2024 CHS SEC 4 PHYSICS PRELIMINARY EXAMINATION
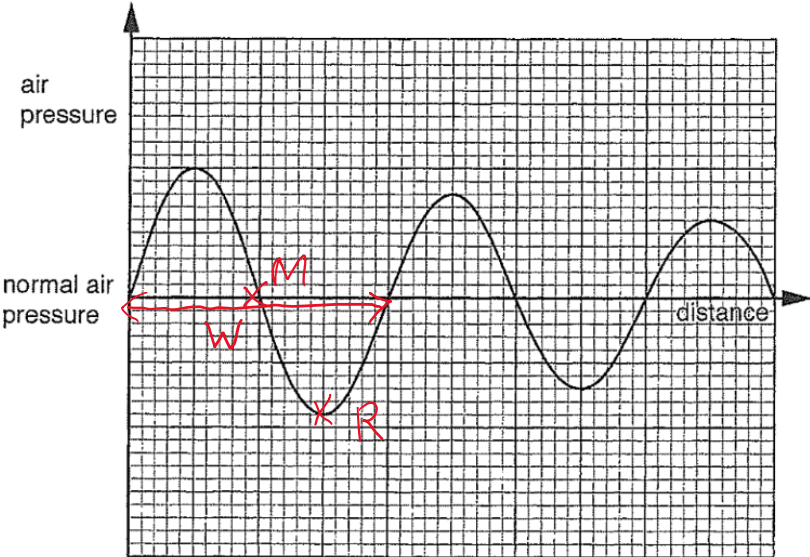
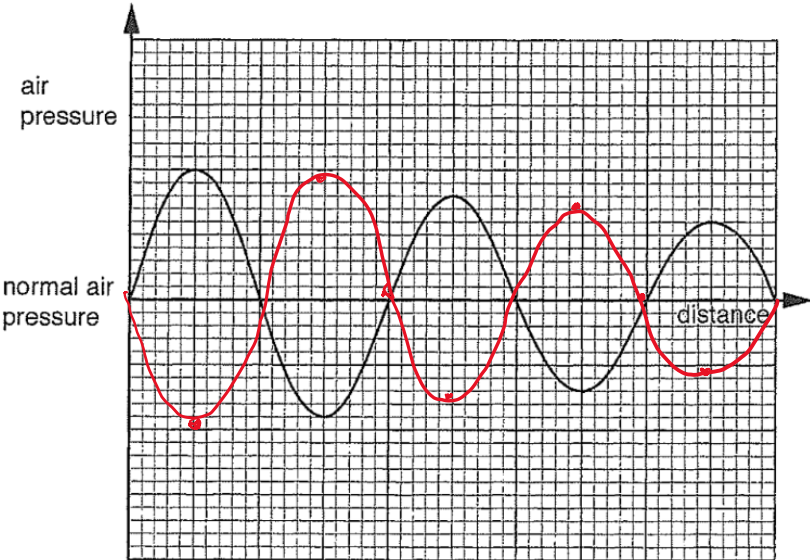**Paper 1**

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

Paper 2 Section A

S/N	Mark Scheme	Remarks
1ai	- Ball's speed is decreasing [M1] at a decreasing rate [A1] OR - Deceleration [M1] is decreasing [A1] OR - Acceleration is decreasing [M1] and negative [A1]	1 mark awarded for "ball is decelerating at decreasing rate".
1aii	(weight and) air resistance acts (on ball) downwards (or in opposite direction to motion/velocity) (resulting in decreasing speed) [B1] - As speed (or velocity) decreases, air resistance decreases [B1] (downward) resultant force decreases (resulting in decreasing deceleration) [B1]	No credit is awarded for 1st mark if the answer mentions that upward force is acting on the ball as it is moving up.
1b	1.750 s [B1]	No penalty if answer in 2 d.p.
1c	- graph is below x-axis and gradient decreases smoothly without reaching 0 at 3.50 s. [B1] - final velocity, v is below x-axis and 0 m / s < v < 25 m / s [B1]	No penalty if draw past 3.50 s.
2a	- energy transferred <u>mechanically</u> to gravitational potential (and kinetic) store of load [B1] (some) energy is transferred - mechanically due to (work done against) friction (or air resistance) [B1] to the internal store of surrounding air (and load). [B1] OR - by heating (due to temperature difference) [B1] to the internal store of surrounding air (and load). [B1] OR - by propagation of electromagnetic waves / infra-red radiation [B1] to the internal store of surrounding air (and load). [B1] OR - by propagation of mechanical / sound waves [B1] to the kinetic store of surrounding air. [B1]	If student writes "store" at least once, BOD all answers without "store". If student does not write "store" at all, penalise 1 mark. No credit awarded for the method of energy transfer to surrounding air if the energy transfer is not from the motor.

2b	Moment = F x d [formula]
	         = 2.5 x 0.20 [B1]
	         = 0.50 Nm (or 50 Ncm) [B1]	

S/N	Mark Scheme	Remarks
2c	As load is stationary, Upward force due to liquid (F) = Weight of Load M = 2.5 N [B1] $F = pA$ $\quad = (p_{bottom} - p_{top}) \times A$ $\quad = [(h_{bottom} - h_{top})\, \rho\, g] \times A$ $2.5 = [0.030 \times \rho \times 10] \times (0.12 \times 0.02)$ [B1] $\quad \rho = 3\,500$ kg m^{-3}	Accept if student calculated density of load M [B1] and concluded that density of load M and the liquid are the same [B1]
3a	● molecules are in constant random motion [B1] ● collide with (inner walls of) piston, exerting a force per unit area on it [B1]	
3b	● (when gas is heated), molecules collide more frequently and forcefully with (inner walls of) piston, exerting a larger force / pressure (than that due to atmosphere) [B1] ● hence, a downward force (or pressure) is needed to balance this larger force (or pressure) / keep the piston stationary / result in no net force on piston [B1]	
3ci	● wood is a poor conductor/good insulator of heat [B1]	
3cii	● prevents hot gas rising out of the cylinder / prevents surrounding cool air sinking into the cylinder / minimising convection currents [B1]	
3ciii	● reduce heat transfer to surrounding air by infra-red radiation / silver is a poor emitter of infra-red radiation [B1]	Penalise if student writes "absorber" or "absorber and emitter" as question specifically mentions "outer walls".
4a	● a wave that travels in a direction parallel to the direction of vibration (or oscillation) of particles [B1]	

S/N	Mark Scheme	Remarks
4bi 4bii 4biii		[B1] for W (arrow must be horizontal) [B1] for R (accept any position that is at the lowest point of first 2 cycles) [B1] for M (accept any point where graph intersects with distance axis)
4c	● Frequency of wave depends on the source of vibration, which remains the same. [M1] ● Hence, claim is incorrect. [A1]	Also accepted if students say that the wavelength in the graph is constant, (hence since velocity is constant as the medium is constant), then the frequency is constant.
4d	$v = f \lambda$ $f = v / \lambda$ 　$= 330 / 3.3$ 　$= 100$ Hz $T = 1/f = 1/100 = 0.01$ s $= 10$ ms As 15 ms corresponds to 1.5 periods later, graph is as drawn below.	[B1] for obtaining T

S/N	Mark Scheme	Remarks
		[B1] for graph shape and correct values of maximum and minimum air pressures
5a	satellite: microwaves [B1] terrestrial: radio waves [B1]	
5b	v = d / t t = d / v = (36 000 x 1000) / (3.0 x 10^8) [B1] = 0.12 s [B1]	Penalise 1 mark for unit conversion error
5ci	● Plastic is an optically denser medium / has a higher refractive index than glass [B1] ● Angle of incidence (in plastic) is larger than critical angle (so total internal reflection occurs) [B1]	
5cii	● lighter (than copper wires) ● cheaper to manufacture (than copper wires) ● experience less signal loss ● carry much more information (than copper wires) ● faster rate of data transmission	[B1] for any answer
6a	live: brown neutral: blue earth: green and yellow	[B1] for all three correct answers
6b	● neutral wire connected to the live pin/fuse and live wire connected to the neutral pin [B1]	Accept "live and neutral wires are swapped in position"

S/N	Mark Scheme	Remarks
6c	● even when fuse is blown (or switch is off), appliance is live / at high potential [B1] ● user can get electrocuted [B1]	
6d	● electrical cables are insulated from (internal components which are in turn insulated from) external casing. [B1] ● user cannot get electrocuted as there is no electrical contact between the user and bare wire(s). [B1]	allow e.c.f. from (c) Also accept if students stated that "even if the first layer of insulation is worn out, there is an additional layer of insulation", or words to that effect.
7a	● copper [B1]	
7b	● When magnet falls, there is a change in magnetic flux experienced by the copper tube. [B1] ● By Faraday's Law, there is an induced electromotive force (e.m.f.) in the tube. [B1] ● As the copper tube forms a closed circuit, there is a current induced in the tube. [B1]	Allow e.c.f. from (a), except for last [B1] as plastic is not an electrical conductor
7c	● By Lenz's Law, induced current creates a magnetic field that opposes the approaching (or departing) pole(s) of the magnet. [B1] ● Magnetic force of repulsion (or attraction) is upwards (opposite to direction of weight), resulting in decreasing (downward) resultant force / acceleration. [B1]	Accept "approaching and departing poles" as well when magnet is within the tube.
7d	South [B1]	
8a	● medical X-rays ● building materials ● waste products from nuclear power stations ● rocks ● radon gas ● cosmic rays from outer space (accept the Sun) ● food high in potassium eg. bananas, carrots, salt [B1]	Any other possible answer
8b	CPM α $1/d^2$ CPM = k/d^2 k = CPM x d^2 When d = 1.0, k = (3 620 – 20) x $(1.0)^2$ = 3 600 When d = 2.0, k = (920 – 20) x $(2.0)^2$ = 3 600 When d = 3.0, k = (420 – 20) x $(3.0)^2$ = 3 600 Since the values of k are the same, the claim is true.	[B1] to show k is the same for 2 sets of data [B2] to show k is the same for 3 sets of data
8ci	24 000 years [B1]	
8cii	Count rate due to plutonium alone = 70 – 20 = 50 Count rate due to plutonium alone after 1 half-life = 200 Count rate after 2 half-lives = 100 Count rate after 3 half-lives = 50 Hence, t = 3 x 24 000 = 72 000 years [B1]	No working required e.c.f. from (c)(i) ie. 3 times the answer

S/N	Mark Scheme	Remarks
8d	$$^{239}_{94}\text{Pu} \rightarrow\ ^{235}_{92}\text{U} +\ ^{4}_{2}\text{He}$$	[B1] for correct atomic numbers [B1] for correct mass numbers
8e	● alpha particles are easily absorbed by paper [B1] ● beta particles are suitable [B1]	Do not accept gamma rays as they penetrate through paper regardless of thickness.
8f	● wear lead-lined gloves / suits ● use thick concrete walls and lead-lined doors for rooms in which ionising radiation is produced ● store plutonium in a lead box	Accept "protective / radiation / hazmat suits"
9a	● 9.0 J of work is done per unit charge (by the battery) in driving charges around a complete circuit. [B1]	Accept "per 1 coulomb of charge"
9bi	$I = V / R$ $= 6.3 / 1800$ $= 3.5$ mA [B1]	
9bii	By Potential Divider Principle [formula] $6.3 / (9.0 - 6.3) = 1800 / R_L$ [B1] $\qquad R_L = 771\ \Omega$ [B1] OR $R_L = V_L / I$ $\quad = (9.0 - 6.3) / 0.0035$ [B1] $\quad = 771\ \Omega$ [B1]	
9c	● lamp drawn (with correct circuit symbol) in parallel to LDR [B1] ● when light intensity decreases, resistance of LDR increases, causing p.d. across LDR to increase (and lamp to light up). [B1]	
9d	● same p.d. across lamp and LDR, but LDR has smaller resistance than lamp [M1] ● hence, (by $P = V^2 / R$) LDR dissipates more power. [A1]	e.c.f. if lamp is drawn in series to LDR in (c). Answer must be consistent to that of (c).
9e	● reduce length of filament to ¼ of its original length [B1] ● increase cross-sectional area of filament to 4 times its original area (or increase diameter of filament to twice its original diameter) [B1]	Penalise 1 m if both answers do not have numerical factors.

Paper 2 Section B

S/N	Mark Scheme	Remarks
10a	● a region of space in which an electric charge experiences a force. [B1]	
10bi	● (at least 3) parallel equidistant lines with arrows pointing downwards [B1]	
10bii	● force (on electron) due to electric field is (vertically) upwards [B1] ● force (on electron) due to magnetic field is (vertically) downwards (or opposite direction to electrostatic force) and of same magnitude as electrostatic force [B1] ● no net/resultant force [B1]	Award 1 mark overall if direction of electric and magnetic forces are reversed.
10biii1	● at least 1 cross in region between parallel plates [B1]	
10biii2	● using Fleming's Left-Hand Rule [B1] ● thumb representing force is (vertically) downwards and second finger representing current is to the left, (so forefinger representing magnetic field is into plane of paper) (with all three directions mutually perpendicular) [B1]	
10biv	● electron causes electrons in metal rod to move to the right side of the rod as like charges repel [B1] ● force of attraction between electron and positive charge on the left side (of rod) is larger than force of repulsion [B1]	
11ai	● an energy store that is made up of total kinetic energy associated with the random motion of the particles [B1] and the total potential energy between the particles in the system. [B1]	Accept if students say "sum of the kinetic energy and potential energy of all the particles". Penalise 1 m if student mentions "store" for potential or kinetic. Penalise 1 m if student writes "one particle" or "substance/object/body" instead of "particles". No marks awarded for "gravitational potential" instead of "potential".
11aii	● potential energy of steam molecules higher than potential energy of water molecules (while kinetic energy is the same). [B1] ● steam molecules are further apart / steam molecules can move freely in all directions / (higher potential energy) to overcome intermolecular forces of attraction (compared to water molecules) / (higher potential energy) as it has absorbed latent heat of vaporisation [B1]	

S/N	Mark Scheme	Remarks
11bi	$E = Pt$ $\quad = IVt$ $\quad = (3.0)(24)(15.0 \times 60)$ [B1] $\quad = 64.8$ kJ	
11bii	Let final temperature be θ By conservation of energy, Energy transferred electrically + Loss of energy of water = Gain in energy of ice $$E + m_w c_w (\Delta\theta_w) = m_i l_f + m_i c_w (\Delta\theta_i)$$ $$64800 + (0.050)(4200)(100 - \theta) \text{ [B1]} = (200)(334) + (0.200)(4200)(\theta - 0) \text{ [B1]}$$ $$\theta = 18.1 \text{ °C [B1]}$$	Penalise 1 m for wrong unit conversion.
11biii	● some of the energy transferred from the heater and water is used to increase energy in internal store of container / surrounding air. [M1] ● actual temperature lower than (ii) [A1]	No need to write "store". Accept "some energy is transferred by heating due to temperature difference from surrounding air of higher temperature, so actual temperature higher than (ii)" as long as (b)(ii) answer is lower than typical room temperature.