2025 S4 Physics Prelim Mark Scheme

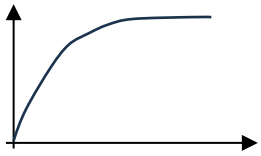
Paper 2

Section A

Qn	Solution	Mark
1(a)(i)	0 to 1 s and 8 to 12 s	[1]
(ii)	0 to 1 s, the car is at rest. 8 to 12 s, the car is moving at constant velocity or constant speed.	[1] [1]
(b)(i)	At t = 3.0 s, total resistive force is 700 N. F_{net} = forward force – total resistive force ma = 2400 – 700 800 x a = 1700 a = 2.13 m/s^2	 [1] [1]
(ii)	F_{net} = ma = 800 x 0.50 = 400 N 400 = forward force – total resistive force Total resistive force = 2400 – 400 = 2000 N t = 6.8 s	 [1] [1]
2(a)	anticlockwise moment = clockwise moment 23 x 10 x d = 60 x 1.7 230d = 102 d = 102/230 = 0.44 m	 [1] [1]
(b)(i)	Wooden barrier arm will turn anticlockwise about the pivot. The electromagnet will induce magnetism in soft iron bar A with an opposite pole, attracting and pulling it down.	[1] [1]
(ii)	Steel bar is a hard magnetic material and will retain some magnetism that is induced in it by the electromagnet. When the switch is opened, the steel bar will remain attracted to electromagnet and the wooden barrier arm cannot return to horizontal position.	 [1] [1]
3(a)	E_k = ½ m v^2 = ½ x 700 x 40^2 (this step must be shown to be awarded full credit) = 560 000 J (shown)	 [1]
(b)	As the car moves up slope, all the energy in kinetic store of the car will be transferred to the gravitational potential store of the car, as well as to the internal store of the car and escape lane.	[1] [1]
(c)(i)	Gain in E_p = mgh = 700 x 10 x 3.0 = 21 000 J	 [1]

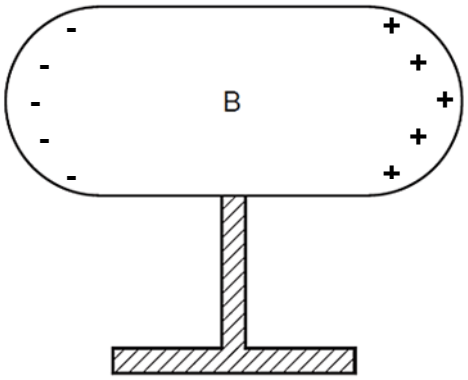
(ii)	Loss in E_k = Gain in E_p + work done to overcome friction 560 000 = 21000 + (f_r x s) = 21000 + (f_r x 40) f_r = 13 475 = 13 500 N	[1] [1]
(d)	Unevenness of the surface of the stones	[1]
4(a)(i)	Pressure is the force acting per unit area.	[1]
(ii)	Particles of steam are moving randomly at high speed. These particles will bombard the walls of the piston with a force. The total force acting per unit area results in a pressure on piston.	 [1] [1]
(b)	Pressure difference = $2.1 \times 10^6 - 1.0 \times 10^5$ Force/Area = $2.1 \times 10^6 - 1.0 \times 10^5$ Force = $(2.1 \times 10^6 - 1.0 \times 10^5) \times 0.30$ = 6.0×10^5 N	[1] [1]
5(a)	Microwave / Radiowave	[1]
(b)	Wave speed = freq x wavelength $3.0 \times 10^8 = 18 \times 10^9 \times \lambda$ λ = 0.017 m No of wavelengths = (560 000)/0.017 = 3.3×10^7 or 3.4×10^7	 [1] [1]
(c)(i)	Less disruption of signal / Less degradation of signal	[1]
(ii)	$\eta = 1/(\sin c)$ = 1/ (sin 45) = 1.41 or 1.4	 [1] [1]
(iii)	Angle of incidence = angle of reflection and angle between incident ray and reflected ray > 90° (use set square/protractor to ensure)	 [1]
6(a)	Larger percentage of energy is dissipated or wasted as heat in filament lamp	[1]
(b)	Both have the same output power 6.2 % = (output power/input power) x 100% 6.2 = output power/120 x 100 Output power = 7.44 W Efficiency of LED = (output power/input power) x 100% = 7.44/15 x 100 = 49.6 %	 [1] [1]
(c)(i)	A large current will flow from the live wire to ground via the low resistance earth wire. This will blow the fuse and disconnect the shiny metal surface and filament lamp (or circuit) from the high voltage supply.	[1] [1]
(ii)	A large current will flow from the live wire to the ground via the earth wire and will blow the fuse in the earth wire, disconnecting the circuit but the live wire is still connected to the shiny metal surface. Hence, the shiny metal surface remains at high voltage and user may get an electric shock when he touches the metal surface.	[1] [1]

7(a)(i)	The alternating current in the primary coil creates a changing magnetic field linking the secondary coil. This produces a change in magnetic flux linkage in the secondary coil, resulting in an induced emf in the secondary coil which produces a current in a closed circuit.	[1] [1]
(ii)	There is leakage or loss of magnetic flux linkage between the primary coil and secondary coil.	[1]
(b)	Vp/Vs = Np/Ns 240/Vs = 1000/50 Vs = 12 V	 [1] [1]
(c)	Energy = VIt 22 000 = 12 x 0.65 x t t = 2820 s	 [1] [1]
8(a)(i)	The amount of carbon-14 decreases by half every 5700 years.	[1]
(ii)	For living organisms ratio carbon-14 : carbon-12 1: 1 x 10^{12} 1/ (1x 10^{12}) : 1 For dead tree 1/(4 x 10^{12}) : 1 1/(4 x 10^{12}) = $(½)^n$ x (1/(1x10^{12}) , where n is no of half-lives n = 2 (or 2 half life) No of years = 5700 x 2 = 11400 yrs ago	 [1] [1]
(b)	Isotope will not remain radioactive for too long.	[1]
9(a)	The distance fallen by the ball every 0.5 s is indicative of the rate of change of displacement or the velocity of the ball. When the distance fallen every 0.5 s becomes constant, the ball has reached terminal velocity.	[1] [1]
(b)	When the ball falls, the drag force exerted by glycerin on it increases until it is equal to the weight of the ball. The resultant force acting on the ball becomes zero and acceleration of the ball become zero. Hence the ball reaches terminal velocity.	[1] [1]
(c)(i)	The 2 balls have different weights. (Do not accept different density) The ball with smaller weight will reach terminal velocity first as a smaller drag force exerted by the glycerin will be sufficient to cause the forces acting on it to be balanced.	[1] [1]
(ii)	Ball X	[1]
(iii)	velocity = (9.0-8.0)/0.5 = 2.0 cm/s	[1] [1]

(iv)		[1]
10 (a)(i)	It is to reverse the current through the coil each time it switches contact with the carbon brushes. This allows the coil to continue to rotate in one direction.	[1] [1]
(ii)	Clockwise	[1]
(iii)	Applying the Fleming's left hand rule, a downward force will be exerted on the right side of the coil and an upward force on the left side of the coil, causing it to turn clockwise.	[1]
(b)(i)	Lighter in weight. Less wear and tear. Less friction between the components within the drone.	[1] Any valid reason
(ii)	Reduce the current in the fixed coils	[1]
(c)(i)	Re = $(1/12 + 1/12)^{-1}$ + 9 = 6 + 9 = 15 Ω I = V/R = 12/15 = 0.80 A	[1] [1]
(ii)	p.d. across lamp = 6/15 x 12 = 4.8 V	[1] [1]

Section B

Qn	Solution	Mark
11(a)	Metal particles and free electrons near the heated end of metal will gain energy. The metal particles will vibrate faster and more vigorously about their fixed positions and collide with their neighbouring particles and transfer energy to them. The free electrons will move through the metal at a high speed, colliding with the metal particles at the cooler end of the metal and transferring energy to them.	[1] [1] [1]
(b)(i)	When ice melts from time = 2 min to 20 min, energy is absorbed to do work to overcome the atttractive forces between the ice particles. The energy absorbed by the ice is transferred to the potential energy of its particles but the kinetic energy of its particles remain unchanged. Hence the temperature is constant.	[1] [1]

(ii)	Total energy absorbed = $Q_{ice} + L_f$ = $mc\Delta\theta + ml$ = 1.5 x 2100 x 15 + 1.5 x 334 000 = 47 250 + 501 000 = 548 000 J (3 sf) or 550 000 J (2 sf)	[1] for Q_{ice} [1] for L_f [1]
(iii)	Power = Energy/ time = 548 000/(20 x 60) = 457 W or 458 W	Allow ecf [1]
(iv)	Water has a higher specific heat capacity than ice.	[1]
12(a)(i)	Equal no of protons and electrons  	[1]
(ii)	Electrons in conductor B will be attracted to the positively charged conductor A and move to the side facing conductor A (or left side of conductor B) as unlike charges attract. Protons in conductor B will be left on the opposite side (or right side of conductor B).	[1] [1]
(iii)	Conductor B becomes negatively charged as electrons flow from earth into the conductor to neutralise the positive charges.	[1]
(b)(i)	When dust and ash particles pass through the fine wires that are negatively charged, electrons will be transferred to them, making them negatively charged. As these negatively charged dust and ash particles rise, they will be attracted to the positively charged plates as unlike charges attract. Hence the gases that emerge from the chimney will be free of dust and ash.	[1] [1]
(ii)	Plate may contain some charge and will need time to be fully discharged. By wearing glove, user will be insulated and will not receive an electric shock when he touches the plates.	[1] [1]
(iii)	Q = It $1.8 \times 10^{-6} = I \times 1.2 \times 10^{-3}$ I = 0.0015 A	[1] [1]