2014 GCE A-Level H2 Paper 1 *Suggested Solutions*

1	**C**	*9*	**C**	*17*	**A**	*25*	**A**	*33*	**D**
2	**A**	*10*	**D**	*18*	**C**	*26*	**D**	*34*	**B**
3	**A**	*11*	**B**	*19*	**A**	*27*	**D**	*35*	**D**
4	**D**	*12*	**B**	*20*	**D**	*28*	**B**	*36*	**C**
5	**D**	*13*	**B**	*21*	**D**	*29*	**A**	*37*	**A**
6	**C**	*14*	**C**	*22*	**C**	*30*	**D**	*38*	**D**
7	**C**	*15*	**A**	*23*	**B**	*31*	**D**	*39*	**A**
8	**D**	*16*	**B**	*24*	**D**	*32*	**C**	*40*	**C**

1. **Ans: C**
Absolute uncertainties are generally expressed to 1sf. Hence $\Delta v = \pm 3$ m s^{-1}.
The value of the measurement must match the number of decimal places (d.p.) of the absolute uncertainty.
Hence, $v = (348 \pm 3)$ m s^{-1}.

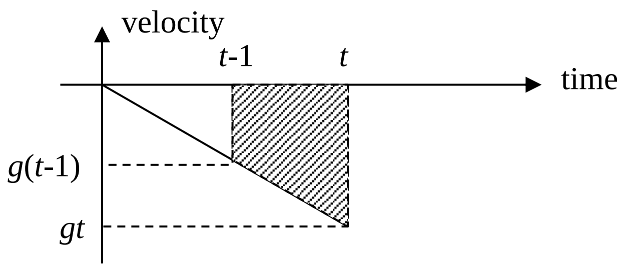
2. **Ans: A**
This is mainly book work.
Visible light has approximate wavelengths 400 nm - 700 nm, which includes 0.5 μm.
Ultraviolet is around 10 nm – 400 nm, hence it includes 0.05 μm.
Infrared is approximately from 700 nm – 0.1mm, which includes 5 μm and 50 μm.

3. **Ans: A**
The gravitational field strength is given by the gradient of the curve at $t = 0$ s where motion of the object is just about to start and air friction has not affected motion yet. Draw a tangent at this instant, calculate the gradient, we find the value to be around 6 N kg^{-1}.

4. **Ans: D**
Let the total time taken be t, and total distance be s. Hence,
$s = \frac{1}{2}a(t)^2$ -- Eqn (1)
From rest to time = (t - 1), the stone covered 0.25s.
$0.25s = \frac{1}{2}a(t-1)^2$ --Eqn(2)
Take Eqn(1) divided by Eqn(2)
$4 = \frac{t^2}{(t-1)^2}$
Solving, we find t = 2.0s

Alternative:

Note: $v = u + at$



Let s be total distance covered and t the total time taken for the fall. Then the distance covered is the area under the velocity-time graph. We have $s = \frac{1}{2}gt^2 \ldots(1)$

Now considering the distance covered in the second last second of the fall.

$$\frac{3}{4}s = \text{area of trapezium from } t-1 \text{ to } t$$

$$\Rightarrow \frac{3}{4}s = \frac{1}{2}(g(t-1)+gt)[t-(t-1)] = \frac{1}{2}(2gt-g) \quad \ldots..(2)$$

Substitute (1) into (2), we have $\frac{3}{4}(\frac{1}{2}gt^2) = \frac{1}{2}(2gt-g)$

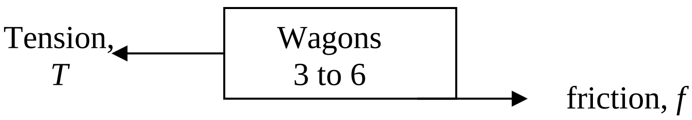
$3t^2 - 8t + 4 = 0$ giving t = 2.00 s (The other answer t = 2/3 s is not applicable)

5. **Ans: D**

D is the answer because since $MV > mv$, the net momentum is always non-zero, which means that both velocities cannot be zero at the same time.

6. **Ans: C**

The tension in the coupling between wagons 2 and 3 pulls and accelerates wagons 3 to 6.



By N2L,

$F_{net} = ma$

$T - f = ma$

$T = ma + f$

Since total friction action on the 4 wagons = 4000 x 4 = 16000 N

$T = (4 \times 6.0 \times 10^4)(0.15) + 16000$

$T = 52000\,\text{N}$

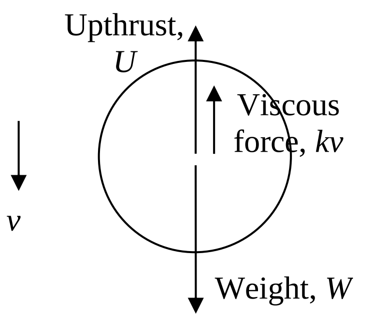
7. **Ans: C**

P is the work done on the fibre by an external force. Q is work done by the fibre. Hence net work done on the fibre is P – Q.

This probably means that there could be deformation to the wire or increase in internal energy in the fibre.

8. **Ans: D**

Since it is falling with constant speed, the net force is zero.



$W = U + kv$

9. **Ans: C**

Since $F_{\text{net}} = ma$
F_{train} – *friction* = ma where F_{train} is the driving or forward force of the train.
F_{train} = *friction* + ma

$P_{train} = F_{train}v$ (*note* : many students mistake F as just = ma)
P_{train} = (*friction* + ma)v

$$P_{train} = [5.0\times10^4 + (3.0\times10^5)(0.50)]\times10$$

$$P_{train} = 2.0\times10^6\ \text{W}$$

At maximum speed, the force of train is equal to the friction acting on it as there is no acceleration. Hence
$P_{train} = F_{train}v_{max}$ = *friction (max speed)*

$$v_{\max} = \frac{P_{train}}{friction} = \frac{2.0\times10^6}{5.0\times10^4} = 40\,\text{m s}^{-1}$$

10. **Ans: D**
The positive charge will experience a force pushing it to the right. As the charge moves towards the right, it will lose electrical potential energy and gain KE.
Since the left plate is grounded, the potential is zero. The potential difference between the plates is hence $\Delta V = V$.
Using $\Delta U = q\Delta V$, we can say that it gains KE of qV and loses EPE of qV

11. **Ans: B**
A and D are wrong because there will be gravitational force (i.e. weight) acting on the astronaut. C is wrong because the capsule is more massive than the astronaut and hence require a larger centripetal force.

The only possible reason is B, when both centripetal accelerations of the capsule and astronaut are the same. As both are accelerating with the same magnitude, they will appear to fall in tandem and this allows the astronaut to seem to float inside the capsule.

12. **Ans: B**
The net force will provide the centripetal force

$$F_{net} = F_c$$

$$mg - N = \frac{mv^2}{r}$$ where N is the contact force.

For it to just not lose contact, $N = 0$

$$g = \frac{v^2}{r}$$

$$r = \frac{v^2}{g} = \frac{20^2}{9.81} = 40.8\,\text{m}$$

≈ 41 m

13. **Ans: B**
Gravitational field strength right in between Y and X must be zero since the forces due to either body on a test mass at the position will cancel out. B is the only answer.

14. **Ans: C**

Gravitational force provides for centripetal force,

$$F_g = F_c$$

$$\frac{GMm}{r^2} = mr\omega^2$$

$$\frac{GM}{r^2} = r\omega^2$$

$$M = \frac{r^3\omega^2}{G} = \frac{r^3\left(\frac{2\pi}{T}\right)^2}{G} = \frac{(2.95\times10^5\times10^3)^3\left(\frac{2\pi}{1.89\times24\times60\times60}\right)^2}{G}$$

$$M = 5.70\times10^{26}\text{ kg}$$

15. **Ans: A**

Since $a \propto -y$ for SHM, the *a-t* graph will be a sine graph since the *y-t* graph is a negative sine graph. Just flip the *y-t* graph about the horizontal axis.

16. **Ans: B**

Under less damping, the amplitude must increase. The point of maximum amplitude must also occur at a slightly larger frequency than that for greater damping.. Next, when frequency is equal to zero, the amplitudes of the more damped and less damped curves must meet.

17. **Ans: A**

Melting point of Ice is 273 K and boiling point of water is 373 K.
The temperature difference is 100 K.

18. **Ans: C**

$P = mc\frac{d\theta}{dt}$. Hence $c \propto \frac{1}{\frac{d\theta}{dt}} \propto \frac{1}{\text{gradient of } \theta\text{-}t \text{ graph}}$ for portion of graph where temperature is rising with time.

$$c_Z < c_X < c_Y$$

For change of phase at constant temperature, $P = \frac{ml}{t}$ or $l \propto t$

$$l_Z > l_X > l_Y$$

19. **Ans: A**

For the initial condition at 300 K, using

$$PV = nRT$$

$$n = \frac{PV}{RT} = \frac{(1.00\times10^5)(0.60)}{8.31\times300} = 24.1\,\text{mol}$$

For the new situation, we know that the air will displace from high to low pressure until the pressures in both bulbs equalize. Hence we have for the smaller and bigger bulb respectively

$P(0.20) = n_2R(600)$ ---eqn1 and $P(0.40) = n_1R(300)$ ---eqn2

Take eqn1 / eqn2:

$$\frac{1}{2} = \frac{2n_2}{n_1}$$

Also, since $n_1 + n_2 = 24.1$ mol

$n_2 = 4.81$ mol

Substitute into equation 1, we have

$$P = \frac{4.81 \times 8.31 \times 600}{0.20} = 1.20 \times 10^5 \text{ Pa}$$

20. **Ans: D**

Since $I \propto amplitude^2$

$$I \propto (a\cos\theta)^2$$

21. **Ans: D**

$$v = f\lambda = \frac{\lambda}{T} = \frac{x_3 - x_1}{t_3 - t_1} = \frac{(x_3 - x_2)}{(t_2 - t_1)}$$

Note

: Although $\frac{x_3 - x_1}{t_3 - t_1}$ is the obvious answer, it is not included in the options. Hence we need to be flexible and find half the wavelength and half a period.

22. **Ans: C**

A standing wave is set up between the transmitter and the metal sheet. The distance between two adjacent maximum detected voltages corresponds to half a wavelength of the standing wave. Hence $\frac{\lambda}{2} = (90 - 30)$ or λ = 120 mm

23. **Ans: B**

Apply Young's Double slit formula,

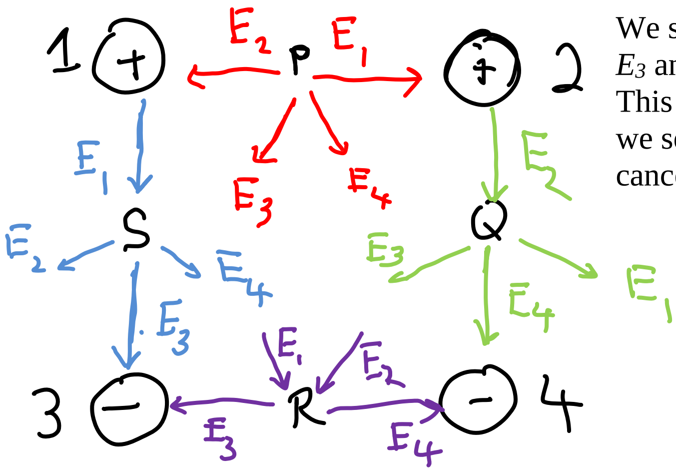
$$\Delta y = \frac{\lambda D}{d} = \frac{600 \times 10^{-9} \times 1.50}{3.0 \times 10^{-3}} = 0.30 \text{ mm}$$

24. **Ans: D**

An electric field line indicates the direction of the electric field strength which must decrease from high to low potential.

25. **Ans: A**

Label the charges 1 to 4 as shown below, and show the *E*-fields due to each charge.



We see that for **P**, E_1 cancels out E_2. E_3 and E_4 will have a net field downwards. This process is repeated for Q, R and S and we see that the horizontal forces always cancel out. Hence all of the net directions point downwards. Answer is A.

26. **Ans: D**

$$\omega = \frac{2\pi}{T}$$

$$T = \frac{2\pi}{\omega} = \frac{2\pi}{4.1\times10^{16}} = 1.53\times10^{-16}$$

This means that the electron completes one circle every 1.53×10^{-16} s.

Consider a point on the electron's orbit. In time *T*, it passes by this point once.

Since $I = \frac{e}{T} = \frac{1.6\text{x}10^{-19}}{1.53\text{x}10^{-16}}$

$I = 1.04\times10^{-3}$ A

27. **Ans: D**

The potential at X for B and C will be zero as the diodes are in reverse bias.

For D, using the potential divider principle, $V_X - 0 = \frac{4}{4+2}(12-0) \Rightarrow V_X = 8\,\text{V}$. For A, the potential at X is 4 V only.

28. **Ans: B**

Consider normal brightness. When resistance of LDR is *R*, the total resistance of the external circuit is $R_T = R + 0.5\,R = 1.5\,R$.

Current, $I_1 = V/R_T = \frac{2V}{3R}$

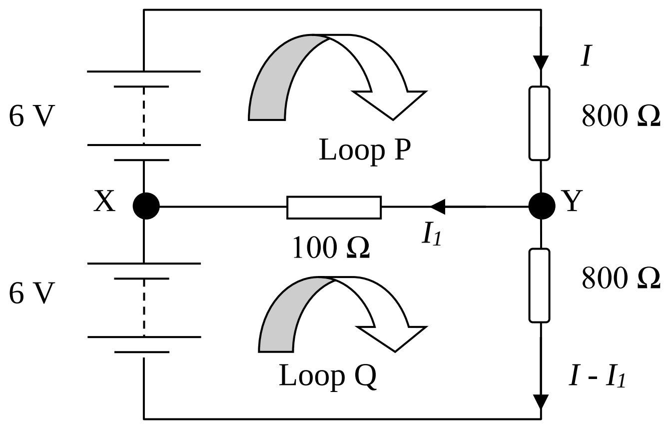
$I_2 = 0.5\,I_1 = \frac{V}{3R}$

When LDR is moved into the dark, the LDR resistance increases. Consider the extreme situation when resistance of LDR becomes infinity (note: this is not likely, but aids us in the thinking process). The total external resistance becomes $R_T = R + R = 2\,R$

New Current, $I_1 = V/R_T = \frac{V}{2R}$. Current decreases.

$I_2 = I_1 = \frac{V}{2R}$. Current increases.

29. **Ans: A**



Using Kirchoff's Voltage Law, in loop P, we have $6 = 800I + 100I_1$ ….(1)
In Loop Q, we have $6 = -100I_1 + 800(I - I_1)$ … (2)
Solving equations (1) and (2), we have $I_1 = 0$

30. **Ans: D**
Initial Total Energy = Final Total Energy of alpha-particle
Initial KE = Gain in PE + Final KE

$$\frac{1}{2}mv_i^2 = q\Delta V + \frac{1}{2}mv_f^2$$

$$\frac{1}{2}mv_f^2 = \frac{1}{2}mv_i^2 - 2eEx \qquad (q = +\ 2e,\ \Delta V = Ex)$$

$$v_f^2 = v_i^2 - \frac{4eEx}{m} \quad \text{Hence } v_f = \sqrt{v_i^2 - \frac{4eEx}{m}} = \sqrt{v^2 - \frac{4eEx}{m}}$$

31. **Ans: D**
Magnetic flux density B is linked to magnetic flux by the following equation,

$\phi = BA$

$B = \phi / A$

Unit of ϕ is Wb and unit of A is m^2
Hence unit of B is Wb m^{-2}

32. **Ans: C**
There will be no change in magnetic flux density because it is independent of the position of the coil.
Magnetic flux is given by $\phi = BA\cos\theta$. As rotation increases, θ increases.
As magnetic flux decreases.

33. **Ans: D**
For ideal transformer,
Input power = Output Power
Primary current × (primary voltage) = secondary current × (secondary voltage)
250 mA × primary voltage = 750 mA × 9V
primary voltage = 27 V

$$\frac{n_s}{n_p} = \frac{V_s}{V_p}$$
$$\frac{600}{n_p} = \frac{9}{27}$$
$$n_p = 1800 \text{ turns}$$

34. **Ans: B**

$$< P >= (I_{rms})^2 R$$
$$I_{rms} = \sqrt{\frac{160}{10}} = 4.0 \text{ A}$$

35. **Ans: D**

Options A and B are wrong because gradient of the the curves where they touch the x-axis is non-zero. It should be zero for a $\sin^2$ graph.

Max Power = $I_0^{\,2} R$

Since $I_{rms} = \dfrac{I_0}{\sqrt{2}}$,

$I_0 = \sqrt{2}\ I_{rms}$

$I_0^{\,2} = 2\,I_{rms}^{\;2} = 2\,I^2$

Max power = $2\,I^2 R$

Hence, answer is D

36. **Ans: C**

Book work.
Photoelectric effect shows particulate nature of light.
Interference shows the wave nature.

37. **Ans: A**

$$E = hf = \frac{hc}{\lambda} = \frac{6.63\times10^{-34}\times3.0\times10^{8}}{633\times10^{-9}}$$
$E = 3.142\times10^{-19}$ J
$E = 1.96$ eV (divide by the charge of electron)

From W to X, the energy gap is 1.96 eV exactly, while X to Y is 2.00 eV.
Hence answer is W to X.

38. **Ans: D**

n-type semiconductor provides a donor level close to the conduction band.

39. **Ans: A**

Atomic number (subscript) shows the number of protons.
Mass number (superscript) minus atomic number gives the number of neutrons.
Hence for Nitrogen, 14- 7 = 7 neutrons.

Nitrogen is the only one in the list with an odd number of protons and neutrons.

40. **Ans: C**

$E = \Delta mc^2$,

$\Delta m = E / c^2 = \dfrac{2.13\times10^{-13}}{(3.0\times10^{-8})^2} = 2.367\times10^{-30}\,kg$

$\Delta m = 0.0014257u$

$m_{exc} = m + \Delta m = (59.9308 + 0.0014257)u = 59.9322u$