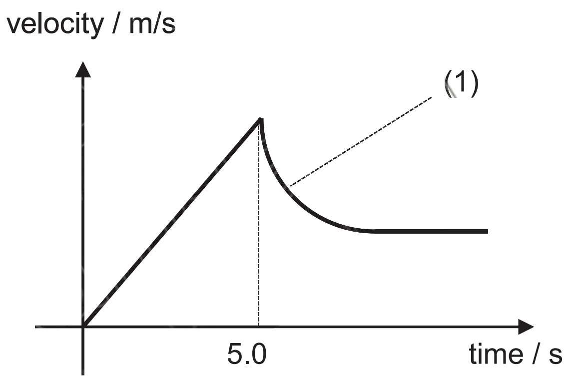
2020 SJI Physics Prelim Exam Marking Scheme

Paper 1

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

Paper 2

Section A

1	(a)	It means that for every 1.0 s the displacement increases constantly by 1.5 m.	
	(b)	Due to inertia, the parachutist still continue to move horizontally.	
	(c)	indicate : velocity at time is 5.0s = 50 m/s ---(1) Distance = ½ x 50 m/s x 5.0s = 130 m or 125 m ---(1)	
	(d)	(i)	
	(d)	(ii)(1)	The air resistance acting on the parachutist is larger than the weight of the parachutist. (1) The resultant force is opposite to the direction of motion. (1)
		(ii)(2)	The air resistance is equal to the weight of the parachutist and the resultant force is 0 N.
2	(a)	Fr = ma 40000 N – 1000 N – Fair = (3000 kg)(5.0 m/s^2) -----(1) Fair = 24000 N ----- (1)	

	(b)		The car accelerates, velocity increases and air resistance increases. (1) The driving force is constant and hence the resultant force decreases. (1) As such the acceleration decreases.
3	(a)		$P = F / A = 8.0\ N / 0.50 \times 10^{-4}\ m^2 = 160\ 000\ Pa$
	(b)		$P_B = P_A$ $F_B / 2.00\ cm^2 = 8.0\ N / 0.50\ cm^2$ --- (1) $F_B = 32\ N$ -- (1)
	(c)		diff pressure = hpg 160 000 Pa – 100 000 Pa = h(13600 kg/m^3)(10N/kg) h = 0.44 m
	(d)	(i)	Difference in level remains the same as the difference in pressure remains the same.
		(ii)	Difference in level is larger as the density of water is lower than density of mercury and the difference in pressure remains the same.
4	(a)	(i)	KE gained = ½ x40 x1.5^2 – 0 J = 45 J
		(ii)	Wd = gain in KE + Wd against resistive force (30 N x 6 m) – 45 J = f x 6.0 m [1] f = 22.5 N[1]
	(b)		It stopped gaining KE when the box starts to <u>decelerate/move at constant velocity</u>, which happen when the pushing force is smaller/equal to the resistive force/when resultant force is negative/when F<22.5) [1] From the graph, when this happens, the distance is 6.9 m. [1]
	(c)		Area under the graph = 30 x 6 + ½ x 30 x 4 = 240 J Average power= 240 J/10.0 = 24 W
5	(a)		correct shape (1) correct arrow (1) f = 4.0 cm ± 0.4 cm (1)
	(b)		n = 1 / sin c 1.5 = 1 / sin c c = 42°
	(c)		Ray C – continue straight Ray A – TIR
6	**(a)**		Direction of force on a positive charge placed in the field.
	(a)	**(i)**	Positive Repulsive force and attractive force on the charge results in a net force that acts to the right
		(ii)	No change, field is uniform
	(c)		Electrons transfer from the plate Swings to the left due to repulsion
7	**(a)**	**(i)**	Q = 0.16(120) = 1920 C
		(ii)	E = 0.60 (1920) = 1150 J
	(b)	**(i)**	Increases (ratio of V to I increases from 3.75 Ω to 12.7 Ω)

		(ii)	Temperature increases as pd increases resulting in an increase in resistance
8	**(a)**	An opposite pole was induced at the end of the paper clip that was closer/facing the magnet while a like pole was induced at the farther end. [1] Since the unlike poles of the paper clip and magnet are nearer than the like poles, a net attractive force is exerted on the paper clip./attractive force is stronger than the repulsive force [1].	
	(b)	Magnetic shielding occurs and the magnetic field lines concentrate within the iron plate.	
9	**(a)**	**(i)**	There is no longer any magnetic field lines between the plate and paper clip hence it stopped being an induced magnet/loses its polarity.
		(ii)	Vertically up/anticlockwise. Magnetic field produced by current in BC interacts with magnetic field of coil of wire. A force is induced on BC as shown by Fleming's left hand rule.
	(b)	No effect as both magnetic fields reverse direction hence direction of force is unchanged.	
	(c)	**(i)**	Left to right
		(ii)	Parallel wires carrying current in the same direction produce a resultant magnetic field that cause adjacent turns of the spring to exert a magnetic force of attraction between each other or Field between adjacent wires is weaker hence resulting in a net attractive force

Section B

10	(a)	The water at the base will be heated up and become less dense and will rise. (1) The cooler denser water will sink to the base and will be heated up. Convection current can be formed throughout the entire water. (1)	
	(b)	(i)	Minimise heat lost from the water to the surrounding through convection.
		(ii)	Metal is a good conductor of heat and heat will be transfer to the water through the metal casing quickly.
	(c)	(i)	4200 J of thermal energy is needed to raise the temperature of 1 kg of water by 1K.
		(ii)	heat supply = heat gain by water $Pt = mc\Delta\theta$ $(1200W)(t) = (0.500kg)(4200\ J/kg/K)(70°C)$ --- (1) $t = 123\ s$ ---- (1)
		(iii)	heat loss by hot milo = heat gain by ice (melt + incr temp) $C\Delta\theta = ml_f + mc\Delta\theta$ $(900\ J/K)(65°C) = m(336000\ J/kg) + (m)(4200\ J/kg/K)(15°C)$ --(1) $m = 0.15\ kg$ --(1)

		(iv)	Not all the heat from the hot milo is transferred to the ice, some is transferred to the surrounding.
11	(a)	As temperature increases, the resistance of the thermistor decreases at a decreasing rate. [1] From 14 to 18, the decrease is 770 per 4 degree Celsius. From 40 to 44, the decrease is 240 per 4 degree Celsius. [1]	
	(b)	(i)	Temperature increases, resistance of thermistor decreases. Vout increases by potential divider principle
		(ii)	Final voltage across thermistor = 12 – 7.2 = 4.8 V Final resistance of thermistor = $\frac{4.8}{7.2} \times 4800 = 3200\ \Omega$ [1] When resistance is 3200, temperature = 24℃. [1]
		(iii)	Effective resistance decreases, hence pd across lamp decreases [1]. Power dissipated decreases hence lamp is dimmer than expected [1]
		(iii)	Power = $7.2^2/4800$ = 0.0108 W
	(c)	(i)	R = $110^2/700$ = 17.3 Ω [1]
		(ii)	I = 240/17.3 = 13.9 A [1] Assuming resistance is constant, if the voltage increases to 240 V, the current is greater than the fuse rating (8A) [1]. This result in the fuse heating up and melting.
12	(a)	(i)	Downward force
		(ii)	cwm = 2.5 m x 1300 N = 3250 Nm
		(iii)	Sum of cwm = sum of acwm 3250 NM +450 x 3.0 = F_B x 1.25 m F_B = 3680 N
		(iv)	As the girl's distance from A increases the sum of the clockwise moment about A increases, hence the anticlockwise moment produced by F_B has to increase as well to ensure that the board remains in equilibrium [1] as the distance of the cone is unchanged, F_B has to increase. [1]
	(b)	Composite density = $\frac{total\ mass}{total\ volume}$ Total volume of the diving board = 130 kg / 1250 = 0.104 m^3 [1] Total mass = volume of resin x density of resin + volume of aluminium x density of aluminium 130 kg = 0.60 x 0.104 m^3x d + 0.40 x 0.104 m^3 x 2700 kg/m^3 d = 283.33 kg/m^3 = 280 kg/m^3 [1]	
	(c)	If X is the cg of the cone, there is a perperpendicular distance from the line of action of the weight to the pivot at Y. [1] Hence the weight would produce an anticlockwise moment about Y and cause the cone to rotate. It will not be at rest. [1]	
12	(a)	-X-ray is a high energy/ionising electromagnetic wave while ultrasound is not ionising. -Accept Xray can cause many health risks to the baby (eg. cell mutation, cell death, heating, cancer, impaired brain function, stunt growth etc) →X-ray is dangerous (not accepted)	

	(b)	ultrasound/waves are partially reflected/refracted (when they meet a boundary) [1] the time taken for it to be reflected is measured (and is used to determine distances) [1]	
	(c)	2d= 1600 m/s x (80-30) x 10^{-6} s [1] d = 0.040 m = 4.0 cm [1] if answer 8.0 cm [1]	
	(d)	(i)	The distance between 1 wavefront to another is one wavelength. Since the distance between the wavefronts is constant. [1] and the frequency of the dipper is constant. [1] the water wave must have a constant speed.
		(ii)	f=8.0 Hz and λ = 0.015 [1] v=fxλ v= 8 x 0.015 m = 0.12 m/s [1]
		(iii)	The wavelength of water wave increases in deeper water. Since wave speed is v = fx λ and frequency is constant, speed will increase.