Prep for Success Answer Series 1

Part 1

January 2013 Paper 2 Q2

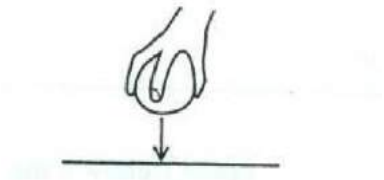
In this Question:

- Weight
- Measuring Instruments
- Vector scale diagram

a) Complete the table which shows physical quantities and the instruments used to measure them.

Quantity	Instrument
Diameter of a wire	Micrometer
Volume of a liquid	Measuring cylinder
Temperature	Thermometer
Weight	Spring balance
Time	Stop clock

b) A child drops a stone as shown in the figure below.



i) Identify the force which acts on the stone, causing it to fall.

The force of gravity

ii) Describe the change in motion of the stone as a result of of this force

It causes an increase in speed

c) i) Given that the mass of a cricket ball is 0.06 kg, calculate its weight in newtons.

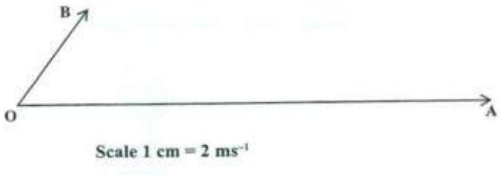
[Acceleration due to gravity, g = 10 ms^{-2}]

W = mg

W = 0.06 kg x 10 ms^{-2}

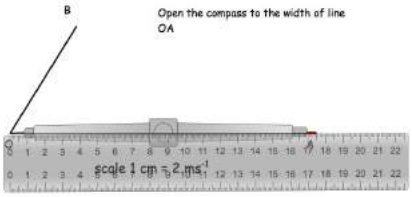
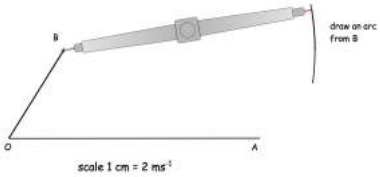
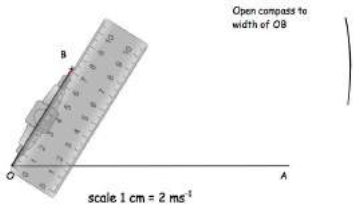
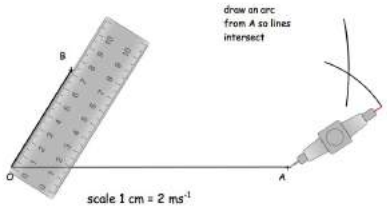
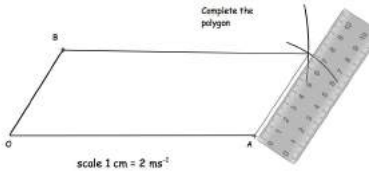
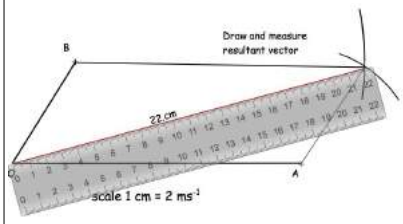
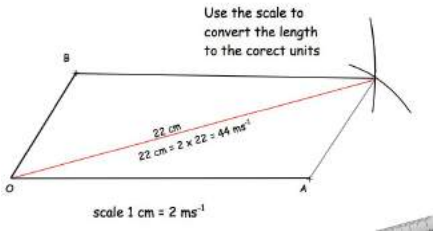
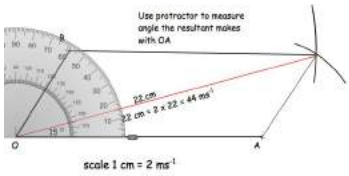
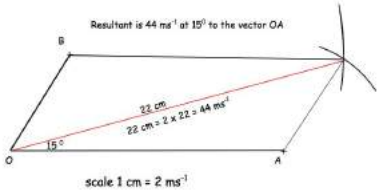
W = 0.6 N

ii) The figure below is a vector diagram representing a cricket ball's velocity, OA and the wind's velocity, OB.



a)By accurate scale drawing on the diagram, determine the resultant vector

b) State its magnitude in ms^{-1} and its direction in degrees from OA

 Open compass to width of OA	 Draw arc from B	 Open compass to width of OB
 Draw arc from A so lines intersect	 Complete polygon	 Draw resultant vector
 Use the scale to convert the length to the correct units	 Use protractor to measure angle the resultant makes with OA	 Resultant is 44 ms^{-1} at 15^0 to the vector OA

Prep for Success Answer Series 1

Part 2

May 2015. Paper 2. Question 4

In this question:

Newton's Laws

Momentum

Force

a. State Newton's laws of motion.

1st Law: A body at rest stays at rest or body in motion stays in motion unless compelled to do otherwise by some external, unbalanced force.

2nd Law: The acceleration of a body is directly proportional to the resultant force acting on it and inversely proportional to its mass. F = ma.

Newton's second law can also be stated as: the rate of change of momentum with time is directly proportional to the applied force

3rd Law: To every action there is an equal and opposite action

6 marks

b. In a crash test a car traveling at a constant velocity of 26 ms^{-1} crashes into a wall and is brought to rest.

i) Calculate the initial momentum of a 70 kg test dummy in the car before the crash.

momentum, p = mv

m = 70 kg

v = 26 ms^{-1}

p = 70 kg x 26 ms^{-1} = 1 820 kg ms^{-1}

3 marks

ii) Calculate the average force exerted on the dummy by the seatbelt during the crash if the duration of the collision is 0.1 seconds

the deceleration in coming to rest is found by using $a=\frac{v-u}{t}$

$$a = \frac{0 - 26\,ms^{-1}}{0.1\,s}$$

$$a = -260\,ms^{2}$$

The negative sign indicates that there is a deceleration. Once there is a deceleration/acceleration, the resultant force causing it can be found by using F = ma.

F = 70 kg x -260 ms^{-2}

F = -18 200 N

The negative sign indicates that it is a retarding force.

3 marks

Alternatively remember that Newton's second law can also be written as: rate of change of momentum with time is directly proportional to the applied force. This results in the following equation

$$F = \frac{mv - mu}{t}$$

Initial momentum, *mu* was calculated to be 1 820 kg ms^{-1}

Final momentum, *mv* is 0, since final speed, v is 0

$$\therefore \quad F = \frac{0 - 1820\,kg\,ms^{1}}{0.1\,s}$$

$$F = -18\,200\,N$$

The negative sign indicates that it is a retarding force and can be omitted.

3 marks

iii) With the removal of all protective features, the dummy was subjected to another crash test with the same initial speed. This time it was subjected to a 'lethal' decelerating force of 45 000N. Calculate the duration of this collision.

Using the concept rate of change of momentum is directly proportional to the applied force,

$$F = \frac{mv - mu}{t}$$

F = - 45 000N (I added a negative sign since it's decelerating)

mu, initial momentum = 1 820 kg ms^{-1}

mv = 0

t =?

$$-45\,000\,N = \frac{0 - 1820\,kg\,ms^{-1}}{t}$$

$$t = \frac{-1820}{-45000}$$

$$t = 0.040\,s$$

3 marks

Prep for Success Answer Series 1

Part 3

Jan 2014 - Paper 2 - Question 3

State the physical property that varies with temperature in each of the following thermometers.

A laboratory thermometer: volume of a liquid

A thermocouple: the voltage between two wires

Complete the table which relates the use of a thermometer to its design.

Use of Thermometer	**Design Feature**
To measure body temperature	small range between 35 ^{0}C - 42 ^{0}C
To measure temperatures lower than -40 ^{0}C	for liquid in glass thermometers, use liquid that has low freezing point alcohol
To measure at a precise location	Junction of small mass

State Charles' Law. Charles' Law states that for a fixed mass of gas at constant pressure the volume of the gas is directly proportional to the Kelvin temperature.

In a sealed cylinder, the volume of gas is recorded as 40 cm^3 with a temperature of 30 ^{0}C. What is the percentage increase in volume of the gas if the cylinder is heated until the gas temperature reaches 70 ^{0}C

Solution

$T_1 = 30^0 C$ converted to Kelvin $273+30=303\,K$

$V_1 = 40\,cm^3$

$T_2 = 70^0 C$ converted to Kelvin $273+70 = 343\,K$

$V_2 = ??$

Using the equation for Charles' Law

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$\frac{40}{300} = \frac{x}{340}$$

$$x = 340 \times \frac{40}{300}$$

$$x = 44.88\,cm^3$$

$x \approx 45\,cm^3$ correct to 2 sig fig

Change in volume = $45\,cm^3 - 40\,cm^3 = 5\,cm^3$

% increase in vol = $\frac{5}{40} \times 100 = 12.5\%$

Prep for Success Answer Series 1

Part 4

May / June 2013 Q3.

(a) i) State Snell's law

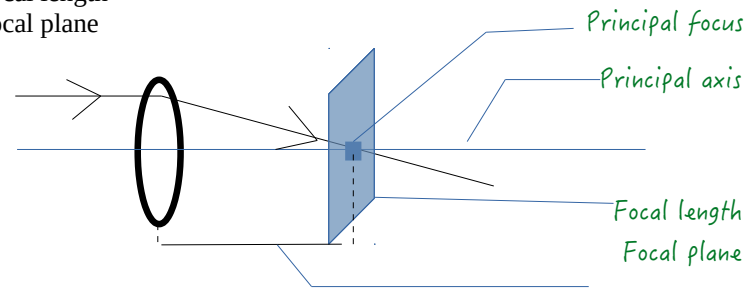
Snell's law states that the ratio of the sine of the angle of incidence to the sine of the angle of refraction is a constant, n. This value is a constant for any two given medium.

$$\frac{\sin i}{\sin r} = n$$

(3 marks)

ii) In the space below, draw a labelled diagram using the converging lens to show clearly the following features:

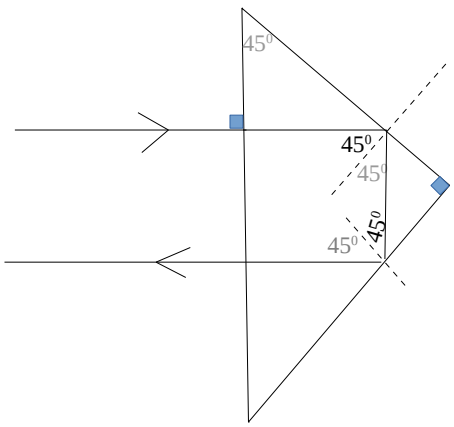
Principal axis
Principal focus
Focal length
Focal plane



(4 marks)

(b) i) Describe the path into a prism and out of a prism when a ray of light is incident at 90^0 to the hypotenuse of a right-angled glass prism as shown in Figure 1.

(7 marks)



At first boundary there is no refraction as the ray of light enters at 90° to the surface along the normal.

The angle of incidence that it makes at the second boundary is 45°. Since 45° is greater than the critical angle of glass, 42°, the light is totally internally reflected. The angle of reflection is 45°

At the other side of the prism the angle of incidence is 45° and again is greater than the critical angle for glass and the ray is totally internally reflected with an angle of reflection of 45°

ii) Through what angle would the ray be turned after emerging?

After emerging the ray is turned a total of 180^0.

(1 mark)

[Critical angle of glass = 42^0]

Jan 2013 Q 4

(a) Describe EACH of the following terms as it relates to the laws of reflection:

i) Normal

This is an imaginary line drawn at 90^0 to the surface at the point where the incident rays strike

ii) Angle of incidence

This is the angle between the incident ray and the normal

iii) Angle of reflection

This is the angle between the reflected ray and the normal

Describe what each of the terms mean.

(3 marks)

b) In the description of the formation of an image produced in a plane mirror, a physics students recalled three features.

State the three features of an image produced in a plane mirror. (3 marks)

Three features of an image produced in a plane mirror are

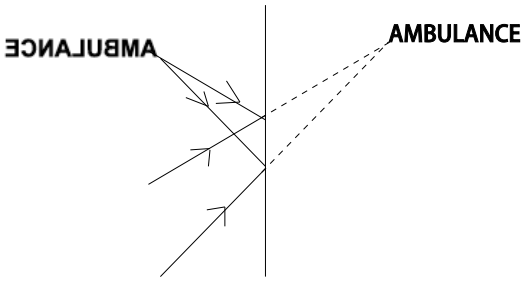
i) the image is laterally inverted

ii) the image is the same height as the object

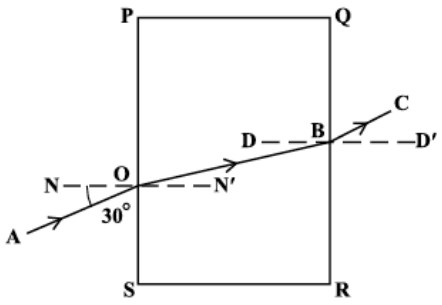
iii) the image is virtual

(c) Using a relevant physics concept, explain why the word  is painted in this manner at the front of some emergency vehicles (4 marks)

This is because when an image is formed in a plane mirror by reflection it is laterally inverted, i.e. what is on the left appears on the right. When it is viewed in the rear-view mirror of a driver who is driving in front the ambulance, the words will appear the right way and make it easy to read. See the diagram



(d) Figure 4 shows a ray of white light, AO, incident at 30^0 to the PS boundary of the rectangular glass block, PQRS



i) Calculate the angle of refraction produced on the PS boundary

$$n=\frac{\sin i}{\sin r}$$

$$1.5=\frac{\sin 30}{\sin r}$$

$$\sin r=\frac{\sin 30}{1.5}$$

$$\sin r=\frac{0.5}{1.5} \quad ==> \quad r=\sin^{-1}0.33 \quad = \quad 19.2^0\approx 20^0 \quad \text{correct to 1 sig fig}$$

ii) Name the angle of refraction produced on the QR boundary

This is the angle of emergence

[Refractive index of glass = 1.5]

(5 marks)