2012 A Levels
H2 Physics
Suggested Solutions
Anderson Junior College

Paper 1 (40 marks)

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

1 **B**

% uncertainty = 0.01/2.16 x 100 = 0.46%
→ Precise.
Zero error: 0.08/2.16 x 100 = 3.7%
→ not accurate.

2 **A**

$$\frac{1}{f}=\frac{1}{u}+\frac{1}{v}$$

$$\text{let } x=\frac{1}{u}, y=\frac{1}{v}, z=\frac{1}{f},$$

$$\Rightarrow z=x+y \Rightarrow \Delta z=\Delta x+\Delta y$$

$$\frac{\Delta x}{x}=\frac{\Delta u}{u}$$

$$\Rightarrow \Delta x=\frac{\Delta u}{u}(x)=\frac{3}{50}\left(\frac{1}{50}\right)=0.0012 \text{ mm}$$

$$\frac{\Delta y}{y}=\frac{\Delta v}{v}$$

$$\Rightarrow \Delta y=\frac{\Delta v}{v}(y)=\frac{5}{200}\left(\frac{1}{200}\right)=0.000125 \text{ mm}$$

$$\Delta z=\Delta x+\Delta y=0.0012+0.000125$$

$$=0.001325 \text{ mm}$$

$$\frac{\Delta z}{z}=\frac{\Delta f}{f}$$

$$\Rightarrow \Delta f=\frac{\Delta z}{z}(f)=\frac{0.001325}{1/40}(40)=2.1\text{mm}$$

OR

$$\frac{1}{f}=\frac{1}{u}+\frac{1}{v}$$

Using extreme values of u and v,
When smallest values of u and v are used,

$$f=\frac{1}{\frac{1}{47}+\frac{1}{195}}=37.87 \text{ mm}$$

When largest values of u and v are used,

$$f=\frac{1}{\frac{1}{53}+\frac{1}{205}}=42.11\text{mm}$$

$$\Delta f=(42.112-37.87)/2=2.1\text{mm}$$

3 **D**

$s_1 = ½ a_1t^2$
$s_2 = ½ at_2^2$
$s_2 – s_1 = ½ t^2 (a_2-a_1)$
t = 3 s,
$12 = ½ (3^2) (a_2-a_1)$
$(a_2-a_1) = 2.67 ms^{-1}$
t = 6 s,
$s_2 – s_1 = ½ (6)^2 (2.67) = 48$ m

4 **D**

Resolving forces along horizontal dir,
Initial $F_{net} = 50 – 2 (40 \cos 60^0) = 10$ N
→ Accelerate in dir XG at first.

Final $F_{net} = 10 – 10 = 0$N
→ Moves at constant speed in dir XG

5 **D**

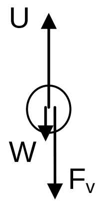
$$p=mv,\ E_k=\tfrac{1}{2}mv^2$$

$$p=\sqrt{m^2v^2}=\sqrt{2\left(\tfrac{1}{2}mv^2\right)m}=\sqrt{2E_km}$$

6 **C**

Since the forces that the spheres act on each other are equal in magnitude and opposite in direction (N3L), they undergo the same rate of change of momentum (N2L).
As they have different magnitudes of initial momentum, they will not reach zero speed at the same time.

7 **C**



Constant v, so $F_{net} = 0$
$U = W + F_v$
$F_v = U – W$
= weight of fluid displaced – weight of air bubble = $\rho_w Vg – \rho_a Vg$
= $Vg\ (\rho_w – \rho_w) = 2.322 \times 10^{-4}$ N

8 **B**
At equilibrium, lines of action of all the forces should pass through the same point.

9 **B**
$P = F_D v$, where is driving force.
At max speed, F_D = resistive force F_R.
$F_R = F_D = P/v = (2.0 \times 10^6)/ 40$
$= 5.0 \times 10^4$ N
At $v = 10\ ms^{-1}$,
$F_{net} = F_D – F_R$
$= P/v – F_R = (2.0 \times 10^6)/ 10 – 5.0\times10^4$
$= 1.5 \times 10^5$ N

10 **B**
Taking the top position as reference point, using COE,
Gain in $E_P = mg\Delta h = 4.2 \times 9.81 \times (-0.29)$
$= -12$ J
$E_{p\ at\ top} = E_s + E_k + E_{p\ at\ eqbm}$ for 1st time
$0 = E_s + E_k + (-12)$
$12 = E_s + E_k$
Since $E_s = ½ kx^2 > 0$, $E_k > 0$

11 **A**
$\omega = 2\pi/T = 2\pi / (365 \times 24 \times 60 \times 60)$
$= 1.99 \times 10^{-7}$ rad s^{-1}
$v = r\omega = 1.50 \times 10^{11} \times 1.99 \times 10^{-7}$
$= 2.99 \times 10^4\ ms^{-1}$

12 **B**
Since ω is constant, $F_{net} = mr\omega^2$ is constant.
When stone is at the top, T is directed downwards.
$F_{net} = T_{top} + mg$
$T_{top} = F_{net} – mg$
When stone is at bottom, T is directed upwards.
$F_{net} = T_{bottom} – mg$
$T_{bottom} = F_{net} + mg$

Variation in $T = T_{bottom} – T_{top} = 2mg$

13 **A**
$$a = \frac{GM}{r^2}$$
$$\text{at } r = R,\ a = g_s = \frac{GM}{R^2}$$
$$\text{at } r = 3R, g'_s = \frac{GM}{(3R)^2} = \frac{GM}{9R^2} = \frac{1}{9}g_s$$

14 **D**
(a) is incorrect: g field of Sun is not dependent on presence of Earth.

(b) is incorrect: g force of Earth on the satellite (call it S) is less than g force of Sun on S, so the two forces do not balance each other.

(c) does not explain: $T^2 = \dfrac{4\pi^2}{GM_{sun}} r^3$,
T is independent of mass of S.

(d) is correct.

Since S and Earth has same period, using $T = 2\pi/\omega$, so they have the same ω.
$\rightarrow \omega_S = \omega_{Earth}$

Centripetal force $F_c = mr\omega^2$
$\rightarrow F_{net\ on\ S} = m_s(0.99R)\omega_{Earth}^2$

Consider another satellite A of same mass as S, at distance 0.99R from the Sun, but far
away from Earth.
$F_{sun\ on\ S} = F_{sun\ on\ A} = F_{net\ on\ A} = m_s(0.99R)\omega_A^2$

Since $T^2 \propto r^3$, and $T = 2\pi/\omega$,
$r_{Earth} > r_A$, so $T_{Earth} > T_A$, so $\omega_{Earth} < \omega_A$

Hence, $F_{net\ on\ S} < F_{sun\ on\ S}$. A lower F_{net} will result in a lower ω.

15 **C**

$$\Delta U = U_{final} - U_{initial}$$

$$= -\frac{GMm}{r_{final}} - \left(-\frac{GMm}{r_{initial}}\right)$$

$$= GMm\left(\frac{1}{r_{initial}} - \frac{1}{r_{final}}\right)$$

$$= 6.67 \text{ x } 10^{-11} \text{x } 5.98 \text{ x } 10^{24}$$

$$\text{x } 810 \text{ x} \left(\frac{1}{6370 \text{ x } 10^3} - \frac{1}{6462 \text{ x } 10^3}\right)$$

$$= 7.22 \text{ x } 10^8 \text{ J}$$

16 **A**

17 **D**

First law of thermodynamics:
$\Delta U = Q + W \rightarrow d(\Delta U)/dt = dQ/dt + dW/dt$
Constant temperature, so
$\Delta U = d(\Delta U)/dt = 0$

Work is done by electricity when energy is converted from electrical form to other forms in the filament.
Rate of work done by electricity on filament, dW/dt = 20 W

Heat is lost by the filament.
dQ/dt = d(ΔU)/dt – dW/dt = 0 – 20 = –20 W

18 **C**

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$P_2 = \frac{P_1V_1}{T_1} \text{ x } \frac{T_2}{T_1} = P_1\left(\frac{V_1}{V_2}\right)\left(\frac{T_2}{T_1}\right)$$

$$= 1.0 \text{ x } 10^5 \text{ x } \frac{1}{2} \text{ x } \frac{273+25}{273+50}$$

$$= 4.6 \text{ x } 10^4 \text{ Pa}$$

19 **B**

$$PV = NkT$$

$$T = \frac{PV}{Nk} = \frac{9.80 \text{ x } 10^4 \text{ x } 8.70}{1.44 \text{ x } 10^{26} \text{ x } 1.38 \text{ x } 10^{-23}}$$

$$= 429 \text{ K}$$

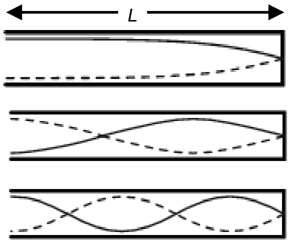
20 **B**

Sound wave is a longitudinal wave, hence it oscillates horizontally.
At displacement antinodes, there is no variation in pressure (pressure nodes).

21 **A**

22 **B**

v = fλ, f = v/λ



$\lambda = 4L \Rightarrow f = \frac{v}{4L}$

$\lambda = \frac{4L}{3} \Rightarrow f = \frac{3v}{4L}$

$\lambda = \frac{4L}{5} \Rightarrow f = \frac{5v}{4L}$

23 **D**

$$\frac{1}{5}x = \frac{\lambda D}{a}$$

$$x = \frac{5\lambda D}{a} = \frac{5 \text{ x } 600 \text{ x } 10^{-9} \text{ x } 2.5}{0.40 \text{ x } 10^{-3}}$$

$$= 1.9 \text{ x } 10^{-2} \text{ m}$$

24 **D**

$$d \sin\theta = n\lambda = \frac{nc}{f}$$

For angle between two third order diffraction maxima,
find 2θ when $n = 3$.

$$2\theta = 2\sin^{-1}\left(\frac{nc}{df}\right)$$

$$= 2\sin^{-1}\left(\frac{3 \text{ x } 3 \text{ x } 10^8}{\frac{1 \text{x} 10^{-2}}{4 \text{x} 10^3} \text{ x } 6.0 \text{ x } 10^{14}}\right) = 74^0$$

25 **A**

ΔV = W/q = KE/q = (½ mv^2)/q
$\Delta V \propto v^2 \rightarrow v \propto \sqrt{(\Delta V)}$

26 **B**

Using $E \propto 1/r^2$ and $V \propto 1/r$

27 **A**

I = Q/t = ne/t =(n/V)Ve/t
= 8.5 x 10^{28} x 3.2 x 10^{-7} x 0.0047
x 1.60 x 10^{-19} / 60
= 0.34 A

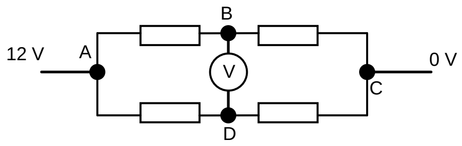
28 **C**

Let R be resistance of variable resistor.
Terminal pd V = E – Ir ,
I = E / (R+r)
When R↑, I ↓, so V ↑.

By maximum power theorem,
P across R will increase and reach maximum when R = r, then decreases.

29 **A**
$R = \rho l/A$
$E = Pt = V^2t/R = V^2tA/\rho l$

30 **A**
Circuit can be redrawn into



pd across AB = pd across AD.
Hence, pd across BC = 0

31 **D**
The three resistors on the right are arranged in parallel. The less the number of resistors in the circuit, the higher the effective resistance.

32 **A**
Resistor and thermistor arranged in series, so they have the same current passing through.
Sum of V across each component = 3.0 V
This is fulfiled when I = 0.10 A

33 **B**
No deflection, so F_B in opposite direction as F_E.
F_E directed upwards, so F_B directed downwards.
Using FLHR, B directed into the paper.

34 **D**
$F \times 0.23 = 7.4 \times 10^{-3}$ Nm
$F = 3.22 \times 10^{-2}$ N
$F = BIL$, $I = F/(BL)$
$I = 3.22 \times 10^{-2} / (3.6 \times 10^{-2} \times 0.093) = 9.6$ A

35 **C**
emf against time should be a sinosoidal function, so options A and D are eliminated.

Assume t = 0, and $\theta_X = 0^0$ when coils are at their positions as shown in the diagram. For both options B and C, emf for X is a positive sine function.

Hence, emf for X is positive from t = 0 to t = ½ T, or from $\theta_X = 0^0$ to $\theta_X = 180^0$

Hence, emf for X is positive when θ_X $=120^0$, which is the position of Z at t = 0.

It follows that emf of Z is positive at t = 0. Only Option C fulfils this condition.

Alternatively, since Z is ahead of X by 120^0, the emf of Z is also ahead of emf of X by 120^0.

36 **A**
$I = I_0 \sin(\omega t)$
$I_{rms} = I_0/\sqrt{2} = 13.4 / \sqrt{2} = 9.5$ A
$\omega = 2\pi f$, $f = \omega/(2\pi) = 380/(2\pi) = 60$ Hz

37 **C**

38 **C**
According to band theory, conductivity increases with temperature because some valence electrons acquire thermal energy greater than E_G and hence move into the conduction band to become free electrons, leaving behind holes in the valence band. Both free electrons and holes are the charge carriers of electricity.

39 **D**

A = A_0 exp(-λt)

$$\text{For X}: \frac{9}{10} = e^{(-4\lambda_X)}$$

$$\ln\left(\frac{9}{10}\right) = -4\lambda_X$$

$$\text{For Y}: \frac{9}{10} = e^{(-2\lambda_Y)}$$

$$\ln\left(\frac{9}{10}\right) = -2\lambda_Y$$

$$\text{At } t = 8\text{h}, \frac{A_X}{A_Y} = \frac{A_0 e^{(-8\lambda_X)}}{A_0 e^{(-8\lambda_Y)}}$$

$$= \frac{[e^{(-4\lambda_X)}]^2}{[e^{(-2\lambda_Y)}]^4} = \frac{\left(\frac{9}{10}\right)^2}{\left(\frac{9}{10}\right)^4} = \frac{100}{81}$$

40 **C**

If both decays are alpha emissions,
Initial neutron number = 135 + 4 = 139
Initial proton number = 93 + 4 = 97
Hence, S could be the initial isotope.

If both decays are beta emissions,
Initial neutron number = 135 + 2 = 137
Initial proton number = 93 – 2 = 91
Hence, P could be the initial isotope.

If there is one alpha and one beta emission,
Initial neutron number = 135 + 2 + 1 = 138
Initial proton number = 93 + 2 – 1 = 94
Hence, R could be the initial isotope.