National 5 Mini Prelim

DATA SHEET

Speed of light in materials	
Material	*Speed in ms^{-1}*
Air	3×10^8
Carbon	3×10^8
Diamond	$1{\cdot}2 \times 10^8$
Glass	$2{\cdot}0 \times 10^8$
Glycerol	2.1×10^8
Water	$2{\cdot}3 \times 10^8$

Speed of sound in materials	
Material	*Speed in ms^{-1}*
Aluminium	5 200
Air	340
Bone	4 100
Carbon	270
Glycerol	1 900
Muscle	1 600
Steel	5 200
Tissue	1 500
Water	1 500

Gravitational field strengths	
	Gravitational field strength on the
Earth	9.8
Jupiter	23
Mars	3.7
Mercury	3.7
Moon	1·6
Neptune	11
Saturn	9
Sun	270
Venus	8.9
Uranus	8·7

Specific heat capacity of materials	
Material	*Specific heat capacity in Jkg^{-}*
Alcohol	2 350
Aluminium	902
Copper	386
Glass	500
Ice	2 100
Iron	480
Lead	128
Oil	2 130
Water	4 180

Specific latent heat of fusion of	
Material	*Specific latent heat of fusion in Jkg^{-1}*
Alcohol	$0{\cdot}99 \times 10^5$
Aluminium	$3{\cdot}95 \times 10^5$
Carbon	$1{\cdot}80 \times 10^5$
Copper	$2{\cdot}05 \times 10^5$
Iron	2.67×10^5
Lead	$0{\cdot}25 \times 10^5$
Water	$3{\cdot}34 \times 10^5$

Melting and boiling points of		
Material	*Melting point in*	*Boiling point in*
Alcohol	-98	65
Aluminium	660	2470
Copper	1 077	2 567
Glycerol	18	290
Lead	328	1 737
Iron	1537	2 737

Specific latent heat of	
|Material	*Sp.l.ht vap(Jkg^{-1})*
Alcohol	$11{\cdot}2 \times 10^5$
Carbon	$3{\cdot}77 \times 10^5$
Glycerol	$8{\cdot}30 \times 10^5$
Turpentine	$2{\cdot}90 \times 10^5$
Water	$22{\cdot}6 \times 10^5$

Radiation Weighting Factors	
Type of Radiation	*Radiation Weighting Factor*
alpha	20
beta	1
fast neutrons	10
gamma	1
slow neutrons	3

Prefixes

Prefix	Scientific notation	Decimal Value	Examples
pico (**p**)	1×10^{-12}	0.000000000001 $\frac{1}{1000000000000}$	picoFarad (**p**F)
nano (**n**)	1×10^{-9}	0.000000001 $\frac{1}{1000000000}$	nanometer (**n**m)
micro (**µ**)	1×10^{-6}	0.000001 $\frac{1}{1000000}$	microamp (**µ**A)
milli (**m**)	1×10^{-3}	0.001 $\frac{1}{1000}$	millisecond (**m**s)
centi (**c**)	1×10^{-2}	0.01 $\frac{1}{100}$	centimetre (**c**m)
kilo (**k**)	1×10^{3}	1000	kilogramme (**k**g)
Mega (**M**)	1×10^{6}	1000000	Megahertz (**M**Hz)
Giga (**G**)	1×10^{9}	1000000000	Gigawatts (**G**W)
Tera (**T**)	1×10^{12}	1000000000000	Terabytes (**T**B)

Relationship Sheet

$$E_p = mgh$$

$$E_k = \frac{1}{2}mv^2$$

$$Q = It$$

$$V = IR$$

$$R_T = R_1 + R_2 + \ldots$$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$$

$$V_2 = \left(\frac{R_2}{R_1 + R_2} \right) V_S$$

$$\frac{V_1}{V_2} = \frac{R_1}{R_2}$$

$$P = \frac{E}{t}$$

$$P = IV$$

$$P = I^2 R$$

$$P = \frac{V^2}{R}$$

$$E_h = cm\Delta T$$

$$p = \frac{F}{A}$$

$$\frac{pV}{T} = \text{constant}$$

$$p_1 V_1 = p_2 V_2$$

$$\frac{p_1}{T_1} = \frac{p_2}{T_2}$$

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

$$d = vt$$

$$v = f\lambda$$

$$T = \frac{1}{f}$$

$$A = \frac{N}{t}$$

$$D = \frac{E}{m}$$

$$H = Dw_R$$

$$\dot{H} = \frac{H}{t}$$

$$s = vt$$

$$d = \overline{v}t$$

$$s = \overline{v}t$$

$$a = \frac{v - u}{t}$$

$$W = mg$$

$$F = ma$$

$$E_w = Fd$$

$$E_h = ml$$

1. A cyclist rides along a road.

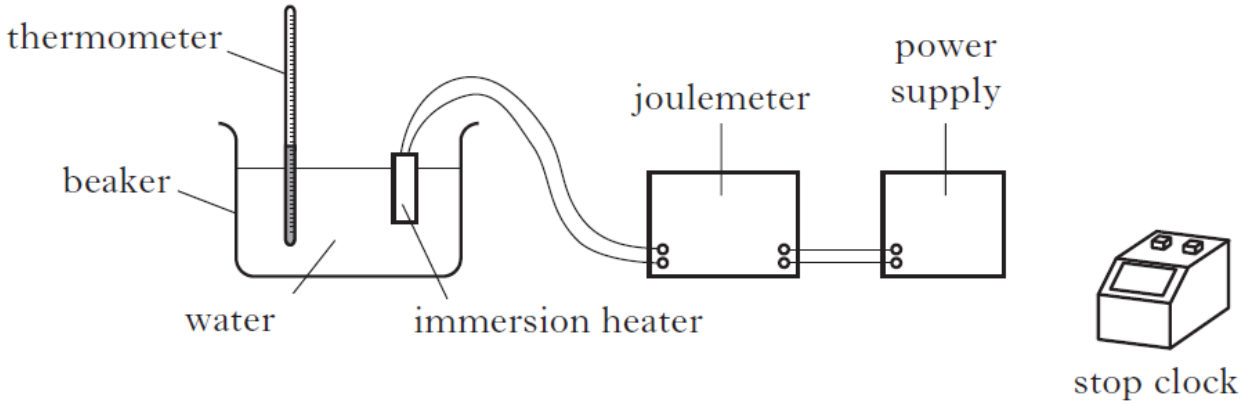
(*a*) Describe a method by which the average speed of the cyclist could be measured.

Your description must include the following

- Measurements made
- Equipment used
- Any necessary calculations.

Total 3 Marks

2. An experiment was carried out to determine the specific heat capacity of water. The energy supplied to the water was measured by a joulemeter.



The following data was recorded.
Initial temperature of the water = 21 °C.
Final temperature of the water = 33 °C
Initial reading on the joulemeter = 12 kJ
Final reading on the joulemeter = 120 kJ
Mass of water = 2.0 kg
Time = 5 minutes

(a) Calculate the value of the specific heat capacity of water obtained from this experiment.

3

(b) (i) The accepted value for the specific heat capacity is quoted in the table in the Data Sheet. Explain the difference between the accepted value and the value obtained in the experiment.

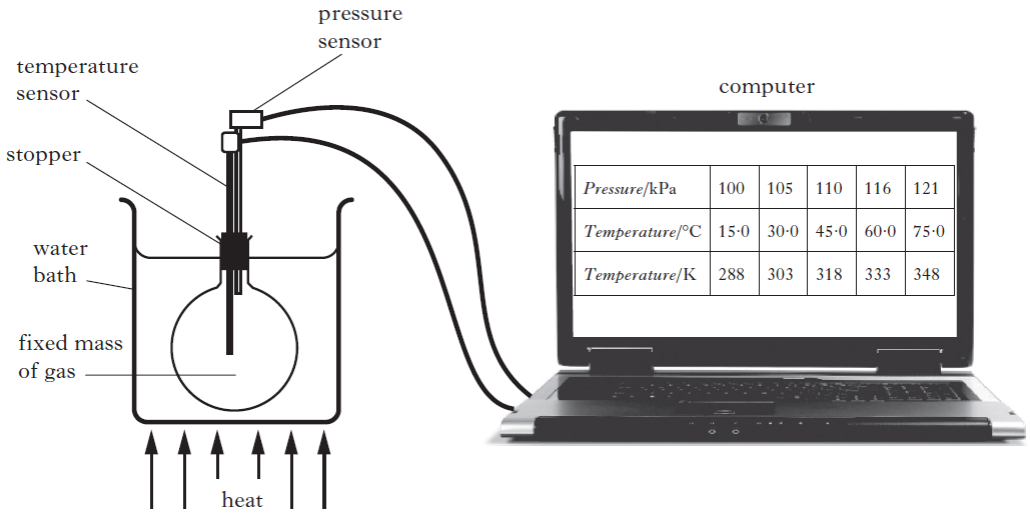
2

(ii) How could the experiment be improved to obtain a value for the specific heat capacity that is nearer to the value in the Data Table?

1

Total 6 Marks

3. A student carries out an experiment to investigate the relationship between the pressure and temperature of a fixed mass of gas. The apparatus used is shown.



The pressure and temperature of the gas are recorded using sensors connected to a computer. The gas is heated slowly in the water bath and a series of readings is taken.
The volume of gas remains constant during the experiment. The results are shown.

Pressure / kPa	100	105	110	116	121
Temperature/ °C	15.0	30.0	45.0	60.0	75.0
Temperature /K	288	303	318	333	348

(a) Using **all** the relevant data, establish the relationship between pressure and the temperature of the gas.

2

(b) Use the kinetic model to explain the change in pressure as the temperature of the gas increases.

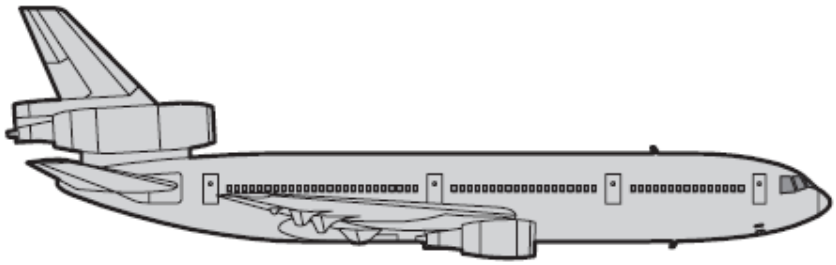
2

(c) Explain why the level of water in the bath should be above the bottom of the stopper.

1

Total 5 Marks

4. An aircraft is flying horizontally at a constant speed.



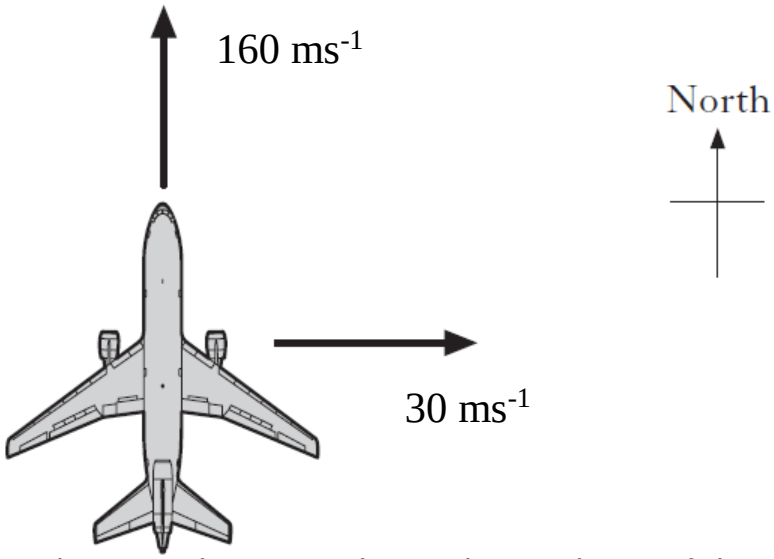
(*a*) The aircraft and passengers have a total mass of 50 000 kg.
Calculate the total weight.

3

(*b*) State the magnitude of the upward force acting on the aircraft.

1

(*c*) During the flight, the pilot selects a course of 160 ms^{-1}, due North.
The aircraft encounters a crosswind of 30 ms^{-1}, blowing from west to east.



By scale diagram, or otherwise, determine the resultant velocity of the aircraft.

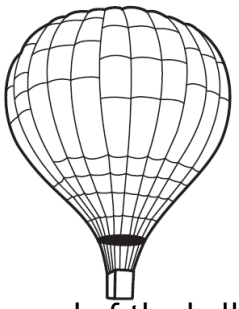
3

(d) Describe what action the pilot could take to ensure the aircraft remains travelling north at 160 ms^{-1}.

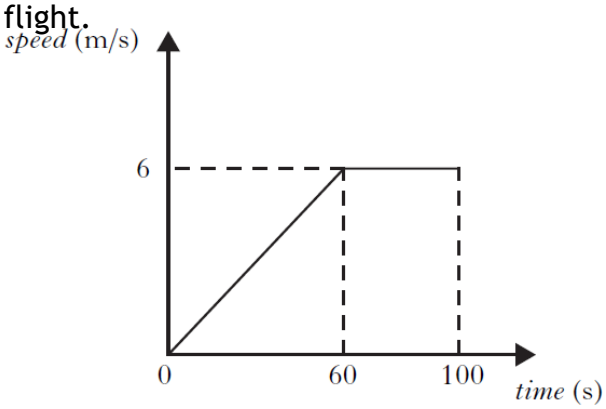
1

Total Marks 8

5. A balloon of mass 400 kg rises vertically from the ground.



The graph shows how the vertical speed of the balloon changes during the first 100 s of its upward flight.



(*a*) Calculate the acceleration of the balloon during the first 60 s of its flight.

3

(b) Calculate the unbalanced force acting upwards on the balloon during the first 60 s.

3

(*c*) Calculate the weight of the balloon.

3

(d) Calculate the size of the total upwards force acting on the balloon as it accelerates.

1

(e) Calculate the distance travelled by the balloon in 100 s.

3

Total Marks 13

6. A television commentator was heard to describe a free kick in a football match in the following way.

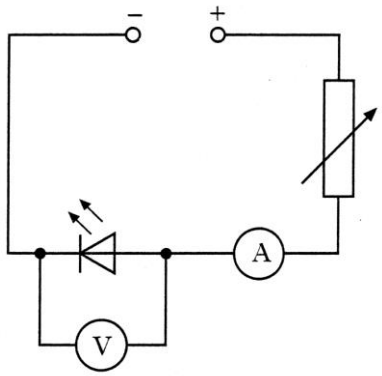
'It was a magnificent free kick. The ball flew into the net. Once it left his foot it really accelerated into the goal.'

Image: Soccer Ball In Goal Net" by tungphoto Free digital photos

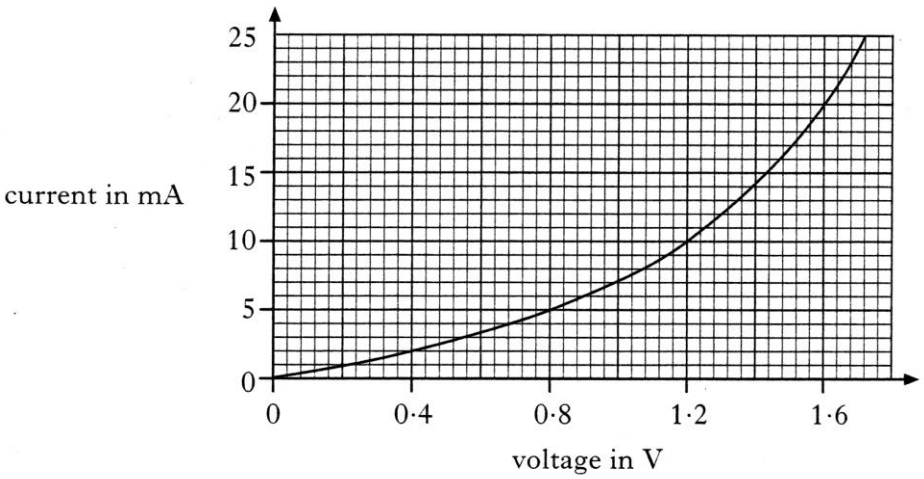
Using physics principles, comment on the way the television commentator has described the motion of the ball.

Total Marks 3

7. An LED is connected in the circuit shown.



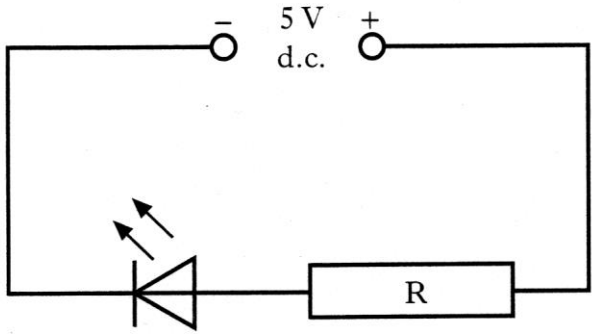
The variable resistor is adjusted and voltmeter and ammeter readings are taken. The following graph is obtained from the experimental results.



(a) Using information from the graph, determine how the resistance of the LED changes as the voltage across it is increased.
You **must** justify your answer by calculation.

3

(b) The LED is now connected into a circuit with a resistor R as shown.



The current in the LED is 20 mA.

(i) Using the graph on the previous page, state the voltage across the LED

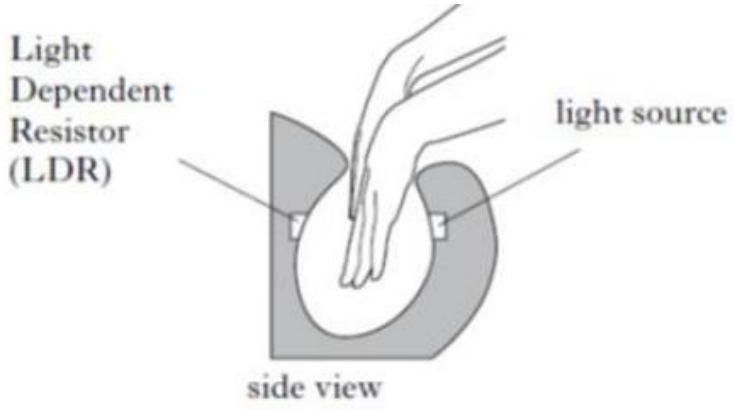
1

(ii) Calculate the resistance of resistor R.

4

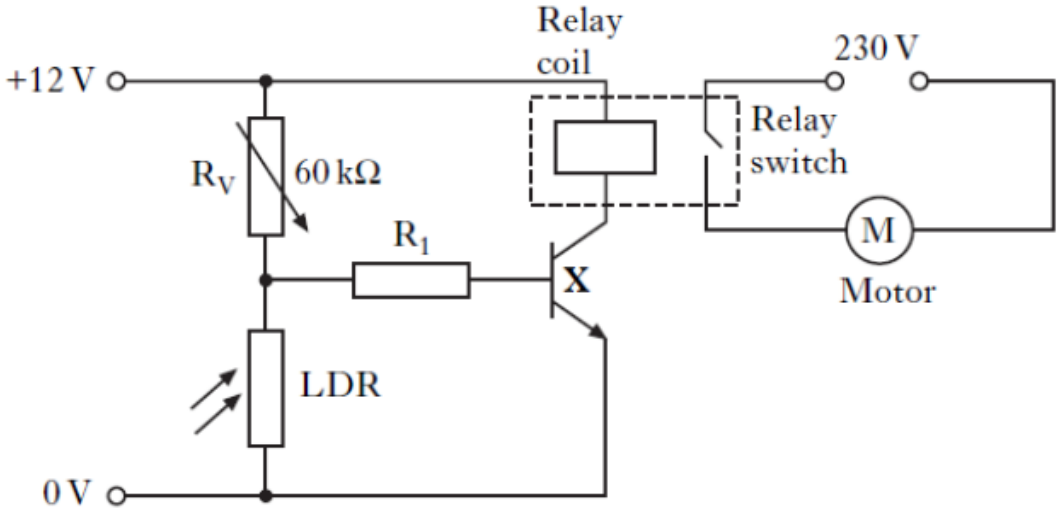
Total Marks 8

8. An automatic hand dryer used in a washroom is shown in the diagram below.



Inserting hands into the dryer breaks a light beam, this is detected using a light dependent resistor (LDR). The LDR is part of a switching circuit which activates the dryer when hands are inserted.

Part of the circuit for the hand dryer is shown.



(a) The variable resistor RV is set to a resistance of 60 k.
Calculate the voltage across the LDR when its resistance is 4 kΩ.

3

(b) Name component X in the circuit diagram.

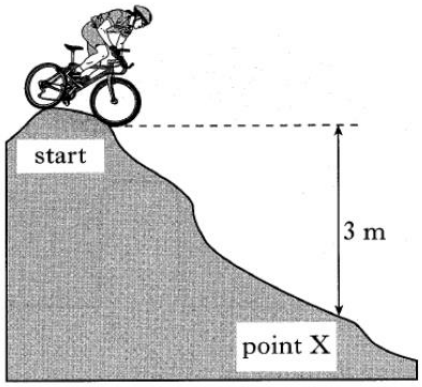
1

(c) Explain how this circuit operates to activate the motor in the dryer when the light level falls below a certain value.

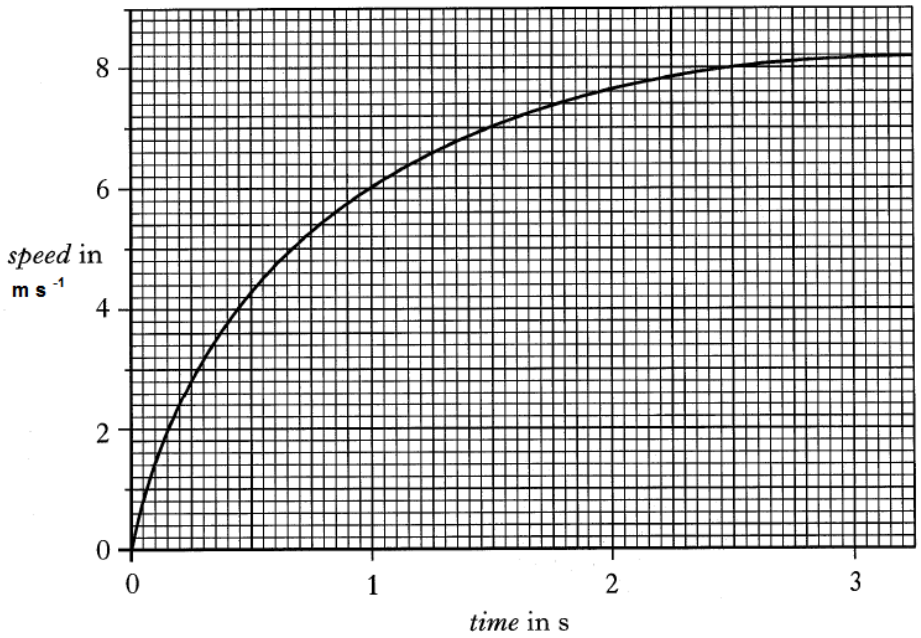
2

Total Marks 6

9. In a mountain bike competition, a competitor starts from rest at the top of a hill. He pedals downhill and after 2.5 s he passes point X which is 3 m lower than the start.



The total mass of the bike and the competitor is 90 kg.
A speed-time graph for this part of the competitor's journey is shown below.



(a) Calculate the decrease in gravitational potential energy of the competitor and bike between the start and point X.

3

(b) Calculate the kinetic energy of the competitor and bike at point X.

3

(c) Explain the difference between your answers to (a) and (b).

2

Total Marks 8

Total for Paper 60