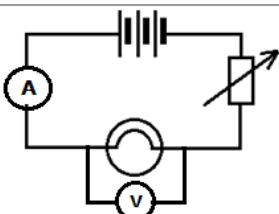
7	a		A light year is the distance that light covers in one year.		1	
	b		Distances in the universe are very large. (not to have large values of distances in metres).		1	
	c	i		Distance = speed x time = $3 \times 10^8 \times (320 \times 365.25 \times 24 \times 60 \times 60)$ = 3.03×10^{18} m	1 1 1	3
		ii		Earth is a planet, Proxima Centauri/Sun are stars. Earth is non-luminous, stars are luminous. Stars emits energy whereas our Earth emits only IR.	1 1 Consider other valid answers	2
		iii		A galaxy is a collection (or solar systems), bound together by gravity.		1
	d	i		Telescope.		1
		ii		Discovery of new technologies; Job creation; Virtual reality. Any correct benefit is accepted.		1
Total:					10	
8	a	i	Rubbing balloon with an insulator/cloth/etc.		1	
		ii	Gained Electrons.		1	
		iii	Because insulators do not conduct charge. So no electrons leave the balloon through the thread.		1	
	b	i		Balloon Q = Negative Balloon R = Positive or Neutral	1 1 Award mark only if both positive and neutral are mentioned	2
		ii		This is because like charges repel.		1
	c	i		Free electrons in the needle Are repelled by the negative charge of plate and move through the needle through the galvanometer, creating a small current.	1 1	2
		ii		$Q = It$ = 0.0003×0.2 = 0.00006 C (or 6×10^{-5} C)	1 1 Deduct 1 mark if units for I are not converted to A	2
Total:					10	
9	a	i	Soft magnetic material: Iron. Hard magnetic material: Steel.	1 1 Accept other valid materials	2	


		ii	Hard.		1
		iii	Place bar inside a solenoid/coil of wire. Pass direct current through solenoid for some time.	1 1	2
	b	i	Mark S of magnet at geographic N & N at geographic S pole.		1
		ii	Since direction of field lines from N to S.		1
		iii	Magnetism induced in them as they have been standing in earth's magnetic field.		1
		iv	Nearby magnetic materials may affect the compass. Leading to a wrong direction bearing.	1 1	2
Total:					10
10	a	i	Time taken for half the atoms/nuclei to decay. OR Time taken for the activity (or count rate) to decay by half.		1
		ii	Half-life = 6 hrs. Time taken to decay from, say, 70 000 to 35 000.	1 1	2
		iii	Starting from 70 000 on y-axis AND with a smaller gradient.		1
	b	i	Having same no of protons but different no of nucleons/neutrons.	Accept atomic and mass numbers instead	1
		ii	6 protons and 8 neutrons.		1
	c	i	$\frac{1}{4}$ atoms remaining = $\frac{1}{2} \times \frac{1}{2} = 2$ half-lives. 2 h.l. = 5700 years x 2 = 11 400 years.	1 1	2
		ii	No C-14 atoms left to measure after such a long time. OR Radioactive nuclei would have decayed.		1
		iii	A longer half-life.	Accept numerical values, if stated, of half-life 10 million years and above.	1
Total:					10

Paper 2A

Question		Suggested Answer	Marks Distribution	Marks				
1	a	Ruler /Measuring tape.		1				
	b	Set the initial height of the ramp and measure it. Release the toy car. Let the toy car come to a stop and measure the horizontal distance. Repeat this procedure by varying the height.	1 1 1 1	4				
	c	Take readings from the ruler at eye level. Release the toy car with no initial force. Make sure that the toy car comes to a complete stop before measuring the horizontal distance.	1 mark each for any two Accept any correct answer Reference to using the same car and ramp will not be accepted	2				
	d	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 50%;">Height (m)</th> <th style="width: 50%;">Horizontal Distance (m)</th> </tr> </thead> <tbody> <tr> <td style="height: 20px;"> </td> <td> </td> </tr> </tbody> </table>	Height (m)	Horizontal Distance (m)			1 1 Accept cm as units	2
	Height (m)	Horizontal Distance (m)						
	e	Plot a graph of height against horizontal distance. If the graph is a straight-line through the origin, then the two variables are directly proportional.	1 1	2				
	f	i	$PE = mgh$ $PE = 0.4 \times 10 \times 0.12$ $PE = 0.48 \text{ J}$	1 1 Deduct 1 mark if mass is not in kg	2			
		ii	0.48 J		1			
		iii	Energy cannot be created nor destroyed. But it can only change from one form to another.	1 1 Do not accept 'The principle of conservation of energy'	2			
	iv	$KE = 0.5m v^2$ $0.48 = 0.5 \times 0.4 \times v^2$ $v = 1.55 \text{ m/s}$	1 1	2				
	v	Energy losses. Due to work done against friction /heat /sound.	1 1	2				
Total:				20				

2	a	Polystyrene is an insulator. It contains trapped air, which increases the insulation.	1 1	2	
		b	Conduction.		1
	c	Kate. Vacuum is a better insulator than polystyrene since it completely stops conduction and convection.	1 1	2	
		d	Silver/White. It reflects infrared radiation to stay inside the kettle or it does not absorb the heat energy.	1 1	2
	e	Spout. It needs to be covered to prevent hot air from leaving the kettle.	1 1	2	
		f	i	Particles close to the heating source start to vibrate more. This increases the distance between them which increases the volume as well, hence the density decreases. The hot water will rise to the top while the cold water will sink to the bottom.	1 1 Assign 1 mark if convection currents are mentioned only without explanation
	ii		$Q = mc\Delta\theta$ $265300 = 0.75 \times c \times (100 - 18)$ $c = 4313.82 \text{ J/kg}^\circ\text{C}$	1 1	2
	iii		Energy losses to the kettle and surroundings. (Although it is not the main cause for the variation obtained, impurities in the water was accepted, since the water used was not pure water).		1
	iv		$Q = mc\Delta\theta$ $46200 = 0.75 \times 4200 \times \Delta\theta$ $\Delta\theta = 14.67^\circ\text{C}$ Final temperature = $100 - 14.67 = 85.3^\circ\text{C}$	1 1 1	3
	v		$Time = 2 \times 60 \times 60 = 7200 \text{ s}$ $Power = \frac{energy}{time} = \frac{46200}{7200}$ $Power = 6.42 \text{ W}$	1 1 1	3
			Total:	20	
3	a	i	Dipping a straight bar repeatedly in the water. OR Using a wave generator.		1
		ii	Placing a glass. OR Similar block at the tank bottom.		1
	iii	Refraction. It takes place, as there is a change in speed.	1 1	2	
	iv	Wave speed decreases. Frequency unchanged. Wavelength decreases.	1 1 1	3	
	v	Place glass or similar block so that boundary is parallel to the incident wave fronts. OR $i = 0^\circ$	Accept any explanation /diagram that	1	

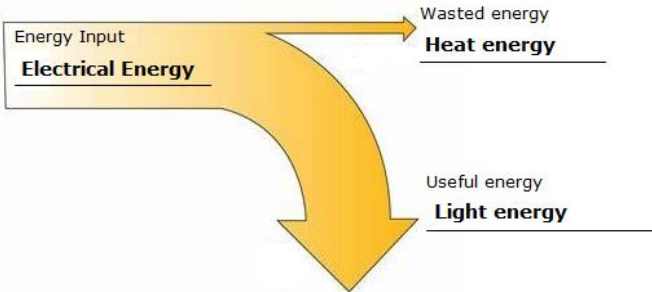
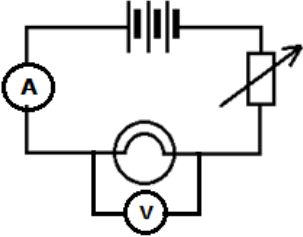
			shows the correct setup		
b	i	Similarity: Both transverse. OR Both carry energy.	1	2	
		Differences: Water needs a medium, EM travel in vacuum. OR Water travels at speeds smaller than the speed of light, while EM waves all travel with the speed of light in vacuum.	1		
c	i	Longitudinal.		1	
	ii	Sound intensity decreases until inaudible. Sound does not travel in a vacuum / requires a medium.	1 1	2	
		iii	Bell would still be heard. Sound would be conducted through base of bell jar.	1 1	2
d	i	Distance travelled = $200 \text{ m} \times 2 = 400 \text{ m}$ Speed = distance/time = $400 \text{ m} / 1.2 \text{ s} = 333 \text{ m/s}$	1 1	2	
		ii	No other close reflecting walls / quieter environment.		1
	iii	Stopwatch introduces reaction time errors. Errors are significant due to the short time interval involved.	1 1	2	
Total:				20	
4	a	i	Electrical energy to light energy and heat energy.	1 mark each	3
		ii	The bulb uses 21 J of electrical energy per second to convert it to light and heat energy.		1
	b	i	Total power = $21 \times 3 = 63 \text{ W}$		1
		ii	$I = p/v$ $= 63/12$ $= 5.25 \text{ A}$	1 1	2
			iii	Current in 1 bulb = $5.25/3 = 1.75 \text{ A}$ $R = V/I = 12/1.75 = 6.86 \Omega$	Accept other correct methods
		iv	Total voltage required to operate the bulbs = Increases. Total power generated by circuit = Stays the same. Total current that flows in circuit = Decreases.	1 1 1	3
	c	i		1 1 No marks are awarded if the instruments are connected incorrectly	2
			ii	Different values of current and voltage are taking by changing the value of the variable resistor. Each time the resistance is found by dividing the voltage by the current.	1 1


		iii	<p>Quantity:- Voltage Unit:- V / Volts</p>  <p>Quantity:- Current Unit:- A / Amps</p> <p>A graph of Voltage/V against Resistance/Ohms is also accepted.</p>	1	2
		iv	<p>Paul's theory was correct. Because the filament lamp is non-ohmic. OR Voltage and current are not proportional. OR Resistance does not remain constant as temperature rises. OR As Voltage increases, resistance increases.</p>	1 1	2
				Total:	20
5	a	i	Galvanometer.		1
		ii	Galvanometer needle deflects. Coil cuts magnet's field. Emf /current induced /generated in coil.	1 1 1	3
		iii	North pole induced. Pole induced opposes changes causing it. Lenz's law.	1 1 1	3
		iv	Same effect as in part (ii). No deflection observed.	1 1	2
		v	kinetic electrical dynamo /generator /microphone	1 1 1	3
	b	i	Step-down.		1
		ii	$\frac{V_P}{V_S} = \frac{N_P}{N_S}$ $\frac{230}{12} = \frac{N_P}{100}$ $N_P = 1,916.7$ <p>Accept 1,916 and 1,917</p>	1 1	2
		iii	<p>Power in primary(input) = Power output/efficiency</p> $= 100 \times 100/90$ $= 111 \text{ W}$ <p>Current in primary $I = \frac{P}{V} = \frac{111}{230}$</p> $= 0.483 \text{ A}$	1 1 1	3
		iv	A: Step-up B: Step-down	1 1	2
				Total:	20

Paper 2B

Question		Suggested Answer	Marks Distribution	Marks				
1	a	Ruler/Measuring tape.	Do not accept inch tape	1				
	b	Height/distance/length. Rest/stop. Distance. Height.	1 1 1 1	4				
	c	Take readings from the ruler at eye level. Release the toy car with no initial force. Make sure that the toy car comes to a complete stop before measuring the horizontal distance. Take repeated readings of the horizontal distance by releasing the car from the same height several times.	1 mark each for any two Accept any correct answer Reference to using the same car and ramp will not be accepted	2				
	d	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 50%;">Height (m)</th> <th style="width: 50%;">Horizontal Distance (m)</th> </tr> </thead> <tbody> <tr> <td style="height: 20px;"> </td> <td> </td> </tr> </tbody> </table>	Height (m)	Horizontal Distance (m)			1 1	2
	Height (m)	Horizontal Distance (m)						
	e	Plot a graph of height against horizontal distance. OR A graph of horizontal distance against height.		1				
	f	If graph is a straight-line through the origin.	No marks are given if the origin is not mentioned	1				
	g	i	$PE = mgh$ $PE = 0.4 \times 10 \times 0.12$ $PE = 0.48 \text{ J}$	1 1	2			
		ii	0.48 J		1			
iii		Energy cannot be created nor destroyed. But it can only change from one form to another.	1 1	2				
iv		$v = \sqrt{\frac{KE}{m}} = \sqrt{\frac{0.48}{0.5 \times 0.4}} = 1.55 \text{ m/s}$	1 1	2				
v		Energy losses. Work done against friction /heat /sound.	1 1	2				
			Total:	20				
2	a	Polystyrene is an insulator (bad conductor). It contains trapped air, which increases the insulation.	1 1	2				
	b	Conduction.		1				
	c	Vacuum is a better insulator than polystyrene.		1				

	d	Silver is a bad absorber/emitter of radiation. It reflects infrared radiation to stay inside the kettle.	1 1	2
	e	Energetic particles leave (evaporation) / convection currents.		1
	f	Cover the spout (close it).		1
	g	i	The water molecules close to the heating source start to <u>vibrate</u> / <u>move</u> more rapidly. This increases the distance between the molecules which increases the <u>volume</u> (space) of water at that point. This will cause a decrease in <u>density</u> so that the hot water will rise to the top while the cold water will sink to the bottom.	1 1 1 3
		ii	$Q = mc\Delta\theta$ $265300 = 0.75 \times c \times (100 - 18)$ $c = 4313.82 \text{ J/kg}^\circ\text{C}$	1 1 2
		iii	Due to energy transfer to the kettle and surroundings. (Although it is not the main cause for the variation obtained, impurities in the water was accepted, since the water used was not pure water).	1
		iv	$Q = mc\Delta\theta$ $46200 = 0.75 \times 4200 \times \Delta\theta$ $\Delta\theta = 14.67^\circ\text{C}$	1 1 2
		v	Final temperature = $100 - 14.67 = 85.33^\circ\text{C}$	1
		vi	Time = $2 \times 60 \times 60 = 7200 \text{ s}$	1
		vii	$Power = \frac{energy}{time} = \frac{46200}{7200}$ $Power = 6.42 \text{ W}$	1 1 2
Total:				20
3	a	i	Dipping a straight bar repeatedly in the water/wave generator.	1
		ii	To change the depth of water in a region tank.	1
		iii	As the waves travel from deep to shallow water there is a change in wave direction as shown in Figure 3. This phenomenon is known as <u>refraction</u> and is caused by the change in <u>speed</u> as the waves cross the boundary into shallow water. The distance between two wavefronts, known as <u>wavelength</u> , changes also. There is however no change in <u>frequency</u> as this depends only on the source producing the vibrations.	4
		iv	Same as: Spacing of wavefronts (wavelength). OR The wave speed decreases as well in this case. Different than: No change in direction.	1 1 2
	b		Similarity: Both transverse or both carry energy. Differences: Water needs a medium, EM travel in vacuum, or water travels at speeds smaller than the speed of light, while EM waves all travel with the speed of light in vacuum.	1 1 2

c	i	Longitudinal.		1
	ii	Sound intensity decreases until inaudible. Sound does not travel in a vacuum / requires a medium.	1 1	2
	iii	Bell would still be heard. Sound would be conducted through base of bell jar.	1 1	2
	d	i	Reflection of sound from an object.	
	ii	Distance travelled = $200 \text{ m} \times 2 = 400 \text{ m}$		1
	iii	$\text{speed} = \frac{\text{distance}}{\text{time}}$ $= \frac{400}{1.2}$ $= 333 \text{ m/s}$	1 1	2
	iv	No other close reflecting walls / quieter environment.		1
Total:				20
4	a		1 mark each	3
b	i	The bulb uses 21 J of electrical energy per second to convert it to light and heat energy.		1
	ii	Total power = $21 \times 3 = 63 \text{ W}$		1
	iii	$P = IV$ $I = P/V$ $= 21/12$ $= 1.75 \text{ A}$	1 1	2
	iv	Total current = $1.75 \times 3 = 5.25 \text{ A}$		1
	v	12 V		1
	iv	$R = \frac{V}{I} = \frac{12}{5.25} = 2.29 \Omega$	Accept any other correct method	2
c	i	Variable resistor / rheostat		1
	ii			2

	iii	<p>2 The value of component X is changed and a new reading of current and voltage is recorded.</p> <p>1 The circuit is switched on and the current and voltage through the filament lamp is recorded.</p> <p>4 The value of resistance is worked for each set of readings.</p> <p>3 The step above is repeated for another 4 times.</p>		3	
	iv	<p>Quantity:- Voltage Unit:- V / Volts</p>  <p>Quantity:- Current Unit:- A / Amps</p> <p>A graph of Voltage/V against Resistance/Ohms is also accepted</p>	<p>Award mark if both quantities and units are correct</p> <p>No marks awarded if axis are swapped</p>	2	
	v	Paul's theory was correct.		1	
Total:				20	
5	a	i	Galvanometer (center-zero ammeter). Detects (small) currents in a circuit.	<p>1</p> <p>1</p> <p>Do not accept ammeter</p>	2
		ii	Galvanometer needle deflects. Coil cuts magnet's field. Current/emf/voltage induced in coil.	<p>1</p> <p>1</p> <p>1</p>	3
		iii	Opposes. Lenz's law.	<p>1</p> <p>1</p>	2
		iv	Same effect as in part (ii). No definition observed.	<p>1</p> <p>1</p>	2
		v	Electrical. Dynamo / generator / microphone / alternator. 'Wind turbine' or 'power station' are not accepted.	<p>1</p> <p>1</p>	2
	b	i	Step-down.		1
		ii	$\frac{V_P}{V_S} = \frac{N_P}{N_S}$ $\frac{230}{12} = \frac{N_P}{100}$ $N_P = 1,916.7$ <p>1,916 and 1,917 are accepted.</p>	<p>1</p> <p>1</p>	2
		iii	$\text{Efficiency} = \frac{\text{Power output}}{\text{Power input}}$ $\frac{90}{100} = \frac{100}{\text{Power input}}$ <p>Power input = 100 x 100/90 = 111 W</p>	<p>1</p> <p>1</p>	2
		iv	<p>Current in primary $I = \frac{P}{V} = \frac{111}{230}$ = 0.483 A</p>	<p>1</p> <p>1</p>	2
	c		A: Step-up. B: Step-down.	<p>1</p> <p>1</p>	2
Total:				20	