WESTMINSTER SCHOOL
THE CHALLENGE 2017

PHYSICS

Thursday 27 April 2017

Time allowed: 30 minutes

Please write in black or blue ink.

Write your answers in the spaces provided.

For examiner use only

Total Mark		

Blank Page

The first question consists of 5 multiple choice questions, each worth one mark.

P1 *Choose A,B,C,D or E for each of the following questions.*

a) Which of these values is an appropriate estimate for the density of lead?

A: 1 kg/m³ *B: 10 kg/m³* *C: 10 g/cm³* *D: 1000 g/cm³* *E: 100kg/m³*

b) The graph to the right shows the Volume and Density of several different objects. The two objects that have the same mass are:

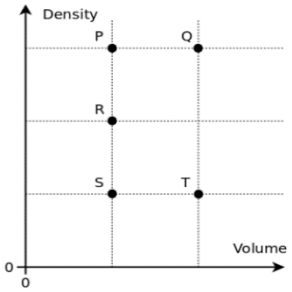
A. S & Q

B. P & S

C. R & Q

D. R & T

E. None of them



c) A spring that obeys Hooke's law has a spring constant *k*. Three such springs are attached side by side. What is the spring constant of this new composite spring?

A: k/3 *B: 2k/3* *C: k* *D: 3k/2* *E: 3k*

d) A group of explorers near the Equator leave base camp and travel 7km North and then 2km East and then finally 5km South. They then realise that they are late for dinner! In which direction should they travel to return directly to base camp?

A. West

B. South West

C. South

D. South East

E. North East

e) The Earth is a distance of 1 Astronomical Unit (1 AU) from the Sun. In these units the speed of the Earth in its orbit around the Sun is:

A. 1.00 AU / year

B. 2π AU / week

C. 0.017 AU / day

D. 0.26 AU / hour

E. 1.99×10^{-7} AU / min

Short answer Questions



P2

Johannes Kepler (1571-1630) came up with several laws of planetary motion. One of these stated that for all the planets, the average time taken for the planet to orbit the sun T, and the average distance of the planet from the sun R, were related as follows:

$$\frac{T^2}{R^3} = a\ constant$$

a) How long does the Earth take to orbit the Sun (the 'Orbital Period'), giving your answer in seconds?

[1]

b) The Earth is a distance of 1.5×10^{11} m from the Sun. Show that the constant in Kepler's law is approximately 3×10^{-19} s^2/m^3 (NB work out your own value)

[1]

c) Mars takes 687 days to orbit the Sun. Estimate the distance between Mars and the Sun based on Kepler's observation.

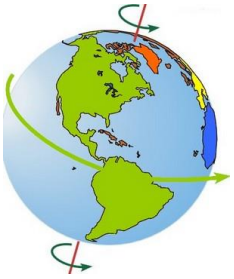
[2]

d) The distance between Saturn and the Sun is 1.8 times the distance between Jupiter and the Sun. What is the ratio of their orbital periods?

[2]

P3

The rate of rotation of an object is measured by the angle that it turns through each second. The scientific unit for angle is the radian, where 2π radians = 360° and therefore 1 radian = 57.3°.



a) Calculate the rate of rotation of the Earth about its own axis in radians per second.

[2]

b) A certain type of vinyl record rotates at 78 'revolutions per minute' (rpm). Convert this into radians per second.



[2]

c) The wheel of a unicycle spins round with a constant rotational speed of 9.425 radians per second and does not slip on the road. The wheel has a radius of 35cm. Calculate:



i) How many revolutions the wheel will make in 1 minute

[2]

ii) How far the unicycle will travel forward in that time

[2]

P4

Some students have come up with incorrect explanations for various phenomena. In each case identify their mistake and write the correct explanation.

a) Josh says that white is the best colour to wear in the summer because it radiates heat away from the body better than black, helping you cool down.

[2]

b) Chris states that you can tell if something is magnetised by bringing another magnet close to it. If they are attracted together then they must both be magnets.

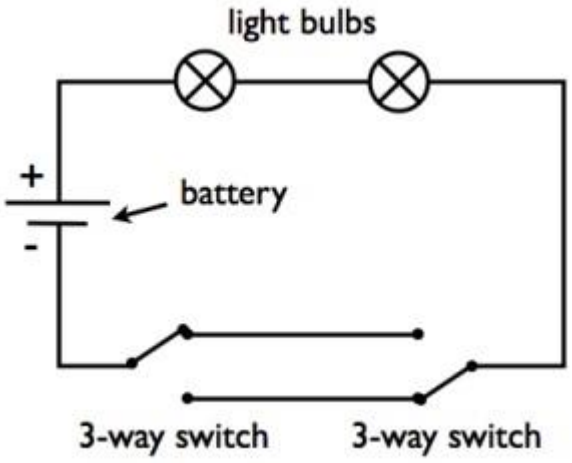
[2]

c) Jane suggests that her stiletto heels sink into soft ground because the force applied to the ground is greater than for flat shoes. Put a pair of flat shoes on and the force is less, so you don't sink in.

[2]

P5 Electricity

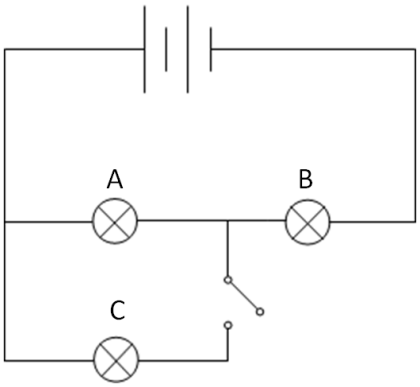
Examine the circuit below.



a) What would be the benefit of having two of these "3-way switches" (called SPDT switches) arranged in this fashion?

[1]

b) Examine the circuit to the right. All the bulbs are identical. When the switch is closed, state whether each bulb would get brighter, dimmer or stay the same:



A:

B:

C:

[3]

P6 Three friends take part in a 'Relay Triathlon'. Bhavna swims 1 km, Charlie cycles 9km, and Helen runs 5km. They notice the following facts about their performance:



- The time taken by Helen was exactly half the time taken by Bhavna and Charlie combined
- Charlie's average speed on the bike was 6 times Bhavna's average speed in the water
- Helen ran at an average speed of 15 km/h
- The team completed the whole course in exactly one hour

How long did each member of the team take to complete their section of the course?

Bhavna took _____ minutes

Charlie took _____ minutes

Helen took _____ minutes

[4]