# Mark Scheme for H1 Physics Preliminary Exams 2014

**Paper 2**
**Section A**

**1** **(a)** acceleration is the rate of change of velocity (with respect to time) [1]

**(b)** **(i)**

$$a = \frac{F}{m}$$

$$= \frac{3.36 \times 10^{-17}}{9.11 \times 10^{-31}}$$ [1]

$$= 3.69 \times 10^{13} \text{ m s}^{-2}$$

[1]

Towards positive plate / upwards [1]

**(ii)** time between plates = 0.12 / (5.0 x $10^7$) = 2.4 ×$10^{-9}$s [1]

vertical displacement = ½ × 3.69 ×$10^{13}$ ×(2.4 ×$10^{-9}$)$^2$

= 1.05 ×$10^{-4}$ m [1]

Since 0.0105 cm < 0.75 cm, electron will pass between plates (valid conclusion based on numerical value) [1]

**2** **(a)** λ = a x / D

590 x $10^{-9}$ = (1.4 x $10^{-3}$) x / 2.6 [1]

x = 1.1 mm [1]

**(b)** **(i)** 180° [1]

**(ii)** max resultant amplitude = 3.4, Min resultant amplitude = 0.6 [1]

From $I = k A^2$ [1]

Ratio = $3.4^2$ / $0.6^2$ = 32 [1]

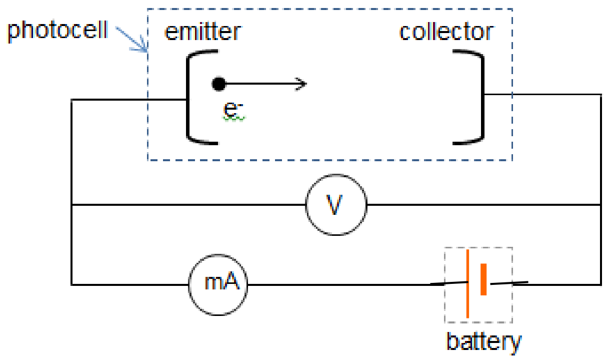
**(a)** Waves must be coherent, have same type, approximately same amplitude and be unpolarized or polarized in the same plane. [3]

**(d)** [1] each below:

- The peaks represent areas of constructive interference whereby the light from the double slits arrive in phase / path difference is an integer multiple of wavelength of the waves.
- The points of minimum intensity represent areas of destructive interference; the light from the 2 sources arrive in anti-phase/ path difference is an odd multiple of half wavelength.
- The intensities varies in between whereby the light from double slits arrive out of phase but not in anti-phase and there is partial destructive interference.

- Intensities of peaks decrease as they get further away from the central maximum (P) due to the fact that intensity of each individual wave arriving decreases with distance from the source.
- Fringes are equally spaced according to x = λ D / a.

**3** **(a)** **(i)**

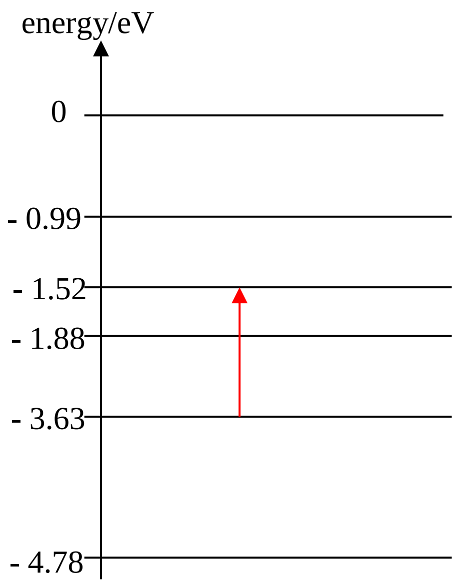



[1]

**(ii)** $KE_{max} = eV_s = (1.6 \times 10^{-19})(1.6)$ [1]
$= \mathbf{2.56 \times 10^{-19}\ J}$ [1]

**(iii)** From $hf = \phi + KE_{max}$
$hf = 2.0 \times 10^{-19} + 2.56 \times 10^{-19}$ [1]
$\Rightarrow f = 6.87 \times 10^{14}$ Hz
$\Rightarrow \lambda =$ **436 nm** [1]

**(b)**




[1]

**(i)** 10 possible emission lines. [1]

**(ii)** Energy of the "missing" photon, $E = hc/\lambda$
$= (6.63 \times 10^{-34} \times 3 \times 10^{8} / 5.88 \times 10^{-7})$

$= 3.38 \times 10^{-19}$ J = 2.11 eV [1]
= –1.52 – (–3.63) eV [1]

The transition is from $E_2$ = – 3.63 eV to $E_4$ = – 1.52 eV.

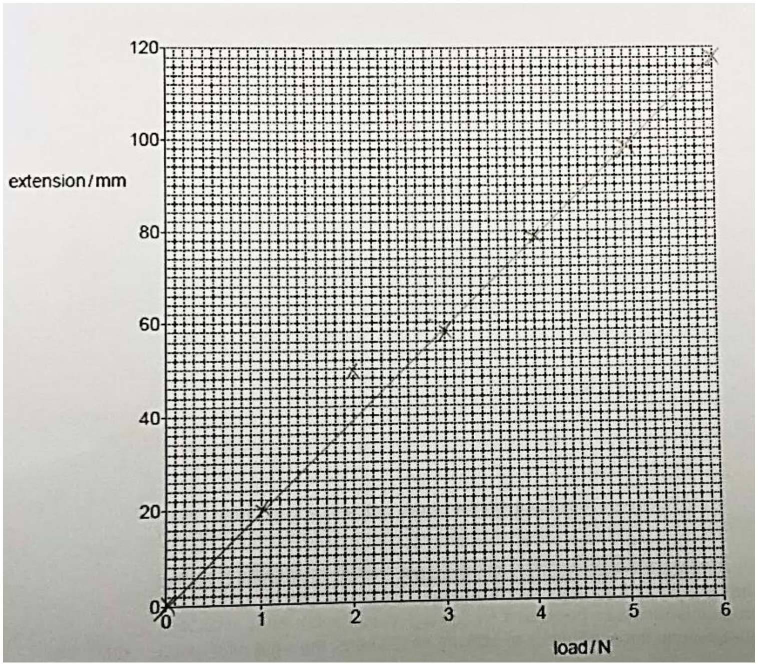
**4**

**(a)** ruler placed vertical next to spring [1]

**Either**
Measure length before and after [1]
then subtract readings [1]
**OR**
Put zero of ruler at bottom of spring [1]
note reading of bottom after load applied [1]

**(b)** **(i)** 49 and 318 (both) [1]

**(ii)** 6 points correctly plotted ± half a small square [2]




**(iii)** 249 mm / 49 mm extension [1]

**(iv)** good straight line through points and (0,0) [1]

**(v)** doubles [1]
directly proportional [1]

**Section B**

**5** **(a)** **(i)** lamp C [1]
lamp is shorted [1]

**(ii)** (shorted lamp A) would cause damage to the supply/lamps /blow fuse in supply. [1]

**(iii)** 15 Ω [1]

**(iv)** **1.** $V = I R$
$R$ = 30 Ω [1]

**2.** $P = VI$ or $I^2 R$ or $V^2 / R$
$P$ = 1.2 W [1]

**(v)** filament is cold when measuring with ohm-meter in (iii) [1]
resistance of filament rises as temperature rises [1]

**(b)** **(i)** The resistance R of a component is the ratio of the potential difference across its ends to the current flowing through it. [1]

It is a property of the sample where it depends on both the material as well as the dimensions of the component. [1]

The resistivity ρ of a component is the constant of proportionality that relates the resistance of a component to its length-to-cross sectional area ratio as given by the equation R = ρl / A, where l is the length and A is the cross-sectional area. [1]
It is a property only of its material but not dimensions. [1]

**(ii)** **1.** Resistance of R = 1.5 / 0.3 = 5.0 Ω [1]
Resistance of X = 1.0 / 0.3 = 3.3 Ω [1]

**2.** e.m.f. of cell = p.d. across R and X (*when they were in series, part 1*)
= 1.0 + 1.5 (from graph)
= 2.5 V [1]

From Fig. 5.3, when p.d. across each resistor is now 2.5 V, current through R and X is 0.5 A each.
Current through cell = 2 x current through each branch/ resistance
= 2.x 0.5 A (from graph, when V = 2.5)
= 1.0 A [2]

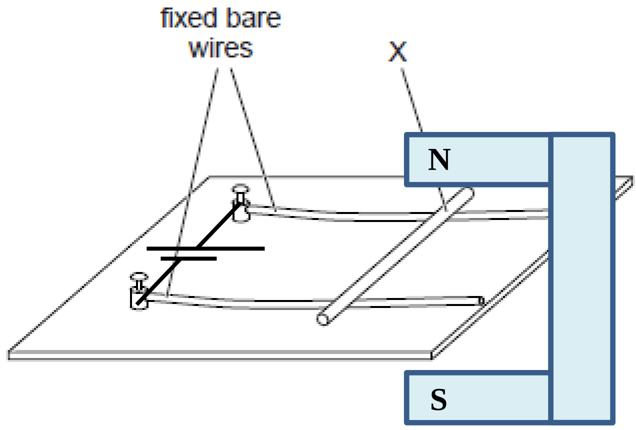
**(iii)** From $E = I r + I R_{R\ and\ X}$ ,
5.5 = (2 x 0.5)(r) + (2 x 0.5)(5.0) [2]

Hence $r$ = 0.5 Ω [1]

**6** **(a)** The magnetic flux density (*B*) is defined as the force acting per unit current in a wire of unit length placed at right-angles to the field. [2]

Tesla. [1]

**(b)** **(i)**




**OR**
Flip the battery polarities AND magnetic poles of above diagram.

Correct positions of battery [1] and magnetic poles [1] that produce a magnetic force to the right on wire X.
Magnetic fields clearly vertical and interact with conductor X [1]

**(i)** **1.** $F = BIL \sin 90^o = (25 \times 10^{-3})(1.2 \times 10^{-3})(0.15)$ [1]
$= 4.5 \times 10^{-6}$ N [1]

Assumption: (Any one, [1] )
- Field lines are perpendicular to current/ wire
- Wire placed perpendicularly to magnetic field.

**1.** $F_{net} = ma$
Magnetic force – friction = ma
$(4.5 - 0.2) \times 10^{-6} = (4/ 1000)$ a [1]
a = $1.08 \times 10^{-3}$ m $s^{-2}$ [1]

**(c)** Chemical energy from battery → electrical energy carried by electrons [1]
→ kinetic energy to move the wire + thermal energy [1]

**(b)** **(i)** Using Fleming's Left hand rule on the top wire, and knowing that the force on the top wire must be to the left when viewed from the end P, [1]
the field must point upwards. [1]
Hence the top part of the magnet is a South pole and the bottom part is a North pole (to draw on Fig. 6.2). [1]

**(ii)** Taking moments about PQ,
Anticlockwise moments about PQ = clockwise moments about PQ [1]

$$BIL^2 = Mgx$$ [1]

$$x = BIL^2 / (Mg)$$ [1]

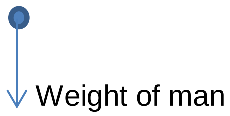
**(iii)** Length of coil doubles hence resistance doubles and the current is halved since the e.m.f. remains constant. [1]

Let the new balance length be *x'*.

$$x' = B(I / 2)(2L)^2 /(Mg) = 2x$$

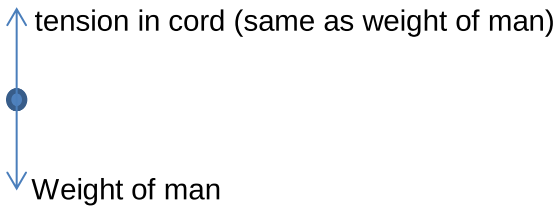
→ Therefore the balance length is doubled**.** [1]

**7** **(a)** **(i)** **1.**



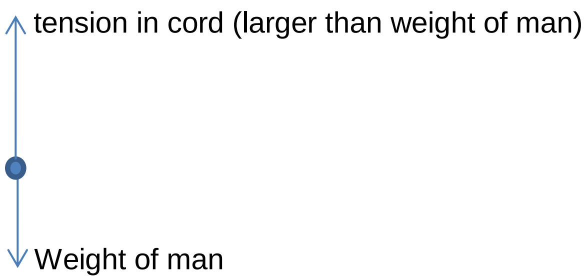

[1]

**2.**



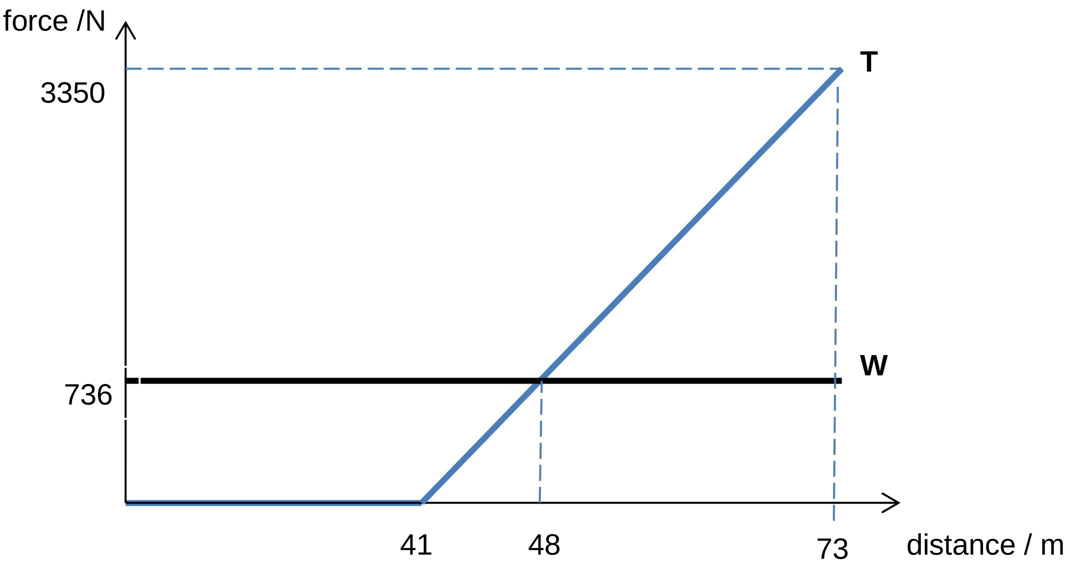

[1]

**3.**



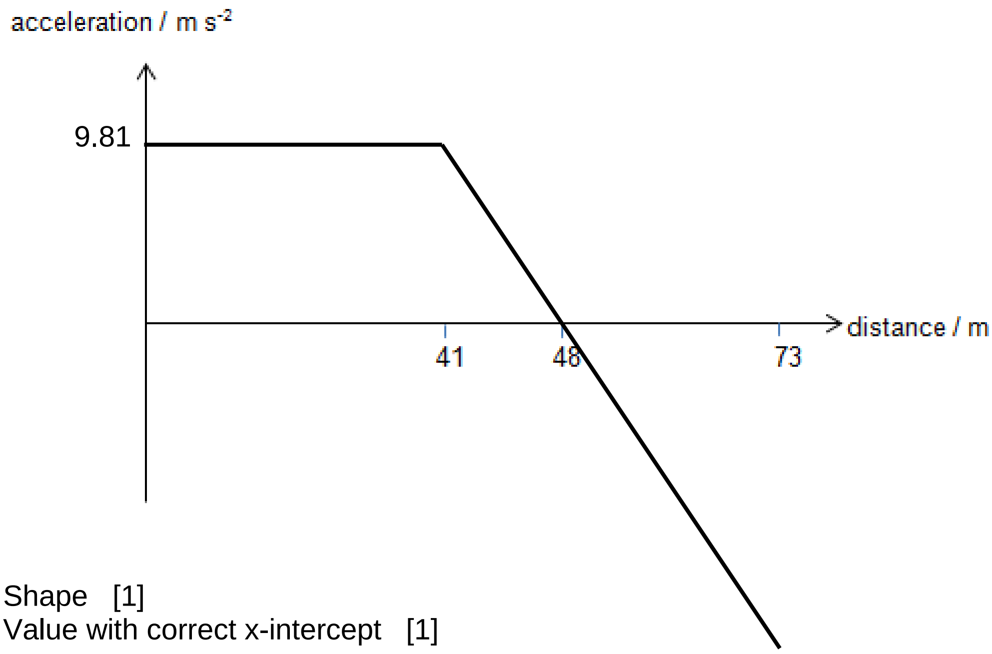

[1]

**(ii)**




[1] for W,
[2] for T (note intercept of graphs at 48 m)

**(iii)**




Shape [1]
Value with correct x-intercept [1]

**(b)** **(i)** According to the principle of conservation of linear momentum, the total momentum of the system (comprising the toy car and its fuel) should remain unchanged at any instant if no external net force acts, as in this situation. [1]

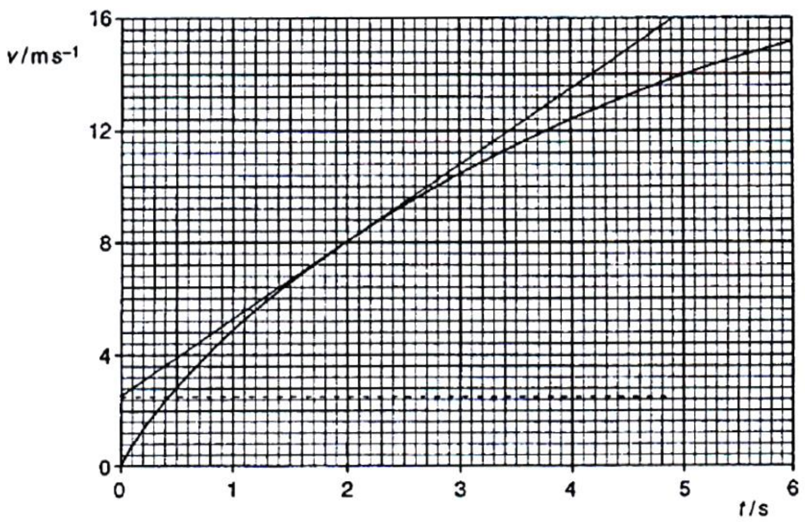
Since momentum is a vector quantity, the change in the exhaust gases' backward momentum at any instant must be matched by an equal but opposite change in the toy car's forward momentum, in order that total momentum remains unchanged. [1]

The rate of change of the toy car's forward momentum, according to Newton's second law of motion, is the resultant force it experiences. [1]

**(ii)** **1.** Gradient of the velocity-time graph at t = 2.0 s (acceleration):

$a = (v-u) / t = (16 – 2.5)/ 4.9$ (to show tangent) [1]

$= 2.75 = 2.8$ m $s^{-2}$ [1]




**2**. Using Newton's second law,

Resultant Force, $F_R = ma = 0.440 \times 2.75 = 1.21$ N [1]

$F_R$ = Forward Force – Resistive Force

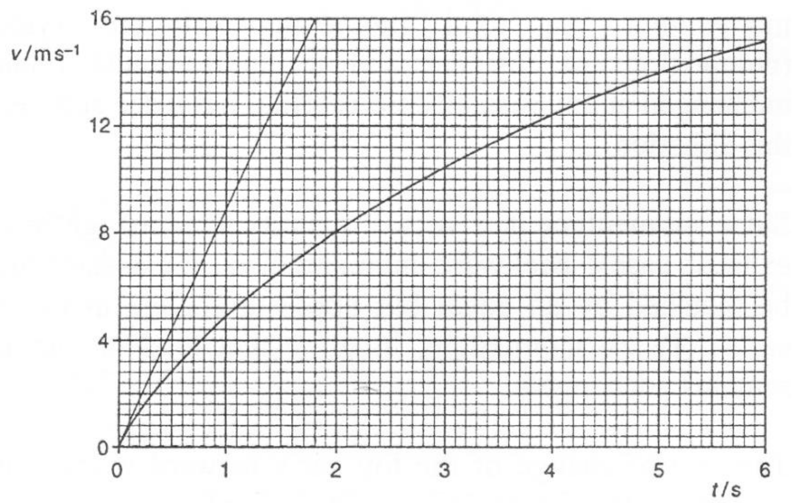
Resistive Force = Forward Force – $F_R$ = 4.6 – 1.21 = 3.39 = 3.4 N [1]

**(iii)** The gradient of the velocity-time graph, which is the acceleration, from the given graph is decreasing with time and speed. [1]

Using Newton's second law, the resultant force is given by $F_R$ = ma. Since the mass of the toy car (m) and the acceleration (a) are both decreasing with time and speed, the resultant force must be decreasing with time and speed. [1]

However, the forward force is constant at 4.6 N.
Hence, the resistive force must be increasing with speed so that the resultant force is decreasing.

**(iv)** Gradient of the velocity-time graph at t = 0 is (16 – 0)/1.8 = 8.89 m $s^{-2}$. [1]
(must show tangent drawn at origin)




At time t=0, the resistive force is zero (since air resistance is 0 when speed is 0 and friction does not apply to vertical motion). Therefore, upward force = resultant force = $8.89m_{t=0}$, where $m_{t=0}$ is mass of the toy car + fuel at t =0. [1]

However, the weight of the rocket is $m_{t=0}g = 9.81m_{t=0}$.

Since the initial upward force is less than the weight of the (vertical) toy car at t=0, the rocket engine will not be able to produce a force sufficient to propel the car at t=0. [1]

**End of solutions**