Proposed solutions to H1 Physics Prelim Paper 1

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

1 Ans: (B)

$$\mathrm{F=BIL}$$

$$\mathrm{B}=\frac{\mathrm{F}}{\mathrm{IL}}=\frac{\mathrm{ma}}{\mathrm{IL}}$$

$$\text{Base unit of B} = \frac{\mathrm{kg\ m\ s^{-2}}}{\mathrm{A\ m}} = \mathrm{kg\ s^{-2}\ A^{-1}}$$

2 Ans: (B)

A Both vectors
B Magnetic flux density: vector, kinetic energy: scalar
C Both scalars
D Both scalars

3 Ans: (D)

$$R=\frac{V}{I}$$

$$\frac{\Delta R}{R}=\frac{\Delta V}{V}+\frac{\Delta I}{I}$$

$$\Delta R=\left(\frac{0.5}{2.0}+\frac{0.01}{0.30}\right)\left(\frac{2.0}{0.30}\right)=1.89=2\ \text{(1s.f.)}$$

4 Ans: C

Let the total distance be S and the total time t.
Since the stone falls 0.75S in the last two seconds of its fall, it travels 0.25S in the first (t-2) seconds.

$$\frac{1}{2}g(t-2)^2 = 0.25S$$

$$\frac{1}{2}g(t-2)^2 = 0.25(\frac{1}{2}gt^2)$$

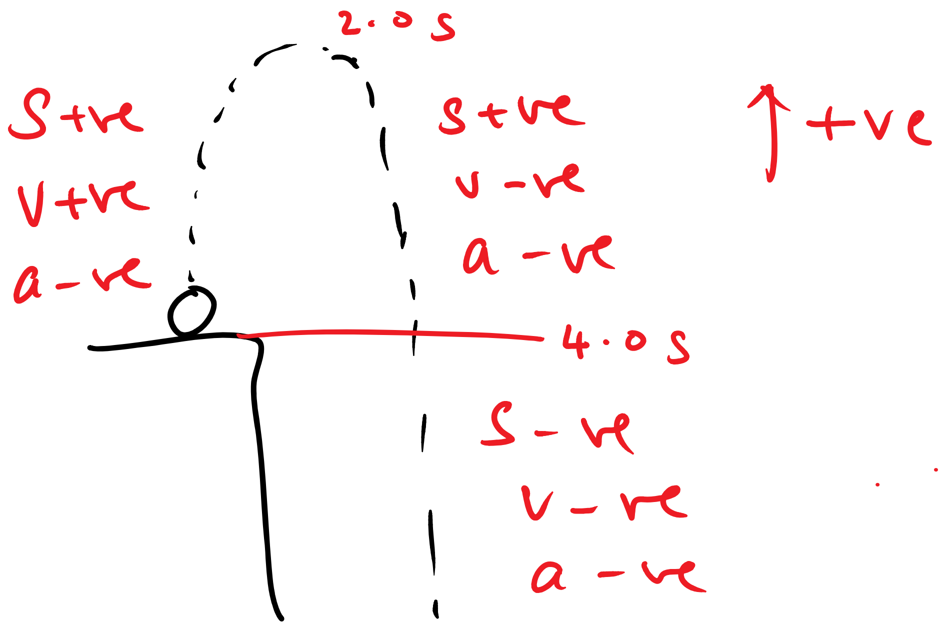
$$(t-2)^2 = 0.25t^2$$

$$t-2 = 0.5t$$

$$t = 4.0\,\text{sec}$$

5 Ans: D

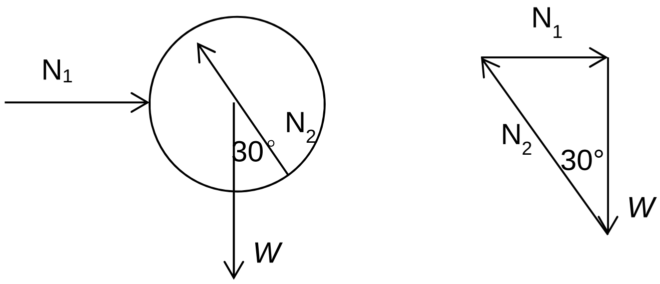
Since the stone takes 2.0 s to reach its highest point, at 4.0 s it will have reached the point of S = 0.
Taking upwards as positive,
Option A incorrect – Stone is on its upwards motion. The displacement and velocity is positive and the acceleration is negative.
For option B and C, the stone is on its downwards motion but has not reach the point of S = 0. Hence displacement is positive, velocity and acceleration are negative.
Option D correct – the stone is on its downward motion (having passed the point of S = 0) with negative displacement. Velocity and acceleration are negative.



6 Ans: B

Total distance travelled = estimated area under the speed-time graph
= 6 big squares = 10(20)6 = 1200 m
Average speed = total distance travelled/ total time taken
= 1200 m / 100 s =12 m s^{-1}

7 Ans: C



Using force diagram and resolving horizontally and vertically,

$N_2 \sin 30 = N_1$ (1)

$N_2 \cos 30 = W$ (2)

$\frac{(1)}{(2)}$: $\tan 30 = \frac{N_1}{W}$

(Alternative: Using vector triangle)

$N_1 = W \tan 30 = 15 \tan 30 = 8.66 = 8.7$ (2s.f.)

8 Ans: D

When reading is more than F, means that upward force by spring balance on mass is greater than weight of mass. Net force upwards – acceleration directed upwards.

9 Ans: C

The collision must be inelastic since a “loud sound” was produced (conversion of kinetic energy into sound energy).
Option A: The carts may move in opposite directions even for an inelastic collision.
Option B: Violates principle of conservation of momentum.
Option D: This is only true if collision is elastic.

10 Ans: D

Since particle Y is stationary (no KE nor momentum),
Initial KE of system is E, initial momentum of system is p.
Collision is inelastic – final kinetic energy of system should be less than E (Option C or D)
Momentum of any collision must be conserved, final momentum of system should be still p.

Full working:
Conservation of momentum, $mu + 0 = 2mv \rightarrow v = ½\, u$
System: Total $p = 2mv = 2m\,(½\, u) = mu = \mathbf{p}$
Total KE = $½\,(2m)(v^2)$
$= ½\,(2m)\,(½u)^2 = ½\,(½\, mu^2) = \mathbf{½\, E}$
X: $p = mv = m\,(½\, u) = \mathbf{½\, p}$
KE = $½\, mv^2$
$= ½\,(m)\,(½u)^2 = ¼\,(½\, m\, u^2) = \mathbf{¼\, E}$

11 Ans: D

Both boats travel the same distance *s* and experience the same force *F*. Hence the total work done by the force *F* between the starting line and the finish line is the same for each boat – they will have the same final kinetic energy.
Boat with mass *m* will experience a larger acceleration, and will thus reach the finish line first.
Note: Boat with mass *m* will also have a higher speed, since the two boats have the same final kinetic energy.

12 Ans: D

Total initial KE = Total final EPE
½ (5.0) $(4.0)^2$ = 40 J = Total final EPE
Considering area under graph, EPE at x = 1.0 will be ¼ of the final EPE.
Therefore KE at x = 1.0 will be ¾ of the final EPE = 30 J
v = 3.46 m s^{-1}

13 Ans: C

Section C has the steepest gradient, indicating the highest velocity. Since *P*=*Fv*, this section has the greatest work done per unit time against friction.

14 Ans: A

By conservation of energy, elastic potential energy is converted to kinetic energy and work done against friction. As height is the same at initial and final positions, gravitational potential energy is unchanged.

$$EPE_{loss} = KE_{gain} + WD_{\text{friction}}$$

$$\frac{1}{2}kx^2 = \left(KE_{final} - KE_{initial}\right) + fd$$

$$KE_{final} = \frac{1}{2}kx^2 - fd \qquad \left(KE_{initial} = 0\right)$$

15 Ans: A

Sound waves are longitudinal in nature and cannot be polarised.

16 Ans: C

P and Q will move in opposite direction regardless of direction of wave propagation. If the wave moves rightwards, P will be displaced less positive (moving leftwards) while Q will be displaced positive (moving rightwards).

17 Ans: B

$$\lambda_1 = \frac{v}{2400}$$

$$\lambda_2 = \frac{v}{2800}$$

At 2800 Hz the path difference has 1 more λ than at 2400 Hz

Number of wavelengths occupying 0.70 m $= \frac{0.7}{\lambda_2} = \frac{0.7}{\lambda_1} + 1$

$$\frac{0.70 \times 2800}{v} = \frac{0.70 \times 2400}{v} + 1$$

$$v = 280 \text{ m s}^{-1}$$

18 Ans: B

A: destructive interference involves two waves meeting antiphase.
C: By principle of superposition, interference occurs whenever two waves of the same type meet at a point in space.
D: The phase difference of the sources has to be known. If the sources are emitting waves of antiphase, path difference of $n\lambda$ will result in destructive interference).

19 Ans: A

$$d = \frac{\lambda L}{x}$$

$$d_{new} = \frac{(2\lambda)(0.5L)}{4x} = 0.25\frac{\lambda L}{x} = 0.25d$$

20 Ans: A

A: $$I_{ammeter} = \frac{V_{PQ}}{R_{total}} = \frac{V_{PQ}}{1+2+2} = 0.2V_{PQ}$$

B: $$I_{ammeter} = \frac{V_{PQ}}{R_{total}} = \frac{V_{PQ}}{\left(\frac{1}{1}+\frac{1}{2}\right)^{-1}+2} = \frac{V_{PQ}}{8/3} = 0.375V_{PQ}$$

C: $$I_{ammeter} = \frac{V_{PQ}}{R_{total}} = \frac{V_{PQ}}{1+2} = \frac{V_{PQ}}{3} = 0.333V_{PQ}$$

D: $$I_{ammeter} = \frac{V_{PQ}}{R_{ammeter}} = \frac{V_{PQ}}{2} = 0.5V_{PQ}$$

21 Ans: B

With bulb 3 in parallel to bulb 2, the potential difference across bulb 2 is a smaller fraction of the cell's e.m.f as compared to that of bulbs 1 and 4.
With bulb 3 removed, the potential difference across bulb 2 increases while those of bulb 1 and bulb 4 decrease correspondingly. With fixed resistance, power dissipated increases as potential increases, hence bulbs 1 and 4 became dimmer and bulb 2 became brighter.

Alternatively,
Before bulb 3 was removed,

$$R_{total} = R + \left(\frac{1}{R}+\frac{1}{R}\right) + R = 2.5R$$

$$I_{total} = \frac{V}{2.5R} = 0.4\frac{V}{R} = I_{bulb1} = I_{bulb4}$$

$$I_{bulb2} = I_{bulb3} = 0.2\frac{V}{R}$$

After bulb 3 was removed,

$$R_{total} = R + R + R = 3R$$

$$I_{total} = \frac{V}{3R} = 0.33\frac{V}{R} = I_{bulb1} = I_{bulb2} = I_{bulb4}$$

$\therefore I_{bulb1}$ and I_{bulb4} decreased, I_{bulb2} increased
since brightness $\propto$ power dissipated $= I^2R$
bulbs 1 and 4 became dimmer, bulb 2 became brighter

22 Ans: D

When $I = 0$, $E = 2.5\ V$
$V = E - Ir$
Substituting point from graph,
$1.2 = 2.5 - 1.7r$
$r = 0.76\ \Omega$

23 Ans: C

Option A is a true statement. The metallic conductor obeys Ohms Law and the IV characteristics is a straight line P passing through origin while Q represents a thermistor's IV characteristics as the resistance of semiconductor diode decreases with increasing forward biased voltage.
Option B is a true statement. As graph Q illustrates that as current increases, its resistance decreases.
Option C is a false statement. As At 1.9 A, both P and Q have the same p.d. Hence they have the same resistance. The resistance is not given by the reciprocal of the gradient at current 1.9 A
Option D is a true statement. The power can be determined as product IV. At 0.5 A, pd across Q is twice of that of P, hence power dissipated is twice.

24 Ans: D

Option A is not valid. The resistivity of the conductor is the same.
Option B is not valid. The current is the same for both sections by conservation of charges.
Option C is not valid. The lengths of the narrow section and wide section are not known. Hence, the relationship cannot be determined.
Option D is valid. By the equation, resistance per unit length is inversely related to the cross sectional area. Hence, with

$$R = \frac{\rho\ell}{A}$$

$$\frac{R}{\ell} = \frac{\rho}{A}$$

25 Ans: C

At point P,

(1) Magnetic field due to S is upwards (small magnitude due to larger distance)

(2) Magnetic field due to Q (towards R)

(3) Magnetic field due to R (away from Q) – magnitude same as 2)

The horizontal components of (2) and (3) point in exact opposite direction. Net horizontal component is zero.

Therefore, resultant of (2) and (3) point downwards (with a larger magnitude than that of "S")

26 Ans: B

$$F = BIL\sin\alpha$$
$$= 0.15 \times 5.0 \times 0.5 \times \sin 75°$$
$$= 0.36 \text{ N}$$

27 Ans: A

Direction: By Fleming's left hand rule, a magnetic force acts into the paper along CD and out of the paper along EF. Hence, viewing from the top, the rotation is clockwise.

Magnitude:

$$F = BIL$$
$$= 0.010 \times 2.0 \times 0.25$$
$$= 0.0050 \text{ N}$$

$$\text{Torque } = Fd = 0.0050 \times 0.25 = 1.3 \times 10^{-3} \text{ Nm}$$

28 Ans: C

This observation can be explained using the classical wave theory.

29 Ans: A

In the photoelectric experiment, photons are shone on the metal surface.

Hence by COE, the energy of the incoming photon = the least energy required to release a photoelectron + the maximum kinetic energy of the photoelectron.

30 Ans: A

The visible spectrum ranges from 400 nm (violet) to 700 nm (red).

$$\text{Energy of a red light photon } = \frac{hc}{\lambda}$$
$$= \frac{6.63\times10^{-34}(3.00\times10^{8})}{7.0\times10^{-7}}$$
$$= 2.84\times10^{-19}\text{ J}$$
$$= 1.77 \text{ eV}$$