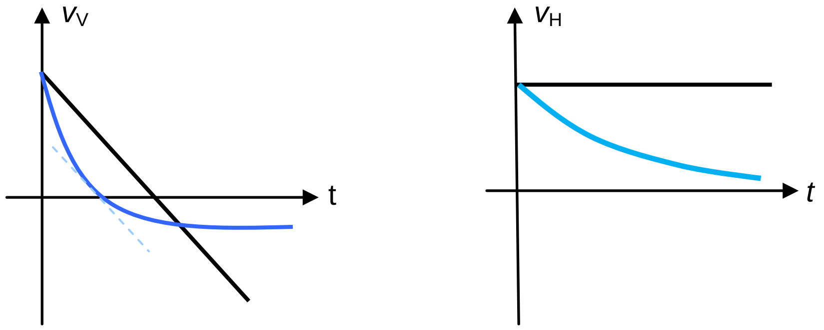
PRELIMINARY EXAMINATION II 2015
H1 Physics Paper 2 solutions

1 **(a)** B1
(b) B1



B1
B1

(c) Before the highest point,
weight and drag act in the same direction W + D = ma B1
resultant acceleration = Gradient > 9.81.

After the highest point,
weight and drag act in the opposite direction W – D = ma B1
resultant acceleration = Gradient < 9.81.

At the highest point,
drag = 0, weight = ma
resultant acceleration = Gradient = 9.81

(d) smaller magnitude of acceleration for downward journey therefore takes longer. M1

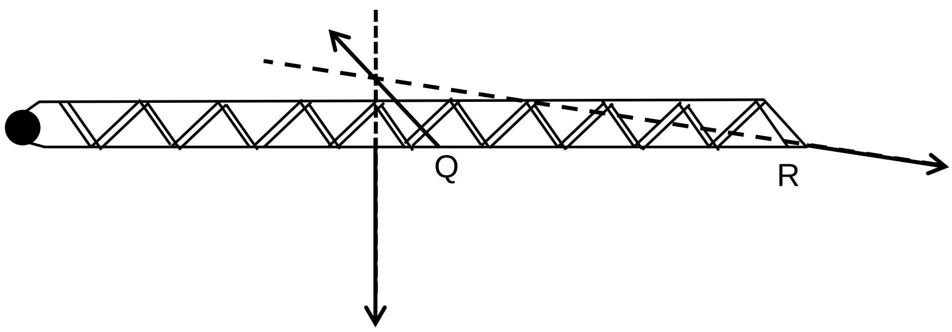
OR

Loss in total energy due to work done against air resistance → when the ball is at the same level, it will have a smaller speed, therefore for the same distance up and down, the time taken is longer for the downward journey.

Time taken upward is lesser than the time taken downward. A1

2 **(a)** No resultant force ; no resultant torque. A2

(b)
(i)



Force intersect at common point [B1]
R direction - Right and down [B1]

(ii) Take moment about R
(F sin 40)(8) = (2800)(10) M1
F = 5400 N (2 sf) A1

3 **(a)** Conservation of momentum

$m_1u_1 = (m_1 + m_2)\ v$ M1

$3 \times 12 = (3 + 5)\ v$ A1

$v = 4.5\ m\ s^{-1}$

(b) loss in E_K = gain in E_P M1

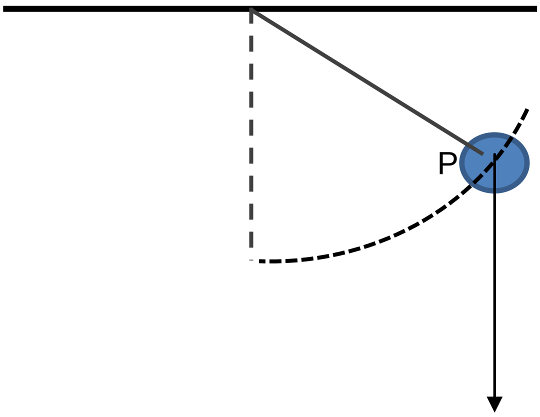
$\frac{1}{2}\ mv^2 = mgh$

$h = \frac{1}{2}v^2 / g = 1.0\ m$ A1

(c) (i)
1. efficiency no change as the amount of gravitational E_P gained depends on the initial E_K (which is unchanged) M1
2. height h will be larger since g is smaller (mgh = constant) M1

A1

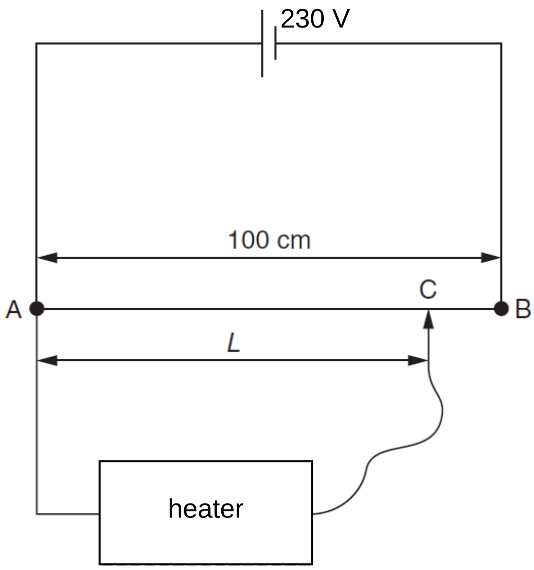
(iii) A1



4 **(a) (i)** $P = V^2 / R$ C1

reduction = $(230^2 - 220^2)/230^2 = 8.5\%$ A1

(ii) workable potential divider circuit M2



(b) **(i)** zero A1

(ii) $I = 1.5/5.0 = 0.30$ A A1

(c) **(i)** correct plots to within ± 1 mm A1

(ii) reasonable line through points giving current as 0.12 A M1

(allow ± 0.005 A) A1

	(iii)	As AC and CB are equivalent to 2 resistors connected in series, the potential difference across AC (across L) can be determined by the potential divider expression: $V_{AC} = R_{AC} / (R_{AC} + R_{BC})$ E	M1
		When L is increased, resistance between point A and C increases while total resistance (R_{AC} + R_{BC}) stays constant, hence potential difference across L increases.	A1
	(iv)	V = IR	C1
		V = 0.12 × 5.0 = 0.60 V	A1
(d)		Even at midpoint, because of the 5.0 Ω connected in parallel with AC, resistance between AC is not equal to resistance between CB. OR current in AC is not the same as the current in BC	M1 A1
(e)		With internal resistance, the potential difference across AC would be reduced ($V_{AC} = R_{AC} / (R_{AC} + R_{BC} + R_{internal})$ E).	M1
		Hence the current would be reduced and the data points shifted downwards.	A1
(f)		straight line showing p.d. increasing as L increases.	M1

Section B

5	**(a)**	when two or more waves meet at a point, the resultant displacement is a vector sum of the individual displacements due to each wave	B1 B1
	(b)	amplitude 5 small squares on 3 peaks	B1
		correct phase (ignore lead/lag), allow ± ½ square	B1
		correct resultant displacement = displacement of wave X at 0.5T, T and 1.5T where displacement of wave W is zero	B2
	(c)	$\lambda = ax/D$	M1
	(i)	$540 \times 10^{-9} = (0.65 \times 10^{-3})\, x / 2.80$	
		x = 2.33 mm	A1
	(ii)	same separation	B1
	1.	bright fringes brighter and dark fringes unchanged OR fewer fringes observed	B1
	2.	same separation	B1
		bright fringes darker and dark fringes brighter	B1
	(d)	$d \sin \theta = n\lambda$	M1
	(i)	($\underline{10^{-3} / 600}$) sin 90° = n × 650 × 10^{-9}	C1
		n = 2.6	C1
		so two orders	A1
	(ii)	$d \sin \theta = n\lambda$	
	1.	$\underline{\theta \text{ is greater}}$ so λ is greater	B1
	2.	when n is larger, $\Delta\theta$ is larger	M1
		so greater in second order	A1

6	**(a)** **(i)**	Magnetic flux density is the **force per unit length per unit current** acting on an **infinitely long current carrying conductor placed perpendicularly** to the magnetic field.	[B1]
	(ii)	$T = \dfrac{N}{Am}$	[B1]
		$T = \dfrac{kgms^{-2}}{Am} = kgA^{-1}s^{-2}$	[B1]

(b) (i) [B1]

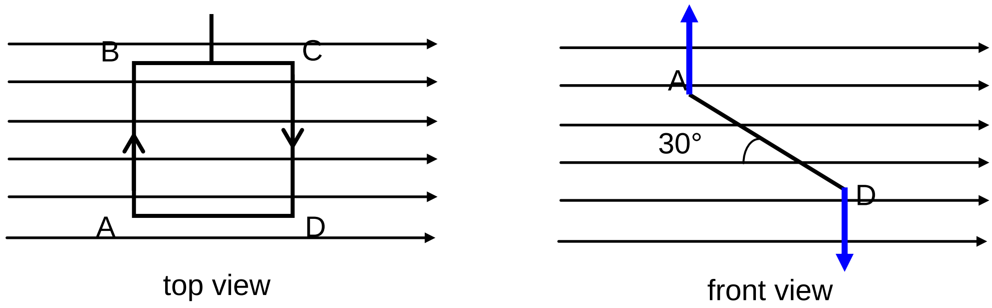


Fig. 6.1

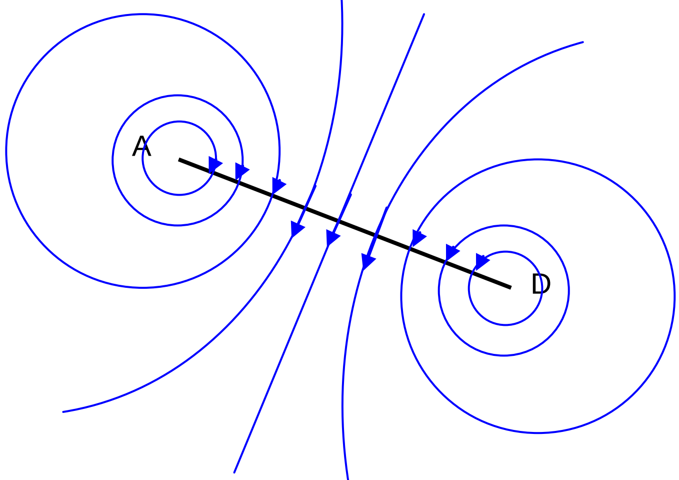
(ii) $F_B = (200)(0.18)(0.1)(5.0)$

$F_B = 18\ \text{N}$

(iii) $\tau = 18 \times 0.1\cos 30^\circ$ [B1]

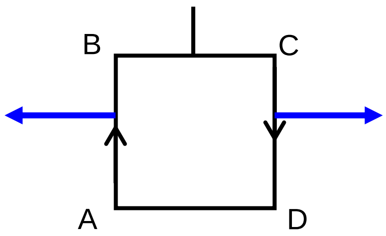
$\tau = 1.56\ \text{Nm}$ [A1]

(c) (i) correct directions (clockwise for A, anticlockwise for D) [B1]



closer field lines in the middle, field lines farther apart on the outside [B1]

(ii) [B1]



(iii) The current in AB sets up a magnetic field that interacts with the current in CD giving rise to the force acting on CD and vice versa. [B1]

The directions of the forces can be found using Fleming's Left Hand Rule. [B1]

(d) (i) downward force [B1]

(ii) F = BIL and I = Q/t

F = B(Q/t)(L) and v = L/t M1

F = BQv = Bev A1

(iii) B1

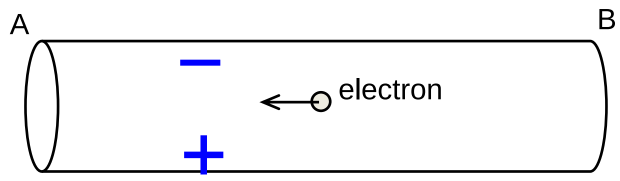


Fig. 6.4

(iv) The magnitude of the induced e.m.f. increases as more and more electrons move downwards.
The increasing induced e.m.f. sets up an electric field which exerts an increasing repulsive/upward force on electrons. B1
A steady state is reached when the upward electric force balances the downard magnetic force. B1

7 **(a)** packet/quantum of energy M1
(i) of electromagnetic radiation A1
(ii) minimum energy to cause emission of an electron (from surface) B1
(b) $hc/\lambda = \Phi + E_{MAX}$ M1
(i) c and h explained M1
(ii) when $1/\lambda = 0$, $\Phi = -E_{MAX}$ (<u>evidence</u> of use of x-axis intercept from graph) M1
1. $\Phi = 4.0 \times 10^{-19}$ J (allow $\pm 0.2 \times 10^{-19}$ J) C1
$f_0 = 6.0 \times 10^{14}$ Hz A1

OR when $E_{MAX} = 0$, $1/\lambda_0 = 1.95 \times 10^6$ m^{-1} (allow $\pm 0.5 \times 10^6$ m^{-1}) (<u>evidence</u> of use of y-intercept from graph) M1
$f_0 = c/\lambda_0$ C1
$= 6.0 \times 10^{14}$ Hz A1

OR chooses point on the line and substitutes values of $1/\lambda$ and E_{MAX} into $hc/\lambda = \Phi + E_{MAX}$ (deduct 1 mark for quoting Planck constant instead of finding it from graph) M1 A1

2. gradient of graph is 1/hc M1
gradient = $4.80 \times 10^{24} \rightarrow 5.06 \times 10^{24}$ (gradient triangle shown or gradient coordinates stated or dotted lines on graph to axes) M1
$h = 1/(\text{gradient} \times 3.0 \times 10^8)$ A1
$= 6.6 \times 10^{-34}$ J s $\rightarrow 6.9 \times 10^{-34}$ J s, condone 3 s.f.

or chooses point on the line and substitutes values of $1/\lambda$ and E_{MAX} into $hc/\lambda = \Phi + E_{MAX}$ M1
values of $1/\lambda$ and E_{MAX} are correct within half a square M1
$h = 6.6 \times 10^{-34}$ J s $\rightarrow 6.9 \times 10^{-34}$ J s, condone 3 s.f. A1

(iii) same gradient B1
bigger y-intercept B1

(c) (** $I = \dfrac{Nhf}{tA} \Rightarrow$ when I increases, it can mean $\dfrac{N}{t}$ increases or f increases.)
Number of electrons emitted (per second) increases because there are now more photons striking the metal surface (per second). B1 B1

E_{MAX} stays constant as photon-electron interaction is 1 to 1, and since *f* is fixed, energy of photon absorbed by electron is constant and for same surface with same work function, E_{MAX} of emitted photoelectron is the same. B1 B1

(d) $1/\lambda = 1/(370\text{nm}) = 2.7 \times 10^{6}\ \text{m}^{-1}$ M1

Read off from graph, Emax = 1.5×10^{-19} J M1

$E = p^2/2m \Rightarrow p = \sqrt{(2mE)}$ M1

de Broglie's wavelength = h/p M1

$= 1.27 \times 10^{-9}$ m A1