

2019 Year 4A Physics Preliminary Exam Suggested Solution

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
A	B	D	A	C	B	B	D	C	A
Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
D	C	D	A	A	B	D	B	A	C
Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30
C	B	B	B	C	B	C	C	A	D
Q31	Q32	Q33	Q34	Q35	Q36	Q37	Q38	Q39	Q40
B	D	A	C	D	D	A	D	B	D

1	5.5 mm + 0.37mm = 5.87mm 5.87mm - (-0.04mm) = 5.91mm
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2	a	$\eta_{glass} = \frac{1}{\sin C}$ $\eta_{glass} = 1.52$
	b	Angle of incidence = 55° $\sin r = \frac{\sin 55^\circ}{1.52}$ $r = 32.6^\circ$

3	a	<p style="text-align: center;">thin converging lens</p>
	b	Image is upright / Image is virtual

4	a	30 cm
	b	$v = f\lambda$ $2.8 = f(0.8)$ $f = 3.5 \text{ Hz}$
	c	X-rays, Gamma rays

5	a	The pulse spreads out in all directions as it propagates across the room, not all of the first echo will be picked up by the microphone when it returns as the second echo.
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		OR Some sound energy was absorbed by the medium as the pulse propagates and absorbed by the wall / microphone when the pulse hits.	
	b	distance = speed \times time = 330×0.080 = 26.4 m	

6		Float. The volume of the container is larger than 235 cm^3 , hence the density is less than 1.0 g cm^{-3} .	
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7	ai	The centre of gravity of any object is defined as the point through which its whole weight appears to act.	
	aii		
	b	When displaced, the line of action of weight produces an anti-clockwise moment about the pivot to return it to its original position.	
	c	Decrease the angle between the vertical and the satay stick.	

8	a	Work done is the product of the force applied and the distance moved by the object in the direction of the force.	
	b	Word done against friction = GPE – KE = $mgh - \frac{1}{2} mv^2$ = $(80)(10)(108) - \frac{1}{2} (80)(5.0)^2$ = 85400 J	

9	ai	$118 \text{ kPa} = h\rho g + 101 \text{ kPa}$ $17 \text{ kPa} = 4.5 \times \rho$ $\rho = 3780 \text{ kg m}^{-3}$	
	aii	$\frac{13600}{3777.8} \times 76 = 274 \text{ cm}$	

	bi	Force acting per unit area.	
	bii	Increased surface area for the weight of the excavators will cause the pressure with the ground to decrease, prevent excavator from sinking in the mud.	
10	a	The kinetic theory of matter states that the tiny particles that make up matter are always in continuous, random motion.	
	b	Increase in average kinetic energy/ speed. Increase in collision frequency and average force per collision (against the walls of the container). Average force of collisions to increase.	
11	a	<u>Sudden discharge may produce sparks, which can ignite the petrol.</u>	
	b	Earth the can and/or pipe.	
12	a	R_1 has increased. Current has bypassed R_1 , effective resistance of circuit has decreased.	
	b	1 : 1	
13	a	Live	
	b	Blue	
	c	Provides a path of low resistance for current to flow through in the event the metal casing becomes live.	
	d	Double insulation / The casing is insulated	
14	a	The particle must have a charge. The charged particle must be moving.	
	b	Electrons deflected, upwards. No deflection to microwaves.	
15	a	$Q = m l_v$ $m = (2.2 \times 10^6) \div (2.4 \times 10^6)$ ≈ 0.91667 $= 0.92 \text{ kg (2 sf) or } 0.917 \text{ kg (3 sf)}$	
	b	amt. of thermal energy retained in body in one hour = $(3.3 - 2.2) \times 10^6$ $= 1.1 \times 10^6 \text{ J}$ $Q = m c \Delta\theta$ $\Delta\theta = (1.1 \times 10^6) \div (70 \times 3400)$ $= 4.6 \text{ }^\circ\text{C (2 sf) or } 4.62 \text{ }^\circ\text{C (3 sf)}$	
	c	The body temperature in one hour during the race is already $37 + 4.6 = 41.6 \text{ }^\circ\text{C}$. This is higher than the $40 \text{ }^\circ\text{C}$ where overheating may cause serious damage.	
	d	$Q = m l_v$ in 1 hour, $m = (1.1 \times 10^6) \div (2.4 \times 10^6)$ $= 0.45833 \text{ kg (5 sf)}$ in 4.5 hours, $m = 4.5 \times 0.45833$ $\approx 2.0625 \text{ (5 sf)}$ $= 2.1 \text{ kg (2 sf) or } 2.06 \text{ kg (3sf)}$	

	e	total amt. of water lost in 4.5 hours = $(0.91667 \times 4.5) + 2.0625$ ≈ 6.1875 kg (5 sf) level of dehydration = $(6.1875 \div 70) \times 100\%$ $= 8.8\%$ (2 sf) or 8.84% (3 sf) or $= (6.1875 \div 63.8125) \times 100\%$ $= 9.7\%$ (2 sf) or 9.70% (3 sf) He will experience severe dehydration.	
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16	a	$F_{\text{resultant}} = ma$ $a = (22000 - 2000) / 25000$ $= 0.80 \text{ m s}^{-2}$	
	b	As the speed of the hovercraft increases, the air resistance acting on it increases. When the air resistance equals the forward force, resultant force is zero.	
	c	The propellers exert a force on the air in the backward direction which results in a force by the air on the propellers in the forward direction.	
	di	Acceleration is zero or 0 m/s^2 .	
	ii	Distance = Area under the speed – time graph $= (12.5)(2.5) + (5.0)(2.0)$ $= 41.25 \text{ m}$	
	iii		

17	ai	$\frac{1}{100} + \frac{1}{150} + \frac{1}{450} = \frac{1}{R_{\text{eff}}}$ $P = 53 \Omega$	
	aii	$Q = 700 \Omega$	
	aiii	As effective resistance increases, the current drawn decreases. For a fixed resistor R_T , the potential difference across the fixed resistor will decrease.	
	aiv	$R_T = 1.99 \div (43.2 \times 10^{-3}) = 46.1 \Omega$	
	av	Total resistance = $232 + 46.1 = 278.1 \Omega$ p.d across batteries = $278.1 \times 0.0432 = 12.0 \text{ V}$	
	bi	$I = 0 \text{ A}$ up till $V = 2.9 \text{ V}$, thereafter, I increases non-proportionally with V .	
	bii)	LED A will be brighter. $P_A = 45 \times 3.54 = 159.3 \text{ mW}$; $P_B = 33 \times 3.7 = 122.1 \text{ mW}$	

Or	ai	a.c. changes direction or changes polarity / from positive to negative continually.	
	ii	There is no change in magnetic flux and hence, no induced voltage / current in the secondary coil.	

	b	$N_s = V_s / V_p \times N_p$ $= 8.0 / 240 \times 560$ $= 19 \text{ (whole no.)}$	
	ci	Ammeters in series with each coil; Voltsmeters in parallel with each coil	
	ii	It is the ratio (or percentage / proportion / fraction) of useful output power (or energy) to input power (or energy)	
	iii	$\text{Efficiency} = (0.72 \times 8.0) / (0.033 \times 240) \times 100\%$ $= 73\% \text{ (2 sf) or } 72.7\% \text{ (3 sf)}$	

