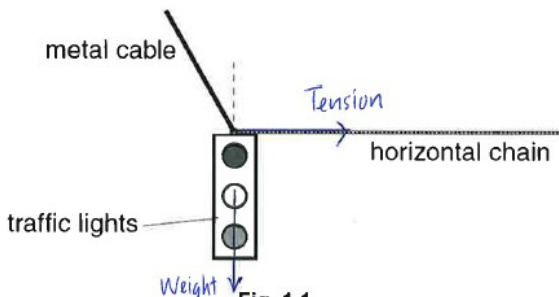
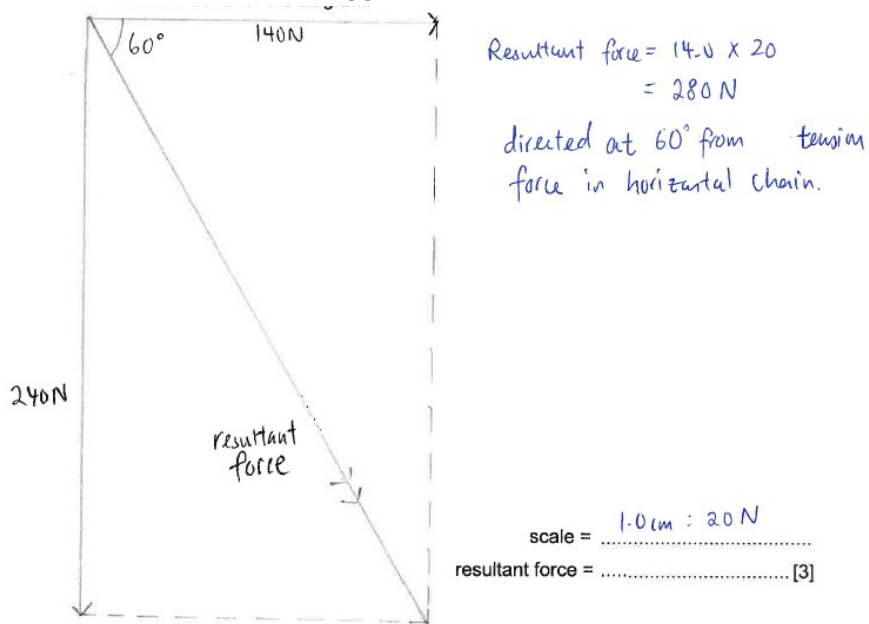


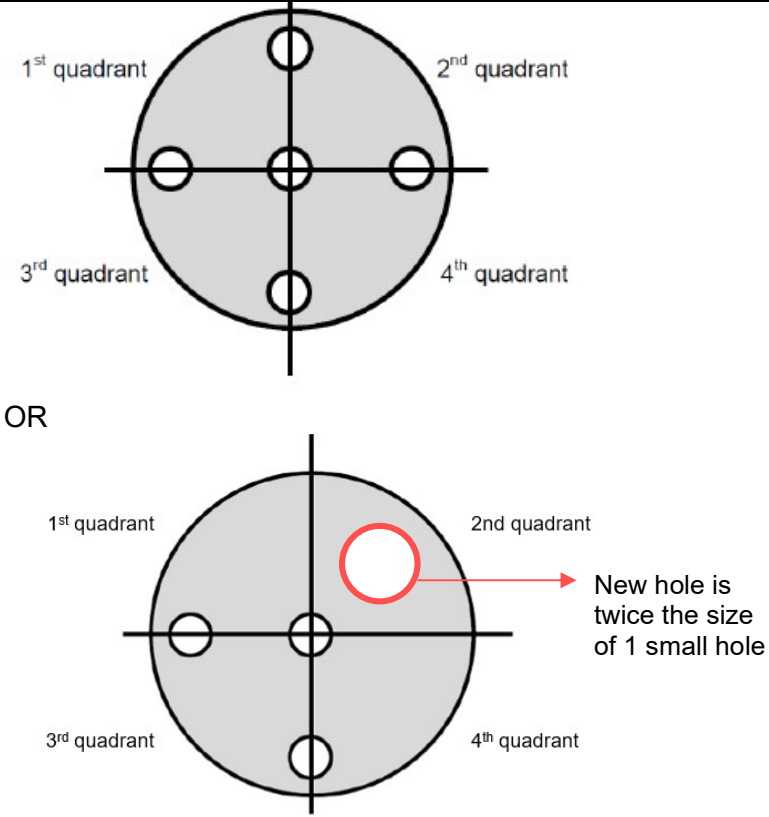
Subject : 6091 Pure Physics  
Exam : 2024 Prelim Examination

Level : Secondary 4 Express  
Paper : Paper 2

**Note :** -No mark is given if the answer has **no unit** or **wrong unit**.  
-Appropriate significant figures/ decimal places for each numerical answer, max 1 mark deducted for entire Paper 2.  
-ecf marks are only given if they satisfy certain conditions indicated in the Remarks.

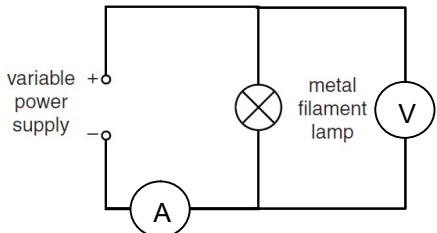
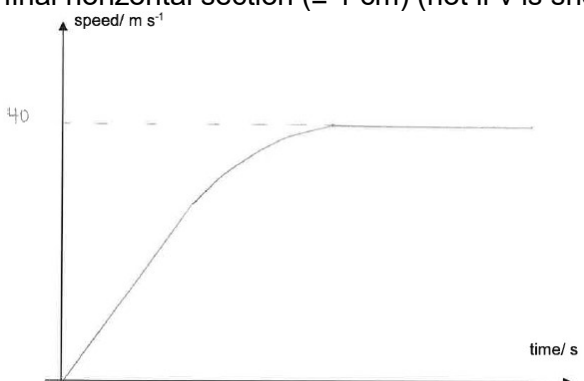
**Paper 2**

| Qn             | SECTION A [Workings / Calculations / Methods]                                                                                                                                                                                                                                                                                                                                                                                                                                     | Marks / Remarks                                                                                          |
|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
| 1a             | <p>arrow(head) on chain pointing to the right</p>  <p>vertical arrow downwards and part of arrow touching or within rectangle of lights or direction of arrow in (i) and (ii) correct (by eye)</p>                                                                                                                                                                                               | 1m                                                                                                       |
| 1b             | <p>scale given (must have unit of cm:N or cm/N or N:cm or N/cm)<br/>correct triangle or rectangle (might be implied) and<br/>correct resultant (compulsory e.c.f. from (i) or (ii): i.e. correct<br/>diagonal according to candidate's (i) and (ii))<br/><math>272 \leq \text{candidate's value} \leq 283 \text{ N}</math></p>  <p>scale = 1.0 cm : 20 N<br/>resultant force = 2.8 cm [3]</p> | <p>1m scale<br/>1m correct length/dir weight<br/>1m correct diagram and direction of resultant force</p> |
| <b>Total =</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>4 m</b>                                                                                               |
| 2a             | Centre of gravity of any object is defined as the point through which its whole weight appears to act.                                                                                                                                                                                                                                                                                                                                                                            | 1m                                                                                                       |
| 2b             | 2 <sup>nd</sup> quadrant                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 1m                                                                                                       |
| 2c             | <p>When the centre of gravity is directly above the finger (pivot), the line of action of the weight of the disc lies within the finger.<br/>There will be no net moment about the finger and the disc will not topple.<br/>Or<br/>When the centre of gravity is directly above the finger (pivot), the</p>                                                                                                                                                                       | <p>1m<br/>1m</p>                                                                                         |

| Qn             | SECTION A [Workings / Calculations / Methods]                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Marks / Remarks                                                           |
|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|
|                | <p>perpendicular distance from the finger to the line of action of the weight of the disc is zero.<br/>           There will be no net moment about the finger and the disc will not topple.<br/>           Or<br/>           When the centre of gravity is not directly above the finger (pivot), the line of action of the weight of the disc lies outside the finger.<br/>           There will be a moment due to the weight of the disc about the finger that causes the disc to topple over.</p> |                                                                           |
| 2d             | $A = \pi(10 \text{ cm})^2 - 3\pi(2 \text{ cm})^2$ $= 276.5 \text{ cm}^2$ $V = 276.5 \text{ cm}^2 \times 0.2 \text{ cm}$ $= 55.29 \text{ cm}^3$ $m = \rho V$ $= 8.05 \text{ g cm}^{-3} \times 55.29 \text{ cm}^3$ $= 445 \text{ g}$ <p><math>m = 450 \text{ g (2 sf)}</math></p>                                                                                                                                                                                                                        | <p><b>1m</b> for correct workings<br/> <b>1m</b> for correct ans/unit</p> |
| 2e             |  <p>1<sup>st</sup> quadrant      2<sup>nd</sup> quadrant</p> <p>3<sup>rd</sup> quadrant      4<sup>th</sup> quadrant</p> <p>OR</p> <p>1<sup>st</sup> quadrant      2<sup>nd</sup> quadrant</p> <p>3<sup>rd</sup> quadrant      4<sup>th</sup> quadrant</p> <p>New hole is twice the size of 1 small hole</p>                                                                                                        | <b>1m</b>                                                                 |
| <b>Total =</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>7 m</b>                                                                |
| 3a i           | (p =) $F/A$ or $12\,000/0.048 = \underline{2.5 \times 10^5 \text{ Pa}}$                                                                                                                                                                                                                                                                                                                                                                                                                                | <p><b>1m</b> for correct workings<br/> <b>1m</b> for correct ans/unit</p> |
| 3a ii          | (F =) $pA = 12\,000 \times 0.14 = \underline{35000 \text{ N}}$                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>1m</b>                                                                 |
| 3b             | atmospheric pressure or friction (between cylinder and piston/oil)<br>(accept bubbles (of air) in oil or viscosity of oil)                                                                                                                                                                                                                                                                                                                                                                             | <b>1m</b>                                                                 |
| 3c             | (W.D. =) $F \times d$ or $12\,000 \times 0.065 = \underline{780 \text{ J}}$                                                                                                                                                                                                                                                                                                                                                                                                                            | <p><b>1m</b> for correct workings<br/> <b>1m</b> for correct ans/unit</p> |
| <b>Total =</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>6 m</b>                                                                |

| Qn    | SECTION A [Workings / Calculations / Methods]                                                                                                                                                                                                                                                 | Marks / Remarks                                    |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|
| 4a    | geothermal                                                                                                                                                                                                                                                                                    | 1m                                                 |
| 4b i  | $(E =) mc\theta = 1000 \times 4200 \times 80 = \underline{3.4 \times 10^8 \text{ J}}$                                                                                                                                                                                                         | 1m for correct workings<br>1m for correct ans/unit |
| 4b ii | <ul style="list-style-type: none"> <li>steam condenses or steam changes from gas to liquid</li> <li>latent heat given out/ released/ lost from internal store</li> <li>particles come closer together <b>or</b> potential energy of particles decreases <b>or</b> bonds being made</li> </ul> | 1m<br>1m                                           |
|       | <b>Total =</b>                                                                                                                                                                                                                                                                                | <b>5 m</b>                                         |
| 5ai   | horizontal ray continued to bottom of l                                                                                                                                                                                                                                                       | 1m                                                 |
| 5aii  | 2.4 cm                                                                                                                                                                                                                                                                                        | 1m                                                 |
| 5aiii | any two other rays drawn, e.g. through centre of lens                                                                                                                                                                                                                                         | 1m                                                 |
| 5bi   | rays go to / meet at image or can be formed on a screen                                                                                                                                                                                                                                       | 1m                                                 |
| 5bii  | image height / object height or image distance / object distance<br>4.0                                                                                                                                                                                                                       | 1m for correct working/ans/unit                    |
|       | <b>Total =</b>                                                                                                                                                                                                                                                                                | <b>5 m</b>                                         |
| 6a    | The brush is charged by friction with the floor.<br>The dust and ash will be induced by the brush to carry opposite charges.<br>Opposite charges attract so they are pulled by the electrostatic attractive force created by the brush                                                        | 1m<br>1m                                           |
| 6b    | Carpets and wood are insulators.<br>The brush will be charged by friction when rubbing against the floor.                                                                                                                                                                                     | 1m<br>1m                                           |
| 6c    | The electrostatic sweeper is quieter than an electric vacuum cleaner<br>There is no need to use electricity, which causes the release of greenhouse gases such as carbon monoxide, more environmentally friendly                                                                              | 1m                                                 |
|       | <b>Total =</b>                                                                                                                                                                                                                                                                                | <b>5 m</b>                                         |
| 7a i  | $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$ or $\frac{R_1 R_2}{R_1 + R_2}$ or $\frac{1}{R} = \frac{1}{1800} + \frac{1}{9000}$ or $\frac{9000 \times 1800}{10800}$ or 0.00066667<br>R = 1500 $\Omega$ (2 sf)                                                                                 | 1m for correct workings<br>1m for correct ans/unit |
| 7a ii | $I = V/R = 4.5/1500 = 0.0030 \text{ A}$ (2 sf)                                                                                                                                                                                                                                                | 1m for correct workings<br>1m for correct ans/unit |
| 7b i  | increases <b>and</b> resistance of LDR decreases                                                                                                                                                                                                                                              | 1m                                                 |
| 7b ii | does not change <b>and</b> resistance / e.m.f. does not change / not affected by LDR                                                                                                                                                                                                          | 1m                                                 |
|       | <b>Total =</b>                                                                                                                                                                                                                                                                                | <b>6 m</b>                                         |
| 8a i  | 0.20 kWh (2 sf)                                                                                                                                                                                                                                                                               | 1m                                                 |
| 8a ii | $I = P/V = 40/230 = 0.17 \text{ A}$ (2 sf)                                                                                                                                                                                                                                                    | 1m for correct workings<br>1m for correct ans/unit |
| 8b i  | To disconnect from live, high voltage,<br>when appliance is switched off                                                                                                                                                                                                                      | 1m<br>1m                                           |
| 8b ii | if one lamp fails the other still works                                                                                                                                                                                                                                                       | 1m                                                 |
|       | <b>Total =</b>                                                                                                                                                                                                                                                                                | <b>6 m</b>                                         |
| 9ai   | force on PQ / wire or PQ / wire moves<br>force / movement out of page / outwards / towards observer<br>(Ignore upwards)                                                                                                                                                                       | 1m                                                 |
| 9aii  | force / speed / acceleration greater                                                                                                                                                                                                                                                          | 1m                                                 |
| 9b i  | change in field / flux (in coil) or field (lines) cut coil / wire produced<br>an induced emf across coil                                                                                                                                                                                      | 1m                                                 |
| 9b ii | more turns or stronger magnet or move magnet faster                                                                                                                                                                                                                                           | 1m                                                 |

| Qn             | SECTION A [Workings / Calculations / Methods]                                                                                                                                                                                                                                                                                                                                            | Marks / Remarks                                  |
|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|
| <b>9b</b>      | (current in coil) produces magnetic field / poles                                                                                                                                                                                                                                                                                                                                        | <b>1m</b>                                        |
| <b>iii</b>     | N pole created at right-hand of coil or repels magnet / field in opposite direction                                                                                                                                                                                                                                                                                                      | <b>1m</b>                                        |
|                | <b>Total =</b>                                                                                                                                                                                                                                                                                                                                                                           | <b>6 m</b>                                       |
| <b>10a</b>     | swimming direction towards left<br>- Water resistance opposite to swimming direction<br>- Forward force (thrust) from water on swimmer, same as direction of swimming                                                                                                                                                                                                                    | <b>1m</b><br><b>1m</b>                           |
| <b>10b</b>     | When the swimmer's hand pulls backward, an action force is exerted on water, backwards.<br>By Newton's Third Law of motion, water exerts a forward reaction force on the swimmer's hand, equal in magnitude                                                                                                                                                                              | <b>1m</b><br><b>1m</b>                           |
| <b>10c</b>     | With more volume of water and hence larger mass of water, the force exerted by the water on swimmer is larger.<br>With a larger force on swimmer, and minimized water resistance, the swimmer can accelerate more.                                                                                                                                                                       | <b>1m</b><br><b>1m</b>                           |
| <b>10d</b>     | When the forward force is greater than the water resistance force, there will be a forward resultant force.<br>By Newton's Second Law, since resultant force is the product of mass and acceleration, the resultant force will lead an acceleration of the swimmer.<br>Accept: resultant forward thrust for 1st mark.<br>Reject: forward thrust creates/causes/ equal to resultant force | <b>1m</b><br><b>1m</b>                           |
| <b>10e</b>     | Work done on water increases.<br>Since work done is product of force and displacement, a longer S path has larger displacement and larger work done on water.                                                                                                                                                                                                                            | <b>1m</b><br><b>1m</b>                           |
|                | <b>Total =</b>                                                                                                                                                                                                                                                                                                                                                                           | <b>10 m</b>                                      |
| <b>11a i</b>   | diagram with GM tube or other detector, source and absorber between<br>count/reading used in experiment ,repeat to take average reading<br>alpha stopped by paper/card /2–10 cm air     ))<br>between 2 mm and 2 cm aluminium/metal/lead stops beta     ))<br>(some) gamma passes through aluminium/metal/lead     ))                                                                    | <b>1m</b><br><b>1m</b><br><b>1m</b><br><b>1m</b> |
| <b>11aii</b>   | any 2 points:<br>• keep a distance, e.g. use tongs<br>• point source away (from user)<br>• use a barrier, e.g. wear lead apron<br>• use a lead container to store/transport sources<br>• use for a short time or monitor with film (badge)                                                                                                                                               | <b>1m, 1m</b>                                    |
| <b>11a iii</b> | (otherwise) source decays/decreases (quickly) B1<br>or source has to be replaced often                                                                                                                                                                                                                                                                                                   | <b>1m</b>                                        |
| <b>11b i</b>   | top line of beta 0<br>Xe proton and neutron numbers both balance                                                                                                                                                                                                                                                                                                                         | <b>1m</b><br><b>1m</b>                           |
| <b>11b ii</b>  | gamma rays pass out of / are not stopped by body<br>less chance of cell or gene damage / cancer / radiation sickness / mutation / ionisation (of body tissues)                                                                                                                                                                                                                           | <b>1m</b>                                        |
|                | <b>Total</b>                                                                                                                                                                                                                                                                                                                                                                             | <b>10 m</b>                                      |

| Qn      | SECTION B [Workings / Calculations / Methods]                                                                                                                                                                                                                                                                                                | Marks / Remarks                                    |
|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|
| 12a     | work done per (unit) charge/coulomb/C or energy transformed per (unit) charge/coulomb/C<br>property of a source (of electricity) or energy transformed to electrical energy per (unit) charge/coulomb/C                                                                                                                                      | 1m                                                 |
| bi, ii  | ammeter in series/ voltmeter in parallel with lamp<br>                                                                                                                                                                                                      | 1m, 1m                                             |
| ci      | Use absolute values of point: $I = 0.70 \text{ A}$ and $V = 2.0 \text{ V}$<br>$R = V/I = 2.0/0.70 = 2.86 \text{ V} = \underline{2.9 \Omega}$ (2 s.f.)                                                                                                                                                                                        | 1m for correct workings<br>1m for correct ans/unit |
| c ii    | <ul style="list-style-type: none"> <li>increases</li> <li>as voltage increases, gradient of I-V graph decreases and resistance is <math>1/\text{gradient of I-V graph}</math></li> </ul>                                                                                                                                                     | 1m                                                 |
| d i     | $P = VI = 12 \times 2.0 = 24 \text{ W}$                                                                                                                                                                                                                                                                                                      | 1m for correct workings<br>1m for correct ans/unit |
| d ii    | <ul style="list-style-type: none"> <li>dimmer,</li> <li>lesser pd across each lamp and lesser current through lamp</li> </ul>                                                                                                                                                                                                                | 1m<br>1m                                           |
| Total = |                                                                                                                                                                                                                                                                                                                                              | 10 m                                               |
| 13a     | start at origin and not horizontal<br>gradient (gradually) decreasing (ignore sudden decrease)<br>(not if part of curve above horizontal section)<br>final horizontal section ( $\geq 1 \text{ cm}$ ) (not if $v$ is shown as $\neq 40 \text{ m/s}$ )<br> | 1m<br>1m<br>1m                                     |
| b i     | friction/air resistance increases (as speed increases)<br>resultant force decreases (not if driving force decreases)                                                                                                                                                                                                                         | 1m<br>1m                                           |
| b ii    | (air resistance increases until) net force becomes zero or forces balance or air resistance and driving/forward force are in equilibrium/balanced/equal                                                                                                                                                                                      | 1m                                                 |
| c i     | $(KE = ) \frac{1}{2} mv^2 = \frac{1}{2} \times 5.5 \times 10^5 \times 40^2 = \underline{4.4 \times 10^8 \text{ J}}$                                                                                                                                                                                                                          | 1m for correct workings<br>1m for correct ans/unit |
| c ii    | (total energy input =) useful energy output efficiency or<br>efficiency = useful power output/total power input or $4.4 \times 10^8/0.40 = \underline{1.1 \times 10^9 \text{ J}}$                                                                                                                                                            | 1m for correct workings<br>1m for correct ans/unit |
| Total   |                                                                                                                                                                                                                                                                                                                                              | 10 m                                               |