EUNOIA JUNIOR COLLEGE
JC2 Preliminary Examination 2024
8867 PHYSICS
MARK SCHEME

Paper 1 – Multiple Choice Questions

Question	Key
1	D
2	B
3	B
4	C
5	B
6	B
7	D
8	A
9	B
10	A

Question	Key
11	A
12	B
13	D
14	C
15	B
16	D
17	D
18	C
19	D
20	B

Question	Key
21	D
22	A
23	D
24	A
25	D
26	C
27	B
28	C
29	C
30	C

1	**Answer: D**
	units of energy = J $=(\text{kg m s}^{-2})(\text{m})$ Intensity = Power/Area = Rate of Work done/Area units of intensity = $\dfrac{\text{kg m s}^{-2}\text{m}}{\text{m}^2\ \text{s}}$ $= \text{kg s}^{-3}$

2	**Answer: B**
	$R = \rho \dfrac{L}{A}$ $\rho = \dfrac{RA}{L}$ $= 0.0534$ $\dfrac{\Delta\rho}{\rho} = \dfrac{\Delta R}{R} \pm 2\dfrac{\Delta D}{D} \pm \dfrac{\Delta L}{L}$ $= \dfrac{1}{68} + 2\dfrac{0.1}{5.0} + \dfrac{1}{25}$ $= 0.0947$ $\Delta\rho = 0.0534 \times 0.0947$ $= 0.005057$ $= 0.005$ $\Delta\rho = (5.3 \pm 0.5) \times 10^{-2}\,\Omega\text{m}$

3	**Answer: B**
	Option A gives a radius of 6 cm Option B gives a radius of 13 cm Option C gives a radius of 29 cm Option D gives a radius of 62 cm B is the most sensible answer.

4	**Answer: C**
	$s=\frac{1}{2}gt^2$ on earth, $s=\frac{1}{2}\left(\frac{g}{6}\right)t'^2$ on moon → $t'^2=6t^2$ and $t'=\sqrt{6}t$

5	**Answer: B**
	As the projectile rises, the vertical component of the velocity of the projectile decreases to zero at the top of its trajectory, then increases to its initial value in the downward direction as the projectile comes back down to its original launch level. The projectile's horizontal velocity component, however, remains constant throughout. Speed *v* is the magnitude of velocity, which is a vector sum of the horizontal and vertical component. The graph for *v* should be a curve that decreases to a non-zero value (when projectile is at its highest), then increases back to its initial value *u.*

6	**Answer: B**
	Change in momentum, $\Delta p = Area\ under\ F-t\ graph$ $=\frac{1}{2}(2+5)2+(2\times1)$ $=9.0\,\text{kg}\,\text{m}\,\text{s}^{-1}$ $\Delta p = m(v-2.0)$ $9.0=2.0(v-2.0)$ $v=2.0+\frac{9.0}{2}$ $=6.5\,m\,s^{-1}$

7	**Answer: D**
	$F = 8ma$ $a = \dfrac{F}{8m}$ To find the force on X by Y, consider X: $F - F_{XY} = ma$ $F_{XY} = F - m(\dfrac{F}{8m})$ $= \dfrac{7}{8}F$ To find the force on Y by Z, consider Z: $F_{ZY} = 4ma$ $F_{ZY} = 4m(\dfrac{F}{8m})$ $= \dfrac{1}{2}F$ By Newton's 3rd Law: $\lvert F_{ZY} \rvert = \lvert F_{YZ} \rvert$ Ratio: $\dfrac{F_{XY}}{F_{YY}} = \dfrac{\frac{7}{8}F}{\frac{1}{2}F}$ $= \dfrac{7}{4}$

8	**Answer: A**
	Total momentum of the system is conserved because no external force acts on the gliders. Option B: Before collision, total momentum of the system is zero. Option C: Kinetic energy is not conserved when both magnets are rest. Option D: Both magnets have the same mass, the magnetic force on each magnet is the same, no friction on track, total kinetic energy of the system is conserved before and after collision.

9	**Answer: B**
	Using relative speed of approach = relative speed of separation Eliminate Option A: 5-(-2) = 5-2 (false) Eliminate Option C: 5-(-2) = 4-4 (false) Using logical deduction, eliminate D as after collision, the speed of the large mass cannot remain the same. Option B: 5-(-2) = 10 – 3 (True), and after colliding large mass's speed is smaller as it has transferred some of its momentum to the smaller mass, resulting in increased in speed of the smaller mass. Mathematical approach using conservation of linear momentum: (Let Large mass = M, Small mass = m) Option D: 5M- (2m) = 5M +12m 0 = 14 m (impossible) Option B: 5M- (2m) = 3M +10m 2M = 12 m M= 12 m (possible)

10	**Answer: A**
	P and Q are stretched by a force = W/2. Each of their extension = (W/2)/k = W/(2k) R is stretched by a force = W and its extension = W/(3k) Total extension = W/(2k) + W/(3k) = 5W/6k

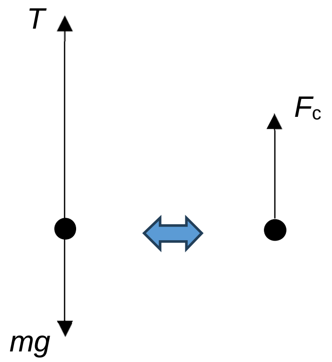
11	**Answer: A**
	Using point when F= 14 N and x =14 mm $F = kx$ $k = \dfrac{14}{(\frac{10}{1000})} = 1400$ at (20,28) the elastic limit of spring is reached work done $= \dfrac{1}{2}kx^2 = \dfrac{1}{2}(1400)(\dfrac{20}{1000})^2 = 0.28$ J

12	**Answer: B**
	The two tension forces T are to be added, hence the tail of one T should be at the head of the other T. The tail of the resultant R should be at the free tail of one T and the head of R should be at the free head of the other T.

13	**Answer: D**
	Constant speed, acceleration = 0 $F_{net} = 0$ Hence, $mg - kv = 0$ $mg = kv$ $v = \frac{mg}{k}$ $KE = \frac{1}{2}mv^2$ $= \frac{1}{2}m(\frac{mg}{k})^2$ $= \frac{1}{2}\frac{m^3g^2}{k^2}$

14	**Answer: C**
	When the speed is 20 m s^{-1}, the driving force F is solved using $\text{power output} = Fv$ $23\times10^3 = F\times20$ $F = 1.15\times10^3$ N The frictional force f at this speed is equal to the driving force: $f = 1.15\times10^3$ N because the net force on the car is zero. When the speed increases to 40 m s^{-1} (speed is doubled), because the frictional force is proportional to the square of the speed, the frictional force increases by a factor of 4. By N2L, since the velocity is again constant (net force is 0), the driving force is equal to this new frictional force $F_{new} = 4f = 4\times1.15\times10^3 = 4.6\times10^3$ N The new power output is then $\text{new power output} = 4.6\times10^3\times40 = 184$ kW

15	**Answer: B**
	radius of rotation $r = \frac{0.50}{2}\sin\frac{120°}{2} = 0.2165$ m angular speed $\omega = \frac{5\times 2\pi}{60} = 0.5236$ rad s^{-1} acceleration $a = \omega^2 r$ $= 0.5236^2 \times 0.2165$ $= 0.059$ m s^{-2}

16	**Answer: D**
	D Tension in string is always perpendicular to velocity, hence no work is done on the tension (external force). By conservation of energy, Gain in KE = Loss in GPE $\frac{1}{2}mv^2 = mgr$ $\frac{mv^2}{r} = 2mg$  Since resultant of tension and weight provides centripetal force at the bottom, $T - mg = \frac{mv^2}{r}$ $T = mg + \frac{mv^2}{r} = 3mg$ See the diagram.

17	**Answer: D**
	gravitational acceleration $g = \frac{GM}{d^2}$, where d is the distance to the centre of the Earth, and M is the mass of the Earth. Hence, $g = \frac{GM}{(h+R)^2}$ $g(h+R)^2 = GM =$ constant

18	**Answer: C**
	$V_X = V_Y$ $A_X L_X = A_Y L_Y$ $\frac{A_X}{A_Y} = \frac{L_Y}{L_X} = 4$ $A_X = 4A_Y$ $R = \frac{\rho L}{A}$ $\frac{R_Y}{R_X} = \frac{L_Y A_X}{A_Y L_X} = \frac{L_Y}{L_X}\frac{A_X}{A_Y} = 4 \times 4 = 16$

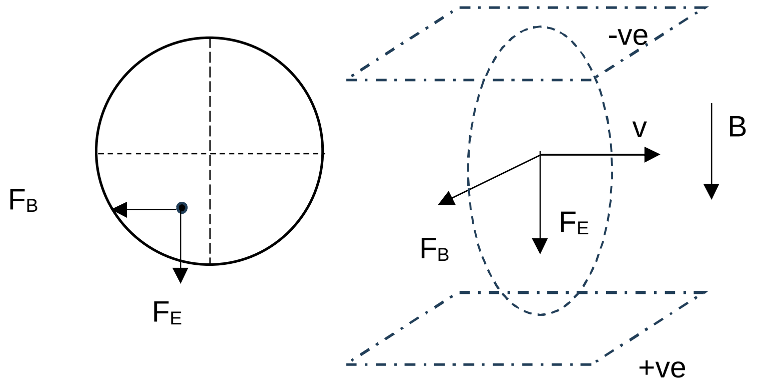
19	**Answer: D**
	Potential difference across parallel branches in a circuit are equal.

20	**Answer: B**
	$P = VI = 12 \times 2 = 24$ W

21	**Answer: D**
	A and B are wrong because the diode is connected in reverse-bias. When temperature of the thermistor is low, resistance is high and hence p.d. across the thermistor is high. The heater should be connected across the thermistor.

22	**Answer: A**
	Positive charge attracted to the lower electric potential by the constant electric force. The path is parabolic. Option C and D are wrong as the path of the positive charge will not be circular. It will travel in a parabolic path into the plane of the paper for both options.

23	**Answer: D**
	$F = BIL$ $I = \dfrac{2.4 \times 10^{-2}}{0.5 \times 0.10}$ $= 0.48\ \text{A}$ Using FLH Rule, the direction of current is Y to X

24	**Answer: A**
	

25	**Answer: D**
	When the current is doubled, the magnetic force is doubled. Newton's 3rd Law will dictate that both forces on one another must be of same magnitude. Hence eliminate option A and C. When the current is doubled, the magnetic field at X due to Y will be doubled. The magnetic field at Y due to X remains the same. Hence answer is D.

26	**Answer: C**
	By FLR, on entry, the magnetic force on the proton is upwards. Hence, to be undeflected, the electric force must be downwards. The direction of E-field must be downwards. Eliminate B and D. Electric force, F=qE Magnetic force, F =Bqv For net force to be zero, qE = Bqv E=Bv = (1.5)(2.0×10^{7}) = 3.0×10^{7} NC^{-1}

27	**Answer: B**
	Isotopes have the same number of protons but different number of neutrons. By emitting one α- and two β-particles, the number of protons of the element will be conserved.

28	**Answer: C**
	Binding energy per nucleon = (Mass Defect) x c^2 $\text{Binding energy per nucleon} = \frac{(\text{mass defect}) \times c^2}{\text{nucleon number}}$ $= \frac{c^2 \Delta m}{x}$

29	**Answer: C**
	Paper stops alpha particles, so $\alpha + \beta + background$ = 352min^{-1} $\beta + background$ = 256min^{-1} Initial count of beta particle source = 256-16=240min^{-1} Initial count of alpha particle source = 352-256=96min^{-1} After 12 days, alpha particle source undergo 3 half-lives and beta particle source undergo 4 half-lives Final count of alpha particle source=$\frac{96}{2^3}$ = 12min^{-1} Final count of beta particle source=$\frac{240}{2^4}$ = 15min^{-1} Total count = 12+15+16=43min^{-1}

30	**Answer: C**
	1.0 g of H → 0.0010/1.008u = 5.976×10^{23} H Sufficient amount of Li → 5.976×10^{23} Li, since ratio of H: Li = 1: 1 Energy released in one reaction = $[7.018u + 1.008u – 2(4.004u)]c^2$ = 2.689×10^{-12} J Total energy released = $2.689 \times 10^{-12} \times 5.976 \times 10^{23}$ = 1.61×10^{12} J

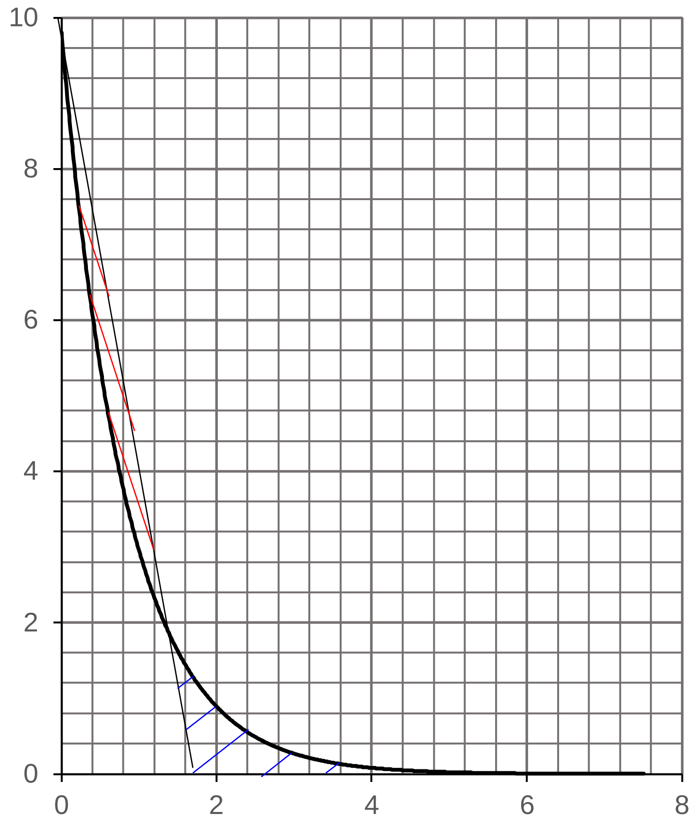
Paper 2 – Structured Questions

Qns	Answer	Marks
1(a)	Acceleration is the rate of change of velocity with respect to time.	**B1**
(b)(i)	As the object accelerates downwards, its velocity increases with time. Since the viscous force on the object increases with speed, net force (weight – viscous force) acting on the object decreases, hence the acceleration decreases with time.	**B1** **B1**
(b)(ii)	Initially the velocity of the object is zero, hence the viscous force is also 0. The acceleration of the object is only due to its weight / gravitational force, hence acceleration 9.8 m s^{-2}.	**B1**

<table>
<tr><td>(b)(iii)</td><td>
Change in velocity = area under a-t graph

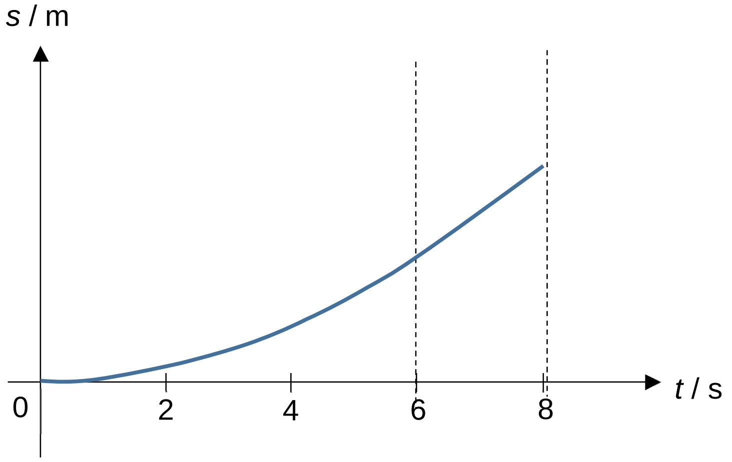
$v - 0 \approx$ (50 small squares)(0.4 x 0.4) = 8.0 m s^{-1} (range: 7.5-9.0 m s^{-1})

One way to estimate the area under the curve is to draw a line as shown in the diagram below. The line chosen is such that the area shaded in red is roughly equal to the area shaded in blue. The area under the original curve is then roughly equal to the area of the triangle, with base 1.7 and height 9.8. Thus,
$\text{velocity} = \text{area under curve} \approx \frac{1}{2} \times 9.8 \times 1.7 = 8.3 \text{ m s}^{-1}$.
Better estimation of the area can be achieved by using more triangles/trapeziums to approximate it.



</td><td>C1

A1</td></tr>
</table>

(b)(iv)	 **Gradient = 0 at *t* = 0 s**, then gradually increasing till $t \approx 6$ s . After $t \approx 6$ s, gradient is constant (terminal velocity reached) at the value that was reached at 6 s - no kink allowed.	 **B1** **B1**

Qns	Answer	Marks
2(a)	An object stays at rest or continues to move at constant velocity unless a resultant force acts on it.	**B1**
2(b)(i)	$KE = \frac{1}{2}mv^2 = \frac{1}{2}(0.40)(0.30)^2$ $= 0.018$ J	**C1** **A1**
2(b)(ii)	loss in kinetic energy = work done on spring OR increase in elastic potential energy $\frac{1}{2}mv^2 = \frac{1}{2}Fx^2$ $0.018 = \frac{1}{2}F(0.08)^2$ $F = 0.45$ N	**B1** **C1** **A1**
2(b)(iii)	1. constant velocity / resultant force is zero, so in equilibrium 2. decelerating / resultant force is not zero, so not in equilibrium	**A1** **A1**
2(c)(i)	By taking moments about the base, $W = mg = 180(9.81) = 1770$ N $d = 2.3\cos 45° = 1.63$ m Moment = $W \times d = 1770 \times 1.63$ $= 2890$ N m $\approx 2.9 \times 10^3$ N m	**M1** **A0**
2(c)(ii)	By Principle of moments, Total anti-clockwise moments = Total clockwise moments $T \sin 35° \times 4 = 2.9 \times 10^3$ $T = 1.26 \times 10^3$ N	**C1** **A1**

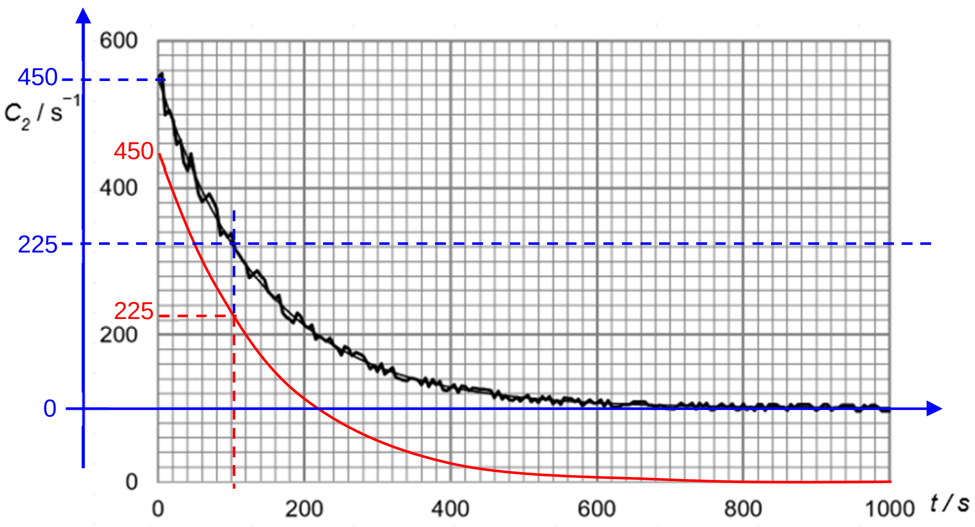
Qns	Answer	Marks
3(a)(i)	An arrow originating from the object, pointing towards point O.	**B1**
3(a)(ii)	The frictional force provides the centripetal force, and hence must be in the same direction.	**B1**
3(b)(i)	Using points (6.00, 5.90) and (9.00, 8.90) on the line $\text{Gradient} = \dfrac{8.90 - 5.90}{9.00 - 6.00} = 1.00$	**B1** **B1**
3(b)(ii)	$\text{gradient} = \dfrac{\omega_{\max}^2}{\frac{1}{r}} = r\omega_{\max}^2 = a_{c(\max)}$ Hence, the gradient is numerically equal to the **<u>maximum</u>** <u>centripetal acceleration</u>.	**B1** **A1**
3(c)	$f = \text{gradient} \times m$ $= 1.00 \times 0.80$ $= 0.80\ \text{N}$	**C1** **A1**
3(d)	As angular v increases, **required** centripetal force increases. (friction provides required centripetal force) When required centripetal force exceeds maximum frictional force, object slides.	**B1** **B1**

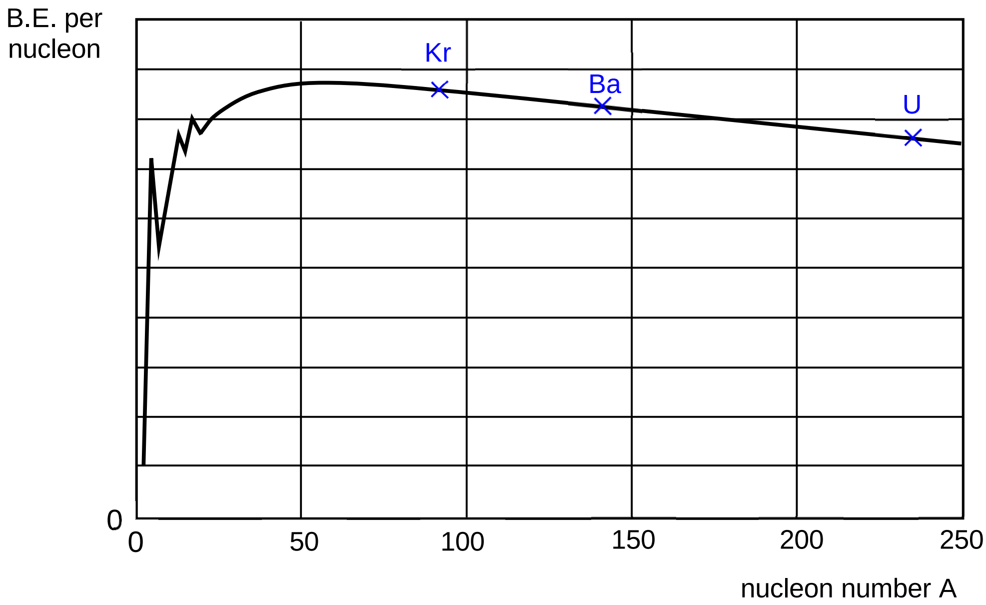
Qns	Answer	Marks
4(a)	Product of force and displacement in the direction of the force	**B1**
4(b)(i)	1. Loss in KE $= \frac{1}{2}mu^2 - \frac{1}{2}mv^2 = \frac{1}{2}(580)(22)^2 - \frac{1}{2}(580)(12)^2$ $= 9.9 \times 10^4$ J	**C1** **A1**
	2. Gain in GPE $= mg\Delta h = (580)(9.81)(13)$ $= 7.4 \times 10^4$ J	**C1** **A1**
	3. $d = \frac{1}{4}(2\pi r) = \frac{2}{4}(3.14)(13)$ $= 20$ m	**C1** **A1**
4(b)(ii)	work done against resistive force = $9.9 \times 10^4 - 7.4 \times 10^4$ = 25 000 J average resistive force = $(9.9 \times 10^4 - 7.4 \times 10^4) / 20$ = 1300 N	**C1** **A1**

Qns	Answer	Marks
5 (a)(i)	The Principle of Conservation of Linear Momentum states that the **total linear momentum** of an **isolated system** **of interacting bodies** before and after collision remains constant if **no net external force acts on the system**. OR The Principle of Conservation of Linear Momentum states that <u>the total linear momentum of a system remains constant provided that no resultant external force acts on the system</u>.	**B1**
(a)(ii)	The **resultant force acting on a body** is **proportional to the rate of change of momentum** of that body.	**B1**
(b)(i)	After collision, the bodies will move along the same line that joins the 2 bodies' centre of mass rightwards.	**B1**
(b)(ii)	By principle of conservation of momentum: $mu + 14m(0) = 15mV$ $V = \frac{1}{15}u$ Ratio of kinetic energy $= \frac{KE_{nitrogen}}{KE_{neutron}} = \frac{\frac{1}{2}MV^2}{\frac{1}{2}mv^2} = \frac{15\cancel{m}\left(\frac{\cancel{v}}{15}\right)^2}{\cancel{m}\,\cancel{v^2}} = \frac{1}{15} = 0.067$	**C1** **M1** **A1**
(b)(iii)	From (bii), since initial total KE before collision not equals to final total KE after collision, the collision is not elastic (inelastic). OR Since there is no relative separation between the neutron and nitrogen atom after collision, the relative speed of approach is not equals to relative speed of separation, the collision is not elastic (inelastic).	**M1** **A1**

Qns	Answer	Marks
6 ai	current decreases as resistance of R and total circuit resistance increases drop in p.d. across internal resistance decreases $\left(V_{\text{int resistance}} = Ir\right)$ terminal p.d. increases as it is the difference between electromotive force and p.d. drop across internal resistance $\left(V_{\text{terminal}} = \text{e.m.f.} - Ir\right)$	**M1** **M1** **A1**
aii	current in circuit $I = \dfrac{\text{e.m.f}}{R_{\text{total}}}$ $= \dfrac{5}{0.25+4+3.5} = \dfrac{5}{7.75}$ $(= 0.645\text{ A})$ $V_{\text{terminal}} = \text{e.m.f.} - Ir$ $= 5 - \dfrac{5}{7.75}(0.25)$ $= 4.84\text{ V}$ or by potential divider rule: $\dfrac{V_{\text{internal}}}{\text{e.m.f.}} = \dfrac{r_{\text{internal}}}{R_{\text{total}}}$ $V_{\text{internal}} = (\text{e.m.f.})\dfrac{r_{\text{internal}}}{R_{\text{total}}}$ $= 5\dfrac{0.25}{0.25+4+3.5} = 0.161\text{ V}$ $V_{\text{terminal}} = (\text{e.m.f.}) - V_{\text{internal}}$ $= 5 - 5\dfrac{0.25}{0.25+4+3.5}$ $= 4.84\text{ V}$	**C1** **C1** **A1**
aiii	same current passing through efficiency $= \dfrac{P_{\text{external}}}{P_{\text{total}}} \times 100\%$ $= \dfrac{IV_{\text{terminal}}}{I(\text{e.m.f.})} \times 100\%$ $= \dfrac{4.84}{5} \times 100\%$ $= 96.8\%$ Note that "efficiency of power transfer" is about the ratio of useful power to total power given by emf.	**M1** **A1**

bi	Lamps have same p.d./ lamps hv p.d. of 2.7 Current = 0.15 + 0.090 = 0.24 A	**B1** **A1**
bii	R' = (4.5 – 2.7) / 0.24 = 7.5 Ω	**C1** **A1**
biii	$R = \rho l/A$ and $R = V/I$ (same V and ρ) $R \propto A/l \propto d^2/l$ $R_X / R_Y = (d_P/d_Q)^2 \times (l_Q/l_P)$ $= 2^2 \times (0.09/0.15)$ = 2.4	 **C1** **A1**

Qns	Answer	Marks
7(a)(i)1	The short-term fluctuations for the two graphs are different. The rate of decay for each nucleus is unpredictable. Thus, radioactive decay is random.	**B1** **B1**
7(a)(i)2	Both long-term trends are exponential graphs. The decay is spontaneous because the rate of decay is independent of temperature (external condition).	**B1** **B1**
7(a)(ii)	The graph comes to a constant rate of 100 counts per s eventually, indicating only the background radiation is significant then. Thus, background count = 100 per s	 **B1**
7(a)(iii)	Half-life is the time taken for the number of undecayed nuclei / activity / count rate to be reduced to half its original value.	**B1**
7(a)(iv)	Re-number the count rate values by deducting 100 count per s. This can be done by shifting the exponential curve downwards or shifting the x-axis upwards. Evidence of drawings/workings on either Fig. 7.1 or Fig. 7.2 must be seen. Then at 0 second, initial count-rate = 450 count per s. Half of it = 225 count per s. Time for count rate to drop by half = 105 s from graph. (Accept 90 ≤ $t_{1/2}$ ≤ 110 s)  	**M1** **C1** **A1**

7(b)(i)	${}^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{141}_{56}\mathrm{Ba} + {}^{92}_{36}\mathrm{Kr} + \underline{\ 3\,{}^{1}_{0}\mathrm{n}\ } +$ energy released	**A1**
7(b)(ii)	Nuclear fission is the splitting of a heavy nucleus into two lighter nuclei of approximately the same mass.	**B1**
7(b)(iii)	Approximate positions of the three nuclides in the correct column in the grid. 	**B1** (only mark for relative positions of Kr, Ba, U AND all 3 points of the right side of highest point)
7(b)(iv)	From 7(b)(iii), both (B.E./nucleon) of Ba and (B.E./nucleon) of Kr are larger than (B.E./nucleon) of U, thus (B.E. of Ba + B.E. of Kr) > (B.E. of U), hence energy is released in the fission process.	**B1** **B1** **A0**
7(b)(v)	B.E. per nucleon of ${}^{235}_{92}\mathrm{U}$ $= \dfrac{\left[92m_p + (235-92)m_n - m({}^{235}_{92}\mathrm{U})\right]c^2}{235}$ $= \dfrac{\left[92(1.007) + (235-92)(1.009) - (235.123)\right](1.66\times10^{-27})(3.00\times10^{8})^2}{235}$ $= 1.15\times10^{-12}\ \mathrm{J} = 7.18\ \mathrm{MeV}$	 **C1** **A1**

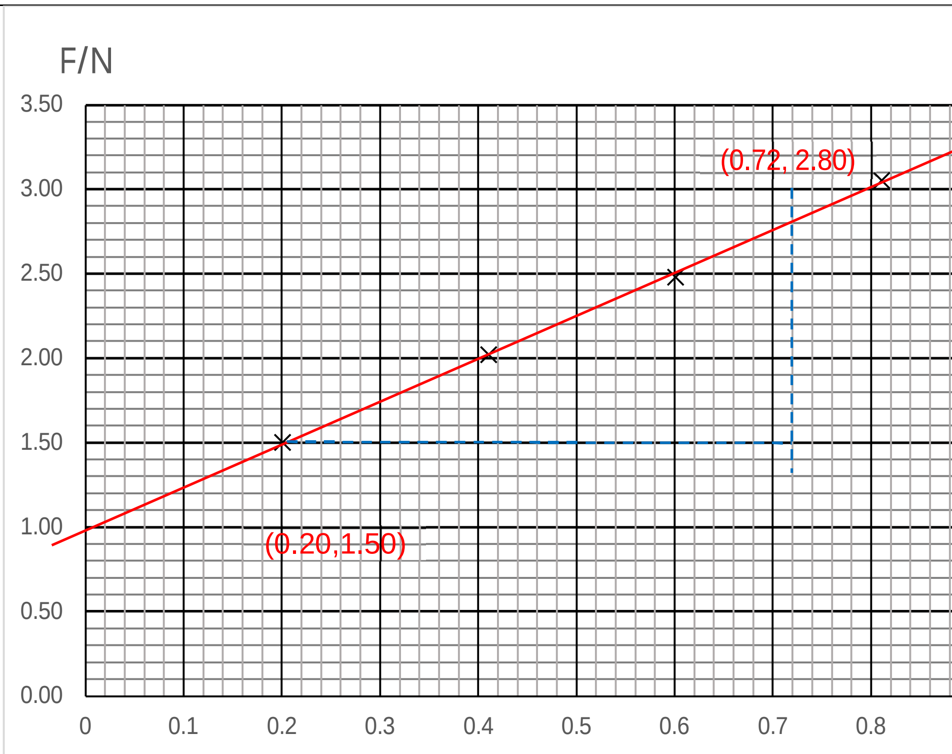
7(b)(vi)	Energy released = BE of products – BE of reactants = (B.E. of $^{141}_{56}Ba$) + (B.E. of $^{92}_{36}Kr$) – (B.E. of $^{235}_{92}U$) = (8.24 $\times$ 141) + (8.56 $\times$ 92) – (7.18 $\times$ 235) = 262 MeV = (262 $\times$ 10^{6})(1.60 $\times$ 10^{-19}) J = 4.19 $\times$ 10^{-11} J Or Energy released = (mass $_{reactants}$ – mass $_{products}$) c^2 = [m($^{235}_{92}U$) – m($^{141}_{56}Ba$) – m($^{92}_{36}Kr$) – 2(m$_n$)] c^2 = [235.123 – 140.912 – 91.913 – 2(1.009)] (1.66 $\times$ 10^{-27})(3.00 $\times$ 10^{8})^2 = 4.19 $\times$ 10^{-11} J	**C1** **A1**
7(b)(vii)	The energy released could be in the form of Gamma photons and/or kinetic energies of the products.	**B1**
7(c)	Any one of following: • Increase the distance between source and person, e.g. marking out danger zones. • Provide shielding between source and person, e.g. wearing of lead-lined clothing, keeping source in lead containers.	**B1**

<table>
<tr><th>Qns</th><th>Answer</th><th>Marks</th></tr>
<tr><td>8(a)</td><td>Magnetic flux density B is the force acting per unit current per unit length on a wire carrying a current that is normal to the magnetic field.
$B = \dfrac{F}{IL(\sin 90°)}$</td><td>B1</td></tr>
<tr><td>b(i)</td><td>Both arrows point vertically downwards (in diagram).

The <u>current</u> flows <u>perpendicular to the magnetic flux</u> at all parts of the coil. Hence the current carrying conductor will experience a magnetic force.

The direction is of the magnetic force can be deduced by <u>Fleming's Left Hand Rule</u>.</td><td>B1

B1

B1</td></tr>
<tr><td>(b)(ii)</td><td>

$\text{Gradient} = \dfrac{2.80 - 1.50}{0.72 - 0.20}$
$= \dfrac{1.30}{0.52}$
$= 2.5$

Force per unit current = F/L = 2.5 N A^{-1}

From the graph, zero error of the balance =1.00 N OR

Use point (0.20,1.50) and gradient =2.50 to find the y-intercept:
1.50 = (0.20)(2.80) + C
C = 0.94
Zero error = C = 0.94 N</td><td>B1
correct plots

B1
Best fit line

B1
use of gradient rather than plots, within range

B1</td></tr>
</table>

(iii)	$F = BIL \Rightarrow \frac{F}{I} = BL$ From (b)(i), $\frac{F}{I} = 2.5$ N A^{-1}, $2.5 = B\left(50 \times 2\pi\left(0.025\right)\right)$ $B = 0.637$ T	**M1** **A1**
c(i)	The force on the electron is (always) **perpendicular** to the velocity/ **perpendicular** to the direction of travel. Thus no work is done by the force on the particle. (The speed remains unchanged and the force changes its direction.)	**B1**
c(ii)	$F = Bqv$ $= (0.050)(1.6 \times 10^{-19})(5.0 \times 10^{6})$ $= 4.0 \times 10^{-14}$N	**C1** **A1**
c(iii)	Magnetic force provides the centripetal force. $F = Bqv$ $Bqv = \frac{mv^2}{r}$ $r = \frac{mv}{Bq}$ $= \frac{(9.11 \times 10^{-31})(5.0 \times 10^{6})}{(0.0050)(1.6 \times 10^{-19})}$ $= 5.67 \times 10^{-3}$ $= 5.7$mm	**B1** correct statement **B1**
c(iv)	Radius of path is proportional to its mass. Mass of proton is <u>many order of magnitude larger</u> than the electron implies the radius of the proton would be many orders of magnitude larger (and is too large as compared to a typical laboratory).	**B1** **B1**

(d)	$F = ma \Rightarrow eE = ma \Rightarrow e\dfrac{V}{d} = ma \Rightarrow a = \dfrac{eV}{md}$ .. $t = \dfrac{x}{v}$ ...... (2) Substituting (1) & (2): $y = \cancel{ut} + \dfrac{1}{2}at^2$ $= \dfrac{1}{2}\dfrac{eV}{md}\left(\dfrac{x}{v}\right)^2$ $= \dfrac{1}{2}\dfrac{eVx^2}{mdv^2}$	**B1** **B1** **A1**