2023 4 IP EOY
SUGGESTED ANSWER SCHEME

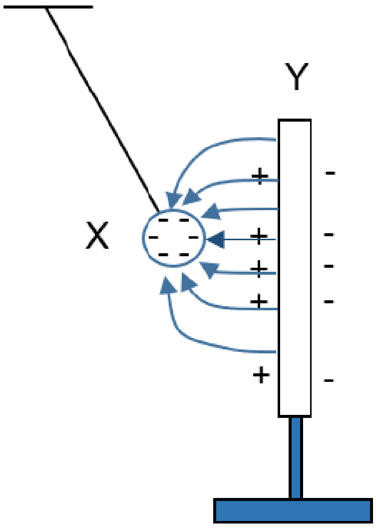
PAPER 1 (40 marks)

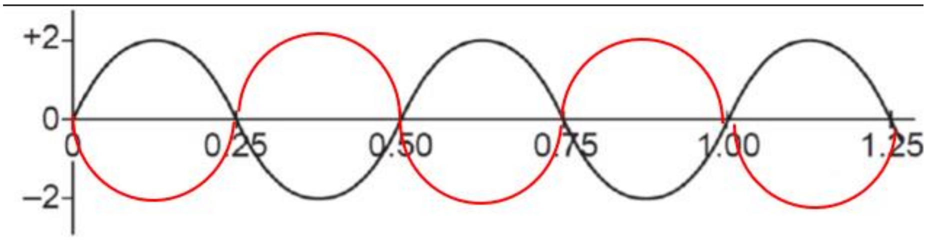
Qn	Answer	Explanation
1	**A**	All three forces form the triangle of forces in the correct order (tip to tail)
2	**D**	Weight decreases with decreasing g ; mass of satellite remains constant
3	**C**	Let the initial volume of air be V cm^3 Mass of air = V x 0.0012 g. Density of air at the final volume = (0.0012 V g)/0.5 V cm^3 = 0.0024 g/cm^3
4	**A**	Acceleration is the rate of change of velocity. Car accelerates when it starts from rest and reaches zero at constant speed.
5	**D**	The area under *v-t* graph of car D is the smallest.
6	**D**	Let the time taken to accelerate by t. Thus ½ 10ms^{-1}(11+ 11-t) = 100 m ⇒ t =2s. Acceleration = 10 /2 ms^{-2} = 5.0 ms^{-2}
7	**D**	When parachute opens fully, the upward force is greater than the weight and the resultant force is upwards causing a sharp deceleration. Since the resultant force is upwards, the acceleration is also upwards.
8	**B**	At constant velocity, $P = Fv$ = 2400 N x 90 ms^{-1} = 2.16 x 10^5 W or 2.2 x 10^5 W (2 s.f.)
9	**A**	From $F_{net}= ma$ 2000 N – R = 750 x 2.0 ⇒ R = 500 N or 0.5 kN
10	**A**	A has the broadest base and the lowest centre of gravity.
11	**A**	Clockwise moment = 16.0 N x (50.0 cm sin 30^o) = 400 Ncm Anticlockwise moment = 5.0 N x 50.0 cm = 250 Ncm Resultant moment -= 150 Ncm or 1.5 Nm anticlockwise
12	**C**	Total anticlockwise moment = F x 0.5 + F x 2.5 = 3.0 F D cannot produce a larger anticlockwise moment as the force on the left is not acting at the edge of the rod, thus that force produces a smaller anticlockwise moment.
13	**D**	Total pressure= 100000 Pa + 15x1000x10 Pa = 250 000 Pa
14	**B**	P_{gas} + 60 mmHg = 756 mmHg ⇒ P_{gas} = 696 mmHg
15	**D**	Pressure is the same throughout the liquid.
16	**C**	Oil : efficiency = 200/500x 100% = 40% ; Nuclear : efficiency = 40/200x 100% = 20% ; Oil : efficiency = 9/10x 100% = 90%
17	**B**	Using h = gain in GPE / weight , Athlete B has the highest jump of 2.3 m
18	**C**	Decreasing volume increases the frequency of collision with the inner walls. Molecules move at the same average speed because temperature remains unchanged. Pressure increases due to more particles hitting per unit area of the inner wall.
19	**A**	Temperature increases ⇒ molecules gain thermal energy and move faster. They move further apart, the potential energy increases.
20	**C**	Brownian motion is the result of the unequal bombardment on all sides of a smoke particle by air molecules moving at different velocities.
21	**D**	Recall EM waves application

Qn	Answer	Explanation
22	**C**	After the wave have move to the right by one wavelength, both buoys would have execute one oscillation and return to their original starting position.
23	**A**	Ultrasound is a longitudinal wave and requires a medium to propagate
24	**D**	An echo is the repetition of a sound due to the reflection of sound
25	**D**	Electrons are transferred to X and it becomes negatively charged. It will then repel electrons to the right of sphere Y , leaving an equal amount positive charges induced to the left of sphere Y.
26	**A**	Positive rod induced electrons to the right of P while earthing discharges the induced positive charges on the right of P. Removing the earthing and the rod will spread the electrons uniformly throughout P. Q remains neutral.
27	**A**	Neutral object, whether a conductor or insulator, can be induced by a charged rod (positive or negative) and will be attracted by it.
28	**B**	Assigning 2Ω to P and 1 Ω to work out the difference between V_1 and V_2.
29	**D**	*I/V* graph of resistor and lamp are standard graphs
30	**C**	Light affects LDR not thermistor. When more light shines on LDR, resistance of LDR drops. Using potential divider equation, p.d. across resistor rises and the current flowing through the lamp increases. Lamp glows brighter.
31	**A**	When galvanometer reading is zero, no current flows through it. There is no potential difference between across the galvanometer. P.D. across 4Ω is = 0.5 A x 4Ω = 2.0 V. Using potential divider eqn, $2V = \frac{R}{R+15}(12V) 5R = 15$ Thus R = 3 Ω
32	**B**	Total energy used in one month = 2 hrs x 2400 W x 3600 s = 17280000 J
33	**A**	Magnetic shielding kept the magnetic field of the magnetic in the iron ring. The N-pole of the compass will be pointing to the geographical north.
34	**A**	End X will be induced by the compass N-pole and becomes for S-pole. End X becomes an induced N-pole as it repels the N-pole of the compass. Since End X can be induced with either pole, it has to be a ferromagnetic material.
35	**C**	The resultant magnetic field direction in between the two wires is to the left, using the right hand grip rule.
36	**D**	Using Fleming's left hand rule to determine the direction.
37	**A**	The two ends of the iron rod facing each other will have opposite polarity : S-pole on the left and N-pole on the right.
38	**D**	When Q is moved to the left, X will be a N-pole. End Y will be a S-pole. To have a S-pole at Y, the S-pole of magnet P must move towards Y.
39	**D**	Recall question. Stronger magnet will have higher flux density (more lines per unit area)
40	**A**	*H*(no car)= 4 div x 2.5 ms/div x 330 m/s= 3.3 m ; *H* (car) = 2.25 div x 2.5 ms/div x 330 m/s = 1.85625 m Height of car = 3.3 m – 1.85625 m = 1.44 m

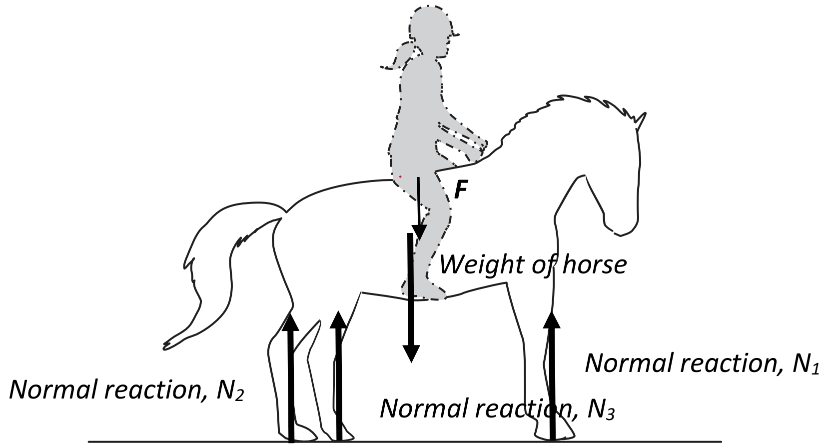
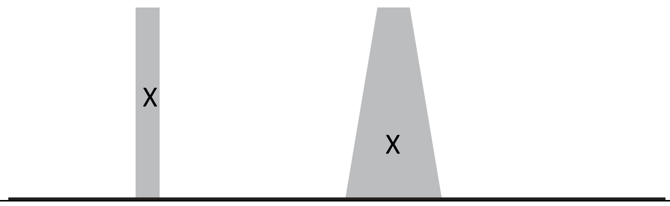
PAPER 2 SECTION A (50 marks)

Qn	Part	Answer	Remark
1	(a)(i)	Displacement is distance travelled in a certain direction / Displacement is the distance travelled by a moving object in a straight line in a specified direction. Distance is the total length covered by a moving object regardless of the direction of motion.	
	(ii)	Average speed = total distance/total time = 85 m / 40 s = 2.1 m/s	
	(iii)	Numerical : Average velocity = total displacement / time $= \frac{\sqrt{35^2+30^2}}{40}$ m/s = 1.2 m/s OR : Since the <u>total displacement</u> is the straight line distance between A and D and is smaller than the <u>total distance</u>, the <u>average velocity</u> is smaller than the <u>average speed</u>.	
	(b)	● Before reaching terminal velocity, the air resistance increases and the downward resultant force (W-F_{air}) acting on the helicopter decreases. The helicopter is undergoing decreasing acceleration. ● When it reaches terminal velocity, W = F_{air}. The resultant force is equal to zero and the helicopter descend with a constant speed/zero acceleration.	
2	(a)	GPE = 0.12 kg x 10 N/kg x 0.45 m = 0.54 J	
	(b)	Let the speed at B be v_B. From ½ (0.12 kg) v_B^2 = 0.54 J $\Rightarrow v_B$ = 3.0 m/s	
	(c)	Since the track friction and air resistance is ignored, by the conservation of energy principle, all the GPE at A must be equal to the GPE at D. To reach F, it must have extra kinetic energy to move to the highest point of the loop. Since GPE is only 0.54 J, it will not go beyond D.	
	(d)	The car will retrace its path and return to A.	
3	(a)	Pressure of trapped air = (0.57 x1.4 x 10^4 x 10) Pa + 1.0x 10^5 Pa = 1.8 x 10^5 Pa	
	(b)(i)	▪ The trapped air particles move at higher average velocities and bombard the inner walls of the tube with a larger average force. ▪ In addition, the frequency of collisions with the walls also increases. The increase in pressure of the enclosed air pushes the liquid down the tube, thus increasing the value of x.	
	(ii)	▪ P_{gas} is now larger. ▪ From $P_{gas} = P_{atm} + h\rho g \Rightarrow h = (P_{gas} - P_{atm}) / \rho g$. Since the difference in pressure now bigger, *h* will now be larger.	
4	(a)	▪ The length will increase ▪ The thickness will decrease	
	(b)(i)	Since the force exerted is closer to the pivot, the perpendicular distance is smaller. From the principle of moments, a larger force needs to be exerted by the rubber band to provide the counterclockwise moment for the moment due to the mass	

	(ii)	From the principle of moments, $F \times 2.0$ cm = 4.0 N x 18.0 cm $F = 36$ N	
	(iii)	The weight of XY will exert an additional clockwise moment. To maintain the position shown in Fig. 4.2, the force exerted by the rubber band must increase	
5	(a)		
	(b)	The negatively charged metal ball X repels electrons to the right side of Y and hence induces positive charges on the left side of Y. X experiences an attraction force from the positive charges of Y and a repulsion force from the electrons of Y. [1] But since the positive charges of Y are closer to the electrons on X, there is a net attraction force and therefore gets attracted. [1]	
	(c)	X will move closer to plate Y. [1] When Y is earthed, electrons from Y will be repelled by X and flow through the earth wire to earth. Plate Y acquires a net positive charge and the force of attraction between X and Y is greater. [1]	
6	(a)	1. The direction of the magnetic field in M and N are opposite. 2. The strength of the magnetic field in M and N are different. Magnetic field strength of M is stronger than N.	
	(b)(i)	The solenoid becomes an electromagnet that induces magnetism in the paper clip. The paper clip hence becomes an induced magnet and the end of the paper clip is induced with an opposite pole to the bottom of the solenoid.	
	(ii)	Paper clip would remain attracted [1] with the solenoid as steel is a hard magnetic material and it would have become a permanent magnet [1] even after the switch is opened.	

7	(a)(i)	Since bulb is operating at its normal brightness, it has a p.d. of 12 V, therefore Voltage of LDR is also 12 V; Current = 12 / 50 [1] = 0.24 A [1]	
	(ii)	Current through R = 0.24 + 0.25 = 0.49 A [1] Resistance R = (18 – 12) / 0.49 = 12.2 Ω [1]	
	(b)	When the brightness of the torchlight increases, the resistance of the LDR decreases. This causes the current in the circuit to increase, since V = IR and R is a fixed value, hence the potential difference across R increases [1] and the lamp becomes less bright. [1] Also accept potential divider formula and explanation.	
8	(a)	According to the question, the corks move up and down as the wave passes. This shows that the water particles move in a direction perpendicular to the direction of the water wave, and this is a characteristic of transverse wave.	
	(b)(i)	Speed = wavelength / period = 8.0 / 0.50 [1] = 16 cm/s or 0.16 m/s [1]	
	(ii)	 Same amplitude [1] and period [1]. When A is at the crest, B is at the trough	
	(c)	Stating another correct transverse wave and its use.	

SECTION B(30 m)

Qn	Part	Answer	Remark
9	(a)(i)		
	(a)(ii)	Force exerted by rider on horse produces a force exerted by horse on rider, **<u>equal in magnitude</u>** but **opposite in direction**. The two forces are contact forces and are of the same nature.	
	(b)(i)		
	(ii)	The wider base lowers the centre of gravity of the fence. A larger angle of tilt is needed before the fence can topple.	
	(c) (i)	Let the speed of the horse with the rider be v. ½ (520 kg)(v2) = 4000 J ⇒ v = 3.92 m/s	
	(ii)	From mgh = gain in GPE 520 kg x 10 Nkg^{-1} x h = 3000 J ⇒ h = 0.58 m Thus maximum height = 1.4 m + 0.58 m = 1.98 m	
10	(a)(i)	Alternating current is one where the direction of the current changes direction at regular intervals, many times per second.	
	(ii)	As the magnet rotates, there is a rate of change of magnetic flux linking with the coil, hence there will be an induced emf and an induced current will flow.	
	(iii)	As the magnet rotates anticlockwise as shown in Fig. 12.1, the N pole of the magnet approaches the left side of the coil, the induced emf and hence induced current will flow in a manner such that it produces a N pole on the left side of the coil, so as to oppose the change causing it. [1] As the N pole of the magnet moves away from the left side of the coil, the induced emf and hence induced current will flow in a manner such that it produces a S pole on the left side of the coil, so as to oppose the change causing it. [1]	
	(iv)	▪ Increase the number of turns of the coil. ▪ Use a stronger rotating magnet. ▪ Decrease the distance between the rotating magnet and the coil. ▪ Decrease the resistance of the wires.	

	(b)(i)	As the voltage is stepped up, the current is low, since joule heating $P = I^2R$, when current is low, thermal energy loss is minimised.	
	(ii)	Primary P = VI = 23000 x 100 [1] = 2300000 W or 2.3 MW [1]	
	(iii)	Since transformer is ideal; 23 00000 W = 660 000 x I I = 3.48 A or 3.5 A [1]	
11	EITHER		
	(a)	There is a bigger temperature difference between that of the oil and the freezer at the start. The 10°C fall is more rapid at the start as thermal energy transfer between the two is the faster, resulting in a shorter time. As the temperature of the oil approaches that of the freezer, the temperature difference decreases. Thermal energy transfer is slower and this causes the time taken for the same temperature drop to be longer.	
	(b)	▪ When temperature decreases, the kinetic energy of the molecules decreases. The molecules will move closer to each other. ▪ The intermolecular space shrinks, reducing the volume of the oil, causing the oil level to drop.	
	(c)	Oil is changing from liquid to solid during the given time interval. As there is no change in the temperature, there is no change in the kinetic energy of the molecules as molecular bonds are being formed.	
	(d)(i)	From Q = ml = (45/1000) (5.7×10^4 Jkg^{-1}) = 2570 J	
	(ii)	Rate of energy transferred = (2570 / 7200) W = 0.36 W (2 s.f.)	
	(iii)	Using $Q = mc\,\Delta\theta$ $Q/t = mc\,\Delta\theta /t$ $P = mc\,\Delta\theta /t$ For the liquid and solid phase, For the liquid : $P_{liquid} = mc_{liquid}\,(\Delta\theta /t)_{liquid}$ ...(i) For the solid : $P_{solid} = mc_{solid}(\Delta\theta /t)_{solid}$ ...(ii) assuming that the rate of heat transfer is constant, $c_{liquid} = (P)_{liquid} /[m\,(\Delta\theta /t)_{liquid}]$ $c_{solid} = (P)_{solid} /[m\,(\Delta\theta /t)_{solid}]$ Now $(\Delta\theta /t)_{liquid} > (\Delta\theta /t)_{solid}$ $c_{liquid} < c_{solid}$	
11	OR		
	(a)	Sound wave with frequency above 20 000 Hz / above the upper limit of the human audibility range.	
	(b)	Water particles will vibrate in a direction parallel to the direction of propagation of the sound wave [1], creating a series of compression and rarefaction [1], transferring energy from one particle to another particle.	

	(c)	2 x d = speed x time = 1500 m/s x (4 x 10^{-6} s) [1] d = 0.030 m [1]	
	(d)	T = between 0.6 – 0.8 div of 10 μs [1] f = 1/ T = 125 0000 Hz – 167 0000 Hz [1]	
	(e)(i)	▪ A distinct sound wave of high frequency does not interfere with sound of other frequencies. ▪ High frequency sound waves have high energies. The reflected sound still has enough energy to be detected by the detector.	
	(ii)	▪ Energy is lost when sound wave is reflected from the wall. [1] ▪ Energy is lost due to work done against friction in the water [1] ▪ Energy is absorbed by the water molecules as the ultrasound passes through them ▪ Reflected energy moves out radially. As a result, the 2nd pulse have less energy	