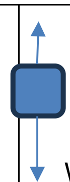
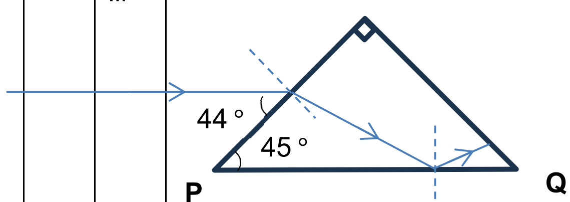
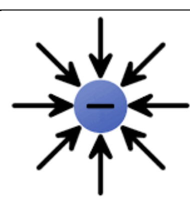
Suggested Marking Scheme for PSS 6091 Prelim 2024

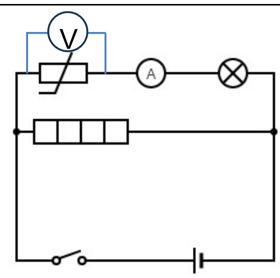
- Correct units are expected for all questions, unless otherwise stated. Penalise units up to once in section A, and up to once in section B.
- Expect lowest sf after multiplication and division, condone 1 more sf than expected. Penalise dp/sf once for the entire paper.

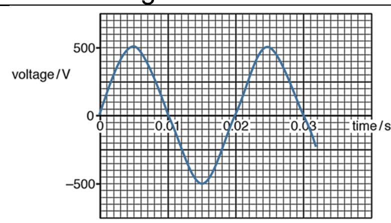
Question			Marking point	Mark	Markers comments
1	a		The velocity is increasing from t = 0 s to t = 80 s Since velocity is the rate of change of displacement, the displacement is increasing at an increasing rate.	B1 B1	
	b		displacement = area under graph $= \frac{1}{2}[(190-90)+220) \times 25.0$ = 4000 m average velocity = $\frac{4000}{220}$ = 18.2 = 18 m / s (2sf)	M1 M1 A1	
	c		$a = \frac{v-u}{t}$ $= \frac{0-25}{30}$ (or $\frac{0-13}{16}$ or $\frac{13-25}{14}$) =–0.83 m/s^2 (or -0.81 or -0.86) d=0.83 m/s^2 penalize for units once with 2c	M1 A1	
					[total: 7]
2	a		 resistive forces = 1200 N W = 2500 N	B1 for both forces	
	b		W=mg 2500 = m × 10 m=250 kg	B1	
	c		F_R=2500 – 1200 = 1300 N $F_R = ma$ 1300 = 250 a $a = \frac{1300}{250}$ = 5.2 m/s^2 penalise for unit once with 1c	M1 M1 A1 / ECF1	

Question			Marking point	Mark	Markers comments
	d		• The surface area of the crate. • The surface area of the parachute. • Presence of wind.	B1 for any	
	e		• As speed increases, air resistance increases • until it is equal in magnitude to weight. • so resultant force is 0.	B1 for any 1 point B2 for all 3 points	
					[total: 8]
3	a		Liquid that is heated at the bottom expands, resulting in a lower density, and rises. Cooler liquid, being denser, sinks, to be heated. Process repeats to form a convection current.	B1 for any 1 point B2 for all 3 points	
	b		From **A** to **B**, energy is transferred to the internal kinetic store and so the temperature of the substance rises. From **B** to **C**, energy is transferred to the internal potential store to separate the particles and not to the internal kinetic store.	B1 B1	
	c		• less steep AB and CD • longer BC • same boiling point	B1	
	d		Particles are changing from closely and disorderly packed to far apart and randomly arranged.	B1	
					[total: 6]
4	a		air particles (molecules) are in constant random motion and collide with the smoke particles randomly, exerting a force	B1 B1	
	b	i	The smoke particles change directions more frequently. Reject "more randomly"	B1	

Question			Marking point	Mark	Markers comments
		ii	Air particles move more quickly and collide with the smoke particles more frequently.	B1	
					[total: 4]
5	a		• The gas particles travel at high speeds and • collide frequently with the mercury and • exerting a force • Since pressure is force per unit area, a pressure is exerted (which pushes the column of mercury)	B1 for any 2 B2 for all 4	
	b		$P_{gas} = P_{atm} + P_{mercury}$ $= 760 + 500$ $= 1260$ mm Hg	B1	
	c	i	• Less space for gas or shorter distance to travel (or more particles per unit volume) • Increased frequency of collision with walls of manometer • Increase in gas pressure	B1 for all 3	
		ii	$P_{new} – P_{old}$ $= (P_{atm} + P_{new\ Hg}) – (P_{atm} + P_{old\ Hg})$ $= P_{new\ Hg} – P_{old\ Hg}$ = 640 mm Hg – 500 mm Hg = 140 mm Hg $= 13\ 600 \times 10 \times (140 \times 10^{-3})$ = 19 040 = 19 000 Pa (3sf)	M1 A1	
		iii	F=PA $= 19\ 040 \times \frac{12}{100^2}$ = 22.8 = 23 N (2sf)	M1 A1 / ECF1	
					[total: 8]

Question			Marking point	Mark	Markers comments
6	a		Accept any correct answer. • Travel at 3.0 x 10^8 m / s in vacuum (insist on 3.0 or 3.00) • They are all transverse waves. • They transfer energy without transferring mass. • They can travel through vacuum.	B1 for any 1 point	
	b	i	$\frac{\sin i}{\sin r} = 1.52$ $\frac{\sin 46°}{\sin r} = 1.52$ $\sin r = \frac{\sin 46°}{1.52}$ $r = \sin^{-1}\left(\frac{\sin 46°}{1.52}\right)$ $= 28.2°$	M1 A1	
		ii	c = $\sin^{-1}\left(\frac{1}{n}\right)$ = $\sin^{-1}\left(\frac{1}{1.52}\right)$ =41.1°	B1	
		iii	 Angle of incidence = 90 – (180 – 45 – 90 – 28.2) = 73.8 °	B1 / ECF1	
		iv	• Total internal reflection occurs at PQ, expect $i \approx r$. • Arrows on rays	B1	
					[total:6]
7	a	i	 • Arrows pointing in • Symmetric	B1	

Question			Marking point	Mark	Markers comments
		ii	It shows the direction of a force that a positive test charge would experience if placed at that point.	B1	
	b		• The metal plates are positively charged • The dust particle are negatively charged. • Opposite charges attract • The dust particles are attracted to the metal plates and stay there.	B1 for any 2 points B2 for all 4	
			[total: 4]		
8	a		 	B1	
	b	i	Resistance of thermistor is very high at first so current in that branch is too low to light the lamp. Reject short circuit.	B1	
		ii	the resistance of the thermistor decreased with increasing temperature as it is heated up by the heater so current in that branch increased.	B1	
	c	i	from graph, when I = 0.48 A, V=1.12 V pd across 5.0 Ω bulb, V = IR =0.48 x 5.0 =2.4 V E.M.F = 1.12 + 2.4 = 3.5 V (accept 3.52 V)	M1 M1 A1	
		ii	The graph • Passed through the origin • and is straight when V was between 0 V to 0.40 V. (or I is directly proportional to V between 0 V to 0.40 V)	B1 for both points	
			[total: 7]		

Question			Marking point	Mark	Markers comments
9	a	i	There is a change in magnetic flux as the magnet was moving into and out of the coil. (By Faraday's Law, and e.m.f is induced.)	B1	
		ii	It was moving into the coil	B1	
		iii	As a south pole is induced at the end near the bar magnet (using RHGR), the coil was repelling the magnet to oppose the change, and thus by Lenz's Law, the magnet bar was moving into the coil	B1 B1	
	b		 Shape (sine on the t-axis) amplitude at 500 mV	B1 B1	
	c		smaller amplitude and larger period	B1	
	d		Increase the number of coils in the solenoid Use a stronger magnet	B1 for any	
	e		When switch is closed, a N pole is produced at Y using the right-hand grip rule. As iron is a magnetic material, a S pole is induced on the end of the pendulum bob nearer Y. Since unlike poles attract, the bob swings towards the solenoid.	B1 B1 B1	
					[total: 11]
10	a		4.5 J of energy is required to raise 1 g of the substance (or tea) by 1 K (or 1 °C)	B1	
	b	i	more energy needs to be absorbed (or transferred out of the internal store of the ingredients) to reduce the temperature of the drink when the mass of tea is larger.	B1	

Question			Marking point	Mark	Markers comments
	b	ii	$Q_{syrup} = m_{syrup}c_{syrup}\Delta\theta_{syrup}$ $= 35 \times 3.1 \times (26 - 4)$ $= 2387$ $= 2400$ J (2sf)	 M1 A1	
		iii	$Q_{tea} = m_{tea}c_{tea}\Delta\theta_{tea}$ $= 300 \times 4.5 \times (65 - 4)$ $= 82\ 350$ J $Q_{pearls} = m_{pearl}c_{pearl}\Delta\theta_{pearl}$ $= 120 \times 3.5 \times (36 - 4)$ $= 13440$ J total energy $= 2387 + 82\ 350 + 13\ 440$ $= 98\ 177$ $= 98\ 000$ J (2sf)	B1	
		iv	98 000 J	B1/ ECF1	
		v	energy transferred out from ingredients = energy transferred into internal store of ice = energy required to melt the ice + energy required to raise to 4°C $= m_{ice}l_{f\,ice} + m_{ice}c_{water}\Delta\theta_{water}$ $m_{ice}l_{f\,ice} = m_{ice}\ 330$ $= 330\ m_{ice}$ $m_{ice}c_{water}\Delta\theta_{water} = m_{ice} \times 4.2 \times 4$ $= 16.8\ m_{ice}$ $98\ 177 = 330\ m_{ice} + 16.8\ m_{ice}$ $98\ 177 = 346.8\ m_{ice}$ $m_{ice} = 283.1$ $= 280$ g (2sf)	 M1 M1 A1 / ECF1	
			[total: 9]		

Question			Marking point	Mark	Markers comments
11	a		$^{226}_{88}Ra \rightarrow ^{222}_{86}Rn + ^{4}_{2}He\ (or\ ^{4}_{2}\alpha)$ correct reactants and products correct number of nucleons and protons	 B1 B1	
	b	i	Alpha particles are more ionizing than gamma radiation	B1	
		ii	• Use thongs to handle the radioactive substances • Wear protective gears when handling the substances • Minimize contact with the substances whenever possible • Reduce exposing the substance to colleagues accept reasonable answers.	B1	
	c		100 → 50 → 25 → 12.5 3 half-lives 3 x 8.3 = 25 days (2 sf)	 M1 A1	
	d		take the background count using a GM-counter (or Geiger-Muller tube). subtract the background count from the measured count to get the corrected count rate. accept description of measurement taken without the source then with the source.	B1 B1	
	e	i	curve upwards towards PQ (circular)	B1	
		i	no deviation as the gamma radiation has no electric charge, so no magnetic force is produced.	B1	

Question			Marking point	Mark	Markers comments
12	a		• Energy cannot be created or destroyed. • It can be transferred from one store to another store. • Total energy in the (closed) system remains constant.	B1 for any 1 point B2 for all 3 points	
	b	i	$E_p = mgh$ $= 2400 \times 25$ $= 60\ 000$ J P = $\frac{W}{t}$ $= \frac{60\ 000}{60 \times 1.2}$ = 833.3 = 830 W (2 s.f)	M1 A1	
		ii	$\frac{useful\ power\ output}{total\ input\ power} \times 100 = 65$ $\frac{833.3}{input\ power} \times 100 = 65$ input power = 1282 W = 1300 W (2sf)	 B1	
		iii	All the E_p is transferred to the kinetic store. $E_k = E_p$ $\frac{1}{2}mv^2 = 60\ 000$ $\frac{1}{2} \times 240 \times v^2 = 60000$ $v^2 = 500$ $v = 22.4$ = 22 m / s (2sf)	 M1 A1	
	c	i	total cw momemts = 2400 × 8.0 + 150 000 × 0.20 = 49 200 Nm 12 000 d = 49200 d = 4.1 m	 M1 M1 A1	
			[total:10]		