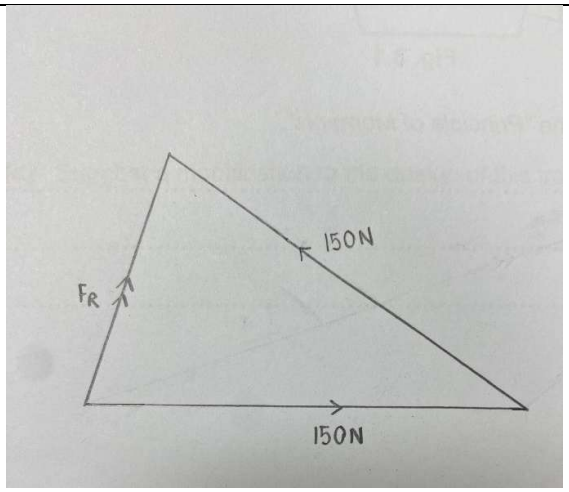
Admiralty Secondary School
Marking Scheme & Marker's Report
4E Pure Physics (6091/2)
PRELIMINARY EXAMINATION 2024

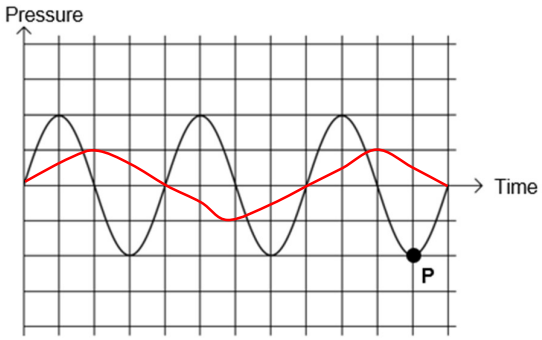
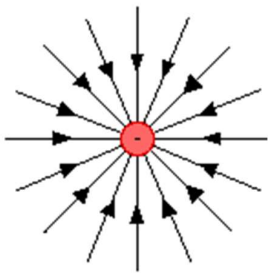
PAPER 2 SECTION A [70 marks]

Qn.	Description	Mark	Marker's Report
1a	t = 5 s to t = 50 s: increasing acceleration t = 50 s to t = 100 s: constant acceleration of 20 m/s^2	1 1 1	MP1 & MP2 were well answered, however many students missed out MP3 of the calculation of the acceleration. Few students still confused between acceleration and velocity, citing constant velocity and acceleration.
b	upward force – weight = ma upward force – $(1.6 \times 10^6 \times 10) = (1.6 \times 10^6) \times 20$ upward force = 4.8×10^7 N	 1 1	Not well done. Many students did not take into account the weight and equated the upward force to *ma*.

2a	 Acceptable scale (min 1cm: 20N) Resultant force = 88 N Direction = 90 ° anticlockwise from horizontal Correct drawing	1 1 1 1	Most students were able to get 2 marks out of the 4 marks, with many drawing the wrong direction of the resultant force. Students also did not read the question carefully, with the direction of the resultant force often measured from the tension given and not with the horizontal.
b	88 N The tyre is in **<u>equilibrium</u>**, thus **<u>resultant force is 0 N</u>**. Hence, the weight must be **<u>equal and opposite</u>** in direction to the resultant force of both tension due to the wires.	1 1	Well done. Ecf was given to students, hence students were able to at least obtain MP1. However, MP2 was rarely achieved, with many missing out that the resultant force is zero.
3a	It states when a body is **<u>in equilibrium</u>**, the **<u>sum of clockwise moment about a pivot is the equal to the sum of anticlockwise moment about the same pivot.</u>**	1	Few students did not mention about the body being “in equilibrium” and missed out moments must be taken from the same pivot.
3b	$\text{moment} = F \times d$ $= 20 \times \frac{1.2}{100}$ $= 0.24$ Nm	1 1	Well done.
c	By principle of moments, sum of clockwise moments = sum of anticlockwise momer $0.24 = 0.10W$ $W = 3$ N $m(10)=3$ $m=0.3kg$	1 1	Could not be done as 10 cm was not shown in the diagram.
d	Widen the **<u>base area</u>** of the bin/construct the base using a **<u>denser/heavier</u>** material/ add weight to the base	1	Well done.

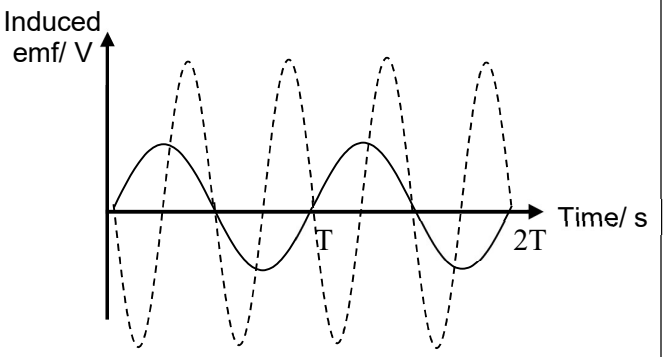
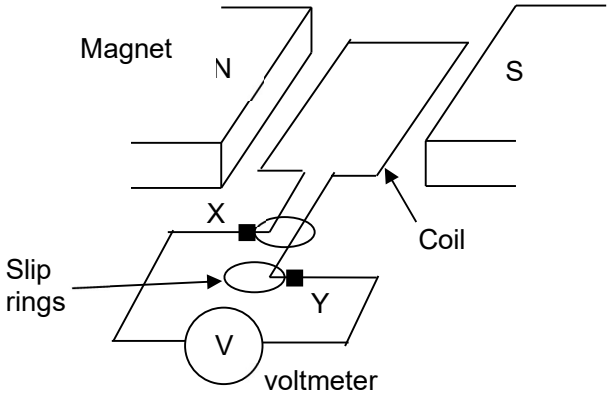
4a	$P = h\rho g$ $4000 = \frac{50}{100} \times \rho \times 10$ $\rho = 800 \text{ kg/m}^3$	 1 1	Not well done. Many students substituted P to be 104000, the pressure of the gas, instead of taking the difference between P_{atm} and P_{gas}.
bi	$F = P \times A$ $= 104000 \times 0.05$ $= 5200 \text{ N}$ Work done $= F \times d$ $= 5200 \times \frac{8}{100}$ $= 416 \text{ J}$	 1 1	Mostly well done. However some students cited the wrong formula of P = FA.
bii	When the cylinder is heated, the gas particles in cylinder **gain kinetic energy** and collide with the walls of cylinder with **greater force and more frequently**. This causes the piston to move outwards and **volume of gas increases,** the number of particles per unit volume decreases. Particles collide with the walls of cylinder **less frequently**. Hence, pressure (**force per unit area**) exerted on the walls remains the same.	 1 1 1	Not well done. Students were not able to obtain the full marks of the question, often missing out MP2.
5ai	E_k = ½ mv^2 = ½ x 500 x 5.5 x 5.5 = 7.56 x 10^3 J	 1	Well done.
aii	E_p = mgh = 500 x 10 x 6 = 3.00 x 10^4 J Work done against friction = 3.00 x 10^4 - 7.56 x 10^3 = 2.24 x 10^4 J	 1 1	Not well done. Many students used the formula of W = Fs and used the weight log as F and did not realise that s has to be in the same direction of the force used.
b	Friction causes the log to slow down from Y to Z. All the energy from the kinetic store of the log is transferred to the internal store of the log mechanically to do work against friction.	1 1	Few students still lack the terms in describing the change in energy stores.

6ai	$Q = ml_v$ $600 \times 60 = (569.931 - 560.016)l_v$ $l_v = 39344$ J/g =39300 J/g	1 1	Many students did not take the difference in masses.
aii	Overestimation. Energy from the internal store of the immersion heater could also have been **transferred** to the internal store of the surroundings and the beaker by heating.	1 1	Generally well done but a few students could recognise that there is energy transferred to the internal store of the surroundings but cited it as an underestimation.
b	$Q = ml_v + C\Delta\theta$ $36000 = m(39344) + 28.5(70)$ $m = 0.864$ g	2 1	Not well done. Students are still not familiar with the calculation of heat capacity type of questions.

7ai	Rarefaction	1	Mostly well done.
aii	Half amplitude Double period 	1 1	MP1 was mostly obtained. However, few students could not recognise that half the frequency meant period is doubled.
b	Distance travelled by sound = 2(900) = 1800 v = d/t = 1800 / (1.2) = 1500 m s^{-1}	 1 1	Generally well done.
8a	the waste gases are **<u>warmer and less dense</u>** than surrounding air so they rise and carry the smoke with them	1	Mostly well done. Few students did not recognise that this is a convection question and attempted to answer using electrostatic charging concepts which were unsuccessful.
b	The smoke particles will be <u>repelled by the negative metal grid as like charges repel</u> and <u>attracted to the positive collecting plate as unlike charges attract</u>. Therefore, leaving the smoke particles <u>remain attracted</u> to the metal grid.	1 1	Many students only obtained MP1 but many missed out “remain” as a keyword in MP2.
c		1	Many students drew arcs for the electric field instead of straight lines.

9ai	Radioactivity is a **random process** by which an **unstable atomic nucleus** loses it energy by emission of electromagnetic radiation or particle(s).	1	Not well done. Students do not know the definition of radioactivity.
aii	There is **background radiation** in the environment **like radon gas** in the air.	1	Many students missed out the example of background radiation in their explanation.
b	As Uranium-234 and Thorium-230 decays, the **number of protons and neutrons both decreases by 2**, thus implying that an alpha particle has been emitted.	1	Generally well done but few students saw it as a "gain in protons and neutrons".
c	536 – 44 = 492. After 68 hours which is equivalent to two half-lives, the reading on the detector is $492 \times \left(\frac{1}{2}\right)^2 = 123$ counts per second. 123 + 44 = 167	1 1	A few students did not calculate two half-lives instead they only calculated for one half-life. A few students also did not account for the background radiation in the final answer.

Qn.	Description	Mark	Marker's Report
10ai	When pd is **negative**, the current across the diode remains the **same** / is **independent** of the p.d. When pd is **positive**, the current across the diode **increases at an increasing rate**.	1 1	Many students did not take into account the value of current for negative pd.
aii1	when p.d. = 1.00 V, $I_{batt} = I_{diode} + I_{tungsten}$ $I_{batt} = 0.60 + 0.50$ $= 1.10$ A	 1 1	Generally well done.
aii2	R = V / I = 0.80 V / 0.10 A = 8 Ω	 1 1	Not well done. Students could not see that for a series circuit, the current is the same and should look for the corresponding pd when current is the same.
aiii	The current becomes **too large for the diode** and causes the diode to fuse/melt, breaking the circuit.	1	Generally well done but a few students missed out keywords like current being too large and cited the voltage being too large instead.
.bi	Efficiency is the ratio (percentage) of the useful energy output is to energy input.	1	Students used "power" instead of energy and missed out certain keywords.
bii	$\text{efficiency} = \frac{\text{energy output}}{\text{energy input}}$ $\text{energy output} = \frac{2.1}{100} \times 240 \times 0.5 \times 1$ $= 2.52$ J	 1 1	Many students did not multiply the efficiency of the appliance.

11 ai	Current flows **<u>from A to B</u>**.	1	Not well done. Many students did not see that the question was asking for when the wire is moved downwards and not upwards as seen in the figure,
aii	There will be **<u>no deflection</u>** in the needle as the wire AB is stationary, there will **<u>not be any rate of change of magnetic flux linkage</u>** with the magnet.	1	Students merely stated that there will be no deflection but did not explain.
bi bii		1 1 1 1	Most students were able to answer **bi**. However, students were not able to see that "two times the speed" meant twice the amplitude of induced emf in **bii**.
c	 1) Set up as shown in the figure above 2) **<u>Increase the number of turns of wire</u>** in the coil. Observe the **<u>change in the voltmeter reading.</u>** 3) If the voltmeter reading increases, the increase in the number of loops will mean that the **<u>magnitude of induced current</u>** increases.	(any 4 points)	Not well done. Many students left this blank. However, those who attempted mostly got 3 our of 4 marks, often missing out the conclusion. Few students tried to attempt the question using a transformer but it is not accepted in this question as the number of loops will be inversely proportional to the induced current in the secondary coil.

PAPER 2 SECTION B [10 marks]

Students who did this question mostly did better than those who did Q13.

12a	1. The **earth wire is connected to the heater coil**. It should be connected to the **metal casing**. 2. The **fuse is connected to the neutral wire**. It should be connected to the **live wire**.	1 1	Students merely stated where the wire should be connected to and not the mistake.
bi	The fuse **melts and breaks the circuit** when current **higher than 11 A** flows through it, preventing the excess current to flow in the circuit, **protecting the user from electric shock**.	1 1 1	Students missed out the value of the current stated in the question.
bii	$P = VI$ Total current $= \frac{2500}{240} + \frac{300}{240}$ $= 11.7$ A The fuse is unsuitable because the **fuse rating is lower** than the current required for both appliances to function normally.	 1 1 1	Mostly well done.
c	E = Pt Total energy used for 30 days $= (2.5 + 0.3)(20 \div 60)(30)$ $= 28$ kWh Cost $= 28 \times \$0.25$ $= \$7$	 1 1	Mostly well done.

13a	The refractive index of glass is the **ratio** of the speed of light in vacuum to the speed of light in glass.	1	Many students missed out the "ratio" and some cited the ratio of sine of angle of incidence and angle of refraction which is not accepted in this case as the question asked for refractive index of glass.
b	Angle of incidence is **0°** / incident ray is travelling **perpendicular** to the tangent at X	1	Mostly well done.
c	Medium P. The **gradient for medium P is the greatest**. Hence the refractive index is the **least** compared to the rest of the media, thus it will bend the least.	1 1	Not well done as students did not recognise that the gradient of the graph is the reciprocal of the gradient.
d	$n = \frac{\sin i}{\sin r}$ $= \frac{1}{\text{gradient of graph}}$ $= \frac{0.68 - 0.20}{0.40 - 0.10}$ $= 1.6$ $n = \frac{\text{speed of light in air}}{\text{speed of light in glass}}$ $1.6 = \frac{3 \times 10^8}{\text{speed of light in glass}}$ $\text{speed of light in glass} = \frac{3 \times 10^8}{1.60}$ $= 1.88 \times 10^8 \text{ m/s}$	 1 1	Not well done, ditto part c.
e	Line does not pass through origin or Refractive index is not constant	1	Generally well answered.
f	The **angle of incidence of the light ray on the glass surface is greater than critical angle** of light in silicone oil and **silicone oil is optically denser than glass R**. **Total internal reflection** occurs.	1 1 1	Not well done. Students missed out MP2 with few students incorrectly explaining that incident angle is *less* that the critical angle.