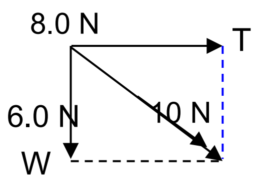
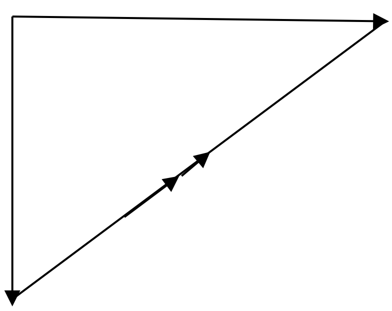
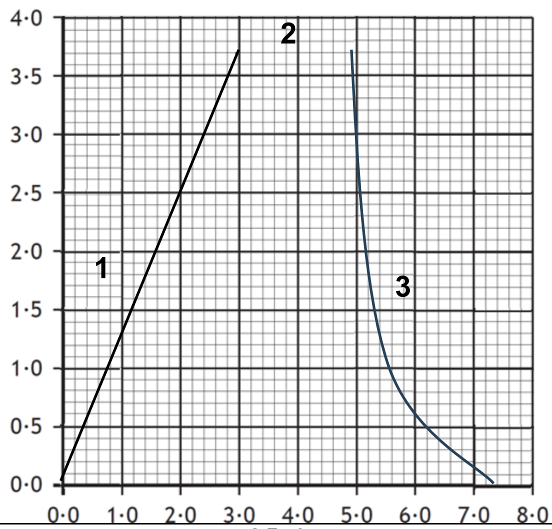
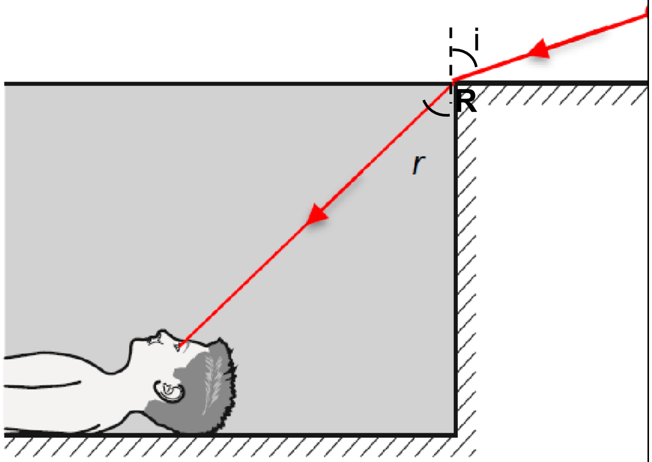
NAN CHIAU HIGH SCHOOL
Sec 4 Express Physics Solution
2024 Preliminary Examination

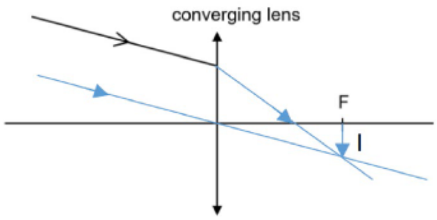
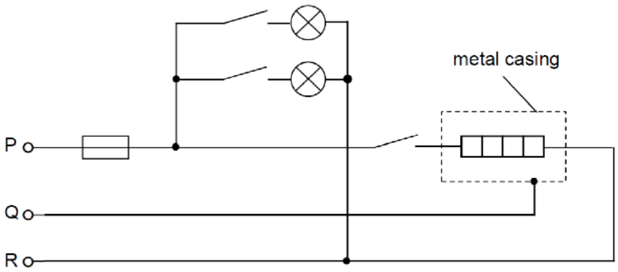
Paper 1 (40 marks)

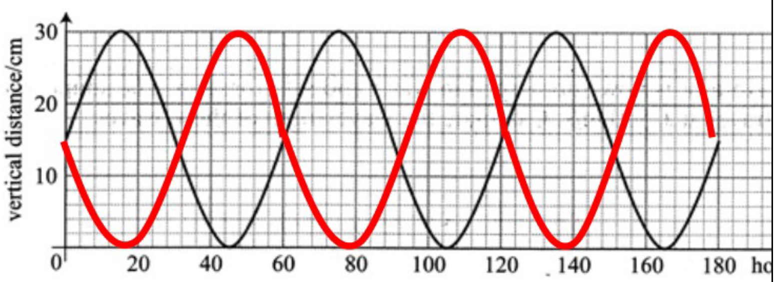
1	2	3	4	5	6	7	8	9	10
C	B	A	D	B	C	C	B	C	D
11	12	13	14	15	16	17	18	19	20
D	B	A	D	D	B	D	D	A	C
21	22	23	24	25	26	27	28	29	30
D	B	D	C	C	D	C	C	C	B
31	32	33	34	35	36	37	38	39	40
C	D	C	C	B	A	A	C	C	B

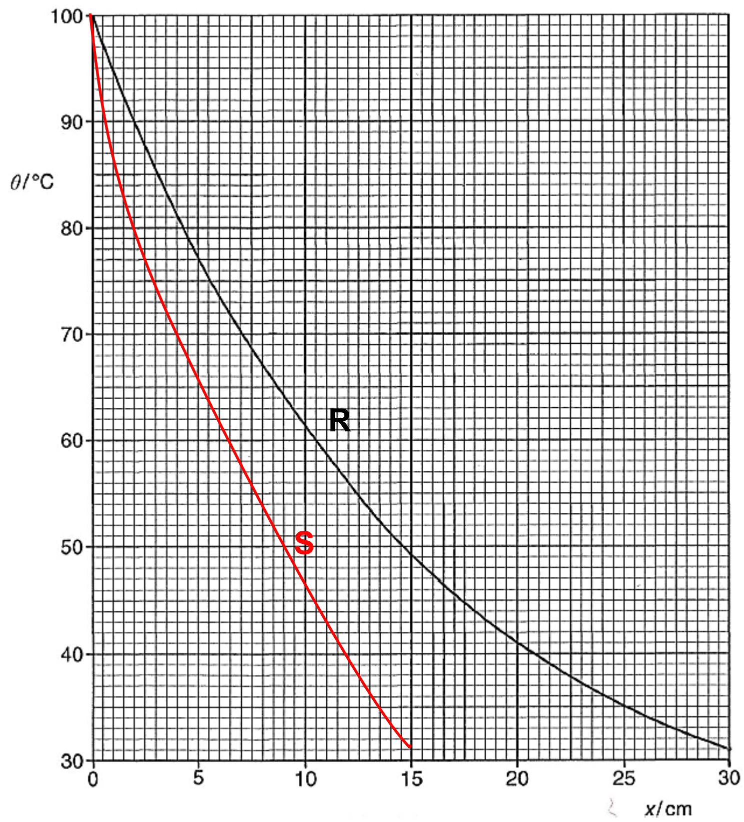
Paper 2 Section A (70 marks)				
Question		**Answer**	**Remarks**	
1	**a**	 Appropriate scale given [1] W (or 6.0 N) and T (or 8.0 N) labelled on perpendicular forces, resultant force = (10 ±1.0) N with correct arrow directions and Scale diagram in correct orientation. [1] Direction = 35° to 40° from T/Y/horizontal or 50° to 55° from W/vertical and correct resultant. [1] **no mark for wrong concept, for example** 	Minus 1m each for no arrows, wrong arrow directions or no double arrows on resultant force	
	b	10.0 N or e.c.f. from **(a)** [1]		

2	**ai**	P and F are not an action-reaction pair of forces. [1] The magnitude of P and F are not equal OR P and F are acting on the same body OR P and F are not the same type of force OR P and F are not from the same point. [1] Reject : P and F are not the same. BOD for “normal” reaction/contact force from box to man	2 marking points; Max 1m	
	aii	Force by box acting on the man. [1] Reject : normal reaction force; reaction force; weight.		
	b	F_{net} = ma 150 – 75 = 20 x a [1] a = 75/20 = 3.8 ms^{-2} (2 s.f.) [1]		
3	**a**	Sections 1 correct = 1m Sections 2 correct = 1m Section 3 correct = 1m (must have correct shape of decreasing deceleration) 		
	b	$a = \frac{v-u}{t} = \frac{3.7-0}{3.0}$ = 1.2 ms^{-2} (2 s.f.) [1]	Allow e.c.f from (a)	
	c	Distance = area under graph = ½ (3.0 x 3.7) [1] = 5.6 m (2 s.f.) [1]	Allow e.c.f from (a)	
	d	Time interval = 3.0s to 5.0s. [1] When the forces are balanced, according to newton’s second law, **resultant force is zero**, the climber will **move with zero acceleration/constant velocity**, [1] which is time between 3.0 s to 5.0 s.		
4	**a**	Sum of Clockwise moment = [(W x 0.45) + (19 X 1.3) + (W x 1.85)] Nm Sum of Anti-clockwise moment =(23 x 2.6) Nm Using POM, Taking moments about A:		

		Sum of Clockwise moment = Sum of Anti-clockwise moment $[(W \times 0.45) + (19 \times 1.3) + (W \times 1.85)] = (23 \times 2.6)$ [1] $0.45W + 24.7 + 1.85W = 59.8$ $2.3\ W = 35.1$ $W = 15$ N (2 s.f) [1]		
	b	$F_{net} = 0$ N Sum of upwards forces = Sum of downwards forces 23 + force = 19 + W + W [1] force = 19 - 23 + 2 (35.1/2.3) or force = 19 -23 +2 (15) = 27 N (0 d.p.) [1] = 26 N (0 d.p.) [1]	Allow ecf from 4a	
5	**a**	$P = P_{atm} + h\rho g = 100000 + (0.50)(13600)(10)$ [1] = 168 000 Pa = 168 kPa (0 d.p) [1]	max 1 mark if student convert atm pressure wrongly.	
	b	The mercury levels in **both ends will rise.** [1] The atmospheric pressure and gas pressure remain the same hence the **height difference of both ends will remain at 50 cm**. [1]		
6	**a**	gain in gravitational potential store = mgh = 80 x 10 x 3.0 = 2400 J = 2.4×10^3 J (2s.f.) [1]		
	b	By POCE: Initial gravitational potential store + Initial kinetic store = Final kinetic store $mgh + \frac{1}{2} mu^2 = \frac{1}{2} mv^2$ $2400 + \frac{1}{2}(80)\ u^2 = \frac{1}{2}\ (80)\ (8.0)^2$ [1] $40u^2 = 2560 - 2400 = 160$ $u = \sqrt{4.0} = 2.0\ ms^{-1}$ (2s.f.) [1]	Allow e.c.f from (a)	
	c	Both the **kinetic store and gravitational potential store** of the diver are **transferred mechanically as work done over a distance against water resistance** [1] and finally to **thermal/internal store of the water particles**. [1]		
7	**a**			

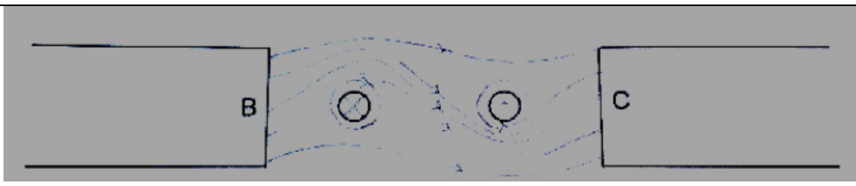
		Ray correctly drawn from Q to R to eye and angle r marked correctly [1] Minus 1 m for wrong/no arrow label on ray label both i, r correctly in diagram [1]		
	b	n = sin i° / sin r ° = sin 72°/sin 46° = 1.32 (3 s.f.) [1] Accept range of 1.29 (sin74°/sin48°) to 1.35 (sin 70°/sin 44°)		
	c	sin c = 1/n Critical angle, c = $\sin^{-1}$ (1/n) = $\sin^{-1}$ (1/1.3221) = 49.1 ° (3 s.f.) [1]		
8	**ai**	 correctly drawn rays [1] correct image location [1] note student need to draw 4 arrows for ray diagram to indicate direction of ray before and after entering the ray. Reject a) if image with a downward arrow is missing. b) if image is dotted. c) if ray is dotted.		
	aii	Real, inverted, diminished [Any 2 out of 3 properties: 1m]		
	b	Not accurate. [1] Not all the data supports the conclusion eg. When d is doubled from d= 5.0 cm to d=10 cm, the magnification at 10 cm (1.5) is not doubled from 1.2, should be 2.4 instead. [1]		
9	**a**	 Correct symbol and position of fuse before lamps [1]		
	b	**Wire Q**. [1] In the event of an electrical fault where the **metal casing becomes 'live'**, **excessive current will flow through the earth wire to earth/ground** instead of through the user, thus **preventing** the user from experiencing an **electric shock**. [1]		

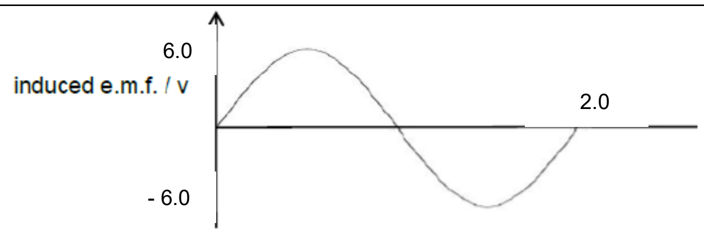
	c	Energy used in a day = (50/1000 x 2 x 3.0) +2.5 x 0.40 = 1.3 kWh [1] OR 9.1kWh in 1 week [M1] ‘ Cost in 1 week = 1.3 x 7 x \$0.30 = \$2.73 (2 d.p.) or 273 cents (0 dp) [1] OR \$0.39 [M1] OR \$2.42 [M1-one bulb]		
10	**a**	v = fλ f = 10/4.0 = 2.5 Hz or T = 0.40 s [1] v = (10/4.0) (60) = 150 cms^{-1} = 1.5 ms^{-1} (2 s.f.) [1]		
	b	f = 10 /4.0 = 2.5 Hz T = 1/f = 1/2.5 = 0.40 s After 25 s, 25/0.40 = 62.5 period later Therefore, the new waveform will be same as 0.5 period later.  Out of phase waveform shape with same wavelength [1] same amplitude [1]		
11	**a**	20 / 4 = 5 half lives [1] 1200 -> 600 -> 300 -> 150-> 75->37.5 After 20min, count rate = 37.5 or 38 ((2s.f.) or 37 counts/min [1]		
	b	**Its half-life is too short**, so Californium-241 will decay very fast. Therefore, **there will not be enough alpha emission** in the smoke detector to keep the current flowing after a short period of time. [1] This would **trigger the smoke detector’s alarm even when there is no smoke present** in the surroundings. [1]		

12	**ai**	 Accept any curve from 100˚C to 31˚C with steeper gradient and x less than 30 cm. [1] When curve reaches 31˚C, it will have a constant horizontal line until x = 30 cm. [1]		
	aii	Wood S is a poorer thermal conductor than metal R so it **will transfer heat through the rod slower or its temperature gradient is higher** compared to R, giving rise to steeper gradient/greater temperature drop from 100˚C to 31˚C. [1] **Graph will hit 31˚C at a shorter x and stays constant after it reaches 31˚C** since it reaches room temperature. [1]		
	bi	Both **rates of thermal energy flows are equal**, so that the temperatures along x stay constant. [1]		
	bii	There is **lesser thermal energy/heat loss** through the surface since the **rod is insulated** and hence is able to maintain a higher temperature. [1] BOD: The temperature of the water bath is 36 degree Celsius, which is higher than the room temperature.		
	biii	temperature gradient = (36-100)/20.5 [1] = **- 3.1**˚C cm^{-1} (2 s.f.) [1]		
	ci	H = -kA x temperature gradient = **- 0.027 x 0.80 x (0-35)/0.050** [1] = 15.12 W = **15** W (2 s.f.) [1]		

	cii	H x t = ml_f **15.12 x 2.0 x 3600 = m x 3.34 x 10^5** [1] m = **0.33 kg** (2 s.f.) [1]	Allow e.c.f from c(i)	
13	ai	Voltmeter 1 reads 4.0 V when C is at X. As C moves towards Y, voltmeter reading **decreases** from 4.0 V [1] Voltmeter 2 reads 0 V when C is at X and **increases** from 0 V as C moves towards Y. [1] Ammeter reading **decreases** as C moves from X to Y. [1]		
	aii	Brightness is measured by the power, P = VI. Since V increases as I increases, **P will increase** which leads to **increased brightness** of the lamp. [1] As the voltage increases, the **resistance increases**, since the ratio I/V in the graph decreases. [1]		
	bi	R = 0.50 V / 0.40 A = 1.25 Ω = **1.3 Ω** (2 s.f.) [1]		
	bii	ρ = (R x A) / l = **[1.25 x (1.5 x 10^{-3})^2 / 4] / 2.2** [1] = **1.0 x 10^{-6} Ω m** (2 s.f.) [1]	Allow e.c.f from b(i)	

Paper 2 Section B (10 marks)

14	a	B = north, C = south [1]	
	b	 Correct magnetic field S-shape (closer at the top for the left, closer at the bottom for the right) [1] Apply RHG rule for both conductors and draw arrows with correct directions. [1]	Allow e.c.f from (a)
	c	Anticlockwise. [1]	Allow e.c.f from (a).
	d	**[Magnetic Fields Explanation]** From Fig. 14.3, in the magnetic lines of force above the left current carrying conductor PQ and the direction of the magnetic lines of force from North pole at are in the same direction. Therefore they reinforce each other and produce a stronger magnetic field at top. [1] In contrast, the magnetic lines of force below the current carrying conductor PQ and the direction of the magnetic lines of force from North	

		pole are in the opposite direction. Therefore they cancel each other and produce a weaker magnetic field at the bottom. [1] This difference in magnetic field strength causes a net downwards force at PQ. [1] Vice versa, the difference in magnetic field strength causes a net upwards force at RS. [1] The two equal and opposite forces of the couple causes a turning effect (or torque) which causes the coil to rotate in anticlockwise direction. [1] **[Fleming's LHR Explanation]** Using Fleming's Left hand Rule, **left side of coil (PQ) experience** induced **downward force** [1] and **right side of coil (RS) experience** induced **upward force** [1] , thus coil will continue turning in the same direction.	4 marking points, Max 2m Allow e.c.f from (c).
	e	The split-ring commutators reverse the direction of the current in the coil after every half revolution or 180˚. [1] This allows the left side of coil to always experience downward force and right side of coil to always experience upward force, thus coil will continue turning in the same direction. [1]	Allow e.c.f from (c).
	f	The coil will begin to change direction of rotation The coil will begin to change direction of rotation or opposite direction/clockwise. [1]	Allow e.c.f from (c): opposite direction in (c).
	g	● increasing the number of turns of the coil, increasing magnetic field strength. ● increasing the current/voltage supplied to the two solenoids by using stronger/more batteries. ● Place a soft iron core inside coil PQRS, increasing magnetic field strength. ● Place solenoids closer to the coil, increasing magnetic field strength. [Any 1: 1m] Reject: Increase strength of permanent magnets(solenoids not magnets)	
15	**a**	As the turbine wheel turns, the magnets move with respect to the detector coil. When a magnet approaches the coil, the **change in magnetic flux linking the coil generates an induced e.m.f**. in the coil according to Faraday's Law of electromagnetic induction. [1] As the **same magnet leaves the coil, it generates an induced e.m.f. of the opposite polarity** according to Lenz's Law. [1] The **cycle repeats with each approaching and leaving magnet**, inducing an alternating e.m.f. in the detector coil. [1]	
	b	 Correct shape with period = 2.0 s [1] Amplitude of +6.0 V and - 6.0 V. [1]	
	c	input power = 1.8 x 6 = 10.8 W, output power = 0.8 x 12 = 9.6 W [1]	

		efficiency = output power / input power x 100% = 9.6 / 10.8 x 100% = 89% (2 s.f.) [1]	
	d	Np/Ns = 6.0/12 or Ns/Np = 12/6.0 [1] = 1 : 2 or = 2:1 = 0.50 or = 2.0 [1]	
	e	V_1 = 12 V and V_2 = 24 V [1]	Allow e.c.f from d