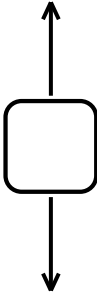


Pure Physics 6091 – Set V

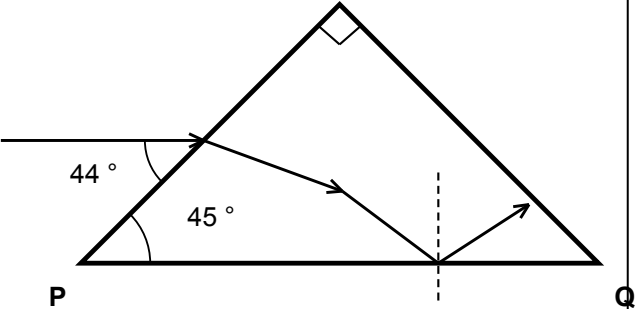
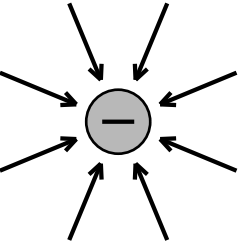
Suggested Marking Scheme

- 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.

Qn			Marking point	Mark	Markers comments
1	a		The displacement is increasing from $t = 0$ s to $t = 80$ s Since rate of change of displacement is velocity, the displacement is <u>increasing at an increasing rate</u> .	B1 B1	Many students could not see that displacement was increasing at an increasing rate
	b		displacement = area under graph = $\frac{1}{2}[(190 - 90) + 220] \times 25.0$ = 4000 m average velocity = $4000 / 220$ = 18.2 = 18 m / s (2sf)	M1 M1 A1	Some did not read values correctly
	c		$a = (v - u) / t$ = $(0 - 25)/30$ (or $(0 - 13)/16$ or $(13 - 25)/14$) = -0.83 m/s^2 (or -0.81 or -0.86) $d = 0.83 \text{ m/s}^2$ penalize for units once with 2c	M1 A1	
				[total: 7]	
2	a			B1 for both forces	Some did not label name or values
	b		$W = mg$ $2500 = m \times 10$ $m = 250 \text{ kg}$	B1	this question was well done
	c		$F_R = 2500 - 1200$ = 1300 N $F_R = ma$ $1300 = 250 a$ $a = 1300 / 250$ = 5.2 m/s^2 penalise for unit once with 1c	M1 M1 A1 / ECF1	this question was well done

	d		- The surface area of the crate in contact with air. - The surface area of the parachute in contact with air - Presence of wind. - Speed of travel	B1 for any	this question was well done
	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	some did not explain why air resistance increased.
				[total: 8]	
3	a		Liquid that is <u>heated</u> at the bottom <u>expands</u>, resulting in a <u>lower density</u> and <u>rises</u>. <u>Cooler</u> liquid, being <u>denser</u>, <u>sinks</u>, to be heated. <u>Process repeats</u> to form a <u>convection current</u>.	B1 for any 1 point B2 for all 3 points	some students mentioned "particles expand" or "particles increase in volume" this is incorrect.
	b		From A to B, energy is transferred to the internal <u>kinetic store</u> and so the temperature of the substance rises. From B to C, energy is transferred to the internal <u>potential store</u> to <u>separate the particles</u> and <u>not to the internal kinetic store</u>.	B1 B1	avoid the use of "energy is converted to..."
	c		- less steep AB and CD - longer BC - same boiling point	B1	new BC should be about twice as long
	d		Particles are changing <u>from closely and disorderly packed to far apart and randomly arranged</u> .	B1	
				[total: 6]	
4	a		air particles (molecules) are in constant random motion and <u>collide with the smoke particles</u> randomly, exerting a force	B1 B1	many students did not describe a force
	b	i	The smoke particles change directions more frequently.	B1	"more randomly" or "move faster" were common answers
		ii	<u>particles move more quickly and collide with the smoke particles more frequently</u>. Reject: "particles move" alone	B1	
				[total: 4]	

5	a		• <u>The gas particles travel at high speeds</u> and • <u>collide frequently with the mercury</u> and • <u>exerting a force</u> • Since <u>pressure is force per unit area</u>, a pressure is exerted (which pushes the column of mercury)	B1 for any 2 B2 for all 4	focus should be on the collision of the gas particles with the mercury surface.
	b		$P_{\text{gas}} = P_{\text{atm}} + P_{\text{mercury}}$ $= 760 + 500$ $= 1260 \text{ mm Hg}$	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	some students mentioned area instead of volume (area should be used on surfaces)
		ii	$P_{\text{new}} - P_{\text{old}}$ $= (P_{\text{atm}} + P_{\text{new Hg}}) - (P_{\text{atm}} + P_{\text{old Hg}})$ $= P_{\text{new Hg}} - P_{\text{old Hg}}$ $= 640 \text{ mm Hg} - 500 \text{ mm Hg}$ $= 140 \text{ mm Hg}$ $= 13\,600 \times 10 \times (140 \times 10^{-3})$ $= 19\,040$ $= 19\,000 \text{ Pa (3sf)}$	M1 A1	some students had issues with sf.
		iii	$F = P A$ $= 19\,040 \times 12 / 100^2$ $= 22.8$ $= 23 \text{ N (2sf)}$	M1 A1 / ECF1	
				[total: 8]	
6	a		Accept any correct answer. • Travel at $3.0 \times 10^8 \text{ m/s}$ 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	some students left out units for speed
	b	i	$\sin i / \sin r = 1.52$ $\sin 46^\circ / \sin r = 1.52$ $\sin r = \sin 46^\circ / 1.52$ $r = \sin^{-1}(\sin 46^\circ / 1.52)$ $= 28.2^\circ$	M1 A1	this question was well done
		ii	$c = \sin^{-1}(1/n)$ $= \sin^{-1}(1/1.52)$ $= 41.1^\circ$	B1	this question was well done.

		iii	 Angle of incidence $= 90 - (180 - 45 - 90 - 28.2)$ $= 73.2^\circ$	B1 / ECF1	some students were unable to use angle properties of triangles to obtain the required angle.
		iv	- Total internal reflection occurs at PQ, expect $i \approx r$. - Arrows on rays	B1	some students did not realise $i > c$ so did not consider TIR
				[total: 6]	
7	a	i	 - Arrows pointing in - Symmetric	B1	this question was well done.
		ii	It shows <u>the direction of a force that a positive test charge would experience if placed at that point.</u>	B1	This was poorly done.
	b		- The metal plates are positively charged - The dust particle are negatively charged as they acquire electrons from the rods. - Opposite charges attract - The dust particles are attracted to the metal plates and stay there.	B1 for any 2 points B2 for all 4	"poles" were mentioned by some students, which was incorrect since this is on charges.
				[total: 4]	

8	a			B1	this was well done.
	b	i	<u>Resistance of the thermistor is very high at first so current in that branch is too low</u> to light the lamp. Reject short circuit.	B1	Most people could identify low current due to high resistance.
		ii	the <u>resistance</u> of the thermistor <u>decreased with increasing temperature</u> as it is heated up by the heater so <u>current</u> in that branch <u>increased</u>. penalize for current once for b(i) and b(ii).	B1	most students could identify resistance decrease with higher temperature and thus current increases.
	c	i	from graph, when $I = 0.48\text{ A}$, $V = 1.12\text{ V}$ (across thermistor) pd across $5.0\ \Omega$ bulb, $V = IR$ $= 0.48 \times 5.0$ $= 2.4\text{ V}$ E.M.F = $1.12 + 2.4$ (parallel) $= 3.5\text{ V}$ (accept 3.52 V) or $R_{\text{thermistor}} = V / I = 1.12 / 0.48 = 2.33\ \Omega$ $R_{\text{total}} = 2.33 + 5.0 = 7.33\ \Omega$ $V = IR = 0.48 \times 7.33 = 3.5\text{ V}$	M1 M1 A1 M1 M1 A1	many students were not able to meaningfully use the graph to find the relevant potential differences
		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]	
9	a	i	There is a <u>change in magnetic flux</u> as <u>the magnet was moving</u> into and out of the coil. (By Faraday's Law, and e.m.f is induced.)	B1	some mentioned a changing magnetic flux but did not mention why it was changing
		ii	It was moving into the coil	B1	
		iii	As a <u>south pole is induced</u> at the end near the bar magnet (using RHGR), the coil was <u>repelling the magnet to oppose the change</u>, and thus by Lenz's Law, the magnet bar was moving into the coil	B1 B1	Some students did not mention that a S pole was produced. Some confused this with magnetic induction.

	b	voltage / mV time / s period of 0.02 s shape (sine on the t-axis) amplitude at 500 mV	B1 for any 2 points B2 for all 3	some did not use the frequency given to identify the period of the wave.
	c	smaller amplitude and larger period.	B1	some students mentioned "lower frequency" which does not describe the graph.
	d	• Increase the number of coils in the solenoid • Use a stronger magnet. • Insert a soft iron core into the solenoid.	B1 for any	
	e	When switch is closed, a <u>N pole is produced at Y</u> using the right-hand grip rule. As iron is a <u>magnetic material</u>, a <u>S pole</u> is induced on the end of the pendulum bob <u>nearer Y</u>. Since <u>unlike poles attract</u>, the bob swings towards the solenoid.	B1 B1 B1	Many students did not mention the poles, and did not mention induced magnetism.
			[total: 11]	
10	a	4.5 J of <u>energy</u> is required to raise the <u>temperature</u> of <u>1 g</u> of the substance (or tea) by 1 K (or 1 °C)	B1	
	b	i <u>more energy needs to be absorbed</u> (or transferred out of the internal store of the ingredients) to reduce the temperature of the drink when <u>the mass of tea is larger</u>. or <u>heat capacity of a larger drink is larger with a bigger volume/mass</u>	B1	
		ii $Q_{\text{syrup}} = m_{\text{syrup}} c_{\text{syrup}} \Delta \theta_{\text{syrup}}$ $= 35 \times 3.1 \times (26 - 4)$ $= 2387$ $= 2400 \text{ J (2sf)}$	M1 A1	

		iii	$Q_{\text{tea}} = m_{\text{tea}} c_{\text{tea}} \Delta \theta_{\text{tea}}$ $= 300 \times 4.5 \times (65 - 4)$ $= 82\,350 \text{ J}$ $Q_{\text{pearls}} = m_{\text{pearl}} c_{\text{pearl}} \Delta \theta_{\text{pearl}}$ $= 120 \times 3.5 \times (36 - 4)$ $= 13\,440 \text{ J}$ total energy $= 2387 + 82\,350 + 13\,440$ $= 98\,177$ $= 98\,000 \text{ J (2sf)}$	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 $= m_{\text{ice}} l_{\text{ice}} + m_{\text{ice}} c_{\text{water}} \Delta \theta_{\text{water}}$ $m_{\text{ice}} l_{\text{ice}} = m_{\text{ice}} 330 = 330 m_{\text{ice}}$ $m_{\text{ice}} c_{\text{water}} \Delta \theta_{\text{water}} = m_{\text{ice}} \times 4.2 \times 4 = 16.8 m_{\text{ice}}$ $98\,177 = 330 m_{\text{ice}} + 16.8 m_{\text{ice}}$ $98\,177 = 346.8 m_{\text{ice}}$ $m_{\text{ice}} = 283.1$ $= 280 \text{ g (2sf)}$	M1 (or M1 if not already awarded) M1 A1 / ECF1	
				[total: 9]	
11	a		$^{226}_{88}\text{Ra} \rightarrow ^{222}_{86}\text{Rn} + ^4_2\text{He (or } ^4_2\alpha)$ correct reactants and products correct number of nucleons and protons	B1 B1	
	b	i	<u>Alpha particles are more ionizing</u> than gamma radiation	B1	
		ii	- Use tongs 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		$100 \rightarrow 50 \rightarrow 25 \rightarrow 12.5$ 3 half-lives $3 \times 8.3 = 25 \text{ days (2 sf)}$	M1 A1	

	d		take the background count using a <u>GM-counter (or Geiger-Muller tube)</u>. <u>subtract the background</u> 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 P Q (circular)	B1	
		ii	no deviation as the gamma radiation has <u>no electric charge</u> , so <u>no magnetic force</u> is produced.	B1	
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	$E_p = mgh$ $= 2400 \times 25$ $= 60\,000 \text{ J}$ $P = W / t$ $= 60\,000 / (60 \times 1.2)$ $= 833.3$ $= 830 \text{ W (2 s.f)}$	M1 A1	
		ii	(useful power output / total input power) $\times 100 = 65$ $(833.3 / \text{input power}) \times 100 = 65$ input power = 1282 W = 1300 W (2sf)	B1	
		iii	All the E_p is transferred to the kinetic store. $E_k = E_p$ $\frac{1}{2}mv^2 = 60\,000$ $\frac{1}{2} \times 240 \times v^2 = 60\,000$ $v^2 = 500$ $v = 22.4$ = 22 m / s (2sf)	M1 A1	
	c	i	total cw momemts $= 2400 \times 8.0 + 150\,000 \times 0.20 = 49\,200 \text{ Nm}$ $12\,000 \text{ d} = 49200$ $d = 4.1 \text{ m}$	M1 M1 A1	
				[total: 10]	