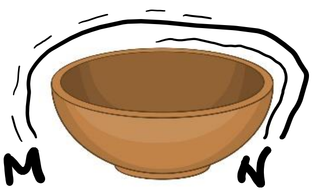
Xinmin Sec 2023 Prelim 4E Physics 6091/02

Section A

Qns	Answers	Remarks
1a	Two vertical forces that are seemingly equal in length [B1] -- Weight -- Upthrust F/U	Do not accept NCF/NRF, accept friction (with water) or (water) resistance Accept reasonable symbols
1bi	The weight of the block is **equal** [A1] to the weight of liquid displaced by the block.	Upthrust = Weight of block (from 3a) Upthrust = Weight of liquid displaced (from question) So, W_{block} = $W_{liquid\ displaced}$
1bii	The weight of water displaced is **equal** [A1] to the weight of diesel displaced.	$W_{block\ in\ water}$ = $W_{block\ in\ diesel}$ So, $W_{water\ displaced}$ = $W_{diesel\ displaced}$
1c	$W_{water\ displaced}$ = $W_{diesel\ displaced}$ m_{water} x g = m_{diesel} x g **[½ for W = mg]** ρ_{water} x V_{water} = ρ_{diesel} x $V_{liquid\ D}$ **[½ for m = ρV]** ρ_{water} x 75% x V_{block} = ρ_{diesel} x 86% x V_{block} **[M1]** (1000) (0.75) = (ρ_{diesel}) (0.86) ρ_{diesel} = 872 kg/m^3 **[A1]**	From 3bii g will cancel off [**1** for relating $V_{liquids}$ to V_{block}] V_{block} will cancel off **FULL MARKS IF NO WORKING BUT CORRECT ANSWER**
		Total 6m
2ai	direction of over-turning moment is **clockwise** [A1]	
2aii	clockwise moments = (U x 36) + (T x 20) = (400k x 36) + (45k x 20) = 15 300 kNm [M1] anti-clockwise moment = (W x 20) = (400k x 20) = 8000 kNm resultant moment = 15 300 – 8000 = 7300 kNm [A1]	
2b	Put the heavier cargo at the lower decks and lighter cargo at the upper decks. [A1]	Lowers the CG
		Total 4m
3a	P = ρgh = 1000 x 10 x 2 = 20 000 Pa [M1] F = PA = 20 000 x 0.02 [M1] = 400 N [A1]	
3b	Upward forces = Downward forces Normal contact forces by slabs = Force by water + Weight = 400 + 19 [M1] = 419 N [A1] upwards [A1]	
		Total 6m
4a	- The water at the bottom, nearest the heater is **heated and expands**. - This water becomes **less dense** and **rises**. - The comparatively **cooler and denser cooler water** at the top is displaced and sinks to come near the heater. - The process repeats and **convection currents** are set up.	Any 2 points for [1m]
4b	[A1] Styrofoam / cork / rubber / plastic [B1] This material contains air pockets. Air/rubber/plastic is a **poor conductor** of heat, so heat loss by conduction is reduced.	Accept any possible answers.
4c	[A1] White and smooth/shiny/glossy [B1] **Light colours and smooth textures are poor emitters** of heat, so heat loss by radiation is reduced.	Accept any light colours besides white.
		Total 6m

5a	30°C --- 0.5 mV 66°C --- 0.5 / 30 x 66 [M1] = 1.1 mV [A1]	
5b	The **higher the temperature** T, (the lower the resistance of the thermistor) the **smaller the potential difference** across it. [A1] (emf divides amongst resistors in series proportionately)	Accept opposite / vice versa.
		Total 3m
6a	50 complete waves are produced in 1 second. [B1]	
6b	5 waves – 30 m ➔ λ = 6 m [M1] v = f λ = 50 x 6 = 300 m/s [A1]	
6c	The **more shallow the water** / the smaller the depth of water (the smaller the wavelength) the slower the wave / the **lower the speed** of the water waves. [A1]	
6d	- keep the shape of the wave and draw a stepped difference between UV and YZ (not sloping but horizontal and higher) OR - keep the shape of pool and draw the waves within YZ as becoming closer and closer [B1]	
		Total 5m
7a	critical angle $\angle c$ = 40° [M1] n = $\frac{1}{\sin \angle c}$ = $\frac{1}{\sin 40}$ = 1.56 [A1]	
7b	angle of refraction $\angle r$ = 90 – 70 = 20° [M1] n = $\frac{\sin \angle i}{\sin \angle r}$ ➔ $\angle i$ = $\sin^{-1}$ (n sin $\angle r$) = 32.1° [A1]	
		Total 4m
8ai	[B1] When peeled, **electrons transfer** from side M to side N. [B1] Side M loses electrons and becomes **positively-charged**; side N gains electrons and becomes **negatively-charged**.	Accept opposite ie from N to M
8aii	[B1] Side M and side N are of opposite charges. Since **unlike charges** attract, the cling wrap can stick onto itself.	Accept opposite ie M -ve, N +ve
8b	[A1]  OR  [B1] The **charged** cling wrap **can attract** a **neutral** bowl.	Accept possible alternatives
8c	Make the cling wrap less taut OR Use a bigger bowl	Accept possible alternatives
		Total 6m
9a	X area of rod : X area of pipe $\pi \left(\frac{D}{2}\right)^2$: $\pi \left(\frac{2D}{2}\right)^2 - \pi \left(\frac{D}{2}\right)^2$ $\frac{D^2}{4}$: $D^2 - \frac{D^2}{4}$ $\frac{D^2}{4}$: 3 x $\frac{D^2}{4}$ 1 : 3 [A1] OR 0.333	[1 for changing diameter to radius] [1 for squaring radius to find area] **FULL MARKS IF NO WORKING BUT CORRECT ANSWER**

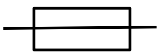
<table>
<tr><td>9b</td><td>

$$resistance = \frac{resistivity \times length}{area}$$

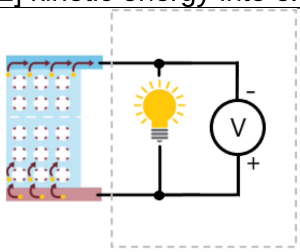
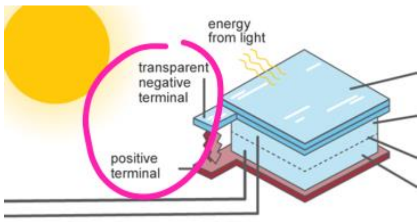
<table>
<tr><td>rod</td><td>pipe</td></tr>
<tr><td>R of rod = $\frac{\rho \times L}{A}$</td><td>R of pipe = $\frac{\rho \times 2L}{3A}$
$= \frac{2}{3} \times \frac{\rho \times L}{A}$
$= \frac{2}{3} \times$ R of rod</td></tr>
</table>

Current through pipe
= $\frac{3}{2}$ x Current through rod = $\frac{3}{2}$ x 6 [M1] = 9 A [A1]</td><td>Same material = same resistivity

Length x 2 → higher R, lower I by 2
Area x 3 → lower R, higher I by 3

Allow ecf
FULL MARKS IF NO WORKING BUT CORRECT ANSWER</td></tr>
<tr><td></td><td></td><td>Total 5m</td></tr>
<tr><td>10a</td><td>[B1] The fan does not have a metal casing that can conduct electricity to its user. OR
The fan has a plastic casing that can insulate electricity from its user.</td><td></td></tr>
<tr><td>10bi</td><td>[B1] wire with switch to be connected to ‘live’ and wire without switch to be connected to ‘neutral’.</td><td></td></tr>
<tr><td>10bii</td><td>[B1] 
in the live wire and between the switch and the pin-hole.</td><td></td></tr>
<tr><td>10c</td><td>energy = P x t = 3 kW x 6 h = 18 kWh per day [M1]
cost = 18 x 7 x $0.30 = $37.80 [A1]</td><td></td></tr>
<tr><td></td><td></td><td>Total 5m</td></tr>
</table>

Paper 2 Section B

Qns	Answers	Remarks
11a	[A1] AC generator [B1] kinetic energy into electrical energy	
11b	 [B1] for correct circuit symbol and parallel connection [B1] for correct labelling of terminals (clue was in Fig 11a, circled in pink)	Electron flow is opposite of conventional current flow.
11c	maximum power $P_{max} = V_{max} \times I_{max}$ = 27.3 x 5.5 [M1] = 150 W [A1]	
11di	open circuit voltage V_{oc} = 32 V	When current is zero
11dii	short circuit current I_{sc} = 5.5 A	When pd is zero
11e	*irradiance of 1000 W/m²* means there is [B1] 1000 **J** of **(light) energy** [B1] per **second (unit time)**, per **square metre (unit area)**	Accept explanation by both **quantities** or by **units**
		Total 10m

12a	70 km/h = 70 000 m / 3600 s [M1] = 19.4 m/s [A1]	
12b	Distance travelled = Area under v-t graph [M1] = (20x40) + **½(20+30)20** + (30x60) + **½(30+10)20** + (10x40) + **½(10+20)20** + (20x20) = 800 + **500** + 1800 + **400** + 400 + **300** + 400 = 4600 m [A1]	
12c	Average speed = total d / total t = 4600 / 220 = 20.9 m/s [A1] [B1] The car **was speeding** as its average speed of 20.9 m/s is higher than speed limit of 19.4 m/s.	Allow ecf Allow ecf
12di	WD = F x d = P x t ➔ F = Pt/d [M1] Driving force = 40 000 x 2 /15 = 5333 ≈ 5330 N [A1]	
12dii	Initial energy = final energy KEi + GPEi = Kef [M1] (½ x 1200 x 15^2) + (1200 x 10 x 3) = (½ x 1200 x v^2) v = $\sqrt{285}$ =16.88 ≈ 16.9 m/s [A1]	
		Total 10m
EITHER		
13ai	Power in P = I^2R = (2.5^2)(28.0) = 175 W [A1] Power in Q = I^2R = (2.0^2)(28.0) = 112 W [A1]	
13aii	Difference between P & Q: The rate of temperature rise in P is greater than the rate of temperature rise in Q. Explanation: The rate of input of thermal energy in P is greater than the rate of input of thermal energy in Q.	[1] [1]
13b	Relationship between θ and t: (In both P & Q) As t increases, θ increases at a decreasing rate. Explanation: - As t increases, temperature of water increases. The <u>temperature difference between the water and the surroundings increases</u>. - The <u>rate of heat loss to the surroundings increases</u>, so temperature rise decreases.	[1] [1] [1]
13ci	Q = mcθ → Q/t = mcθ/t → P = mcθ/t [B1]	
13cii	θ/t is gradient of graph Power in P = mc(θ/t) = mc(gradient) 175 = (m)(4.2)(12 K min^{-1}) = (m)(4.2)(0.2 K s^{-1}) [M1] m = 208.3… = 208 g [A1]	Allow ecf
		Total 10m
OR		
13ai	X	
13aii	Y and Z	
13b	When V_1 is 8 V, V_2 is 16 V. $\frac{N_s}{N_p} = \frac{V_s}{V_p}$ $N_s = \frac{V_s}{V_p} \times N_p = \frac{16}{8} \times 250 = 500$ [M1A1]	
13c	[B1] Some energy is lost as thermal energy due to the **resistance of the coils**. OR [B1] Some energy is lost due to **leakage of magnetic field lines** between the primary and secondary coils. OR	Any two out of four

	[B1] Some energy is lost as thermal energy due to the **eddy currents induced in the iron core**. [B1] Some energy is lost due to **hysteresis** caused by the flipping of magnetic dipoles in the iron core.	
13di	[B1] When a direct current is applied at the primary coil, the current and hence the **magnetic field it produces does not change** in magnitude nor direction. [B1] Since there is **no change in magnetic flux linkage** between the primary coil and the secondary coil, there will be no induced emf/current in the secondary coil.	
13dii	[B1] Copper is a **non-magnetic** material. [B1] Since there is **reduced magnetic flux linkage** between the primary coil and the secondary coil, the efficiency of the transformer is also reduced.	
		Total 10m