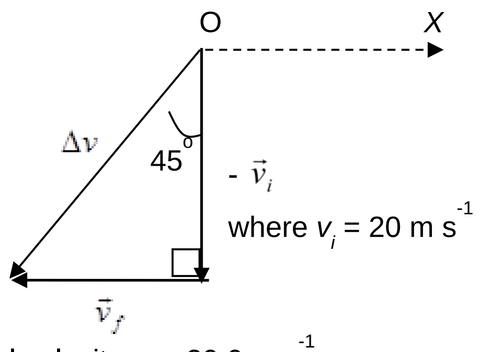
**Answers to 2015 Prelim Paper 1 (H1 Physics)**

| | | | | | |
|---|---|---|---|---|---|
| **1** | **D** | **11** | **C** | **21** | **C** |
| **2** | **C** | **12** | **C** | **22** | **D** |
| **3** | **B** | **13** | **D** | **23** | **C** |
| **4** | **C** | **14** | **B** | **24** | **A** |
| **5** | **C** | **15** | **A** | **25** | **C** |
| **6** | **A** | **16** | **A** | **26** | **A** |
| **7** | **D** | **17** | **B** | **27** | **C** |
| **8** | **A** | **18** | **B** | **28** | **A** |
| **9** | **B** | **19** | **B** | **29** | **D** |
| **10** | **B** | **20** | **A** | **30** | **D** |

**MCQ 1: ( D )**
W (actual reading) – zero error = kx
W = kx + zero error
Hence the y intercept of the graph will occur <u>above the origin</u>.

**MCQ 2: ( C )**




Final velocity $v_f$ = 20.0 m s$^{-1}$

$\Delta\vec{v} = \vec{v}_f + (-\vec{v}_i) =$
$\sqrt{(20)^2 + (20)^2} = 28.3$ m s$^{-1}$
at an angle of 225$^{o}$ anti-clockwise from O*X*.

**MCQ 3: ( B )**
Vettel's speed when Hamilton passes him, v = (11)(3.5) = 38.5 ms-1

When they are next to each other,

$$38.5t + (11/2)t^2 = \left(\frac{250 \times 1000}{60 \times 60}\right)t$$

T = 5.62 s
Total time taken = 3.5 +5.62 = 9.12 s

**MCQ 4: ( C )**

One can plot the corresponding velocity-time graph and calculate its area to obtain the displacement of the object.

Within the first 3 s,
the object gains a speed of

$v = u + at$

$v = 0 + 1 \times 2$

$v = 2\,\text{m s}^{-1}$

For the next 3 s,
the object maintains the same speed.

Finally, between 6 s and 7 s,
it experiences deceleration.

$v = u + at$

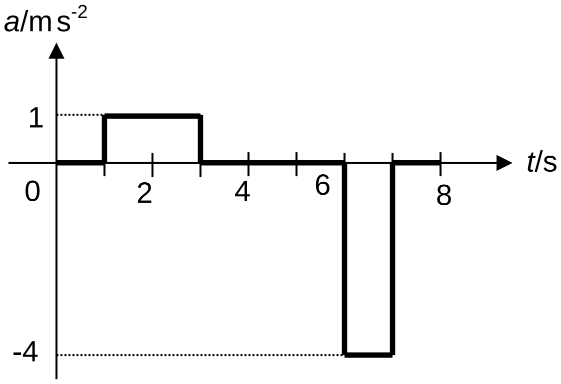
$v = 2 + (-4 \times 1)$

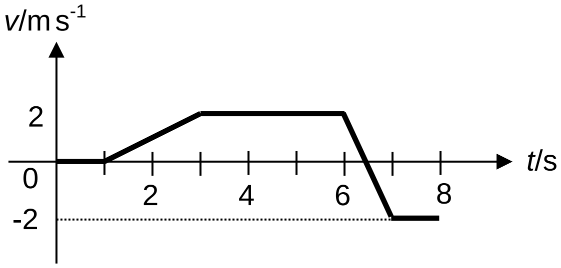
$v = -2\,\text{m s}^{-1}$

Total area under graph

$= \frac{1}{2} \times 2 \times 2 + (3 \times 2) + (-2 \times 1)$

= 6 m




**MCQ 5: ( C )**

During the collision, some of the kinetic energy is converted to elastic potential energy. Total kinetic energy is only conserved before and after the collision, but not during the collision.

**MCQ 6: ( A )**

Due to field X, the magnetic force points out of paper. Due to field Y, the electrostatic force points into paper. Hence both forces can cancel out.

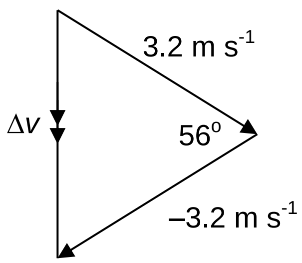
Options B and D are incorrect, as the forces due to both fields will point in perpendicular directions, hence they cannot cancel out.
Option C is incorrect as both electrostatic and magnetic forces point upwards.

**MCQ 7: ( D )**

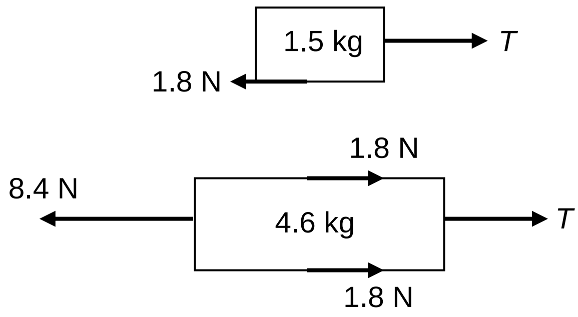
$\Delta p = m\Delta v$

$= (1.2)\left(\sqrt{3.2^2 + 3.2^2 - 2(3.2)(3.2)\cos 56^\circ}\right)$

$= 3.6\text{ N s}$



**MCQ 8: ( A )**
Since the string is light and inextensible, both blocks have the same magnitude of acceleration. Considering horizontal forces acting on the blocks,




Top block:
$T - 1.8 = (1.5)a$

Bottom block:
$8.4 - 1.8 - 1.8 - T = (4.6)a$

Solving,
$a = 0.49$ m s$^{-2}$
$T = 2.5$ N

**MCQ 9: ( B )**
$P = \rho hg = (650)(0.12 + 0.15)(9.81) = 1.7 \times 10^3$ Pa

**MCQ 10: ( B )**
The force acting on each wheel is a resultant of the normal contact force and the frictional force. On rear wheel, the frictional force points forward. On front wheel, the frictional force points backward.

**MCQ 11: ( C )**
$$P = \frac{\Delta E}{t} = \frac{0.5 \times 0.020 \times (0.36^2 - 0.2^2)}{60/80} = 1.2 \text{ mW}$$

**MCQ 12: ( C )**
$F - mg = ma$
$F = 0.25(9.81 + 1.0) = 2.7025$
$P_{out} = Fv = 2.7025 \times 1 = 2.7025$
$P_{in} = IV = 4.75$
$$Eff = \frac{P_{out}}{P_{in}} = 56.9\%$$

**MCQ 13: ( D )**
Particles to the left of point **D** are displaced to the left while particles to the right are displaced to right, hence it is a point of rarefaction.

**MCQ 14: ( B )**
Since phase difference of $\frac{\pi}{3}$ = 40cm, the wavelength = 40 x 6 = 2.40 m
Thus, speed = $f\lambda$ = 200 x 2.40 = 480 m s$^{-1}$

**MCQ 15: ( A )**

$$x = \frac{\lambda D}{a}$$

$\uparrow \lambda \Rightarrow \uparrow x$

**MCQ 16: ( A )**

Principle of superposition apply to all cases when waves of the same type overlap and interact at a point in space and time.

**MCQ 17: ( B )**

Points between 2 nodes are in phase and $\pi$ out of phase with points between the next 2 nodes.

**MCQ 18: ( B )**

$R = \rho L/A = \rho(N2\pi D/2)/(\pi d^2/4) = 4\rho ND/d^2$

$= (4)(1.3 \times 10^{-8})(30)(1.5\times10^{-2})/(0.5\times10^{-3})^2$

$= 9.4 \times 10^{-2}\ \Omega$

**MCQ 19: ( B )**

E = I x (R+r)

E = 2 x ( 4 +r) --- Eqn (1)

E = 3 x ( 2+r) --- Eqn (2)

8 + 2r = 6 + 3r ➔ r = 2

E = 2 x (4 + 2) = 12 V

**MCQ 20: ( A )**

$V = \frac{W}{Q}$ and $Q = It$

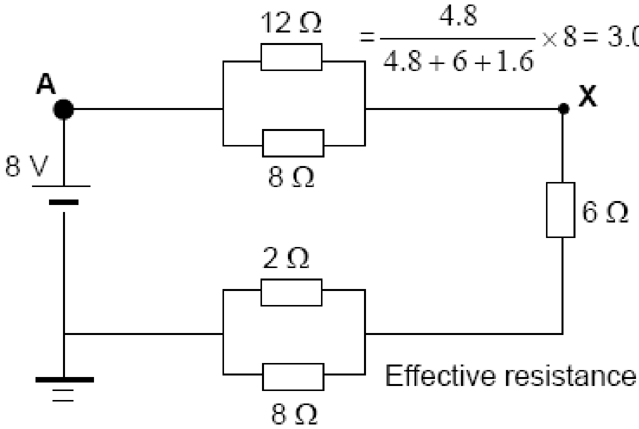
$$V = \frac{W}{It} \Rightarrow I = \frac{W}{Vt} \Rightarrow I = \frac{12}{20 \times 15} = 0.040 \text{ A}$$

**MCQ 21: ( C )**

Effective resistance = $\left(\frac{1}{12}+\frac{1}{8}\right)^{-1}$ = 4.8 Ω

Potential difference across this pair of resistors

$= \frac{4.8}{4.8+6+1.6} \times 8 = 3.097$ V




Effective resistance = $\left(\frac{1}{2}+\frac{1}{8}\right)^{-1}$ = 1.6 Ω

The potential at point A is 8 V (since the other end of the battery is earthed).
Therefore to create a potential difference of 3.09 V across the first pair of resistors, the potential at X must be 8.00 – 3.09 = 4.90 V

**MCQ 22: ( D )**
Redraw circuit with resistors across **FG** and **GH** in parallel with resistors across **HJ**, **JK**, **EF** and **EK** (Resistors across **HJ**, **JK**, **EF** and **EK** are in series).

Effective resistance = $[\frac{1}{2R}+\frac{1}{4R}]^{-1} = \frac{4R}{3}$

**MCQ 23: ( C )**
The force is constant at 0.0112 N as the current flowing in the conductor and the B field are always at right angles to one another.

**MCQ 24: ( A )**
Analyzing the horizontal component,
The time is dependent on the horizontal displacement and the horizontal speed

When B field is increased, since horizontal displacement and horizontal speed does not change, hence time should not change
When angle is increased, horizontal speed decreases, and since horizontal displacement remains unchanged, hence time increases.

**MCQ 25: ( C )**
At the 50 cm mark, B due to 3*I* is the same as B due to 2*I*.

**MCQ 26: ( A )**

The only B field that results in a force that P experiences is due to Q. It does not experience a force due to the B field of R as the B field of R is parallel to the direction of flow of current of P.

Hence as unlike wires repel, the force experienced by P is towards the left. (A)

**MCQ 27: ( C )**
By de Broglie's equation, $p=h/\lambda$

Since intensity has no bearing on the initial momentum of each photon, and the final momentum of each absorbed photon is still zero, the change in momentum remains the same.

**MCQ 28: ( A )**
Most energetic photon = $(6.63 \times 10^{-34})(9.0 \times 10^{14}) = 5.967 \times 10^{-19}$ J = 3.73 eV

$hf = \Phi + E_{Kmax}$

$E_{Kmax} = 3.73 - 2.7 = 1.0$ eV

**MCQ 29: ( D )**
Refer to notes.

**MCQ 30: ( D )**
When the atoms of the cool vapour absorbs a photon, it becomes excited and is unstable. It will de-excite and re-radiate a photon uniformly in any direction.

## Suggested Solutions to 2015 Prelim Paper 2 (H1 Physics)

### Section A

**1** **(a)** **(i)** Newton's first law of motion states that a body will continue in its state of rest or uniform motion in a straight line unless an external resultant force acts on it. [B2]

**(ii)** Inertia is the tendency of things to resist changes in motion. [B1]

**(iii)** Inertia is basically an alternative statement to Newton's first law of motion, however, Newton's first law of motion made reference to how motion of a body can be changed with a resultant force. [B1]

**(b)** **(i)** Taking moments about the fulcrum,

$1150(9.81)(6.2)+(970)(9.81)(d)=(4000)(9.81)(8.3)$ [M1]

$d=26.9$ m [A1]

**(ii)** When accelerated, tension in the cable holding the load will increase, as the tension now has to support the weight of the load and also accelerate it. [B1]
This increases the clockwise moment and hence there will be a net clockwise moment. [B1]

Anyone of the following [B1]:
- Move the counter-weight further away from the fulcrum
- Move the load closer to the fulcrum / reduce distance d
- Increase the mass of the counter-weight

**(iii)** It will be too difficult to keep adjusting the distances of the counter-weight / load to keep the jib in equilibrium / horizontal if the joint is allowed to rotate freely.

**2** **(a)** A magnetic flux density of 0.55 T means that a force of 0.55 N will act on a wire of length 1 m with current 1 A passing through it when wire is placed perpendicular to the magnetic field [B1]

**(b)** **(i)** Direction is downwards [B1]

**(ii)** When the switch is closed, current flows in the rod and as the rod is placed in a magnetic field, it experiences a magnetic force. [B1]

By Fleming's LHR, the direction of the magnetic force is downwards. [B1]

**(iii)** $R=\rho\frac{l}{A}=(2.3\times10^{-3})\left(\frac{0.15}{\pi\left(\frac{10\times10^{-3}}{2}\right)^2}\right)=4.39\ \Omega$ [M1]

$V=IR$

$24=I(4.39)$

$I=5.5$ A [A1]

**(iii)** $F_m = BIL = 0.55 \times 5.46 \times 0.15 = 0.450$ N [M1]

$a = \frac{F_m}{m} = \frac{0.450}{0.050} = 9.0$ m s$^{-2}$ [A1]

**3** **(a)** (−5.45 + 5.00) x 10$^{-19}$ = −0.45 x 10$^{-19}$ J

Hence the highest energy level which the atom can be excited to is **<u>$A_4$</u>** (i.e. −0.78 x 10$^{-19}$ J) [B1]

**(b)** Highest energy photon emitted from $A_4$ to $A_1$ transition

E = ((−0.78) –(−5.45)) x 10$^{-19}$

$$\frac{hc}{\lambda} = A_4 - A_1$$

$$\frac{(6.63 \times 10^{-34})(3.0 \times 10^{8})}{\lambda} = [(-0.78) - (-5.45)] \times 10^{-19} \quad \textit{[M1]}$$

$$\lambda = 4.26 \times 10^{-7} m \quad \textit{[M1]}$$

Region: **visible light** (accept blue or violet light) [A1]

**(c)** **(i)** The transition $A_2$ to $A_1$ will produce photons of energy 3.03 x 10$^{-19}$. This matches the energy difference between $B_1$ to $B_3$ and will result in excitation of atoms in gas B to $B_3$. The de-excitation of atoms from $B_3$ to the lower states results in the emission of photons detected at **P**.

Transitions: **$B_3$** to **$B_1$**, **$B_3$** to **$B_2$**, **$B_2$** to **$B_1$**

[B1 – only 2 transitions stated correctly] OR
[B2 – 3 transitions stated correctly]

**(ii)**

$$p = \frac{h}{\lambda}$$

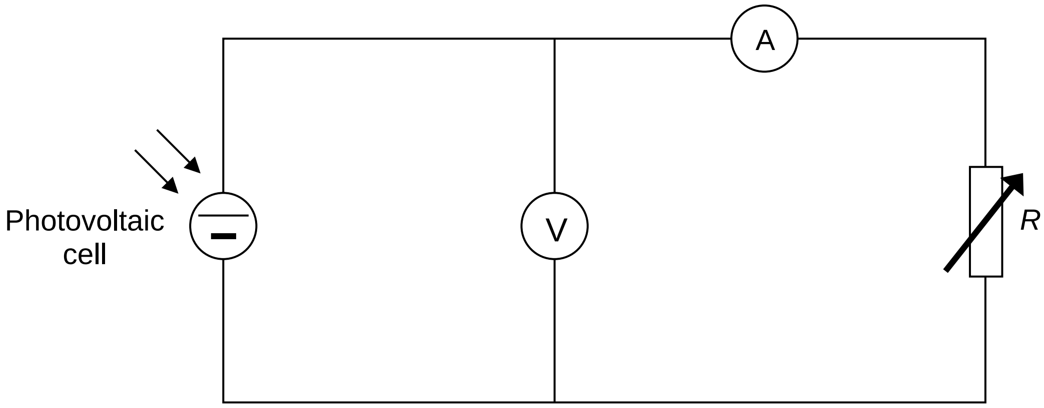
$$E_K = \frac{p^2}{2m} = \frac{\left(\frac{h}{\lambda}\right)^2}{2m}$$

$$\lambda = \frac{h}{\sqrt{(2E_K m)}}$$

$$= \frac{(6.63 \times 10^{-34})}{\sqrt{(2(4.7 \times 10^{-20})(9.11 \times 10^{-31}))}} \quad \textit{[M1]}$$

$$= 2.3 \times 10^{-9} \ m \quad \textit{[A1]}$$

**4** **(a)** (i)




[M1] for the circuit with correct arrangement and symbols for Voltmeter, Ammeter, and variable resistor.

Steps:
Start with maximum resistance, R of variable resistor. Read reading of potential difference, V, across the photovoltaic cell on the voltmeter and corresponding value of current, I. [A1].

Vary value of variable resistor [M1] and read V and I value for each new setting of R.

**(ii)**

| *V*/mV | *I*/mA | *P*/mW |
|---|---|---|
| 250 | 133 | 33.3 |
| 350 | 130 | 45.5 |
| 450 | 120 | 54.0 |
| 470 | 114 | 53.6 |
| 480 | 110 | 52.8 |
| 510 | 70 | 35.7 |

1 mark for each column [Max B2]

**(b)** **(i)** [B1]- for plotting all the 6 points correctly.
[B1] for the correct shape/curve of graph with turning point and max P

**(ii)** From the graph;
Maximum power range = 54.0- 54.8 mW [B1]

**(iii)** $P_{input} = 1100 \times 4.0 \times 10^{-4}$ [M1]

$$E_{max} = \frac{P_{max}}{P_{input}} \times 100\%$$

$$= \frac{P_{max}}{P_{input}} \times 100\%$$

$$= \frac{54.25 \times 10^{-3}}{1100 \times 4.0 \times 10^{-4}} \times 100\%$$ [M1]

= 12. 3 % [A1]

**(c)** Marking point:
Correct number of cells. 3 cells drawn/described/shown in calculation. [B1]
Explanation: Each cell at $500 \times 10^{-3} V$ at max power, 1.0 V can be obtained with 2 cells in series. Two of the cells (out of 3 cells needed to obtain the required power) have to be in parallel, in series with third one. [B1]
Correct arrangement of cells shown on drawing (2 parallel in series with 1 cell). [B1]

OR: If correct diagram drawn with 3 cells in correct arrangement [B3]

<u>WORKING (OPTIONAL TO SHOW)</u>
Considering power only
For each cell,
$P_{max} = 250 \times 10^{-3} W$

However required $P_{total} = 0.750W$

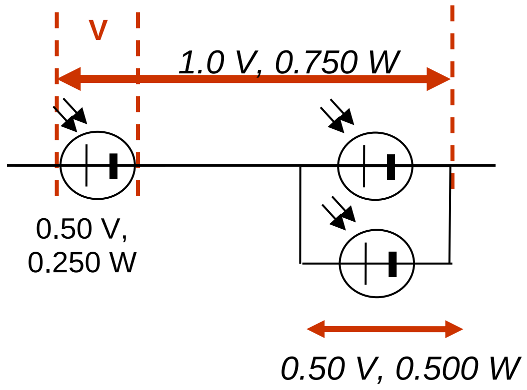
Number of cells = $\frac{0.75}{250 \times 10^{-3}}$ = 3

Considering V only
*Required Voltage = 1.0 V*

$$\frac{1.0}{500 \times 10^{-3}} = 2$$

Arrangement:

For drawing of arrangement.



**Section B**

**5** **(a)** **(i)** It is not correct to say that speed is the distance travelled per second as as we cannot use a unit (seconds) to define a quantity (speed). [A1] [M1]

She should have defined it as the distance travelled per unit time.

**(ii)** It is possible. [A1]
If Bob returned to his starting position at the end of the journey, then it is possible for his average velocity for the journey to be zero while average speed is non-zero. [M1]

**(b)** **(i)**
$v = u + at$

$22.9 = (a)(5.0)$ [M1]

$a = 4.6 \text{ m s}^{-2}$ [A1]

**(ii)** Driving force $= ma + F_{resistive}$

$= (230)(4.6) + 120$ [M1]

$= 1178 \approx 1200 \text{ N}$ [A1]

**(iii)** Addtional force to overcome

$= W \sin 60° = 1954 \text{ N}$ [C1]

Additonal power

$= Fv$

$= (1954)(22.9)$ [M1]

$= 44.7 \text{ kW}$ [A1]

**(iv)** Minimum speed to just clear the spike means that the daredevil reaches the peak of the projectile motion just above the spike. [M1]

$v_y^2 = u_y^2 + 2as$

$u_y^2 = 2(9.81)(20)$

$u_y = 19.8 \text{ m s}^{-1}$

$u = \dfrac{19.8}{\sin 60°}$

$= 22.9 \text{ m s}^{-1}$ [M1] [A0]

**(v)** $s = ut + \frac{1}{2}at^2$

$-5.0 = (19.8)t + \frac{1}{2}(-9.81)t^2$

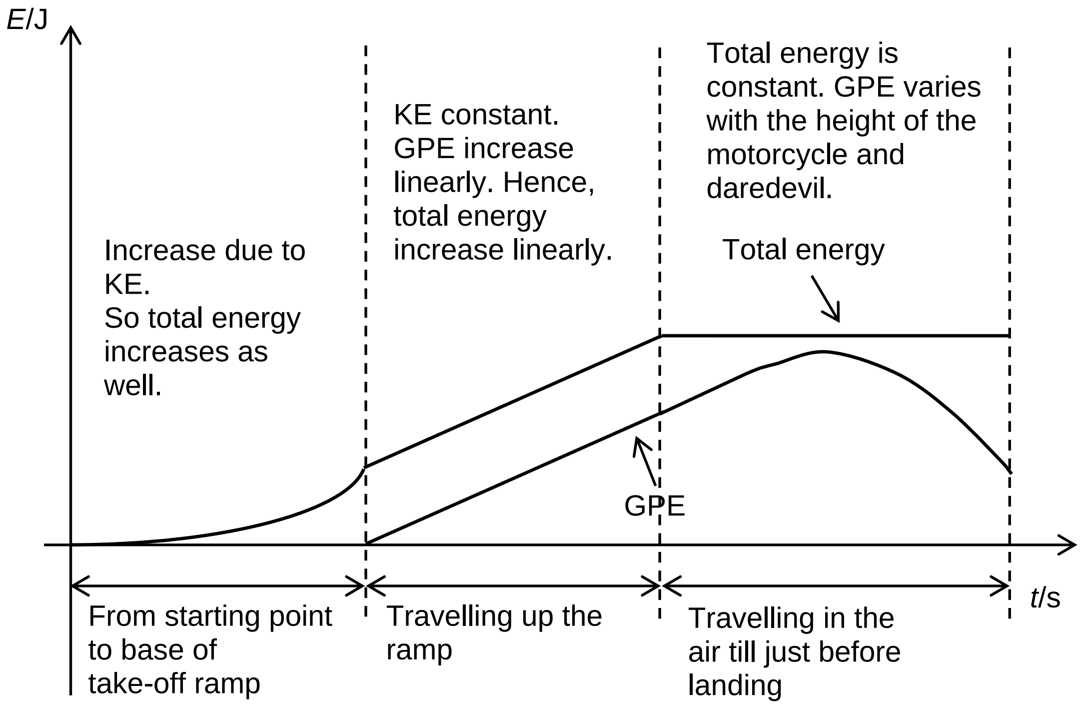
solving

$t = 4.28$ s [M1]

Distance $= u_x t$

$= (22.9\cos 60°)(4.28)$ [M1]

$= 49$ m [A1]




2 marks for each graph.
1 mark subtracted for each mistake in each up to a max. of 2 marks per graph.

**6** **(a)** Newton's second Law of Motion states the rate of change of momentum of a body is directly proportional to the resultant force acting on it and the change takes place in the direction of the force. [B2]

**(b)**

| **Scenario** | **State more / less / same.** |
|---|---|
| Elevator moving with constant speed | **Same** |
| Elevator moving up and speeding up | **More** |
| Elevator moving up and slowing down | **Less** |
| Elevator moving down and speeding up | **Less** |
| Elevator moving down and slowing down | **More** |

[2]

[B2] for all correct.
[B1] for any 3 or more correct

**(c)** **(i)** No. [A1]
When the parachute just opened, the drag force upwards due to air on the parachute is much larger than the weight of the parachutist. Hence the parachutist experiences a net force upwards. [M1]
She is accelerating upwards and hence cannot be experiencing weightlessness since she is not free-falling at acceleration due to gravity.

**(ii)** No. [A1]
The drag force upwards due to air on the boy is equal and opposite to the weight of the boy. Hence the net force on him is zero. [M1]
He is not experiencing weightlessness since he is not free-falling at acceleration due to gravity.

**(d)** The principle of conservation of momentum states that the total momentum of a system of objects remains constant provided no resultant external force acts on the system.

**(e)** **(i)** By conservation of momentum,

$0.53v_A + 0.34v_B = 0.53(7.2) + 0.34(-9.6)$

$0.53v_A + 0.34v_B = 0.552$ [B1]

Relative speed of approach = relative speed of separation

$v_A - v_B = (-9.6) - (7.2)$

$v_A - v_B = -16.8$ [B1]

or $v_B = v_A + 16.8$

Substituting,

$0.53v_A + 0.34(v_A + 16.8) = 0.552$

$v_A = -5.931 = -5.9 \text{ m s}^{-1}$

$v_B = -5.931 + 16.8 = 10.87 = 11 \text{ m s}^{-1}$

[B1]

**(ii)**

[B2] – correct shape and symmetrical vertically and horizontally
OR [B1] – correct shape but not symmetrical

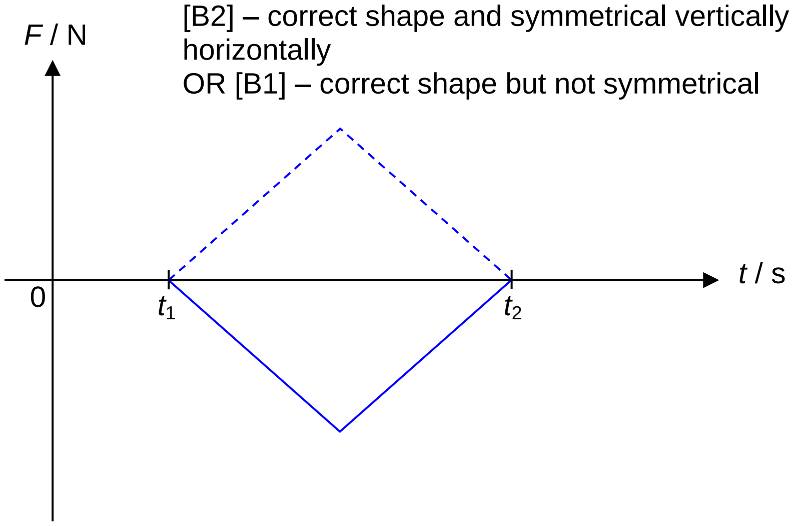



**Fig. 6.3**

**(iii)** Considering Ball A,

$$\text{Average } F_{\text{on A}} = \frac{\Delta p_A}{\Delta t} = \frac{0.53(-5.9-7.2)}{0.42} \quad \text{[M1]}$$

$= -16.57$ N

Hence, max $F_{\text{on A}} = -16.57 \times 2 = -33.1\text{ N}$ [A1]

By Newton's third law,
$F_{\text{on B}}$ = 33.1 N [A1]

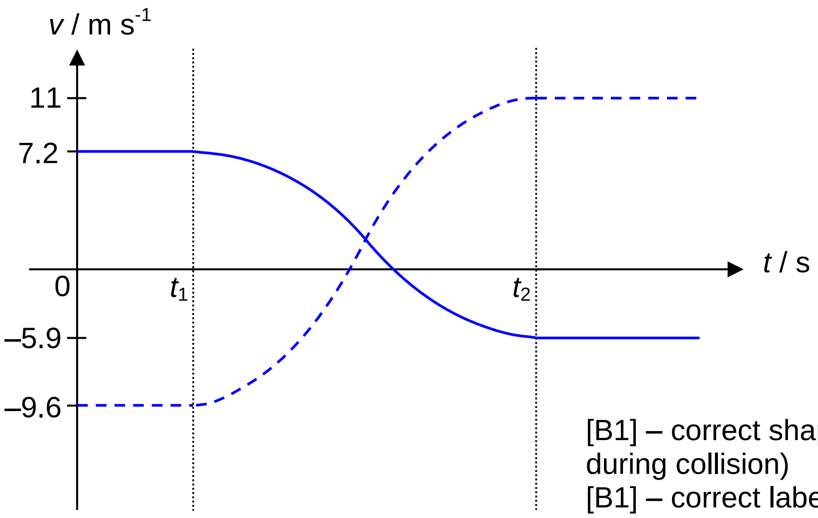
OR
Considering Ball A,
Area under graph for ball A $= \Delta p_A$

$$\frac{1}{2}\left(F_{\text{on A, max}}\right)\Delta t = 0.53(-5.9-7.2) \quad \text{[M1]}$$

$F_{\text{on A, max}} = -33.1\text{ N}$ [A1]

By Newton's third law,
$F_{\text{on B}}$ = 33.1 N [A1]

**(iv)**




[B1] – correct shape (nonlinear lines during collision)
[B1] – correct labels and intersection is positive

**Fig. 6.4**

**7** **(a)** 1. Sources must be coherent, where the 2 waves have a constant phase difference.
2. The 2 waves must be unpolarised or polarised in the same plane
3. The amplitude of both waves must be similar.
[1 mark for each point.]

**(b)** $\Delta\phi = \frac{\Delta x}{\lambda} \times 2\pi$

$= \frac{1.2 - 0.5}{330 / 800} \times 2\pi$ [M1] [C1 for $\Delta x$ ]

$= 10.7$ rad[ [A1]

**(c)** **(i)** For destructive interference,

$\frac{\Delta x}{\lambda} = 1.5$

$\lambda = 0.467$ [M1]

$f = 707$ Hz [A1]

**(ii)** Internodal distance = 0.467 / 2 = 0.2335 m [C1]

Number on right of P = 1.2/0.2335=5 [M1 for either]

Number on left of P = 0.5/0.2335=2

Total number of nodes = 2 + 5 + 1 = 8 [A1]

**(iii)** $I = \frac{P}{4\pi r^2}$

$I_1 = \frac{600}{4\pi(0.5)^2} = 190.99$ [either: C1]

$I_2 = \frac{600}{4\pi(1.2)^2} = 33.16$

$I_{net} = \left(\sqrt{190.99} - \sqrt{33.16}\right)^2$ [M1]

$= 65.2$ W m$^{-2}$ [A1]

**(iv)** The intensity at the minima will be lower [A1] because with an increase in amplitude from $S_2$, the waves can better cancel each other out when they meet exactly out of phase. [M1]

**(d)** **(i)** As he walks, he will pass points at which the path difference from the $S_1$ and $S_2$ are different from one another. Consequently the phase difference between the waves from the two sources at these points will also be different.

At points where waves from the two sources meet in phase, when path difference equal to integer multiple of the wavelength, constructive interference occurs and the intensity of the sound heard is high. [B1]

At points where waves from the two sources meet $\pi$ out of phase, when path difference equal to odd integer multiples of half-wavelengths, destructive interference occurs and the intensity of the sound heard is low. [B1]

**(ii)** $\lambda = 0.4125$

$\Delta x = \lambda D / a = 0.4125 \times 180 / 1.7$ [M1]

$= 43.7$ m [A1]