WESTMINSTER SCHOOL

THE CHALLENGE 2015

PHYSICS

Thursday 30 April 2015

Time allowed: 30 minutes

Please write in black or blue ink.

Write your answers in the spaces provided.

For examiner use only

Total Mark	

P1

Choose A,B,C,D or E for each of the following questions. One mark for each.

a) Which of these values is an appropriate estimate of the weight of a motorbike?

A: 500 kg *B: 1000kg* *C: 100N* *D: 3000N* *E: 900lb*

b) A hiker strolls along a straight path at 4 km/h. After 12 minutes he has travelled

A: 480m *B: 48km* *C: 800m* *D: 8000m* *E: 2.88km*

c) An astronaut with a mass of 120kg would have a weight of 96N if he were standing on the Dwarf Planet Pluto. What is the gravitational field strength on Pluto?

A: 0 N/kg *B: 0.8 N/kg* *C: 1.25 N/kg* *D: 10 N/kg* *E: 80N/kg*

d) A very hot object in orbit around the moon would

A: Cool down because thermal energy would be lost by conduction

B: Cool down because thermal energy would be lost by radiation

C: Get hotter because of friction

D: Stay the same temperature because it is in space

E: Get hotter because of heat radiation from the Sun

e) An electromagnet can be made stronger by

A: Increasing the number of turns

B: Increasing the current in the coil

C: Adding an iron core

D: Making the turns closer together

E: All of the above

f) A spring is compressed by a weight to a length of 22cm. Two identical such springs side by side are then each compressed to a length of 34cm by the same weight. What is the uncompressed length of one spring?

A: 40 cm *B: 42 cm* *C: 44 cm* *D: 46 cm* *E: 48 cm*

g) Which of the following has a volume of 10 cm^3?

A: A rectangular box of dimensions 0.02m x 2.0 cm x 0.25m

B: A rectangular box of dimensions 10cm x 10cm x 10cm

C: A rectangular box of dimensions 10mm x 1cm x 10m

D: A rectangular box of dimensions 0.2m x 100mm x 0.5m

E: A rectangular box of dimensions 0.5cm x 0.2m x 10mm

h) 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 1 radian = 57.3 degrees.

In these units the rate of rotation of the Earth about its own axis is:

A: 7.3 x 10^{-5} radians/second

B: 4.2 x 10^{-3} radians/second

C: 4.4 x 10^{-3} radians/second

D: 6.28 radians/second

E: 15 radians/second

Short answer Questions

P2

The distance from Earth to the Sun can be accurately calculated by measuring the distance from Earth to Venus when exactly half of Venus is visible as seen from Earth.

The angle between Venus and the Sun as seen from Earth is then measured.

a) Draw a labelled diagram to show the relative positions of Earth, Venus and the Sun when exactly half of Venus is visible from Earth.

[2]

b) State the angle between a line drawn from the Sun to Venus and a second line drawn from Earth to Venus (i.e. the angle between Earth and the Sun as seen from Venus).

[1]

c) The distance to Venus is measured by accurately timing how long it takes a radar beam to bounce off Venus and return to Earth.

Given that the speed of the radar beam is 2.9979 $x10^8$ m/s and the 'echo' of the radar signal is detected 692.43 s after being transmitted, show that the distance to Venus is about 10^8 km (calculate a more exact value).

[3]

P3

Astro-geologists on a trip to a distant planet find three different rocks on the surface of the planet – Red, Green and Blue - each with different length sides but each, strangely, in the form of perfect cubes.

They discover the following relationships:

- A red cube and a green cube put together are three times as long as a blue cube

- The volume of the red cube is 27 times that of the green cube

- The surface area of the blue cube added to the surface area of the green cube equals 150cm²

Work out the volumes of each of the cubes.

[3]

P4 This is a question about Units.

An inch is an imperial unit for distance equivalent to 2.54 cm.

A pound is an imperial unit for mass equivalent to 454g.

Convert a density of 1000 kg/m^3 into:

a) g/cm^3

[2]

b) pounds per cubic inch.

[2]

Pounds per Square Inch (psi) are units for pressure that correspond to the **weight** of one pound acting on an area of 1 inch^2. Taking the gravitational field strength to be 10N/kg:

c) Calculate the weight of 20 pounds in newtons

[2]

d) Calculate the pressure in pascals corresponding to 20 psi.

[2]

P5

a) Andrew and Simon are cricketers. They are both wearing whites on a sunny day. Why would white clothing benefit them?

[1]

b) Andrew later decides it's a bit chilly and puts on his old cricket sweater. This is full of holes, but still keeps him warm. Explain in terms of heat transfer why a woolly jumper would insulate the body.

[2]

c) Iain doesn't have time for cricket and prefers to play Squash indoors. Why might he be better off wearing dark clothing?

[1]

P6

A black box has four electrical connections labelled A, B, C and D arranged in a row as shown below

The box contains three components: a high value resistor, a small value resistor and a diode. You know that one component is connected between each consecutive pair of terminals, but you cannot see exactly how they are arranged. You make the following observations with a 9V battery connected in series with an ammeter.

- When the battery is connected with + to A and − to C a very small current flows
- When the battery is connected with + to B and − to D a very large current flows
- When the battery is connected with + to C and − to B no current is measured

Sketch the arrangement of the three components in the box indicating the terminals clearly.

[3]

END OF PHYSICS SECTION