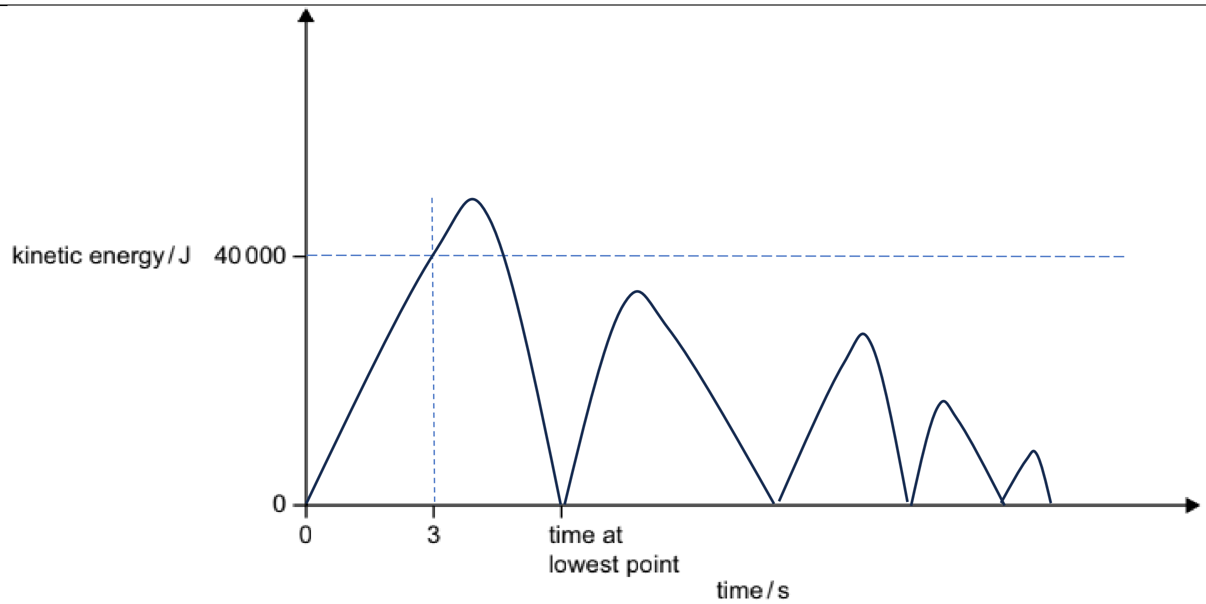
2026 H1 physics P2/Answer

1.	(a) The principle of conservation of momentum states that for an isolated system of objects, where there is no net external force on the system during collision, the total momentum of the objects before collision will be equal to the total momentum of the objects after collision. (bi) the direction of the tennis ball towards the tennis racket is negative, the opposite direction is positive. initial momentum = mass*initial velocity = 56/1000*(-42) = -2.352 $kgms^{-1}$ final momentum = mass*final velocity = 56/1000*(54) = 3.024 $kgms^{-1}$ change in momentum = final momentum - initial momentum = 3.024-(-2.352) $kgms^{-1}$ = 5.4 kg ms^{-1} (2 s.f as the lowest number of significant figures used in calculation is 2 s.f.) (bii) impulse = change in momentum = 5.4 $kgms^{-1}$ (biii) momentum is conserved as there is no net external force acting on the system of tennis racket and tennis ball, the force of the racket on the ball and the force on the racket by the ball, are reaction-action forces and they cancelled out each other in the system.
2.	(ai) GPE store = mass of object * gravitational field strength* height above reference point = mgh. Example of increasing gravitational potential energy store is the throwing of a ball upwards into the air. (aii) Elastic potential energy store = ½*spring constant (k)*$(extension)^2$ = ½*k*e^2 Example of increasing elastic potential energy store is a stretched elastic rubber band. (bi) the change in gravitational potential energy store = mg(Δh) = 82*9.81*50 J = 40,221 J Due to air resistance some of the change in gravitational energy store is used to do work against air resistance, hence the increase in kinetic energy store will be around 40,000 J after considering the work done against air resistance (bii)



- Total 5 times man is at rest after jumping off
- Takes shorter time duration for each bounce to come to rest
- Max KE to be lower after time it comes to rest due to air resistance
- Sharper change in speed closer at the lowest point as compared to at higher point due to larger net force due to elastic force exerted by the extended cord

3. (a) $\frac{1}{2} * m_e * v^2 = Ve$,

$v = \sqrt{(2Ve/m_e)} = \sqrt{[(2*200*1.60 \times 10^{-19})/(9.11 \times 10^{-31})]} = 8{,}381{,}674$ m/s $= 8.38 \times 10^6$ m/s

(bi) $F_{net} = m_e a$

Electric field strength*e = $m_e a$

$12500*1.60 \times 10^{-19} = 9.11 \times 10^{-31} a$

$a = 2.20 \times 10^{15}$ m/s^2

(bii) $\frac{1}{2} * m_e * v_y^2 = Ve$

$v_y^2 = (2Ve/m_e) = 8.78 \times 10^{13}$ m^2/s^2

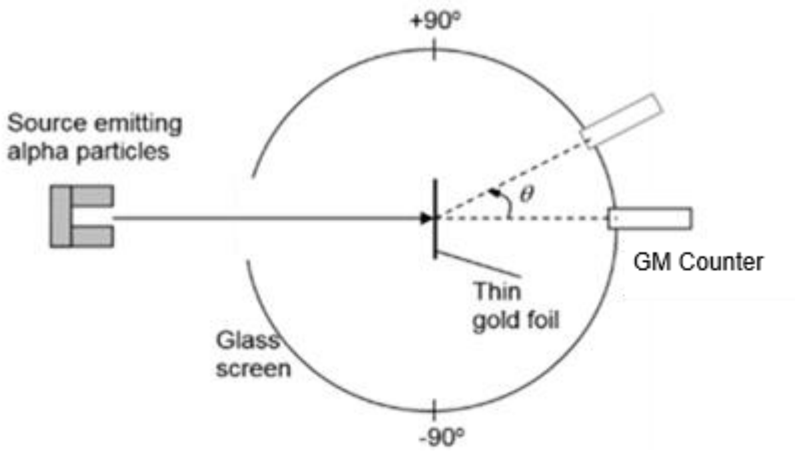
$x = (v_y^2 - u_y^2)/(2a)$

$u_y = 0.00$ m/s

$x = (8.78 \times 10^{13})/(2*2.20 \times 10^{15}) = 0.0200$ m

(b) into the plane of the page. By Fleming left hand rule, the magnetic force will be upwards if the magnetic field is into the plane of the page.

4. (ai)

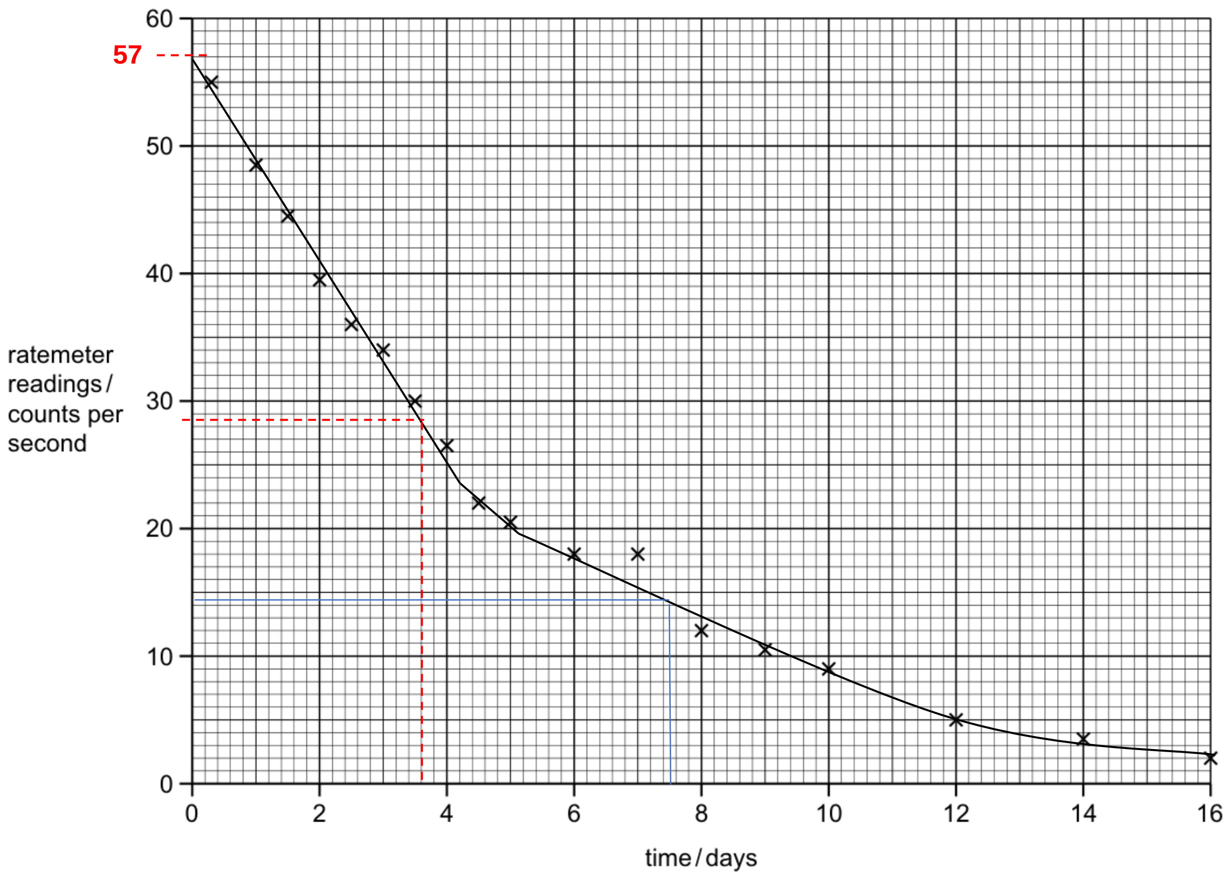


- Alpha particles are directed towards the nucleus of a gold foil.
- Geiger muller (GM) counters were positioned at various angles to determine the count rate.

(aii)

- Most of the alpha particles passed through with little or no deflection ⍰ the atom is mostly empty space.
- A few of the particles were bounced back or deflected through a large angle ⍰ The large deflection suggested that there is very large electrostatic force of repulsion which comes about because of all the positive charges of the gold atom are concentrated in a very small space.

(bi)



(bii)

Label 57, ½ (57), ½ x ½ (57)

Half-life of radioactive material = 3.6 + (7.5-3.6) days = 3.75 ~ 3.8 days

5.	(ai) $I = nAqv = (3.5\times10^{18})\ (\pi\ (\ ½ \times 0.00437)^2\ )(1.60\times10^{-19})v = 0.16 \times 10^{-3}$ v = 19.05 = 19 m/s (aii) the drift velocity in the metal wires assuming same diameter as semiconductor will have a lower drift velocity as the number density of chargers in the metal wires are higher, and the metal wires are connected in series with the cell, and thermistor, thus the current through the metal wires is the same, leading to a lower drift velocity. (aiii) the charge carriers/electrons are constantly colliding with atoms and other electrons, causing a random, zigzag motion, and only exhibiting a net, slower movement in the direction of the electric field (b) At higher temperature, more charge carriers are released by the semiconductor Increasing charge carriers by the semi conductor decreases the resistance of the thermistor significantly [R decreases with higher temperature] Pdf across the thermistor decreases **<u>Side note:</u>** Since current flow is equal in both 1.0kΩ & thermistor, [E is the emf of battery] pdf across thermistor = $\frac{R_{thermistor}}{1000 + R_{thermistor}} \times E = \frac{1}{\frac{1000}{R_{thermistor}} + 1} \times E$ It is recognized that there would be a higher current flow argued either by an increasing charge carriers or that total resistance of the circuit decreases
6.	(a) average speed of the cyclist = total distance/time taken = 161000/[(4*60 + 48)*60 + 20] m/s = 9.31 m/s (bi) cyclist is cycling up a hill/mountain, as distance increases, the altitude increases cyclist is cycling more or less at the same speed based on distance travel as compared to speed of elevation up the hill/mountain (bii)

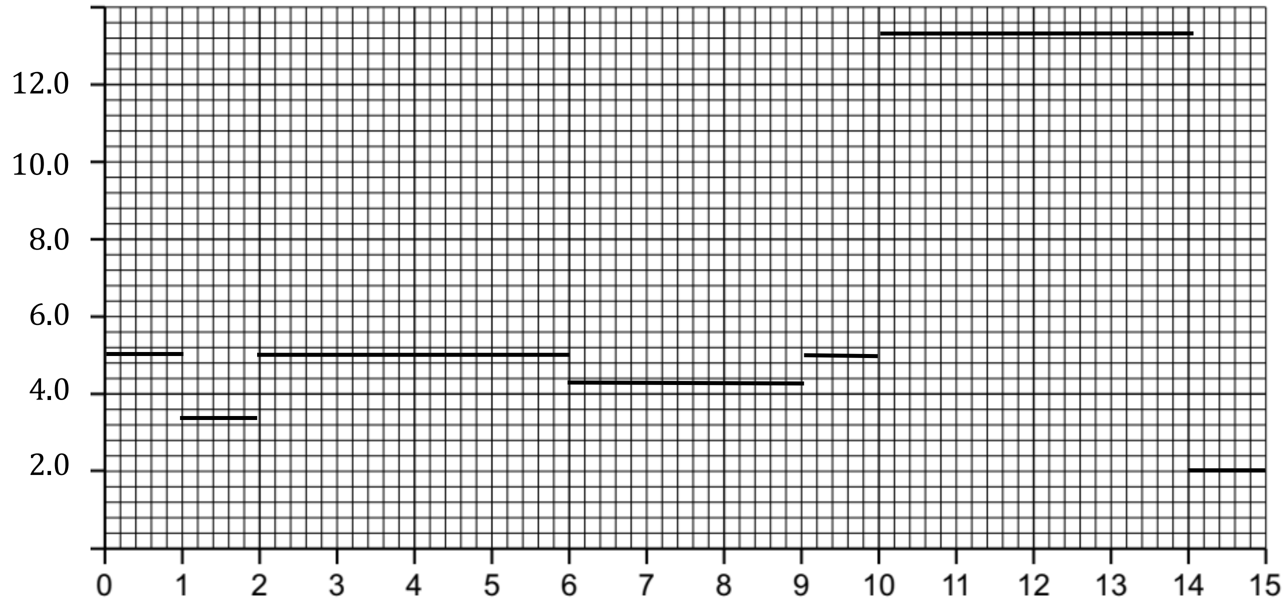


Figure 6.3

Section	distance travelled (m)	time taken (s)	average speed (m/s)
1	1000	200	5
2	1000	300	3.33
3	4000	800	5
4	3000	600	5
5	1000	200	5
6	4000	300	13.3
7	1000	300	3.33

Section	distance travelled (m)	time taken (s)	average speed (m/s)
1	1000	200	5.0
2	1000	300	3.3
3	4000	800	5.0
4	3000	700	4.3
5	1000	200	5.0
6	4000	300	13.3
7	1000	500	2.0

(ci) Work done against resistive forces = 24N * 3000 m = 72000 J

(cii) Power output unit mass against resistive forces = 72000J/(700s * 78 kg) = 1.32 W/kg

(ciii) Work done to overcome gravity = mgΔh = 78 *9.81 * (1500-1100) = 306072 J

Total work done = 306072 + 72000 = 378072 J

Total power output per unit mass = 378072/(700s *78) = 6.92 W/kg

(di) Total power output per unit mass of office worker = 12000*1000/(24*60*60s*70) = 1.98 W/kg

(dii)

$$\frac{\text{Total power output per unit mass for cyclist}}{\text{Total power output per unit mass for office worker}} = 3.48 \sim 3.5$$

Statement made in the beginning of question is correct.

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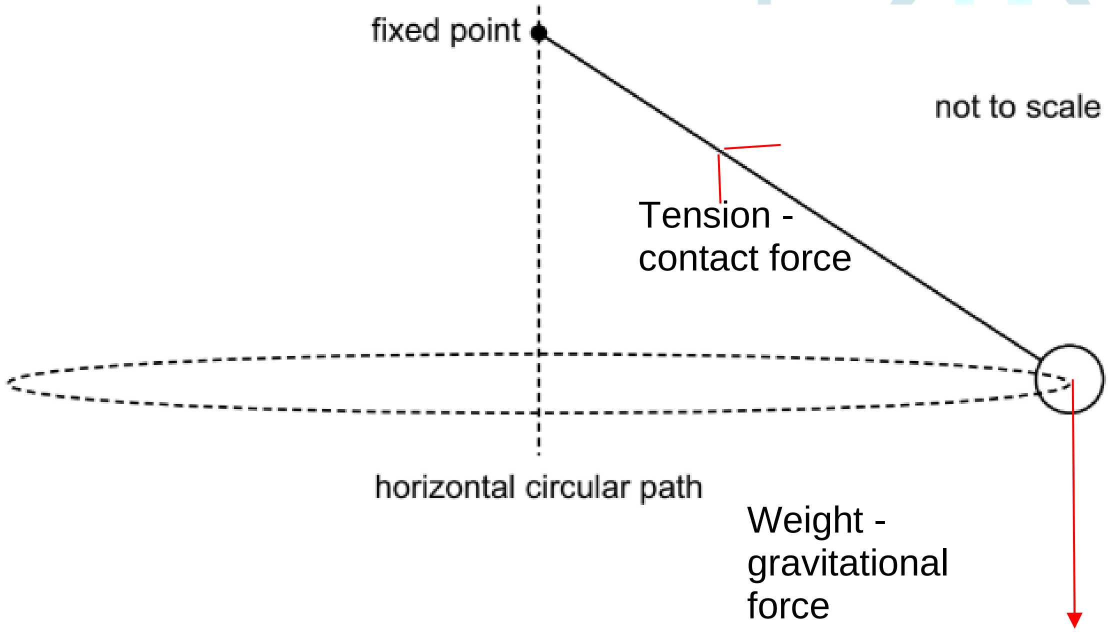
(a)

Newton's first law of motion **states that a body at rest will stay at rest, and a body in motion will continue to move at constant velocity, unless acted on by a resultant external force.**

Newton's second law of motion **states that the rate of change of momentum (defined as product of mass and velocity) of a body is proportional to the resultant force; the direction of the force is in the same direction as the object's acceleration.**

Newton's third law of motion **states that the force exerted by one body on a second body is equal in magnitude and opposite in direction to the force simultaneously exerted by the second body on the first body.**

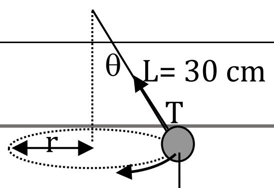
(bi)



(bii) the reaction force to the tension in the string acting on the ball, is the force acting on the string by the ball, which is equal in magnitude but opposite in direction to the tension action force.

There is no reaction force to the weight/gravitational force.

L = 0.70m; θ = 70º, m = 0.040kg
r = Lsinθ
T cosθ = W = mg   ------ (1)



	For circular motion, **$F_c = m\frac{v^2}{r} = mr\,\omega^2 = T\sin\theta$ ---- (2)** **(2) divided by (1)** **$\tan\theta = \frac{mr\omega^2}{mg} = \frac{r\omega^2}{g} = \frac{v}{gr}$** W (biii) v = (gr tanθ) = (9.81*0.70*tan(50^o)) = 8.18 m/s =8.2 m/s (2 sfg) (biv) Tcos θ = mg T = (0.040*9.81)÷ cos 50^o = 0.610 = 0.61 N (2 sfg) (ci) T = 27.3 days = 27.3*24*60*60 s = 2,358,720 = 2,350,000 s (3 sfg) (cii) speed of moon on its orbit = 2πr/T = 2π(3.84 x 10^8)/2,358,720 = 1023 = 1020 m/s (3 sfg) (ciii) angular velocity = 2π/T = 2π/2,358,720 = 2.664 x 10^{-6} rad/s = 2.664 x 10^{-6} rad/s (3sfg) (civ) centripetal acceleration = $r\omega^2$ = 3.84 x 10^8 (2.66 x 10^{-6})^2 = 0.00272 ms^{-2} (3 sfg) (cv) Gravitational force of Earth on moon = $mr\omega^2$ = 7.35 x 10^{22} x 0.00272 = 2.00 x 10^{20} N (cvi) $GM_e m/r^2$ = 2.00 x 10^{20} M_e = (2.00 x 10^{20} x r^2)/(Gm) = 6.02 x 10^{24} kg

8	(ai) resistance of ohmic resistor = 0.5V/(6.0 x 10^{-3}A) = 83.333 ~ 80 ohms

(aii) power supplied to the ohmic resistor = V^2/R = 0.5^2/83.33 = 0.0030W

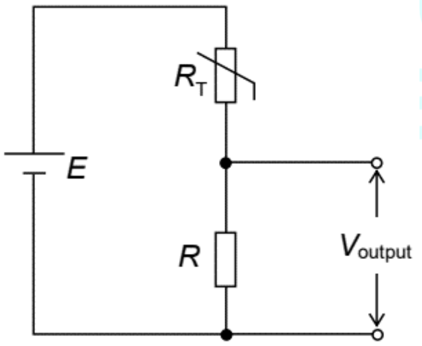
(aiii) resistance of filament lamp = 0.5V/(13.5 x 10^{-3}A) ~ 37 ohms

(b) As the potential difference increases across the filament lamp, the filament is heated up. The increase in electron density in the metal filament is limited. The average kinetic energies of the cations/atoms in the metal filament increase and this resulted in a greater resistance to the flow of electrons across the lattice structure, resulting in a higher resistance, hence the shape of the graph I-V graph is such that as V increases the resistance increases.

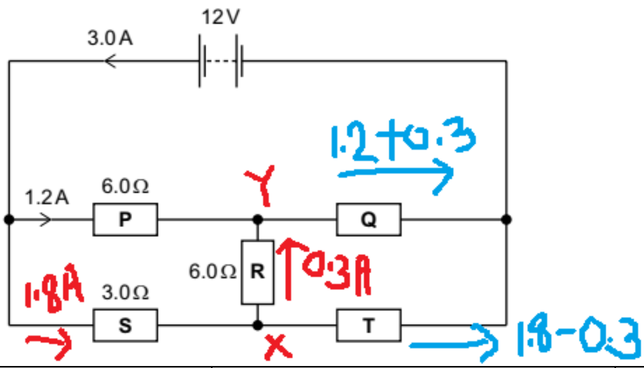
(c) V for diode is 0.7V from the graph as current is 18mA
Pdf across diode + pdf across resistor (V_R) = 12V
Pdf across diode = 0.7V
12 - V_R = 0.7V
V_R = 11.3V → I R = (11.8x10^{-3}) R = 11.3V
R = 627.8 = 628 Ω

(d)
Output pdf to mains circuit = $\frac{R \times E}{R + R_{thermistor}}$

When temperature increases to a preset value, $R_{thermistor}$ decreases, and V output increases to switch on a cooling system



(e)



X > Y since pdf across S < P
Potential Y = 12-6x1.2
Potential X = 12-3x1.8

Component	I/A	V/V	R/Ω
Battery	3.0	12	0
P	1.2	**(1) V = RI** **Ans - 7.2**	6.0
Q	**(7) current + 1.5 = 3.0** **Ans - 1.5**	**(8) pdf + 7.2 = 12** **Ans – 4.8**	**(9) R = V/I** **Ans - 3.2**
R	**(5) I = V/R** **Ans – 0.3**	**(4) pdf across S + R = pdf across P** **Ans – 1.8**	6.0
S	**(2) current + 1.2 = 3.0** **Ans - 1.8**	**(3) V = RI** **Ans – 5.4**	3.0
T	**(6) current + 0.3 = 1.8** **Ans - 1.5**	**(10) pdf + 5.4 = 12** **Ans – 6.6**	**(11) R = V/I** **Ans – 4.4**