Edwest Stage 2 Physics 2A/2B Solutions 2010

Section A

1. C-12 and C-14 are isotopes, which means that they have the same number of protons but a different number of neutrons. Carbon 12 has 6 neutrons and carbon 14 has 8 neutrons.

4 $^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}\beta$

2. a)

1	2	3
Sample	**Activity**	**Corrected count**
0.5 g sample of ancient papyrus	84	**62**
1.0 g sample of new papyrus	196	**174**
Background reading	22	

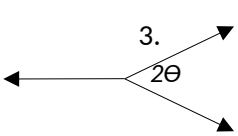
b) New papyrus activity = 174 Bq/g and old papyrus activity = 62/.05 = 124Bq/g

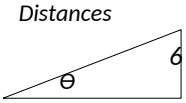
Ratio = 124/174 = 0.713.

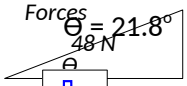
7 c) $124 = 174\left(\frac{1}{2}\right)^{n}$ Trying in different values of n: n ≈ 0.49 half lives (0.488),

So t = 0.488 x 5730 ≈ 2800 years.

3.







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4 Cos 21.8 = $\frac{\frac{F}{2}}{48}$ so F/2 = 48cos21.8 = 44.57. F = 89.1 N

4. When stretching the elastic the forces on her are in equilibrium so her hand must pull with the same force as that on the elastic (89.1 N). This much larger than the force needed just to hold the slingshot without stretching the elastic.

2

5. a) a = F/m = 89.1/0.055 = 1.62 ms^{-2}

4 a) $v^2 = u^2 + 2as$ so $v^2 = 0 + 2 \times 1.62 \times 0.15 = 486$. So v = 22.0 ms^{-1}.

6. Water has a higher specific heat capacity than the land so when the surrounding air gets colder in winter heat is transferred to the air from the land and the water.

2 The water will cool down less for the same amount of heat transferred and so the towns near the water will be warmer due to the higher temperature of the water.

7. Assume the water heats up from 20^0 to 100^0 so $\Delta T = 80^0C$

H = Pt = 2000 x 90 = 1.80 x 10^5 J $n = \frac{H}{c\Delta T} = \frac{1.8 \times 10^5}{4180 \times 80}$ m = 0.538 kg.

Answer mass is about 0.5 kg of water.

3

8. (i) Hot water rises due to convection currents. With the heater at the bottom hot water will circulate to the top and so all the water in the kettle will mix and reach an even temperature.

(ii) The shiny metal plate reflects the radiant heat (IR) so that IR rays travelling downwards will not cause conduction through the base, but will be reflected upwards to further heat the water above.

4

9. Heat lost by beer = 0.35 x 4180 x (30 - 5) = 36,575 J

Let mass of ice = m

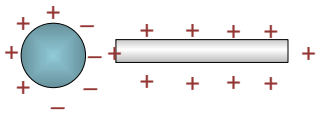
Heat gained by ice = (3.34×10^5m) + (m x 4180 x 5) = 354,900m

m = 0.103 kg.

5

10. The table-tennis ball has equal number of + and – charges but when the + rod is brought close to the left side the negative electrons are attracted to that side.

The ball would be attracted because the – charge (attractive) is closer than the + charge (repulsive). The attractive force is therefore greater than the repulsive force.



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11.

		Relative Brightness
S_1 OPEN	S_2 OPEN	3
S_1 CLOSED	S_2 OPEN	1
S_1 OPEN	S_2 CLOSED	2
S_1 CLOSED	S_2 CLOSED	1

4

12. The yellow/green cable is called the Earth wire. It is connected from the toaster's metal case to earth (at zero volts).

In the case of a fault where the case becomes live (240 V) then the current can run straight to earth, rather than through the person touching it..

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13. a) M_1 = ammeter

M_2 = voltmeter

b) $\text{Gradient} = \frac{(10-2)}{(18-3.5)x\ 10^{-3}}$ Hence total resistance of the circuit = Ω.

c) 250 + R = 552, so R = 3.02×10^2 Ω.

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Section B

1. a) $v = \frac{0.15}{1.56} = 9.61 \times 10^{-2}$ m s

b) No, Suzie is not correct. The result is likely to be quite inaccurate because, although the measuring instruments have a high precision, a large error will arise from her judgement of when to start and stop the stopwatch.

c) Uncertainty in length is ± 0.05 cm in 15 cm.

$\% = \frac{0.05}{15} \times 100 = 0.33\%$ uncertainty

d)

Variable	Must be the same	Doesn't matter
Diameter of the ball		
Distance X-Y		
Type of timer		
Size of measuring cylinder		
Weight of ball		
Type of liquid		

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a) Average time $= \frac{1.75+1.80+1.78+1.73+1.69}{5}$

Using $s = ut + \frac{1}{2}at^2$, $s = 0 + \frac{1}{2}(-9.8)(1.75)^2 = 15.0$ m.

2. a) E_P at start = E_K at end so $\frac{1}{2} \times$ ~~3500~~ $\times v^2 =$ ~~3500~~ $\times 9.8 \times 5$

$v = \sqrt{2 \times 9.8 \times 5} = 9.90$ ms^{-1}.

b) Total momentum (mv) is conserved so 3500 x 9.90 = 8000v

v = 4.33 ms^{-1}.

c) Kinetic energy is $\frac{1}{2} \times 8000 \times 4.33^2 = 7.50 \times 10^4$ J.

d) Kinetic energy is converted to work in stopping so $E_K = Fs$

$7.50 \times 10^4 = 250 \times 10^3 \times s$

S = 0.300 m

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3. a) The breeze causes the water to evaporate. [illegible]evaporating, latent heat is transferred to the water from the air inside [illegible]nd so the air around the food cools down.

b) (i) Q = mL = 0.015 x 3.34 x 10^5 = 5.01 x 10^3 J.

(ii) Volume = 3.5 x 5.2 x 6.1 = 111.02 m^3

Mass = 111.02 x 1.22 = 135 k

(iii) Q = mcΔT so 5.01 x 10^3 = 135 x 995 x ΔT

ΔT = 3.73 x 10^{-2} °C.

(iv) Air with high humidity contains a lot of water vapour. If it is close to saturation level then the air cannot absorb much more water vapour so the water used in the air conditioner will not be able to evaporate effectively.

c) Heat needed to cool the water from 20 to 0°C = 0.35 x 4180 x 20 = 2.926 x 10^4 J

Heat needed to freeze the water = 0.35 x 3.34 x 10^5 = 1.169 x 10^5 J

Total heat extracted =2.926 x 10^4 + 1.169 x 10^5 = 1.462 x 10^5 J

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H = Pt, so the time taken will be $t = \frac{1.42 \times 10^5}{155} = 943$ s or 15.7 m

4. a) $^{226}_{88}Ra \rightarrow {}^{222}_{86}Rn + {}^{4}_{2}He$

Radiation emitted is α particles.

b) Radon is a gas and can therefore end up inside the body, ingested through the lungs.

Outside of the body α-rays are not harmful but in the lungs they can destroy cells.

b) (i) 2.5 x 10^{-3} + 5.4 x 10^{-3} = 7.9 x 10^{-3} mJ per day x 365 = 2.88 J per year.

Absorbed dose = 2.88/95 = 3.03 x 10^{-2} Gy.

(ii) Effective Dose for α particles ¿ $\frac{2.5x\ 10^{-3}x365x20}{95} = 0.192$

Effective Dose for β particles ¿ $\frac{5.4x\ 10^{-3}x365x1}{95} = 0.0207\ Sv$

Total effective dose = 0.213 Sv.

c) 240mBq reduced to 15 mBq is a reduction by a factor of 16 so the decay is for 4 half-lives

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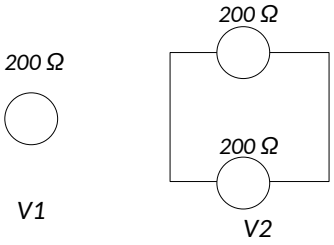
$\frac{1}{16} = (0.5)$ 4 x $T_{½}$ = 60.8 d, so = 15.2 days.

5. a) (i) A non-ohmic conductor is one which does not obey Ohm's Law i.e. I is not proportional to V.

(ii) Graph B is the correct one. With I and V reversed the graph shows a small resistance becoming greater as the lamp gets hotter.

b) P = VI so 0.18 = 6I I = 0.03 A

R = V/I = 6/0.03 = 200 Ω.



c) L_2 and L_3 in parallel will have a resistance of 100 Ω

Total R = 300 Ω.

V α R so V_1 must be 2 x V_2.

V_2 must not exceed 6 V so V_1 must not exceed 12 V.

7

Therefore V_s = 12 + 6 = 18 V. ▯

Section C

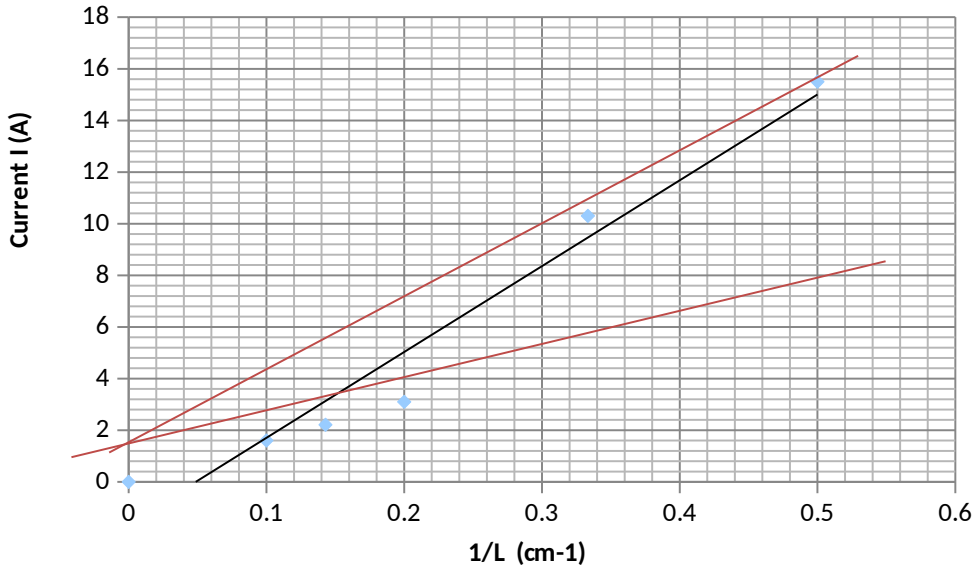
a)

Length L (cm)	Current I (amp)	1/L (cm^{-1})
2	15.5	0.500
3	10.3	0.333
5	3.1	0.200
7	2.2	0.143
10	1.6	0.100

values▯

I think _**Minh** *is correct because* As the length increases the current gets **smaller.** ▯

b)



- **Scaling** ▯
- **Points** ▯
- **Line of best fit** ▯

c) (i) Gradient = 33 = k ▯

(ii) A = $\pi r^2 = \pi(0.25 \times 10^{-3})^2 = 1.96 \times 10^{-7} m^2$ ▯▯

(iii) $\sigma = \frac{VA}{k} = \frac{240 \times 1.96 \times 10^{-7}}{33}$ = 1.4 ▯▯

a) Minimum gradient = 15.6 ▯

Maximum gradient 31.0. ▯

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