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Fourth Form Physics

2014 (February)

Instructions to markers:

Each bullet point is 1 mark unless otherwise noted.

Ecf where appropriate.

1 (8)	
2 (17)	
3 (11)	
Total (36)	

Assume g (Earth) = 10 N/kg g (Mars) = 3.7 N/kg

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Question 1.

On a clear night if you look across a lake at a full moon. Draw a diagram of the reflection of the moon in the lake:

i. When the lake is **flat calm**

Accept only attempt at reflection of moon or simple circle.

ii. When there is a breeze causing **waves and ripples** on the surface.

Accept either attempt at realistic drawing (wavy line) or disturbed reflection of moon. Do not accept circle.

[2]

One type of telescope used to look at other planets in the Solar system is called a 'reflecting telescope.'

a) State the two laws of reflection:

a. *Etc.*……

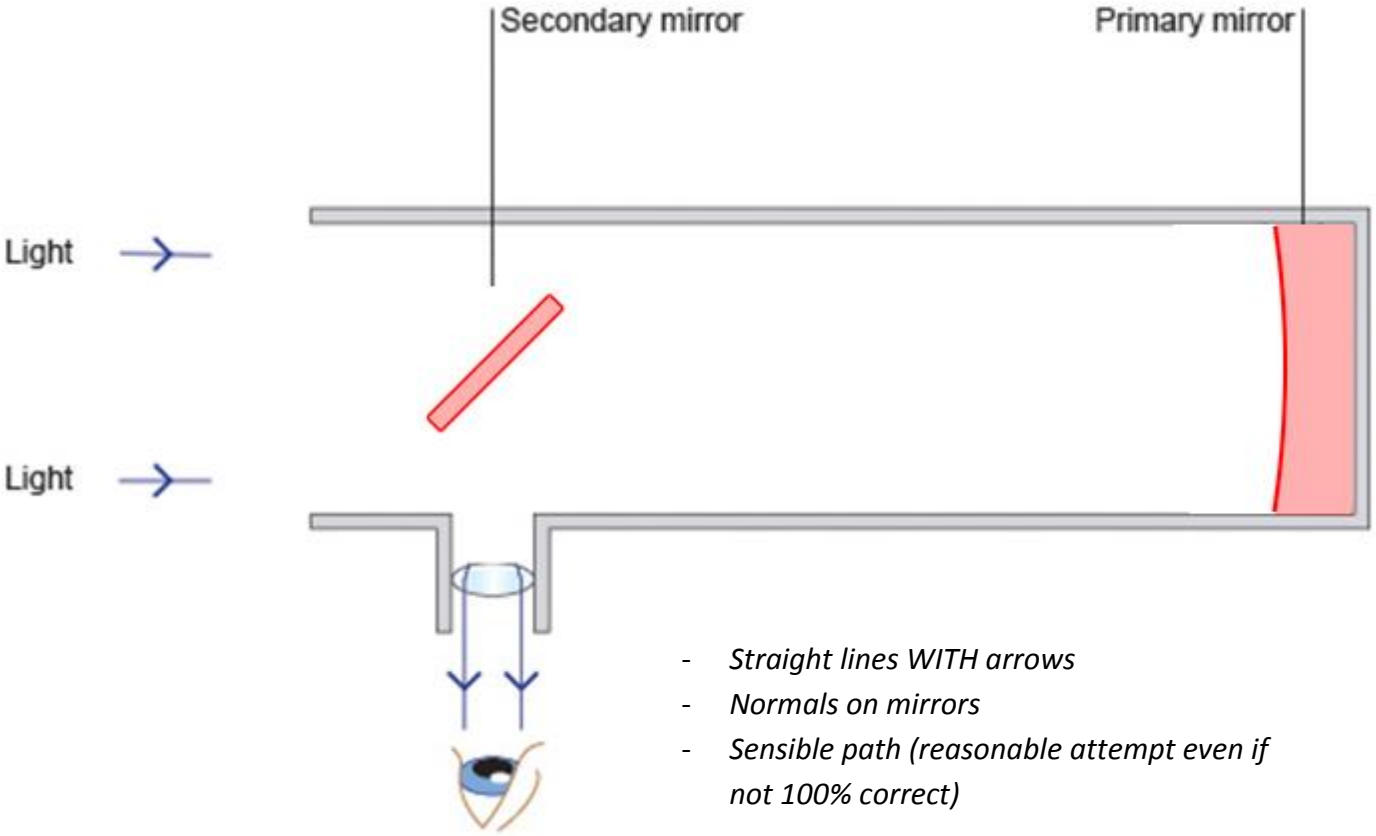
……

b. ……

……

[2]

b) Complete the path of the two light rays shown to show how light from distant objects may be focused into the eypiece lens for the viewer to see by reflections from two mirrors. You should include the normals where appropriate.



- *Straight lines WITH arrows*
- *Normals on mirrors*
- *Sensible path (reasonable attempt even if not 100% correct)*

[3]

c) Comment on the appearance any object viewed through the telescope, will it be inverted, and if so in which directions?

……

……*Answer as appropriate to the diagram drawn. Heavy BOD.*……

……

……

[1]

Question 2.

The Alma telescope is part of an array of telescopes in the Atakama desert, Chile. Many of the dishes can be moved into different positions to maximise the quality of data.

The trucks that move the telescopes have 28 wheels and and weigh 1.2×10^6 N.

a) If each wheel has an area of 1.0 m^2 in contact with the ground, calculate the total pressure exerted on the desert floor by the vehicle. Give your answer to a suitable number of significant figures.

- *P = F/A*
- *Total area A = 28 x 1 = 28m^2*
- *1.2x106 / 28*
- *43000 (-1 if not 2sf)*

Answer: _____ N/m^2

[4]

b) Each wheel is supported by an incredibly stiff suspension spring. State Hooke's Law and explain using the idea of the spring constant what the difference is between a stiff and soft spring.

- F = kx (or equiv in words)

- Stiff cf soft; kstiff > ksoft

OWTTE wrt Hooke's law

[2]

c) Sketch a graph of force against extension for a metal spring. Label the axes and annotate the key features of the graph. You should assume the spring obeys Hooke's law *until* an extension of 30 cm is reached (when a force of 15 N is applied.)

- *Correct axis labels WITH units*
- *Straight line with bend at the end (beyond 30cm/15N & correct direction)*
- *Correct numbers indicated*

[3]

d) You have an unlimited supply of 3cm springs which have a spring constant 0.4 N/cm. Starting from 2m above the ground, what is the maximum number you can join in series (i.e. one under another),hang a 200g mass hanger of length 10cm on the bottom, and not have the hanger touch the ground?

i) Calculate the force acting on each spring

- *F = Weight = mg*
- *200g = 0.2kg = 2N*

[2]

ii) Calculate the extension of each spring (you should neglect the weight of the springs themselves)

- *F = kx*

2= 0.4x

- *X = 5cm*

[2]

iii) Find the maximum length of all the extended springs (i.e. between the top of the hook and 2m above the ground.

- *2 – 0.1 = 1.9m*

[1]

iv) Write down an expression for the maximium number of springs (including both length AND extension) that fit within this length.

- *(spring length + spring extension) x N = 1.9*

Or in words

- *N = 23.75*
- *Therefore 23 springs*

[3]

Question 3.

While exploring on Mars an astronaut stumbles into a cave containing a pool of glowing liquid and three coloured cubes. She decides to investigate the pool using the cubes and her oxygen tank as a measuring tool. She finds the following results:

i) The three cubes together are as heavy as the tank

ii) The length of two red cubes plus a green cube is the same as the tank

iii) The length of two green cubes plus a blue cube is twice as long as the tank

v) All of the cubes float in the glowing liquid with half of their volumes exposed.

On returning to base she measures that the tank is 35 cm long and has a mass of 20 kg.

a) Fill in the missing data from the table:

Colour of cube	Length of cube (cm)
Red	*7.8*
green	*19.4*
Blue	*31.2*

[2]

(you may use this space for working)

- *Both correct scores 2*
- *IF NO working & not correct; score 0*
- *If correct working & 1 correct; 1*
- *If correct working & 0 correct; 0*

a) Calculate the **weight** of all three of the cubes taken together.

- W = mg

- 9.5 x 3.7 (1 mark) = 74 (1 mark)

- score 2/3 for EITHER of 9.5 or 3.7 incorrect

[3]

b) Calculate the **<u>total volume</u>** of displaced liquid in the glowing pool when all of the cubes are put into it.

Ecf on all lengths

- $R^3 + G^3 + B^3 /2 = 19073\ cm^3$

- cubed (1), added (1), /2 (1)

[3]

d) Archimedes' principle states: "for a floating body, the weight of displaced liquid is equal to the weight of the floating object".

Hence find the density of the glowing liquid in g/cm^3

- *D = M/V*
- *M (from Q) / V (from part b)*
- *~1g/cm^3*

[3]

End of paper