VS 2023 Preliminary Examination

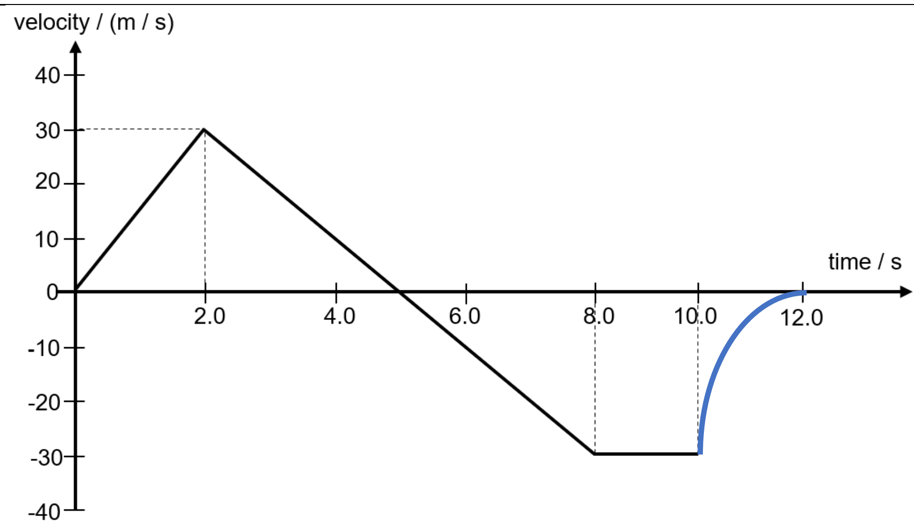
2023 Prelim exam mark scheme

Paper1

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

Paper 2 Section A

Qn	Suggested solution
1a)	displacement = ½ (5.0 x 30) – (1/2 x 3.0 x 30) = 75 – 45 = 30 m
(b)	acceleration of the cyclist = 30 / (2.0) = 15 m / s^2
(c)	The cyclist moves with constant deceleration from 2 s to 5 s. It moves with constant acceleration from 5 s to 8 s in the opposite direction. Or the cyclist moves with constant negative acceleration from 2 s to 8 s. It moves with constant velocity of 30 m / s in the opposite direction.

(d)	 **Fig. 1.1** Correct shape – 1 mark

2(a)	Any 1 condition The resultant moment about any point is zero. or The resultant force acting on the door is zero.
(b)	Moment = 0.80 m x 35 N = 28 Nm
(c)	Taking moment about the hinge, Sum of Clockwise moment = Sum of anticlockwise moment $0.80 \times 35 = F \times 0.26$ $F = 108$ N (3 s.f.)
(d)	Force *F* will remain larger than force *P* since its **perpendicular distance from the hinge is smaller than *P*'s**. The door is in equilibrium when it opens at a steady rate.

3 (a)	Efficiency is the **percentage of total input energy that is converted to useful output energy**.
(b)	Total input energy = $1.3 \times 10^6 \times 20\text{s} = 2.6 \times 10^7$ J Maximum height = $\frac{0.40 \times 2.6 \times 10^7}{1500 \times 10}$ = 693 m

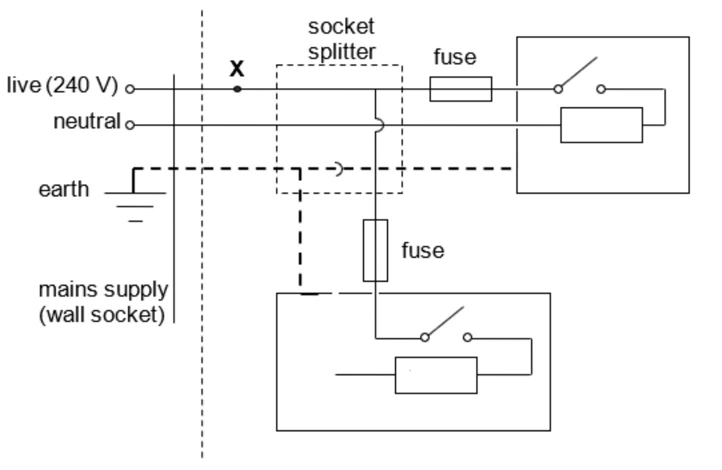
(c)	At point X, the **gravitational potential energy** of the roller coaster car is the **maximum**. As it moves to the lowest point between point X and Y, its **kinetic energy is the maximum** as its gravitational potential energy is converted to kinetic energy. At point Y, it possesses **both kinetic energy and gravitational potential energy** which is gained from the increase in its vertical height.
(d)	Work done is the **product of the force exerted by the machine and the distance travelled in the direction of the force**.

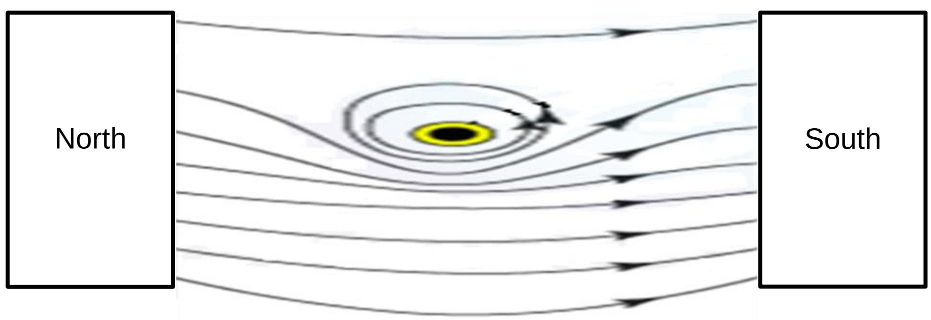
4 (a)	Pressure is **force per unit area**.
(b)	Manometer
(c)	Pressure of the gas in the flask = atmospheric pressure - hpg $= 1.0 \times 10^5 - 0.32 \times 13600 \times 10$ $= 56480$ $= 56.5$ kPa
(d)	The level of mercury at **P will rise** and level at **Q will drop** and their difference will be **less than 320 mm**.

5(a)	3.0×10^6 complete cycles are produced in a second.
(b)	The air particles vibrate/oscillate about their equilibrium position parallel to the direction of the wave motion. They transfer energy through a series of compression and rarefactions from one point to another.
(c)	distance = speed x (time / 2) $= 330 \times (4.0 \times 10^{-4} / 2)$ $= 0.66$ m
(d)	The frequency and amplitude of the sound is greater.

6(a) (i)	The brightness of P decreases to zero.
(ii)	The potential difference (p.d.) across P at X is 20 V and decreases to 0 at Y.
(b) (i)	When the light intensity of the surrounding decreases, the resistance of LDR increases. The p.d. across LDR increases.

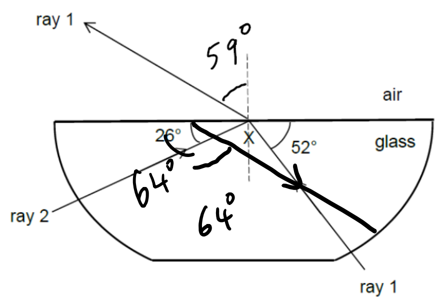
	Since light bulb P is in parallel with LDR, p.d. across P increases. The brightness of P increases.
(ii)	p.d. across R = 20 – 6.5 = 13.5 V resistance of R = 13.5 / 0.40 = 33.8 Ω
(c)	The brightness of P using the LDR changes <u>automatically</u> as compared to Q that needs manual adjustment to change its brightness.

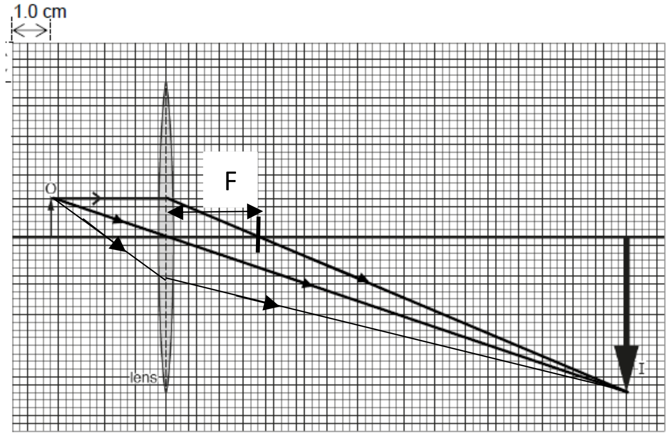
7(a)	
(b)	The fuse is connected on the 'live' wire so that when it blows due to excessive current, the appliance will be <u>disconnected before current reaches the appliances.</u>
(c)	$P = V^2 / R$ $= 240^2 / 80$ $= 720$ W = 0.72 kW $E = Pt$ $= 0.72 \times 24$ $= 17.3$ kWh
(d)	Current in appliance 1 = 240/80 = 3.0 A Current in appliance 2 = 240/40 = 6.0 A The total current required when both appliances are on is 9.0 A
	The fuse used should be higher than 9.0 A, hence rating of 9.0 A is insufficient.

8(a)	Direction of the magnetic force points into the page
(b) (i)	When a current flows in the wire XY, the wire will experience a magnetic force due to the interaction with the magnetic field of the horseshoe magnet.
	Using Fleming's left-hand rule, the direction of force by the horseshoe magnet on the wire is upwards. Where the current points from X to Y, magnetic field points from P to Q. **Or** The concentration of the magnetic field below the wire is higher than above the wire. And the magnetic force on the wire is upwards.
	By Newton's third law of motion, the **magnetic force by the wire on the horseshoe magnet will be downwards**. Hence the reading increases.
(b) (ii)	P: North Q: South
(c)	 **Fig. 8.3** Correct direction of magnetic field lines – 1 mark Spacing between magnetic field lines below the wire is smaller – 1 mark

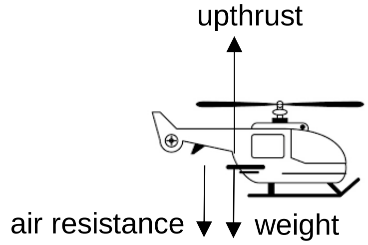
Section B

Qn	Suggested Solution
9(a)	The water molecules are moving in constant random motion.
(b) (i)	Heat transfer by <u>conduction</u> from pipe to coolant. Molecules of the pipe <u>vibrate</u> about their positions and heat is passed through <u>collision</u> with neighbouring molecules of the coolant.
(b) (ii)	The water near the copper pipe loses thermal energy (heat) to the pipe and become <u>denser and sink to the bottom</u> of the tank. The warmer water being <u>less dense will rise and be cooled</u> by the refrigerator unit. This cycle repeats and <u>forms a convection current</u> in the tank.
(c)	The shiny aluminum tank is good reflector of radiant heat (infra-red radiation). It reduces heat gain from the surrounding by infra-red radiation.
(d)	**(i)** energy = P × t = 80 × (1.5 × 60 × 60) = 432 000 J = 432 kJ
	(ii) Let the final temperature be T according to principle of conservation of energy, Heat gain by refrigerator unit = Heat lost by the water energy = m × c × (25 – T) 432 000 = (1000 × 0.013) × 4200 × (25 – T) final temperature, T = 17 °C
(e)	The refrigerator unit will also need to <u>remove heat from the copper pipe and / or the aluminum tank</u> to cool the water. Hence the heat remove is not enough to bring the final temperature of the water to 17 °C. *Do not accept answer that is not specific and only state heat is gained from surrounding.

10(a) (i)	Radio wave, infra-red wave, visible light
(a) (ii)	$v = f\,\lambda$ $3.0 \times 10^{8} = f \times 0.95 \times 10^{-6}$ frequency $f = 3.16 \times 10^{14}$ Hz
(b) (i)	Both ray 1 and 2 are travelling perpendicular to the glass surface. Or They are travelling along the normal of the glass surface.
(ii)	refractive index, $n = 1 / \sin 46°$ $= 1.39$
(iii)	As the angle of incidence(38 °) in glass (denser medium) is less than the critical angle (46°), ray 1 will speed up as it emerges in the air and the light ray bends away from the normal.
(iv)	refer to diagram  1. For ray 1: angle of refraction = 59 ° Working : $Q = \sin^{-1} (1.39 \times \sin 38°) = 59°$ 2. Ray 2 undergoes total internal reflection Angle of reflection = 64 °
(d) (i)	linear magnification= Hi/Ho (or v / u) = 8.0 cm / 2.0 cm = 4.0
(ii)	From the diagram, two correct light rays and correct label F where the light ray passes through the principlal axis

	 focal length = 2.4 cm

Either	
11(a)(i)	Anti-clockwise rotation when viewed from Y.
(ii)	The magnetic field lines are being cut at the greatest rate at the position or rate of change of magnetic flux linkage is maximum.
	Using Faraday's law of electromagnetic induction, the magnitude of the induced emf is directly proportional to the rate of change of magnetic flux linkage and thus the e.m.f. induced is maximum.
(iii)	The period is halved (20 ms)
	The peak output voltage is doubled (10.0 V) (Draw at least two periods)
(b)(i)	<u>Alternating current can be stepped up or down</u> with little power loss whereas direct current cannot be stepped up or down.
	The voltage is <u>stepped up for high voltage transmission so that the current is low</u> during transmission in the cables, this <u>reduces power loss</u> (I^2R) during transmission.
(ii)	Step-up transformer with turns ratio 2.0.
(iii)	At 0.76 efficiency I_p = (1000/0.76)/120
	= 10.96 A = 11.0 A

Or	
11(a)	Weight = 860 x 10 = 8600 N
(b)	Refer to Fig. 11.3  The arrow length of upthrust should be drawn longer than the combined length of air resistance and weight.
(c)	Upthrust - air resistance - 8600 = m a Upthrust - 400 – 8600 = 860 x 4.0 Upthrust = 12 400 N
(d) (i)	Acceleration = (6.0 - 55) / 5.0 = - 9.8 m / s^2 deceleration is 9.8 m / s^2
(ii) 1.	As velocity increases, the force due to air resistance increases. When the force due to <u>air resistance equals to the weight</u> of the parachutist, the resultant force will be zero and there'll be no acceleration.
2.	When the parachute opens, the <u>force due to air resistance increases to become greater than the weight</u> of the parachutist. The resultant force acts upwards, and the parachutist decelerates. (The velocity decreases at a decreasing rate.)
3.	With the parachute opened, the <u>force due to air resistance will be equal to the weight of the parachutist at a smaller speed</u>. Hence the velocity of the parachutist will decrease until an equilibrium is reached.