HUA YI SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2024
SECONDARY 4E (PHYSICS) 6091
MARK SCHEME

Q	Answer	Q	Answer	Q	Answer	Q	Answer
1	D	11	A	21	D	31	B
2	B	12	A	22	B	32	B
3	C	13	D	23	D	33	A
4	C	14	C	24	B	34	C
5	C	15	D	25	C	35	A
6	D	16	A	26	A	36	A
7	B	17	C	27	D	37	A
8	A	18	A	28	C	38	D
9	A	19	A	29	A	39	D
10	C	20	D	30	A	40	D

Section A [50 marks]

Qn No.		Answers	Marks
1	**(a)**	As the **speed increases,** the **air resistance** acting on the child and the sledge also **increases**. Hence the **resultant force decreases** and the **acceleration decreases**. From 24 to 26s, the **forward force is equal to the backward force** and the **resultant force acting on the child and sledge is zero**. Hence, there is **no acceleration** and it **moves with a constant speed**. **Need to mention resultant force in each case to get the marks.**	B1 B1
	(b)	The gradient of the graph becomes zero/ graph become horizontal from t = 24 s to t =26 s. **Need to state the time from t= 24s to 26s to get the mark.**	B1
	(c)	Distance travelled = Area under the graph = ½ x (30-26) x 15.2 = 30.4 m Since the sledge stops in 30.4 m, **it will stop before hitting the wall** which is 35 m ahead.	 M1 A1
	(d)	The energy in the gravitational potential store is transferred to energy in the internal store. OR Gravitational potential energy to thermal / internal energy **Note: the speed is constant, there is no changes in energy in the kinetic store. Reject any answers that mention kinetic store.**	B1
	(e)	The child **experience inertia** where his **body mass resists a change in state of motion** / and **continue to move forward**. **Inertia + resist a change in state of motion / continue to move forward**	B1
		Total:	**[7]**

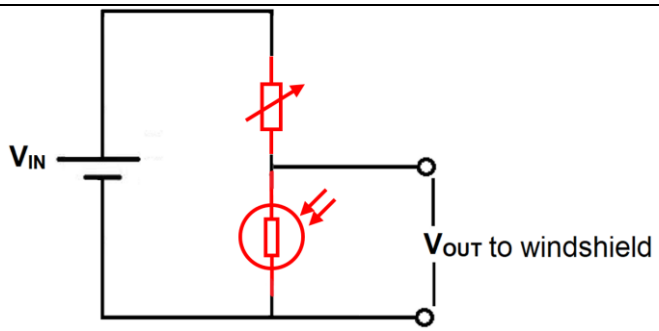
2	**(a)**	6.0 s	A1
	(b)	The rebound velocity of 30 m/s is lower/less than the initial velocity. OR The displacement traveled during rebound is less than the initial velocity. **Accept distance instead of displacement.**	B1
	(c)	a = (v-u)/t a = (-40 – 40)/6 a = - 13.3 N/kg g = 13.3 N/kg **Only accept positive gravitational field strength and unit m/s^2 is not acceptable.**	M1 A1
	(d)	The gradient / acceleration is constant so the ball did not reach terminal velocity / is free falling / experience no resistance. **Need to have both.**	B1
		Total:	**[5]**
3	**(a)**	As the **boom angle increases**, the **perpendicular distance between the load and the pivot decreases**. Since the **moment is the product of the force and the perpendicular distance**, a **decrease in the perpendicular distance allows for an increase in the force (load)** while maintaining the same moment. Hence, the maximum load the boom can support increases. **Formula of moments = F x d is needed.**	B1 B1
	(b) (i)	Moment = F x d = 11 500 x 22 = 253 000 Nm	A1
	(b) (ii)	By taking moments about X, Clockwise moments = Anti-clockwise moments 253 000 = W x 5 W = 50 600 N	A1
		Total:	**[4]**
4	**(a)**	mgh = ½ mv^2 gh = ½ v^2 v^2 = 2gh = 2 x 10 x 1 = 20 v = 4.47 m/s	M1 A1
	(b)	Work Done (friction) = mgh – 4.5 J = (4 x 10 x 1) – 4.5 = 35.5 J Work Done (friction) = friction x distance 35.5 = friction x 2 friction = 17.8 N	M1 A1
		Total:	**[4]**

5	**(a)**	$F_1/A_1 = F_2/A_2$ $5 / 2 = F_2 / 0.08$ $F_2 = 0.2$ N	 M1 A1
	(b) (i)	Mass = Density x Volume = 1 x (0.6 x 2) = 1.2 g	 A1
	(b) (ii)	WD = F x d = 5 x (0.6×10^{-2}) = 0.03 J **Need to convert cm to m.**	 A1
	(c)	Volume = Cross sectional area x distance For the same volume of water, since the **cross-sectional area of the nozzle is smaller than the barrel**, the **distance moved by the water at the nozzle must be greater** than the distance moved at the barrel. Hence, the **speed which is the distance moved by the water per second** is greater at the nozzle. **Reject answer that link area to pressure. (0 m)**	B1 B1 B1
		Total:	**[7]**
6	**(a) (i)**	$V_{lamp} = IR = 17.6 \times 10^{-3} \times 10 = 0.176$ V $V_{thermistor} = 1.5 - 0.176 = 1.32$ V	M1 A1
	(a) (ii)	$R_{thermistor} = V/I = 1.32 / (17.6 \times 10^{-3}) = 75\ \Omega$ Temperature = 40 °C **Allow full ecf**	M1 A1
	(b)	In convection oven, the **heat is transferred from the hot air to the food via conduction**. Since **air is a poor thermal conductor**, the rate of cooking food is slower. In infra-red toaster, the **heat is transferred directly to the food using infra-red radiation at high speed**. Hence, food is cook faster. **1 m – air is a poor thermal conductor** **1 m – infra-red radiation travels at high speed.**	B1 B1
		Total:	**[6]**
7	**(a)**	Lamp A Tungsten wire has a **higher reisistivity** and a coil filament is **longer** compared to uncoil one, hence **resistance of lamp A is higher**. **No marks for Lamp A**	 B1 B1
	(b)	When the lamps are connected in series, the **effective resistance of the circuit increases**. / **the voltage across each lamp is lower.** Hence the **current passing through the lamps decreases** / **The emf is shared between the lamps**. **Temperature of the lamp decreases** and the **resistance of the lamp is lower** as it is a non-ohmic conductor. **To get the last mark, need to link back to lamp being non-ohmic.**	B1 B1 B1

	(c)	The **fuse will still melts/blows** and the **lamp appears off**. However, the metal case is still live and can cause **electrocution or shock** **Many did not mention about the lamp not working and so was not awarded 2 m.**	B1 B1
		Total:	**[7]**
8	**(a)**	At least 3 points plotted at (6000, 800), (12000, 400), (18000, 200) and (24000, 100) Smooth curve drawn	B1 B1
	(b)	9600 years (Answers depend on graph) **Unit must be stated.**	B1
	(c)	β particles are absorbed by the 5 mm thick metal causing a significant decrease in the count rate. Y-radiation is able to pass through the metal, thereby still causing a count rate of 200 with the metal piece in place.	B1 B1
		Total:	**[5]**
9	**(a)**	Lenz's law state that the **direction of the induced current is such that its magnetic effect opposes the motion or change producing it.** When the **magnet approaches the solenoid**, the **current induced in the solenoid will flow in a direction to repel the incoming magnet.** Similarly, when the **magnet is leaving the solenoid**, the **current induced in the solenoid will flow in the opposite direction to attract the leaving magnet**. This generates an alternating current. **Reject 1 m if the Lenz's law is stated incorrectly such as the direction of the induced current opposes the changes that produces it.**	B1 B1 B1
	(b)	The movement of the **magnet causes the surrounding air to be displaced**. Sound then **travels in the form of a longitudinal wave**, consisting of a **series of compression and rarefaction.** Sound **energy is transferred from particles to particles through vibration** until it reaches the person's ear.	B1 B1
		Total:	**[5]**
10	**(a)**	When the switch is closed, an alternating current flow through the solenoid causing the **solenoid to be magnetized with alternating poles attracting and repelling the magnet.** When the magnet vibrates, it creates **disturbances on the water surface**, forming waves. **Need to mention disturbances / vibrate periodically / repeatedly to get the 2nd mark.**	B1 B1

	(b)	Increase the number of turns of the solenoid / Increase the e.m.f of the a.c supply / insert a soft iron core into the solenoid. **Reject incorrect phrasing: Increase number of coils.**	B1
	(c) (i)	A wavefront is an imaginary line representing the points of a wave that are in phase.	B1
	(c) (ii)	Speed = Distance / Time = (4 x 3) / 4s = 3.0 cm/s **Reject wrong unit: m/s.**	A1
	(c) (iii)	6 waves in 4 s 6/4 waves in 1 s frequency = 6/4 = 1.5 Hz **Reject wrong / no unit**	A1
	(d)	The amplitude decreases as it moves from shallow to deeper water because energy is lost to the surround water molecules as it moves away from the source (vibrating magnet) to the other end. The frequency of the waves remains the same in both the shallow and deep ends as the frequency of a wave is determined only by the source of the vibration (the vibrating magnet). Using the formula v = fλ, as the speed of the wave increases when it moves from shallow to deeper water, the wavelength of the wave also increases. **Need to elaborate on why amplitude decrease, frequency stay the same and wavelength increases for each mark.**	B1 B1 B1
	(e)	The wavefronts are further away.	B1
		Total:	**[10]**
11	**(a) (i)**	E = Pt = 2000 x (2 x 60+38) = 316 000 J	A1
	(a) (ii)	Energy output = mcθ + ml_v = 0.75 x 4200 x (100 – 25.5) + (0.01 x 2260 x 10^3) = 257275 J Efficiency = energy output / energy input x 100% = 257275 / 316000 x 100% = 81.4% **No marks if the energy required to boil of 0.01 kg of water is not added.**	M1 A1
	(b) (i)	The temperature remains constant at 0 °C when shaved ice melts because the **energy absorbed is used to increases the internal potential energy to overcome the forces of attraction between water molecules,** changing the ice from solid to liquid.	B1 B1

		This process **does not increase the internal kinetic energy of the molecules, so the temperature remains constant** until all the ice has melted.	
	(b) (ii)	Energy output = ml_f = (800 – 11.2) x 334 x 10^3 = 263459.2 J Efficiency = energy output / energy input x 100% = 263459.2 / 316000 x 100% = 83.3%	M1 A1
	(b) (iii)	The temperature difference is lower between 0 °C and room temperature as compared to 100 °C and room temperature. So the rate of thermal energy transfer with surrounding is lower. **Reject answer such as less energy transfer with surrounding without elaboration / latent heat of fusion is lower.**	B1
	(c)	As the **temperature increases**, the water vapor **gains kinetic energy and collide with the walls of the kettle more frequently and more forcefully**. As the **water boils**, the **amount of water vapor in the kettle also increases which adds to the frequency of collision of water vapor with the kettle's wall**. Thus, a **larger average force is exerted over the surface area** of the kettle causing an increase in pressure. **1 m – gain K.E, frequency and force of collision with walls increases** **1 m – amount of water vapour increases, frequency of collision with wall increases.**	B1 B1
		Total:	**[10]**
Section B [10 marks]			
12	**(a)**	As light is travelling from an **optically denser medium (glass) to an optically less dense medium** (air) and the **angle of incidence is greater than the critical angle**, the infrared light undergoes **total internal reflection** at the boundary between the windshield and the air.	B1 B1
	(b)	n_{water} = sin i_{air} / sin r_{water} n_{glass} = sin i_{air} / sin r_{glass} Using the 2 formulas, n_{water} / n_{glass} = sin r_{glass} / sin r_{water} For total internal reflection, r_{water} = 90°, 1.33 / n_{glass} = sin r_{glass} / sin 90 n_{glass} = 1.33 / sin r_{glass} Given that r_{glass} = 45° < c (not total internally reflected) n_{glass} < 1.33 / sin 45 n_{glass} < 1.88 (shown)	M1 M1 A1
	(c) (i)	Positions of variable resistor and LDR Symbols for variable resistor and LDR	B1 B1

			
	(c) (ii)	On rainy days, **less light is detected by the LDR**. This causes the **resistance of the LDR to increase**. Thus the **potential difference V_{OUT} increases**, turning on the wiper.	B1 B1
	(d)	Variable resistor is able to vary the output voltage to the windshield wiper. / It can adjust the amount of rain / light that will cause the wipers turn on.	B1
		Total:	**[10]**
13	**(a) (i)**	$1/(10 \times 10^{-3}) = 100$ revolutions per second	A1
	(ii)	2.5 ms **Reject wrong / no unit**	A1
	(iii)	Amplitude and frequency is also halved.	B1
	(b)	As the wire is very long, the resistance of the wire is high. The current in the cable is large too. By $\underline{P = I^2R}$, the loss of power as heat by the wire is large and thus less power is supplied to the lamps. OR As the wire is very long, the resistance of the wire is high. Thus, the voltage across the wire is large, causing the voltage across the lamps to be much less than 230 V. Hence, by $\underline{P = V^2/R}$, the power given by the lamp is little/lamps are dim. **Formula is required to get the 2nd mark.**	B1 B1 B1 B1
	(c) (i)	Comparing the voltages of primary coil to secondary coil: Step down ratio = 3 300: 220 = 15 : 1 Hence the coils must be step down to the same ratio of 15 : 1 Comparing the turn ratio, Coil M : Coil K = 1 500 : 100 = 15 : 1	B1 A1
	(c) (ii)	Input power = 100 / 75 x 15 kW = 20 kW I = P / V = 20 000 / 3 300 = 6.1 A	M1 A1

	(c) (iii)	Laminating the iron core reduces the power loss due to heat produced by eddy currents OR Using low resistance (primary and secondary) coils will minimize the amount of heat produced in the coils. OR Increase the magnetic flux linkage between the primary and secondary coils by using a soft magnetic material (iron core) to link **Need to have the correct elaboration of how each one work. Reject answer that just state use thick wire with lower resistance / use laminated iron sheet / insert soft iron core.**	B1
		Total:	**[10]**