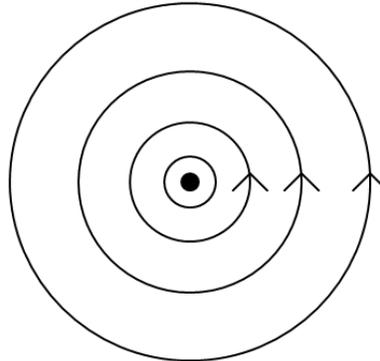


Solution to 2016 H1P2

- 1 (a) Rate of change of velocity A1
- (b)(i) $x = 72 t$ A1
- (b)(ii) $y = \frac{1}{2} (9.81) t^2 = 4.91 t^2$ A1
- (c) $100 = 4.91 t^2$ M1
 $t = 4.5 \text{ s}$ A1
- (d) $v = [(72 \times 4.5) - 125] / [4.5]$ M1
 $v = 44.2 \text{ m s}^{-1} \quad (160 \text{ km h}^{-1})$ A1
- 2 (a) Product of force and perpendicular distance of the line of force from fixed point/axis B1
- (b)(i) Label normal contact force N_1 at wall; normal contact force N_2 at the ground and friction at the ground correctly B1
 Label weight of man and weight of ladder correctly B1
- (b)(ii) As system is in equilibrium,
 $N_2 = (72 + 40) \times 9.81$ M1
 $= 1100 \text{ N}$ A1
- (b)(iii) $\cos\theta = 6.0/12.0 \rightarrow \theta = 60^\circ$ (or other methods)
 Let L be the length of ladder,
 Taking moments about D,
 $N_1 \sin 60 \times L = (72 \times 9.81 \times \cos 60) (3L/4) + (40 \times 9.81 \cos 60) (L/2)$ M1
 $N_1 = 419 \text{ N}$ A1
- 3 (a) Electrical resistance of a conductor is defined as the ratio of the potential difference across it to the current flowing through it. B1
- (b)(i) When S1 is the only switch closed, lamps A and C are in series giving a resistance of 30.0Ω . Thus, resistance of a lamp is 15Ω . B1
 Or when all three switches are closed, lamps A and C are in parallel with lamps B and D giving a resistance of 15Ω . Thus, resistance of a lamp is 15Ω .
- (ii) faulty lamp: lamp E B1
 nature of fault: lamp is short-circuited B1
- (iii) Short-circuited lamp could cause **excessive current** to flow in the circuit that could cause **damage to the power supply / other lamps / blow fuse in power supply**. B1
- (c)(vi) Using $V = IR$
 $R = V / I$
 $= 12.0 / 0.40$
 $= 30.0 \Omega$ B1
- (c)(v) The lamp filament in (v)1 has a **higher resistance** than (iii) because it is **hotter** when operating at normal brightness. B1

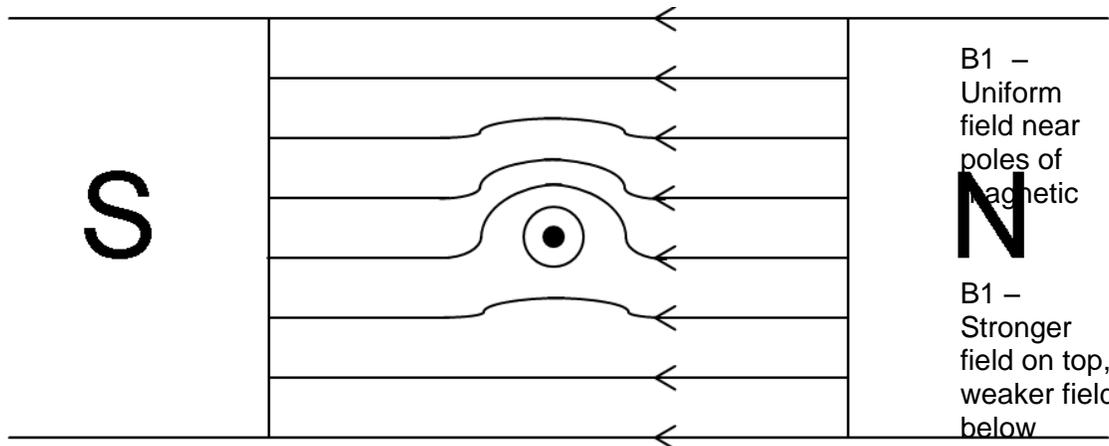
4(a) Magnetic flux density is defined as the force per unit length acting on a straight conductor with unit current placed perpendicular to the magnetic field. B2

4(b)(i)



B1 – Correct direction
B1 – Three concentric circles with increasing spacing

4(b)(ii)



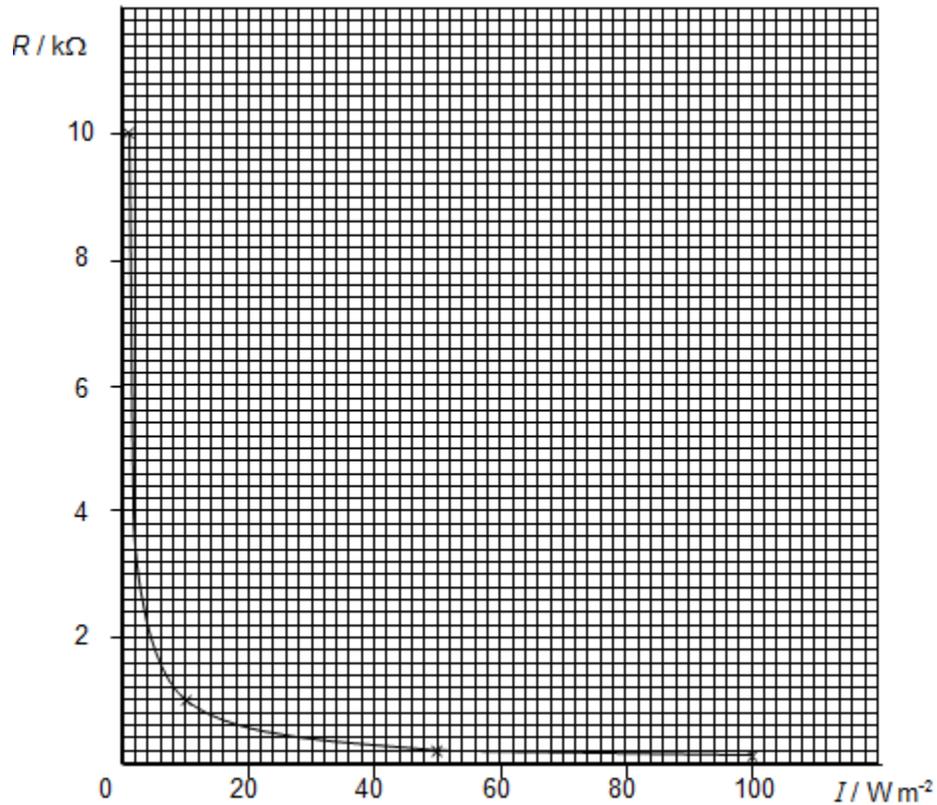
B1 – Uniform field near poles of magnetic
B1 – Stronger field on top, weaker field below

4(b)(iii) Towards the bottom of the page. B1

4(b)(iv) Magnetic force = $(0.50)(1.5)(0.10) = 0.075 \text{ N}$ B1

- 5 (a)(i) resistance of LDR = 0.20 k Ω B1
 (ii) (A logarithmic scale compresses the scale so that the widely differing values can be shown easily on one graph. B1
 (iii) On the logarithmic scale in Fig. 7.1, the graph is similar to lg R against lg I. B2
 It is a straight line with gradient = -1 and y-intercept = lg 10000, the relation is true.

- (b) B2



- (c)(i) $I \geq 50.0 \text{ W m}^{-2} \Rightarrow R_{LDR} \leq 0.2 \text{ k}\Omega$ B1
 When $R_{LDR} = 0.2 \text{ k}\Omega$
 $V_R = \frac{R}{R + R_{LDR}} \times 12 = 9$ M1
 $R = 0.60 \text{ k}\Omega$ A1
- (ii) It can be used as a burglar alarm. B1
- (iii) Below 1 W m^{-2} , the LDR's resistance changes too rapidly with intensity such that any small fluctuation in intensity will cause a trigger. B2

- 6 (a) (i) Axes drawn with correct labelling [including u and v] straight line B1
B1
- (ii) 1. acceleration A1
2. displacement A1
- (iii) area = displacement $s = \frac{1}{2} (u+v) t$ --eqn(1) M1
gradient $a = v-u/t$, so $v = u+at$ substitute into eqn (1) to get M1
 $s = ut + \frac{1}{2} at^2$
- (b) (i) $a = 1.6/2.0 = 0.80 \text{ ms}^{-2}$ A1
- (ii) 1. $s = \frac{1}{2} at^2$
 $= \frac{1}{2} \times .80 \times 2.0^2 = 1.6 \text{ m}$ M1
A1
2. By Newton's 2nd law, $T - mg = ma$
 $T = mg + ma$ M2
 $= 35 \times 9.81 + 35 \times 0.80$ A1
 $= 371 \text{ or } 370 \text{ N}$
- (iii) 1. $t = (32 - 1.6)/1.6 = 19 \text{ s}$
total time = $19 + 2 = 21 \text{ s}$ M1
A1
2. Tension is Less
At constant speed $T = mg$ only [or equiv.] A1
C1
- (iv) 1. Using force resolution:
 $T \sin 30^\circ = \text{total mass} \times g = 539 \text{ N}$
Correctly resolving vertically at A M1
 $T_{AB} = 1078 \text{ N}$ A1
2. AC undergoes Compression
Force by support at point A should be horizontally outwards M1
in order to balance $T \cos 30^\circ$. A1

- 7 (a) When two or more waves of the same kind exist simultaneously at a point in space, the resultant displacement of the waves at any point is the vector sum of the displacement due to each wave acting independently. B2
- (b) sketch has amplitude = 3.0 ± 0.1 cm M1
Correct displacement values at previous peaks to produce correct shape A1
- (c) (i) Sources whose phase difference is constant. B1
(ii) The waves from the transmitters superpose/interfere B1
The path difference between the 2 waves varies as the satellite moves. Hence, the amplitude of the superposed signal varies. B1
(OR path difference change from being an integral multiple of the wavelength for maxima to being half integral multiple of the wavelength for minima as satellite moves.)
- (iii) 1. 3 fringe separations in 7.7 km C1
 $\Rightarrow \Delta x = \frac{7.7}{3} = 2.57 \text{ km}$ A1
2. $\Delta x = \lambda \frac{D}{a}$ M1
 $\Rightarrow D = \frac{2.57 \times 160}{1.2}$ C1
 $= 342 \text{ km}$ A1
- (d) (i) 1. Reflected waves and incident waves superposed to form a standing wave. B1
When detector **D** passes through nodes, it will detect minimum intensity (minima) but when it passes through antinodes, it will detect maximum intensity (maxima). B1
2. Measure distance between 2 nodes (minima) or 2 antinodes (maxima) B1
Distance between 2 nodes (antinodes) = $\frac{\lambda}{2}$ B1
3. $f = \frac{v}{\lambda}$ B1
where v = speed of microwaves = $3.00 \times 10^8 \text{ m s}^{-1}$ B1
- (ii) Place a polarizer between **T** and **D**, and rotate B1
Signal will drop to zero if microwaves are plane-polarized B1

8 (a) (i) *Photoelectric effect is the emission of electrons from the surface of a cold metal when electromagnetic radiation of sufficiently high frequency is incident on the metal.* B1
B1

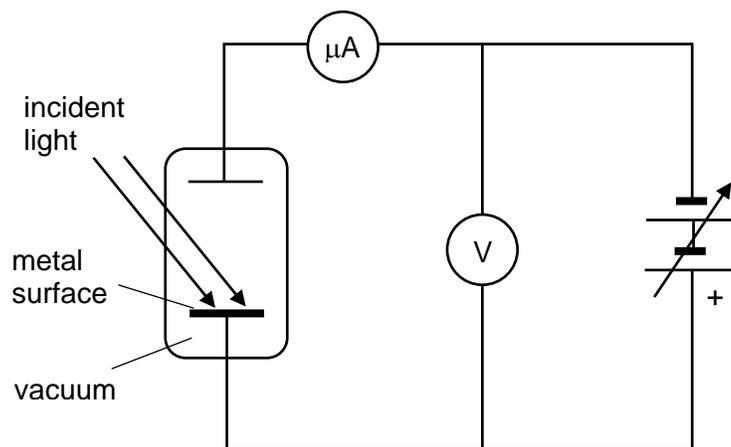
(ii) 1. EM radiation is made up of photons, and the energy of each photon is dependent only on the frequency of the EM radiation. B1

An electron receives energy to escape by absorbing a photon. Since the electron needs a minimum amount of energy to escape from the metal, hence the photon it absorbs must have a minimum frequency. B1

2. The energy of a photon is transferred to the electron in a single collision event. The electron uses part of photon's energy to escape from the metal surface and the excess will be the kinetic energy. B1

Since the energy of the photon is dependent on its frequency and the minimum energy to escape metal is fixed for the metal, the max kinetic energy of ejected electron is only dependent on the photon's frequency. Intensity affects the number of photons arriving per unit time and does not affect the energy of each photon. B1

(b) (i)



Correct connection of voltmeter [B1], Correct connection of microammeter [B1]

Correct connection of variable e.m.f. source. [B1]

(ii) 1. gradient of line = $\frac{h}{e} = \frac{(0.44 - 0.00)}{(5.5 - 4.5) \times 10^{14}} = 4.4 \times 10^{-15}$ M1

$$h = 7.04 \times 10^{-34} \text{ J s}^{-1}$$

A1

$$2. \quad h f_{min} = \phi$$

$$(7.04 \times 10^{-34})(4.5 \times 10^{14}) = \phi$$

$$\phi = 3.168 \times 10^{-19} \text{ J}$$

M1

A1

(c) (i) The atoms absorb energy that corresponds to the energy difference between ground state and the higher excited states. B1

Once at the excited state, the atom will de-excite to a lower energy state emitting a photon of energy that corresponds to the energy difference between the higher and lower energy states. B1

(ii) Levels 2 and 3. B1

(iii) Difference between Level 3 and 1 = 6.7 eV B1
 KE retained = 7.0 - 6.7 = 0.3 eV. B1

(iv) No transitions will be made. B1

The incoming photon must be absorbed entirely or not at all. However, no energy transition is exactly 7 eV. B1