LRN International A levels: Physics (6328)

Candidate Name	
Candidate Number	
Centre Name	
Centre Number	

Paper 1: Physics For Examination June 2023

(2 hours)

It is necessary to respond on the answer sheets provided alongside this question paper. Additionally, you must have a soft pencil (preferably of type B or HB),a clean eraser and a dark blue or black pen.

INSTRUCTIONS:

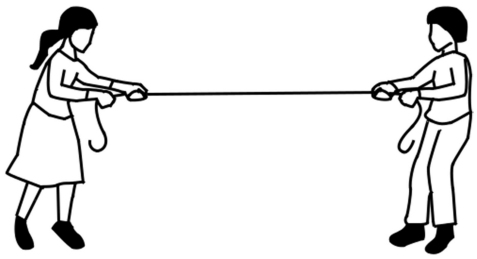
- You must write your name, candidate number, centre name and centre number on the answer sheets in the designated spaces.
- Objective section consists of 40 questions, and it is essential that you attempt all of them.
- Each question has four options labelled A, B, C, and D. Select the option that you think is correct. Mark it on the multiple choice answer sheet using a soft pencil.
- Attempt all the questions from subjective section using a dark blue or black pen.
- It is important to follow the instructions provided on the answer sheets.
- Do not use correction fluid.
- Avoid writing on any bar codes.
- You are allowed to use a calculator if needed.

INFORMATION:

- This paper has a total of 85 marks.
- In objective section there are 25 questions, each carries one mark. There is no negative marking for incorrect responses.
- In subjective section, 30 marks are for extended theory and 15 marks for practical component.
- The number of marks assigned for every question or its parts is indicated within brackets [ ]

Section A: Multiple Choice

1. Two students pull on opposite ends of a rope, as shown in the diagram below. Each student pulls with a force of 400 N.

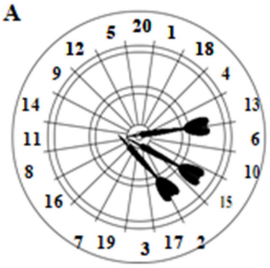


Which one of the following is closest to the magnitude of the force of the rope on each student?

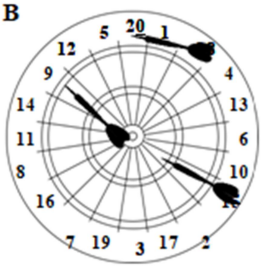
A) 0 N
B) 400 N
C) 600 N
D) 800 N

2. The aim of darts is to hit the bullseye at the centre of a dartboard. Four darts players (A, B, C and D) each threw three darts. The results of their throws are shown below.

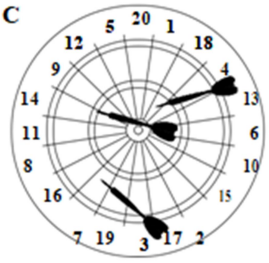
Player A



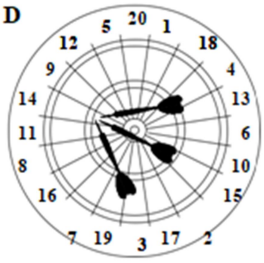
Player B



Player C



Player D



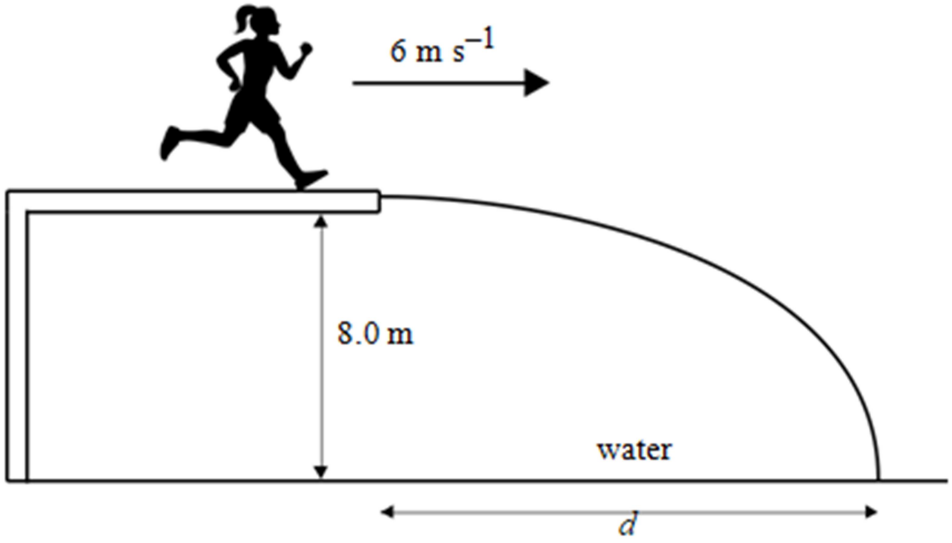
3. Which one of the players produced a set of attempts that could be described as being precise but inaccurate?
   A) Player A
   B) Player B
   C) Player C

4. The experimental uncertainty of a measurement is best understood as
   A) an estimate of the validity of the data.
   B) a mistake in the experimental method used.
   C) a mistake in the recording of a measurement.
   D) an estimate of the maximum likely difference between the measurement and the true value.

For questions 5 & 6, use the below information:

Lucy is running horizontally at a speed of 6 m s^{-1} along a diving platform that is 8.0 m vertically above the water.

Lucy runs off the end of the diving platform and reaches the water below after time *t*.
She lands feet first at a horizontal distance *d* from the end of the diving platform.



5. Which one of the following expressions correctly gives the distance *d*?
   A) $0.8t$
   B) $6t$
   C) $5t^2$
   D) $6t + 5t^2$

6. Which one of the following is closest to the time taken, *t*, for Lucy to reach the water below?
   A) 0.8 s
   B) 1.1 s
   C) 1.3 s
   D) 1.6 s

7. A cyclist is riding at a steady speed on a level road. According to Newton's third law of motion, what is equal and opposite to the backward push of the back wheel on the road?

A) the force exerted by the cyclist on the pedals

B) the total air resistance and friction force

C) the tension in the cycle chain

D) the forward push of the road on the back wheel

8. A resultant force causes a body to accelerate. What is equal to the resultant force?

A) the acceleration of the body per unit mass

B) the change in kinetic energy of the body per unit time

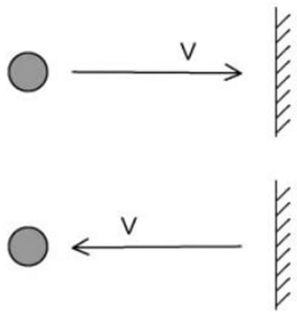
C) the change in momentum of the body per unit time

D) the change in velocity of the body per unit time

9. What is meant by the mass and by the weight of an object on the Earth?

	Mass	Weight
A	its momentum divided by its velocity	the work done in lifting it one metre
B	the gravitational force on it	the property that resists its acceleration
C	the property that resists its acceleration	the pull of the Earth on it
D	the pull of the Earth on it	its mass divided by the acceleration of free fall

10. An object travelling with velocity ***v*** strikes a wall and rebounds as shown



Which property of the object is not conserved?

A. momentum

B. mass

C. kinetic energy

D. speed

11. An egg is dropped from the top of a three-storey building. It falls through air until it reaches the ground. What remains constant throughout the fall?

A. acceleration of the egg

B. weight of the egg

C. velocity of the egg

D. air resistance on the egg

[1 mark]

12. The gravitational field strength on the surface of planet R is one eighth of that on the surface of planet S. On the surface of R, a body has its mass measured to be 2.5 kg and its weight measured to be 12.5 N

What results are obtained for measurements of the mass and weight of the same body on the surface of planet S?

	Mass on S	Weight on S
A	2.5 kg	20 N
B	20 kg	100 N
C	2.5 kg	100 N
D	20 kg	160 N

13. Which is not one of Newton's laws of motion?

A. If body A exerts a force on body B, then body B exerts an equal and oppositely-directed force on body A

B. The rate of change of momentum of a body is directly proportional to the external force acting on the body and takes place in the direction of the force

C. The total momentum of a system of interacting bodies remains constant, providing no external force acts

D. A body continues in a state of rest or of uniform motion in a straight line unless acted upon by some external force

14. As a car accelerates uniformly, its momentum is measured at regular intervals

A graph of the momentum of the car is plotted against time

What is evaluated by finding the gradient of the graph at a particular time?

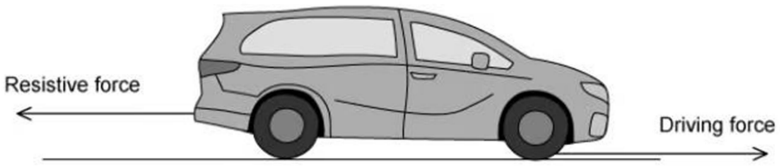
A. the acceleration of the car

B. the resultant force on the car

C. the kinetic energy of the car

D. the velocity of the car

15. A car has a horizontal driving force of 2.0 kN acting on it and a resistive force a quarter of this size. It has a forward horizontal acceleration of 2.0 m s^{-2}



What is the mass of the car?

A. 500 kg

B. 750 kg

C. 1250 kg

D. 2000 kg

16. A Sprinter runs a 200m race in a straight line. He accelerates from the starting block at a constant acceleration of 2.5 m s^{-2} to reach his maximum speed of 10 m s^{-1}. He maintains this speed until he crosses the finish line.

Which time does it take the sprinter to run the race?

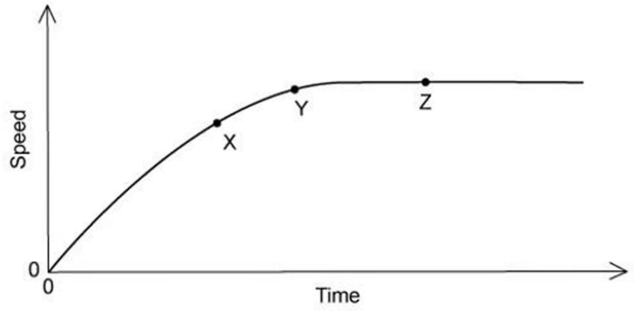
A. 8 s

B. 20 s

C. 22 s

D. 40 s

17. A raindrop falls vertically from rest in air. The variation with time of the speed of the raindrop is shown in the graph.



Which statement about the raindrop is correct?

A. at point X, the raindrop has an acceleration of 9.81 m s^{-2}

B. at point Z, the force on the raindrop due to air resistance has reached its maximum value and so the acceleration of the raindrop has also reached its maximum value

C. at point Z, the force due to air resistance is equal and opposite to the weight of the raindrop and so the speed of the raindrop is zero

D. the resultant force on the raindrop at point Y is less than the resultant force on the raindrop at point X

18. An aeroplane travels at an average speed of 700 km h^{-1} on an outward fight and at 300 km h^{-1} on the return fight over the same distance.

What is the average speed of the whole fight?

A. 400 km h^{-1}

B. 420 km h^{-1}

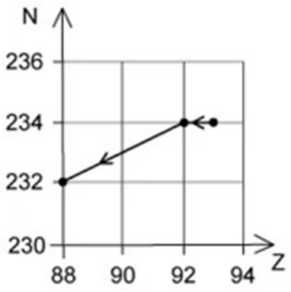
C. 480 km h^{-1}

D. 500 km h^{-1}

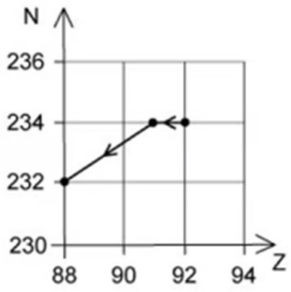
19. A radioactive nucleus is formed by β-decay. This nucleus then decays by α-emission.

The graph below show the nucleon number N plotted against proton number Z. Which one shows the β-decay followed by the α-emission?

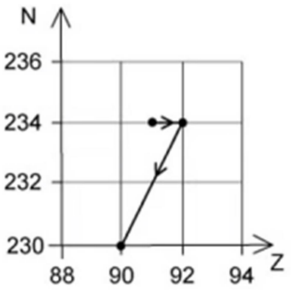
A



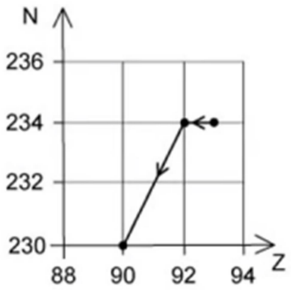
B



C



D



20. An element emits an alpha particle from its radioactive nucleus.

The daughter nucleus then emits a beta particle, and then the daughter nucleus of that reaction emits another beta particle. Which statement describes the final nuclide that is formed?

A) it is a nuclide of the same element but with different proton number

B) it is a nuclide of a different element of higher proton number

C) it is a different isotope of the original element

D) it is identical to the original nuclide

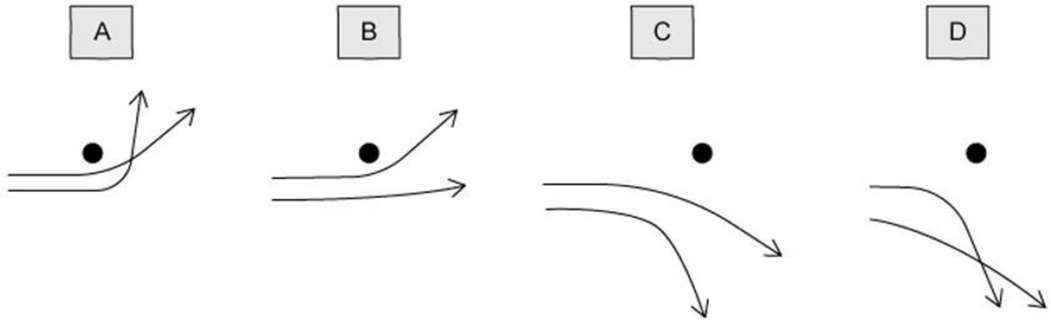
21. A thorium isotope has a nucleon number of 232 and a proton number of 90. It decays to form another isotope of with a nucleon number of 228.

How many alpha particles and beta particles are emitted during this decay?

	Alpha particles	Beta particles
A	0	4
B	1	2
C	1	1
D	2	1

22. Two α-particles with equal energies are defected by a gold nucleus.

Which diagram best represents their paths?



23. Thorium $^{232}_{90}\mathrm{Th}$ decays through a series of transformations. The particles emitted in successive transformations are: α β β γ α

The resulting nuclide may be represented by

A) $^{230}_{82}Pb$

B) $^{227}_{85}At$

C) $^{227}_{85}Fr$

D) $^{224}_{88}Ra$

24. Which of the following equations correctly shows an α-particle causing a nuclear reaction?

A) $^{14}_{7}N + {}^{4}_{2}He \rightarrow {}^{17}_{8}O + {}^{1}_{1}n$

B) $^{17}_{8}O + {}^{4}_{2}He \rightarrow {}^{20}_{9}F + {}^{1}_{1}p$

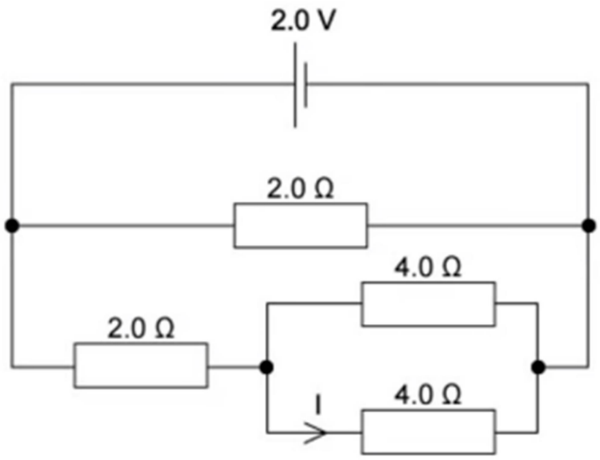
C) $^{17}_{8}O + {}^{0}_{-1}e \rightarrow {}^{13}_{5}B + {}^{4}_{2}He$

D) $^{14}_{7}N + {}^{1}_{1}p \rightarrow {}^{11}_{6}C + {}^{4}_{2}He$

25. Two lamps are connected in series to a 250 V power supply. One lamp is rated 240 V, 60 W and the other is rated 10 V, 2.5 W. Which statement most accurately describes what happens?

A) Both lamps light at less than their normal brightness
B) Both lamps light normally
C) Only the 60 W lamp lights
D) The 10 V lamp blows

26. A cell of e.m.f. 2.0 V and negligible internal resistance is connected to a network of resistors as shown.



What is the current *I* ?

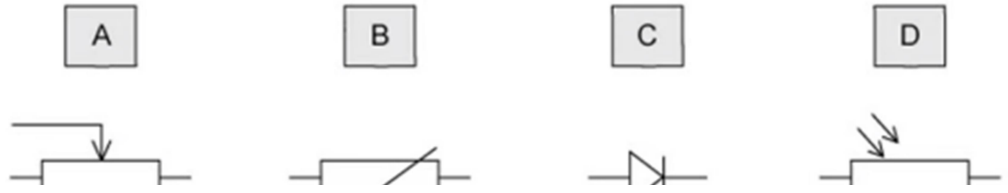
A) 0.25 A
B) 0.33 A
C) 0.50 A
D) 1.5 A

27. A battery is marked 9.0 V.

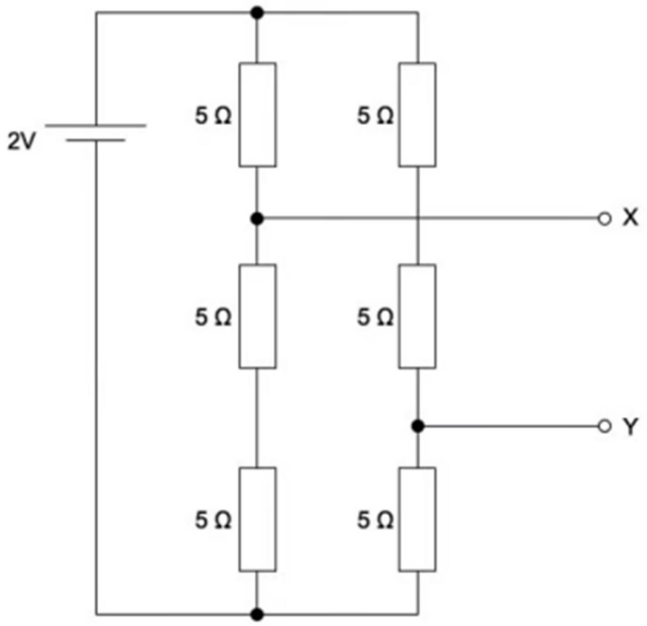
What does it mean?

A) Each coulomb of charge from the battery supplies 9.0 J of electrical energy to the whole circuit
B) The battery supplies 9.0 J to an external circuit for each coulomb of charge
C) The potential difference across any component connected to the battery will be 9.0 V
D) There will always be 9.0 V across the battery terminals

28. Which symbol represents a component whose resistance is designed to change with temperature?



29. Six resistors, each of resistance 5 Ω, are connected to a 2 V cell of negligible internal resistance.



30. What is the potential difference between terminals X and Y?

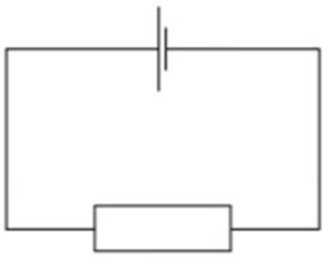
A) $\frac{2}{3}$ V

B) $\frac{8}{9}$ V

C) $\frac{4}{3}$ V

D) 2 V

31. A cell is connected to a resistor. At a given moment, the potential difference across the cell is less than its electromotive force.



32. Which statement explains this?

A) The cell is continually discharging
B) The connecting wire has some resistance
C) Energy is needed to drive charge through the cell

33. The combined resistance R_T of two resistors of resistances R_1 and R_2 connected in parallel is given by the formula

$$\frac{1}{RT} = \frac{1}{R1} + \frac{1}{R2}$$

Which statement is used in the derivation of this formula?

A) The currents through the two resistors are equal
B) The potential difference across each resistor is the same
C) The supply current is split between the two resistors in the same ratio of their resistances
D) The total power dissipated is the sum of the powers dissipated in the two resistors separately

34. An object, immersed in a liquid in a tank, experiences an upthrust.

What is the physical reason for this upthrust?

A) The density of the body differs from that of the liquid
B) The density of the liquid increases with depth
C) The pressure in the liquid increases with depth
D) The value of g in the liquid increases with depth

35. The density of mercury is 13.6 x 10^3 kg m^{-3}. The pressure difference between the bottom and the top of a column of mercury is 100 kPa. What is the height of the column?

A) 0.75 m
B) 1.3 m
C) 7.4 m
D) 72 m

36. A ball is falling at terminal speed in still air. The forces acting on the ball are upthrust, viscous drag and weight.

What is the order of increasing magnitude of these three forces?

A) Upthrust → viscous drag → weight
B) Viscous drag → upthrust → weight
C) Viscous drag → weight → upthrust
D) Weight → upthrust → viscous drag

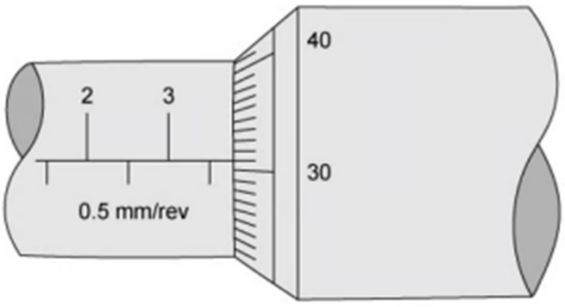
37. A steel wire is stretched in an experiment to determine the Young modulus for steel. The uncertainties in the measurements are given below.

Measurement	Uncertainty
Load on wire	± 2%
Length of wire	± 0.2%
Diameter of wire	± 1.5%
Extension	± 1.0%

What is the percentage uncertainty in the Young modulus?

A) 1.3 %
B) 1.8 %
C) 4.7 %
D) 6.2 %

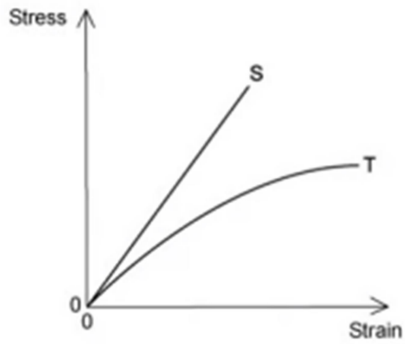
38. The diameter of a cylindrical metal rod is measured using a micrometer screw gauge. The diagram below shows an enlargement of the scale on the micrometer screw gauge when taking the measurement.



What is the cross-sectional area of the rod?

A) 3.81 mm^2
B) 11.4 mm^2
C) 22.8 mm^2
D) 45.6 mm^2

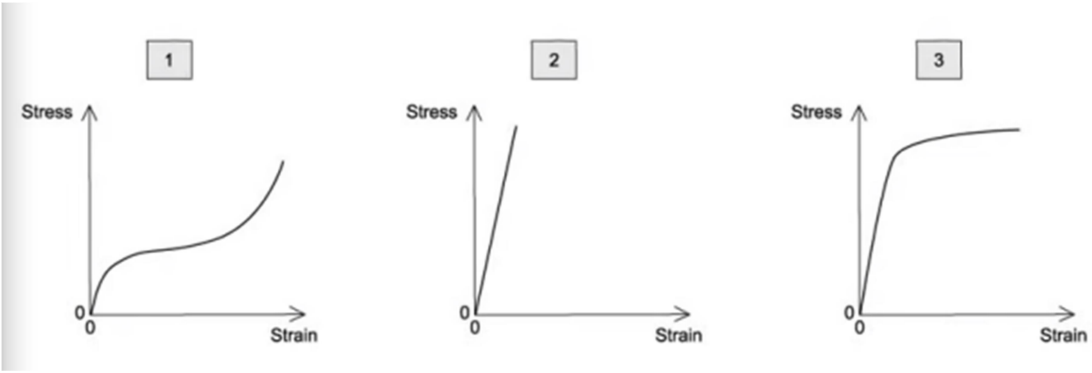
39. Two wires S and T, with the same initial dimensions, were put under stress and strain; the graph shows the results up to their breaking points.



Which statement is not correct?

A) Material S has a larger ultimate tensile stress
B) Material S extends elastically
C) Material S extends more than material T when loaded with the same force
D) Material S is brittle

40. The graphs below show the stress-strain graphs of three materials. The graphs do not have the same scales.



The three materials are copper, rubber and glass.

Which materials are represented by the graphs?

	1	2	3
A	Rubber	Copper	Glass
B	Rubber	Glass	Copper
C	Glass	Copper	Rubber
D	Copper	Glass	Rubber

Section B – Short answer questions (30 marks)

Question 1 (12 marks)

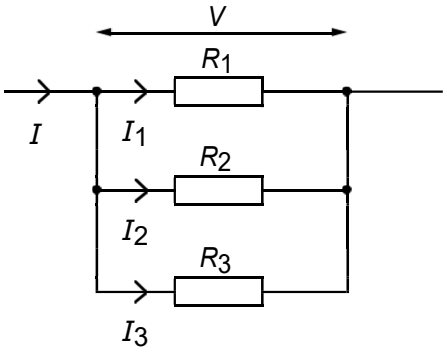


Figure 1.

The currents in the resistors are I_1, I_2 and I_3. The total current in the combination of resistors is I and the potential difference across the combination is *V*.

Show that the total resistance *R* of the combination is given by the equation

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}.$$

[2]

(b) A battery of electromotive force (e.m.f.) 6.0 V and internal resistance *r* is connected to an external resistor of resistance 12 Ω and a thermistor X, as shown in Figure 2.

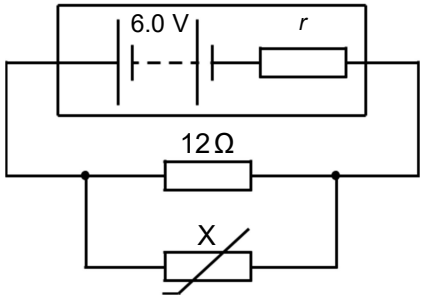


Figure 2.

(i) By considering energy, explain why the potential difference across the terminals of the battery is less than the e.m.f.

.....

..... [1]

(ii) A charge of 2.5 kC passes through the battery. Calculate:

- the total energy transferred by the battery

energy = ... J

- the number of electrons that pass through the battery.

number = ...
[3]

(iii) The combined resistance of the external resistor and thermistor X connected in parallel is 4.8 Ω.

Calculate the resistance of X.

resistance = ... Ω [1]

(iv) Use your answer in (b)(iii) to determine the ratio

$$\frac{\text{power dissipated in thermistor X}}{\text{power dissipated in 12X resistor}}.$$

ratio = ... [2]

(v) The temperature of thermistor X is now decreased.

State and explain the effect, if any, of this temperature change on the total power produced by the battery.

.....

.....

.....

..... [3]

[Total: 12]

Question 2 (14 marks)

(a) (i) Define the term 'force'.

.....

..... [1]

(ii) State what is meant by work done.

.....

..... [1]

(b) A block of mass 0.40 kg slides in a straight line with a constant speed of 0.30 m s^{-1} along a horizontal surface, as shown in Figure 3.

Figure 3

Assume that there are no resistive forces opposing the motion of the block.

The block hits a spring and decelerates. The speed of the block becomes zero when the compression of the spring is 8.0 cm.

(i) Calculate the initial kinetic energy of the block.

kinetic energy = ... J [2]

(ii) The variation of the compression x of the spring with the force F applied to the spring is shown in Figure 4.

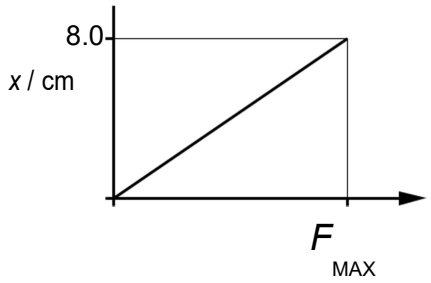


Figure 4

Assume that the elastic potential energy of the spring when its compression is 8.0 cm is equal to the initial kinetic energy of the block.

Use your answer in (b)(i) to calculate the maximum force F_{MAX} exerted on the spring by the block.

F_{MAX} = ... N [2]

(iii) Calculate the maximum deceleration of the block.

Deceleration = ... m s^{-2} [2]

(iv) State and explain whether the block is in equilibrium:

- before it hits the spring

.....

.....

[2]

- when its speed becomes zero.

.....

.....

[2]

(v) The block is now replaced by another block of the same mass. Frictional forces affect the motion of this block so that it has a speed of $0.25\,\text{m s}^{-1}$ when it makes contact with the spring.

A short time later, the block has a speed of $0.15\,\text{m s}^{-1}$ as it loses contact with the spring and moves back along its original path.

Calculate the magnitude of the change in momentum of the block.

Change in momentum = ... N s [2]

[Total: 14]

Question 3 (4 marks)

(a) State what is meant by a *scalar* quantity and by a *vector* quantity.

scalar:

.....

.....

vector:

.....

.....

[2]

(a) Complete Table 1 below to indicate whether each of the quantities is a vector or a scalar.

Table 1

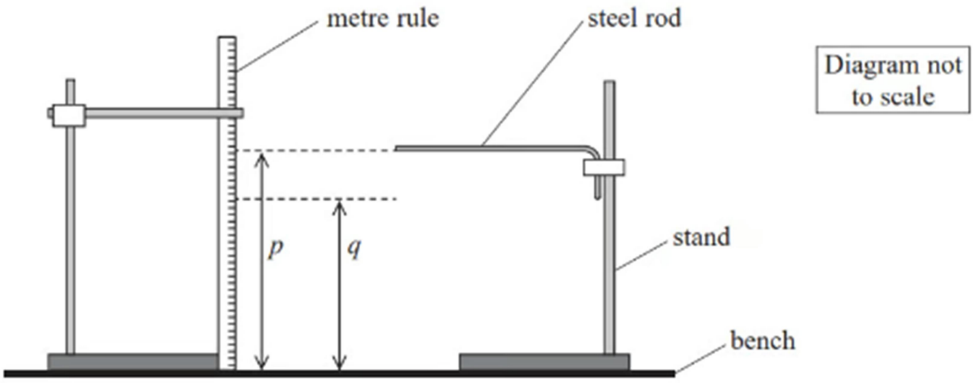
quantity	vector or scalar
power	
temperature	
momentum	

[2]

Section C: Practical-based skills (15 marks)

Question 1 (15 marks)

An L-shaped steel rod was held horizontally in a stand clamped by its shorter end as shown.



The end of the steel rod was at a height p above the bench.

A student attached a mass m to the end of the steel rod causing it to bend towards the bench. The end of the steel rod was then at a height q above the bench.

a) i) Describe two techniques she should use when measuring p and q.

……

……

……

……

[2 marks]

ii) The difference between p and q was recorded as 26 mm ± 1 mm. Explain why the uncertainty in this value was given as 1 mm.

……

……

……

……

[2 marks]

b) The steel rod had a circular cross-section with a diameter d of approximately 2 mm.

i) Explain the most appropriate instrument the student should use to measure d.

.....

.....

.....

.....

[2 marks]

ii) Explain one technique that she should use to measure d.

.....

.....

.....

.....

[2 marks]

iii) She recorded the following measurements.

d / mm				
2.35	2.37	2.34	2.35	2.33

Calculate the mean value of *d* in mm and its uncertainty.

Mean value of d = ...mm

± .....mm

[2 marks]

The shear modulus is a measure of a material's resistance to bending, and is given by:

$$G = \frac{32mglx^2}{\pi y d^4}$$

Where m is the mass attached to the end of the rod and y is the vertical deflection.

L and x are the lengths as shown below.

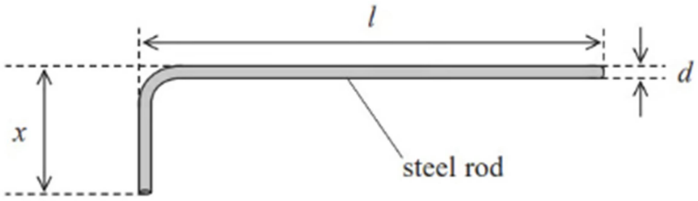


Diagram not to scale

Determine a value of G for steel in N m^{-2}.

m = 100 g with negligible uncertainty
l = 58.9 cm ± 0.1 cm
x = 10.3 cm ± 0.1 cm
y = 26 mm ± 1 mm

G = …….. N m^{-2}.

(2 marks)

(d) The table shows values of G for different types of steel.

Type of Steel	Structural Steel	Carbon Steel
G / 10^9 Nm^{-2}	79.3	77.0

Deduce whether the data provided in part (c) would allow the student to determine the type of steel the rod was made from.

……

……

……

……

……

……

……

……

(3 marks)