



## FORMULAE

You may find the following formulae useful.

$$\text{energy transferred} = \text{current} \times \text{voltage} \times \text{time}$$

$$E = I \times V \times t$$

$$\text{pressure} \times \text{volume} = \text{constant}$$

$$p_1 \times V_1 = p_2 \times V_2$$

$$\frac{\text{pressure}}{\text{kelvin temperature}} = \text{constant}$$

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

$$\text{frequency} = \frac{1}{\text{time period}}$$

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

$$\text{power} = \frac{\text{work done}}{\text{time taken}}$$

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

$$\text{power} = \frac{\text{energy transferred}}{\text{time taken}}$$

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

Where necessary, assume the acceleration of free fall,  $g = 10 \text{ m/s}^2$ .



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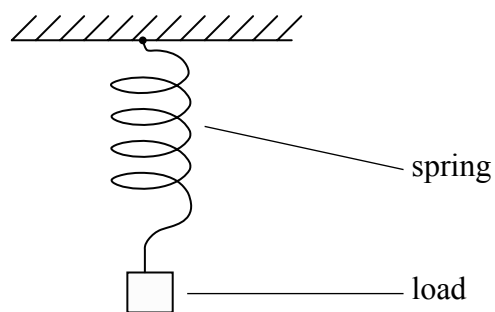


1. (a) Complete the sentence.

Hooke's law states that a force acting on a material produces an extension which is  
 ..... to the force.

(1)

(b) A student attaches a load to the end of a spring.



(i) Name the type of force acting in the stretched spring.

.....  
 (1)

(ii) The student measured the length of the spring for different loads.  
 The table shows her data.

Load (N)	0	1.0	2.0	3.0	4.0	5.0	6.0
Length of spring (mm)	30	70	110	150	190	250	320

1. Deduce the load in newtons that would produce a length of 130 mm.

Load = ..... N  
 (1)

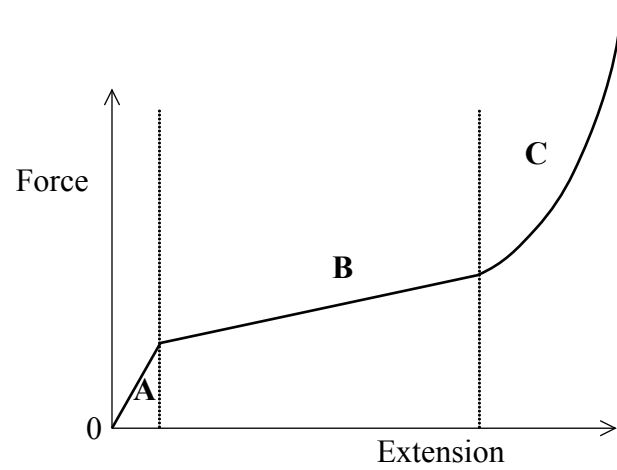
2. Estimate the maximum load in newtons at which the spring obeys Hooke's law.

Maximum load = ..... N  
 (1)



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(c) A force–extension graph for rubber is shown. Three regions A, B and C are labelled.



(i) In which region is Hooke's law obeyed?

.....  
(1)

(ii) In which region is the rubber easiest to extend?

.....  
(1)

(iii) Explain your answer to (ii).

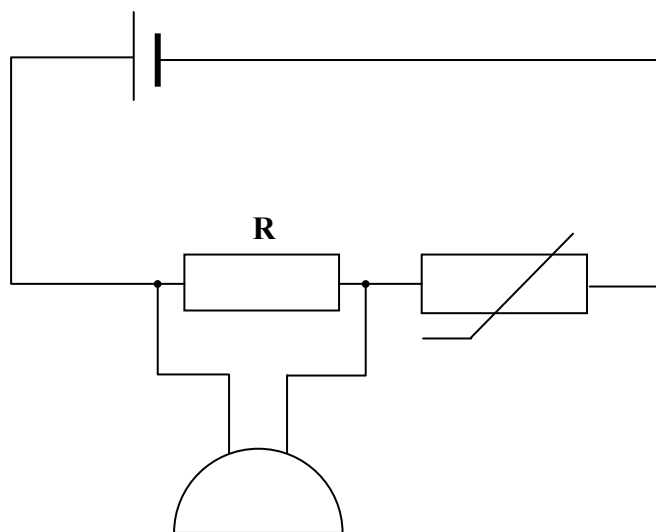
.....  
.....  
.....  
(1)

(Total 7 marks)

Q1



2. A circuit contains a resistor **R**, a thermistor and a buzzer connected to a cell as shown. The circuit can be used as a simple fire alarm.



- (a) (i) Complete the sentence.  
When temperature increases, the resistance of a thermistor ..... (1)
- (ii) What happens to the current in the circuit when the temperature increases?  
..... (1)
- (b) (i) State the equation which relates voltage, current and resistance.  
..... (1)
- (ii) When temperature increases, does the voltage across **R** stay the same, increase or decrease?  
..... (1)
- (iii) Explain your answer.  
.....  
..... (2)



(c) The buzzer starts to sound when the voltage across **R** is a particular value. Add a voltmeter to the circuit diagram to show how this voltage is measured.

(1)

(Total 7 marks)

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blank

Q2

**QUESTION 3 IS ON THE NEXT PAGE**



3. (a) (i) Define frequency.

.....  
(1)

(ii) Define time period.

.....  
(1)

(b) A student has a heart rate of 72 beats per minute.  
Calculate

(i) the frequency of his heart beat in hertz

Frequency = ..... Hz  
(1)

(ii) the time period of his heart beat in seconds.

Time period = ..... s  
(1)

(c) Generally the heavier an animal is, the lower is its heart rate. The data in the table gives the heart rate of animals of different masses.

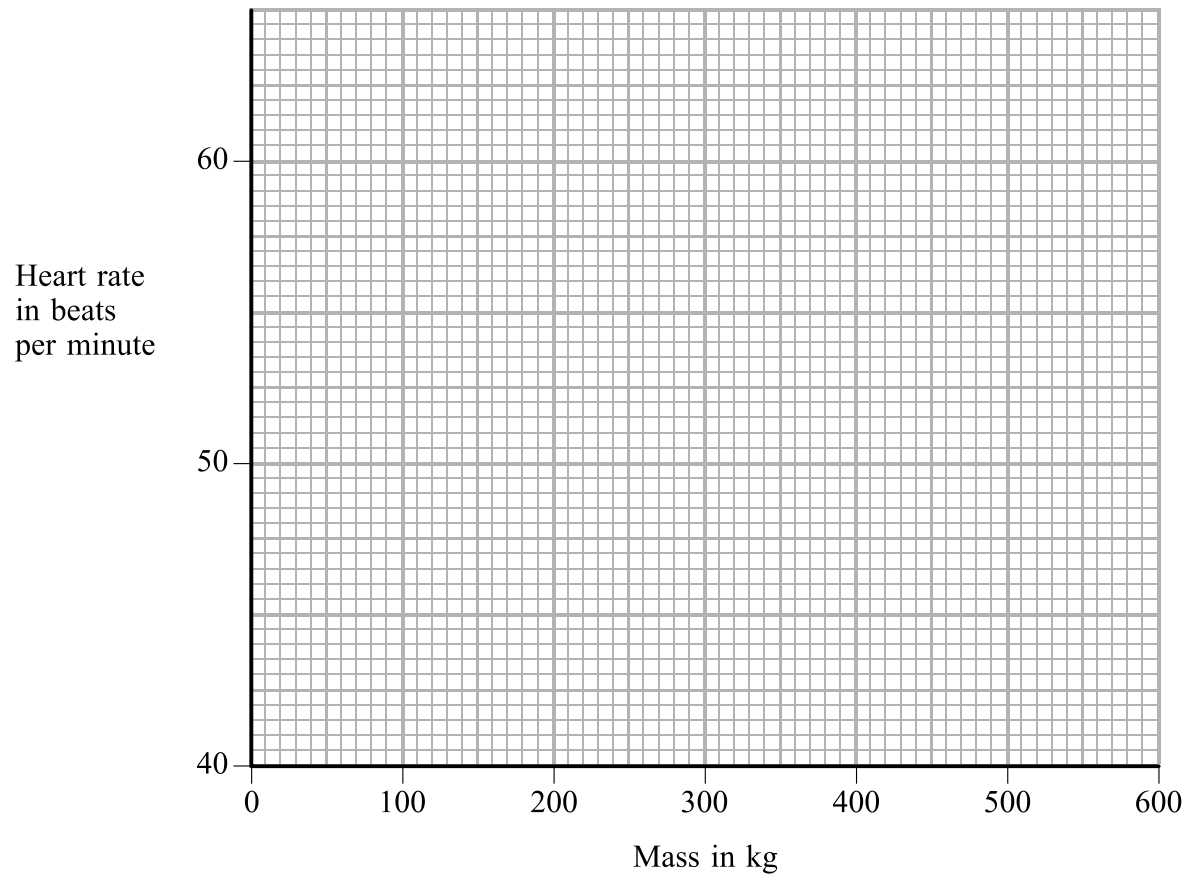
Mass (kg)	100	200	300	400	500	600
Heart rate (beats per minute)	63	53	48	45	42	40

(i) Use the grid opposite to plot a graph of heart rate against mass. Draw a smooth curve for your plotted points.  
(3)

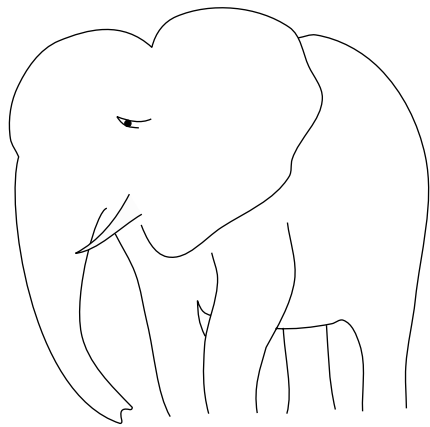




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(ii) This animal has a mass of 5000 kg.



Explain why you cannot use your graph to predict the heart rate of this animal.

.....

.....

(1)

Q3

(Total 8 marks)



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4. (a) Define the following terms.

(i) Atomic number

..... (1)

(ii) Mass number

..... (1)

(iii) Isotope

..... (1)

(b) How many of the following particles are found in a neutral atom of  ${}_{11}^{23}\text{Na}$ ?

(i) protons

..... (1)

(ii) neutrons

..... (1)

(iii) electrons

..... (1)

(c) Alpha, beta and gamma are three types of ionising radiation. Which one of these radiations does **not** contain any of the particles mentioned in (b)?

..... (1)

(d) State **one** danger of ionising radiations.

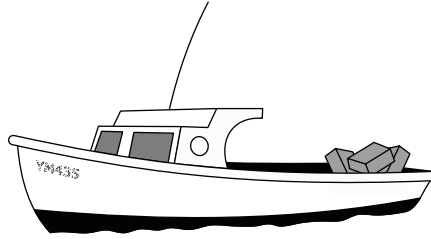
..... (1)

(Total 8 marks)

Q4



5. A fishing boat is floating on the still water of a deep lake.



The fisherman drops a heavy anchor into the lake. The anchor falls through the water and does not hit anything until it reaches the bottom.

- (a) Three forces act on the anchor as it falls through the water.
- (i) One of these forces is upthrust. State the name and direction of the other two forces.

1 .....

2 .....

(2)

- (ii) Which of the three forces changes significantly as the anchor falls?

.....

State how and why it changes.

.....

.....

(2)



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(b) The mass of the anchor is 12 kg. At one point in its fall the unbalanced force on the anchor is 15 N.

Calculate the acceleration of the anchor at this point and give its unit.

.....  
.....

Acceleration = .....  
**(3)**

(c) After a short time the anchor reaches its terminal velocity.

(i) Describe the motion of the anchor when it is at its terminal velocity.

.....  
.....

**(2)**

(ii) State the size of the unbalanced force on the anchor as it falls at its terminal velocity.

.....  
.....

**(1)**

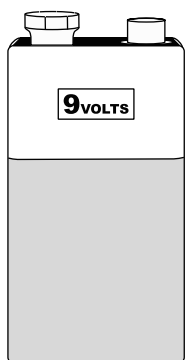
**Q5**

**(Total 10 marks)**

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6. The diagram shows a 9 V battery.



(a) The battery contains six cells connected in series.

Calculate the voltage of each cell.

.....

Voltage = ..... V  
**(1)**

(b) Complete the sentence.

Current is the rate of flow of .....

**(1)**

(c) The battery supplies an average current of 0.20 A for 3.0 hours. Use the equation

$$\text{energy transferred} = \text{current} \times \text{voltage} \times \text{time}$$

to calculate how much energy the battery transfers during this time and give its unit.

.....  
.....

Energy = .....  
**(3)**

(d) Describe the nature of an electric current in a metal wire.

.....  
.....

**(2)**



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blank

(e) The battery is described as a 9 V d.c. supply.  
State what the letters **d.c.** stand for.

.....  
(1)

(f) State **two** differences between a mains supply and the supply from the battery.

1 .....

2 .....

(2)

Q6

(Total 10 marks)

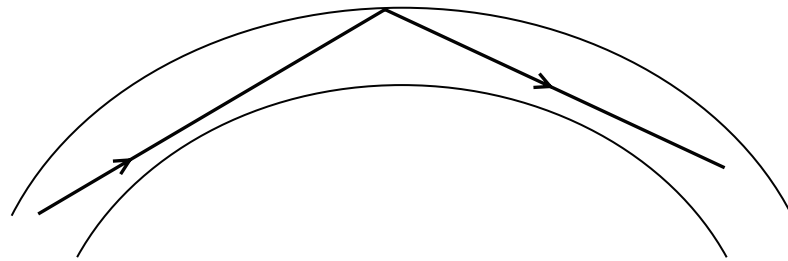


7. (a) State **one** use for optical fibres.

..... (1)

(b) The diagram shows a ray of light moving through part of an optical fibre.

(i) Add the normal and the angle of incidence to the diagram. (2)



(ii) Name the process which takes place in the diagram. (1)

(iii) Use the term **critical angle** to explain why the process takes place. (1)





(c) (i) State the equation which relates critical angle and refractive index.

.....  
(1)

(ii) The critical angle for glass in an optical fibre is  $41.5^\circ$ .

$$\cos 41.5^\circ = 0.749$$

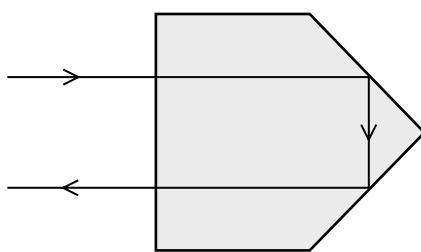
$$\sin 41.5^\circ = 0.663$$

$$\tan 41.5^\circ = 0.885$$

Calculate the refractive index of glass to three significant figures.

.....  
 .....  
 Refractive index = .....  
(3)

(d) A bicycle reflector is made of transparent red plastic. The diagram shows the path of a ray of light through part of the reflector.



The critical angle for the transparent red plastic is less than  $45^\circ$ . Explain how you can tell this from the diagram.

.....  
 .....  
 .....  
 .....  
(3)

(Total 12 marks)

Q7

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8. (a) A student reads in a science text book that

molecules in a gas exert a force on the walls of their container

(i) Describe the motion of the molecules in a gas.

.....  
.....  
.....  
.....

(3)

(ii) Explain how molecules exert a significant force.

.....  
.....  
.....  
.....

(3)



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(b) The student also reads that

the relationship between pressure and volume for a gas is  $p_1V_1 = p_2V_2$

A weather balloon is elastic. On the ground the pressure of the gas inside the weather balloon is 500 kPa and its volume is 1.2 m<sup>3</sup>. As the weather balloon rises its volume increases.

(i) Calculate the pressure in kilopascals inside the weather balloon when its volume has become 6.0 m<sup>3</sup>.

.....  
.....  
.....

Pressure = ..... kPa  
(2)

(ii) State **two** assumptions that you made.

1 .....  
2 .....  
(2)

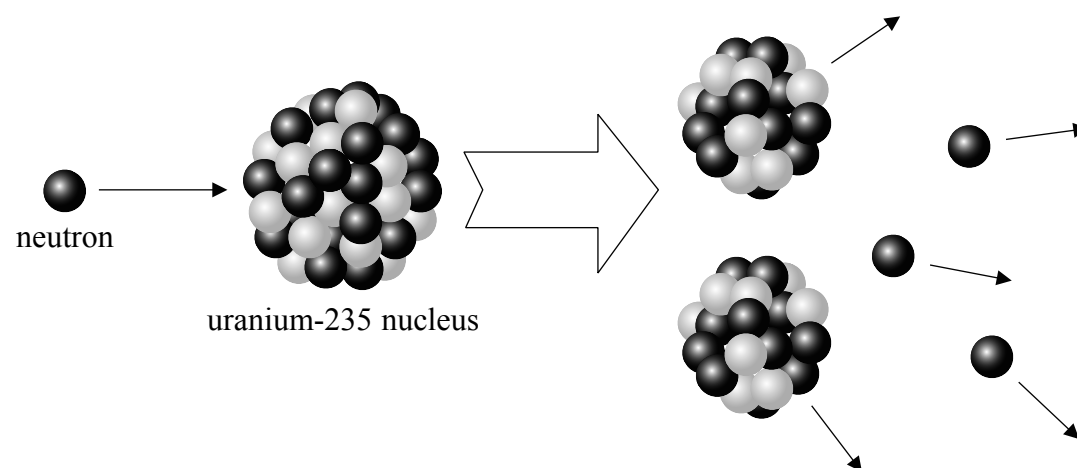
Q8

(Total 10 marks)



9. Uranium-235 can be used as the fuel in a nuclear power station.

(a) A uranium-235 nucleus can be split by a collision with a neutron. The diagram shows what happens.



(i) Name the process shown.

..... (1)

(ii) Three more neutrons are produced in this case. Describe how they can produce a chain reaction.

.....  
.....  
..... (2)

(iii) The process releases a lot of energy. In what form is this energy released?

..... (1)



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blank

(iv) It is easier to hit a nucleus with a neutron than with an alpha particle. Explain why.

.....  
.....  
.....  
.....

(3)

(b) The process in (a) occurs in the reactor of a nuclear power station. The reactor contains a moderator and control rods. State and explain the purpose of

(i) the moderator .....

.....  
.....

(2)

(ii) the control rods .....

.....  
.....

(2)

(Total 11 marks)

Q9

**QUESTION 10 IS ON THE NEXT PAGE**



10. The mass of a rugby ball is 0.44 kilograms.



The ball is kicked into the air. Just after it has been kicked the kinetic energy of the rugby ball is 26.62 joules.

(a) (i) State the equation that relates kinetic energy, mass and speed.

.....  
(1)

(ii) Calculate the speed, in metres per second, of the ball just after it has been kicked.

.....  
.....

Speed = ..... m/s  
(2)



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(b) (i) State the equation which relates the acceleration of free fall  $g$ , gravitational potential energy, height and mass.

.....  
(1)

(ii) Calculate the maximum change in height in metres reached by the ball.

.....  
.....

Maximum height = ..... m  
(2)

(iii) What assumption did you make to calculate the maximum height?

.....  
.....  
(1)

Q10

(Total 7 marks)

**TOTAL FOR PAPER: 90 MARKS**

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