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Multiple Choice Questions [40 marks]

Answer all questions and shade your answers on the OMR sheet provided.

- 1 Fig. 1.1 shows the zero error of a pair of vernier calipers and Fig. 1.2 shows the measurement of the diameter of a copper rod.

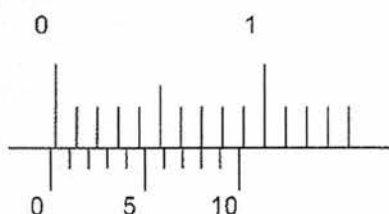


Fig. 1.1

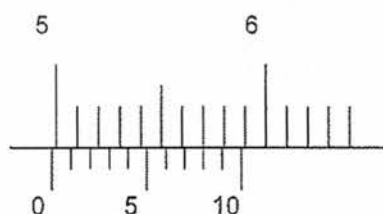


Fig. 1.2

Which of the following sets of data is correct?

	zero error / cm	observed reading / cm	actual diameter / cm
A	-0.02	4.98	4.96
B	-0.02	4.98	5.00
C	+0.08	5.58	5.50
D	-0.08	5.08	5.16

- 2 Which of the following represents the shortest length?

A 1.5×10^{12} nm B 1.5×10^8 μ m C 1.5×10^{-6} km D 1.5×10^{-10} Gm

- 3 A ticker tape timer is used to investigate the speed of a remote control car. The ticker tape timer is set to frequency of 10 Hz and a portion of the tape obtained is as shown in Fig. 3.1.

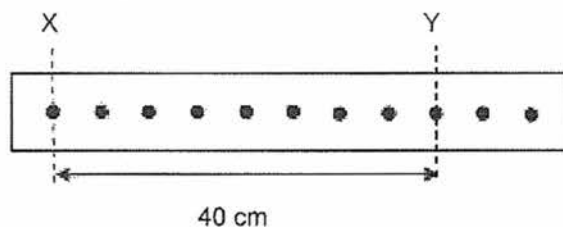


Fig. 3.1

Which of the following statements are correct?

- (i) The average speed is 50 cm/s.
 (ii) The car moves at a constant speed.
 (iii) The car has a uniform acceleration.

A (i) and (ii) only C (i) and (iii) only
 B (ii) and (iii) only D (i), (ii) and (iii)

- 4 Fig. 4.1 describes the motion of three cars.

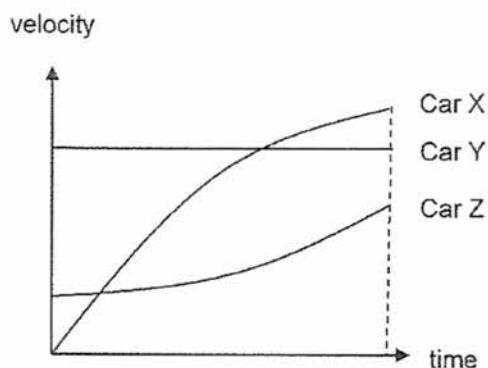


Fig. 4.1

Which of the following sets is correct?

	greatest average velocity	increasing acceleration
A	X	Z
B	X	Y
C	Y	Z
D	Z	X

- 5 A man applied a force, F , to pull a box across the floor at a constant speed. If the man now uses twice the amount of the force to pull the box across the same floor, the box will move
- A at the same constant speed.
 B at a higher constant speed.
 C with a uniform acceleration.
 D with an increasing acceleration.
- 6 An object weighing W is hung from ceiling by a light string. A horizontal constant force F is applied to the object as shown in Fig. 6.1. If T is the tension in the string, which of the following diagrams shows the three forces T , W and F in equilibrium?

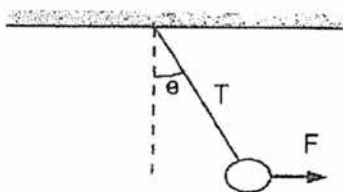
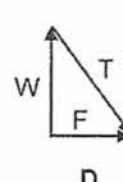
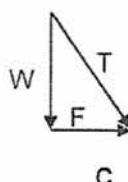
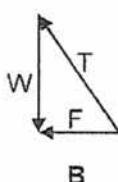
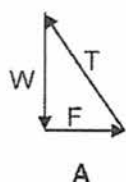


Fig. 6.1



- 7 The weight of an inflated balloon is 200 N. The balloon rises at a constant speed of 2.0 m/s. What is the resultant force acting on the balloon while it is rising?
- A 0 N B 100 N C 200 N D 400 N
- 8 A big cube is formed by 27 identical small cubes. The small cubes are made of the same material and the density of each cube is 2.0 g/cm^3 . Fig. 8.1 shows a new arrangement when one small cube is removed from the big cube.

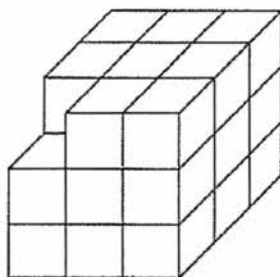


Fig. 8.1

What will be the change(s) to its density and inertia as compared to the original big cube (if any)?

	density of the new arrangement	inertia of the new arrangement
A	remains unchanged	decreases
B	increases	remains unchanged
C	remains unchanged	remains unchanged
D	decreases	decreases

- 9 Three identical hollow pipes X, Y and Z have one or two identical weights attached to their inner surfaces as shown in Fig. 9.1.

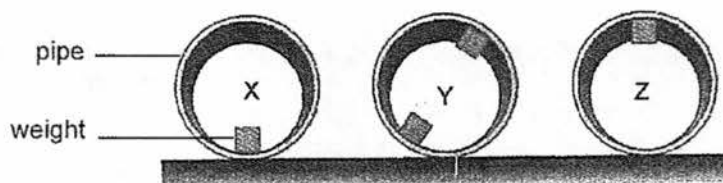


Fig. 9.1

Which of the following sets best describes the state of equilibrium of each pipe?

	X	Y	Z
A	neutral	unstable	stable
B	unstable	neutral	stable
C	neutral	stable	unstable
D	stable	neutral	unstable

- 10 Fig. 10.1 shows four identical heavy bells balancing on light strings and horizontal bars of negligible mass.

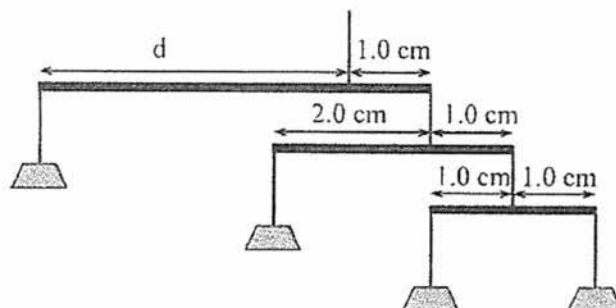


Fig. 10.1

What is the length d ?

- A 3.0 cm B 4.0 cm C 5.0 cm D 6.0 cm
- 11 Fig. 11.1 shows a simple hydraulic jack. Which of the following alterations will enable heavier loads to be lifted?

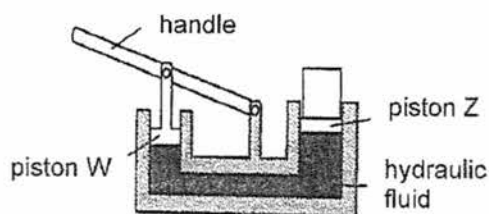


Fig. 11.1

- (i) decrease the cross-sectional area of piston W
 (ii) increase the cross-sectional area of piston Z
 (iii) use a denser hydraulic fluid
- A (i) and (ii) only C (i) and (iii) only
 B (ii) and (iii) only D (i), (ii) and (iii)
- 12 Fig. 12.1 shows a U-tube containing oil and water. The density of water is 1.0 g/cm^3 .

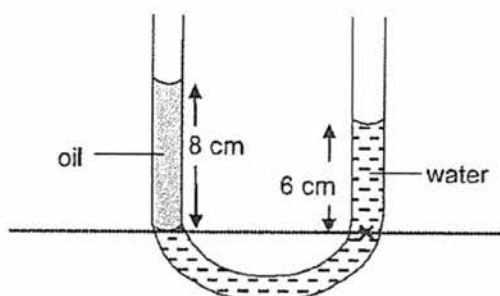


Fig. 12.1

What is the density of the oil?

- A 0.25 g/cm^3 B 0.50 g/cm^3 C 0.75 g/cm^3 D 0.90 g/cm^3

- 13 A 2.0 kg box moves at a constant speed of 7.2 km/h. What is the kinetic energy of the box?
- A 1.0 J B 2.0 J C 4.0 J D 8.0 J
- 14 The power of an electric motor is 20 W. How long does it take to lift a 2.0 kg box through a height of 5.0 m? The gravitational field strength g is 10 N/kg.
- A 5.0 s B 10 s C 15 s D 20 s
- 15 The Brownian motion of fine pollen grains suspended in water occurs because of the
- A convection currents in the water.
 B constant random motion of the pollen grains.
 C water molecules colliding with each other.
 D water molecules colliding with the pollen grains.

- 16 Fig. 16.1 shows bubbles of gas, escaping from the mud at the bottom of a deep lake, rise to the surface.

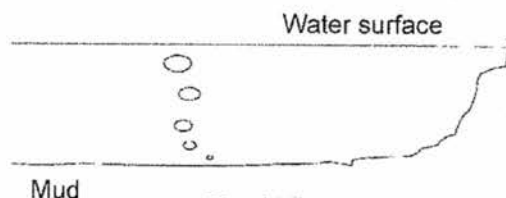


Fig. 16.1

As the bubbles rise, they get bigger. This is due to _____.

- A the formation of convection currents.
 B the evaporation at the water surface.
 C the colder water at the bottom of the lake.
 D the decrease in the water pressure acting on the bubbles.
- 17 Fig. 17.1 shows a piece of paper wrapped tightly around a copper rod and placed above a candle flame. It was observed that the paper did **not** catch fire even when it was placed above the flame for some time.

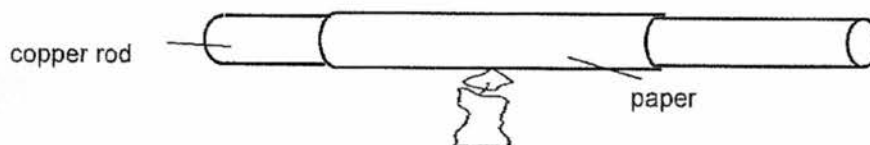


Fig. 17.1

Which of the following statements provides the best explanation?

- A The flame from the candle is too weak to heat up the paper.
 B The copper rod, being a good thermal conductor, conducts heat quickly away.
 C The paper is a poor conductor of thermal energy.
 D The paper is a poor absorber of radiant heat.

- 18 A piece of kitchen aluminium foil is used to wrap around food to be cooked in a barbeque fire. The foil has a shiny and a dull side. Which side should be on the outside and why?

	outside surface	explanation
A	shiny	better heat absorber
B	shiny	better heat conductor
C	dull	better heat absorber
D	dull	better heat conductor

- 19 When one junction of a thermocouple is placed in pure melting ice at 0°C and the other junction in steam at 100°C , the e.m.f. is 8.0 mV . The cold junction is then removed from melting ice and placed in a liquid at constant temperature. The e.m.f. is now 2.0 mV .

What is the temperature of the liquid?

- A 20°C B 25°C C 55°C D 75°C

- 20 Fig. 20.1 shows the rise in temperature of 2.0 kg of a substance, X. The substance is initially in solid state and it was heated uniformly at the rate of 2000 J/min .

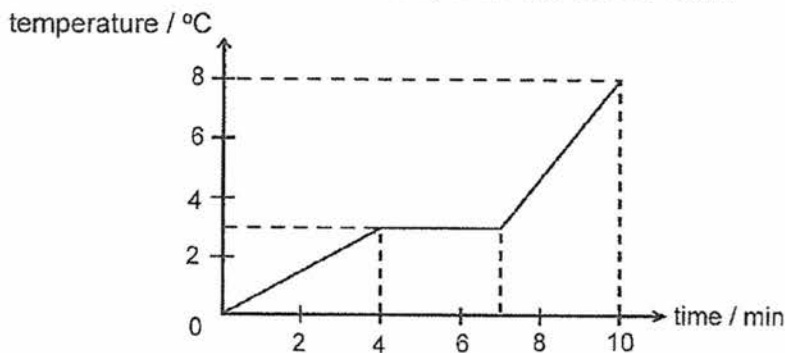


Fig. 20.1

Which of the following sets of data about X is correct?

	specific heat capacity of solid X / $\text{J kg}^{-1}\text{ }^{\circ}\text{C}^{-1}$	specific latent heat of fusion of X / J kg^{-1}	specific heat capacity of liquid X / $\text{J kg}^{-1}\text{ }^{\circ}\text{C}^{-1}$
A	8000	6000	3000
B	1330	6000	600
C	4000	3000	1200
D	1330	3000	600

- 21 A fixed mass of gas is cooled down while its volume is kept constant. How do the properties of the molecules of the gas change?

	average speed	frequency of collisions with walls	average distance apart
A	decreases	increases	unchanged
B	decreases	decreases	unchanged
C	decreases	unchanged	Increases
D	unchanged	decreases	decreases

- 22 Fig. 22.1 shows a ripple tank. The dipper vibrates up and down at a constant frequency.

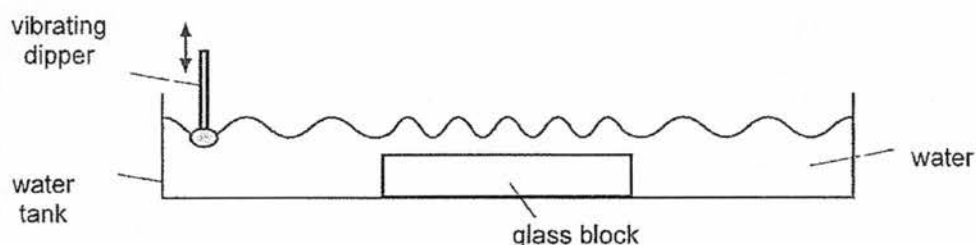


Fig. 22.1

What happens to the wavelength, frequency and speed of the wave as it reaches the glass block?

	wavelength	frequency	speed
A	increases	remains unchanged	increases
B	decreases	increases	increases
C	decreases	remains unchanged	decreases
D	increases	increases	decreases

- 23 Fig. 23.1 shows the cross-section of a water wave.

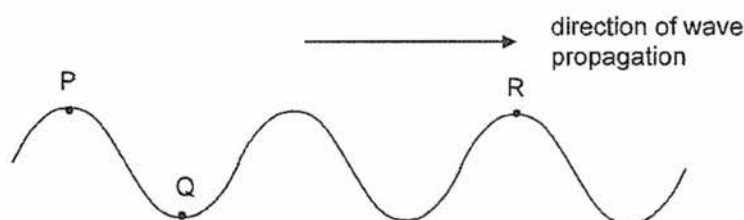


Fig. 23.1

A student made the following statements.

- The particle moves from P to Q after $\frac{1}{2} T$.
- Q is in the same phase as R.
- Wave energy is transferred from position P to R.
- Fig. 23.1 shows a transverse wave.

How many of the above statements is/are correct?

- A 1 B 2 C 3 D 4

- 24 Fig. 24.1 shows a person X standing 1.0 m in front of a plane mirror while observer O stands 2.5 m behind X.

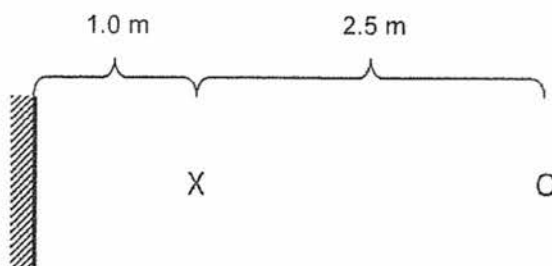


Fig. 24.1

Determine the distance between observer O and the image of X.

- A 2.0 m B 3.5 m C 4.5 m D 7.0 m
- 25 Fig. 25.1 shows the path of a ray of light as it strikes the water-to-air boundary.

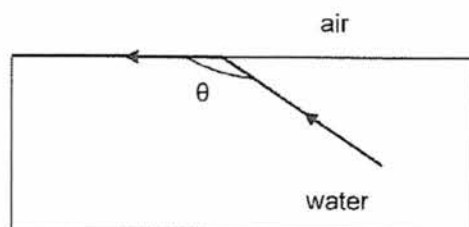
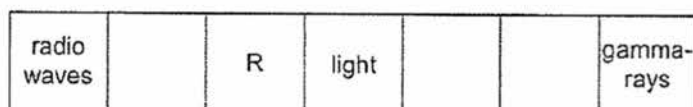


Fig. 25.1

If the speed of the light in the water is 2.3×10^8 m/s and its speed in air is 3.0×10^8 m/s, determine the angle θ .

- A 100° C 130°
 B 120° D 140°
- 26 The diagram shows the main sections of the electromagnetic spectrum in order of increasing frequency. Some of the sections are labelled.



→ increasing frequency

The section R has a frequency just below that of light.
 Which application uses the section R?

- A Sterilisation C Sunbed
 B Satellite television D Television remote controller

- 27 The speed of the radio waves in air is 3.0×10^8 m/s and the wavelength is about 5.0 m. What is the frequency of the waves broadcast by the radio station?

A 60 MHz B 60 GHz C 150 MHz D 150 kHz

- 28 Fig. 28.1 shows a man standing between two cliffs. He claps his hands once.

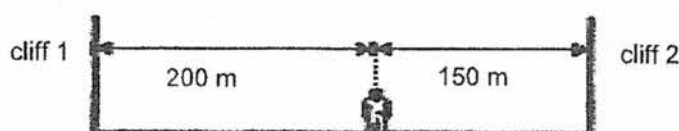


Fig. 28.1

If the speed of sound in air is 300 m/s, determine the time interval between the two loudest echoes.

A 0.33 s B 0.83 s C 1.2 s D 1.3 s

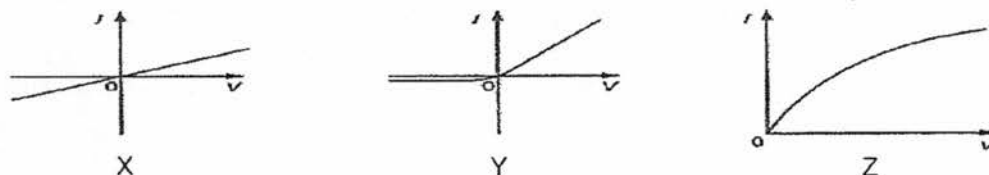
- 29 An insulating rod carries a positive charge after it is rubbed with a woollen cloth. Which of the following statements correctly explains the transfer of charges?

A Friction causes the negative charges on the rod to become positive.
 B Positive charges are transferred from the cloth to the rod.
 C Electrons are transferred from the rod to the cloth.
 D Electrons are transferred from the cloth to the rod.

- 30 During a thunderstorm, a bolt of lightning sends out an electric charge of 20 C from a thundercloud to the earth. If the energy produced by the lightning is about 500 MJ, determine the potential difference between the thundercloud and the earth.

A 25 MV B 500 MV C 10000 MV D 40000 MV

- 31 Three graphs X, Y and Z show the I-V characteristics for three different components.



A student made the following statements:

- X is an ohmic device whereas Y and Z are non-ohmic devices.
- Gradient of graph X gives the resistance of X.
- Y is a semiconductor diode and Z is a thermistor.

How many of the above statements is/are correct?

A 0 B 1 C 2 D 3

- 32 In Fig. 32.1, the current that flows through the point X is 0.50 A.

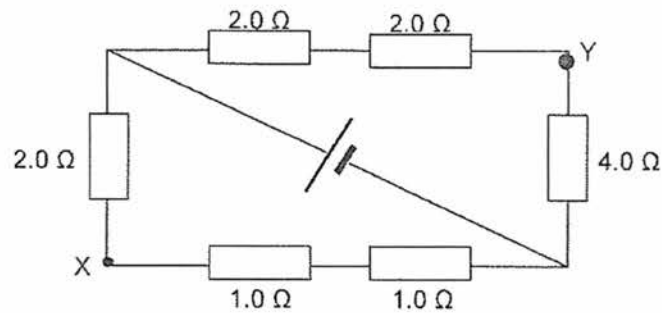


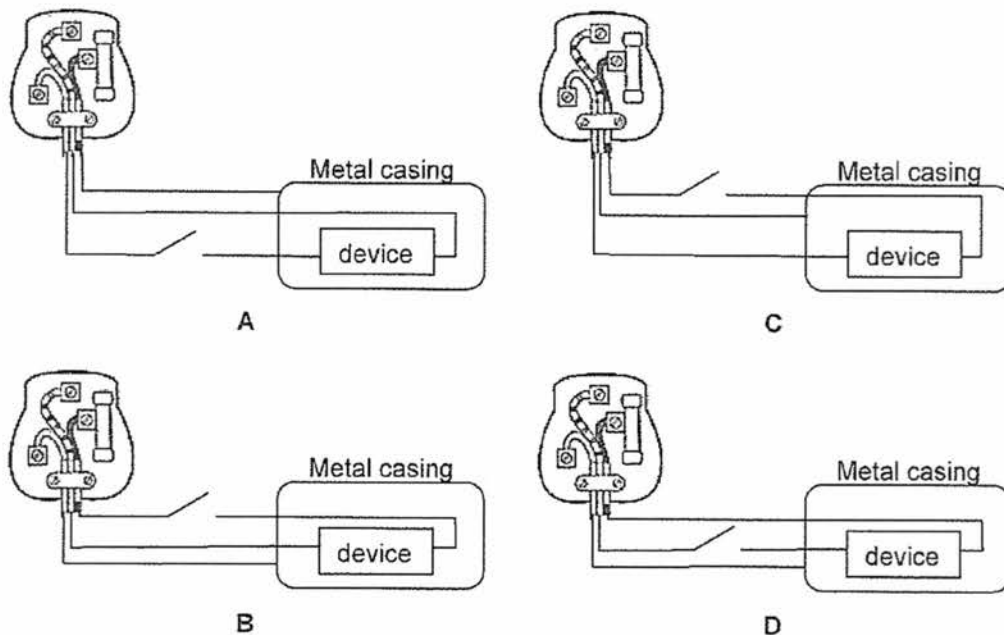
Fig. 32.1

Determine the current that flows through Y.

- A 0.25 A B 0.50 A C 1.0 A D 1.3 A
- 33 An electrical household appliance uses 43.2 MJ of electrical energy after 4 hours of operation. If it costs 25 cents/kWh, find the electrical power of the appliance and the cost of energy usage.

	electrical power / kW	cost / \$
A	3	0.75
B	3	3.00
C	12	3.00
D	12	0.75

- 34 Which of the following is correctly wired?



- 35 Fig. 35.1 shows a small compass placed between two bar magnets with the ends X and Y nearest to the compass.

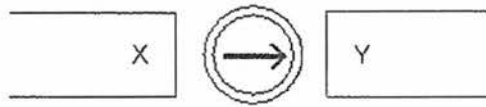


Fig. 35.1

What are the polarities of ends X and Y?

	X	Y
A	North pole	South Pole
B	South Pole	North pole
C	South Pole	South Pole
D	North pole	North pole

- 36 Equal amount of current is flowing in two insulated wires, perpendicular to each other as shown in Fig. 36.1.

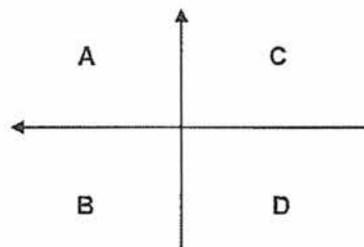


Fig. 36.1

Which segment, A, B, C or D has the strongest magnetic field flowing into the paper?

- 37 Fig. 37.1 shows a transformer. The number of turns between each pair of output terminals of a transformer is shown in the diagram.

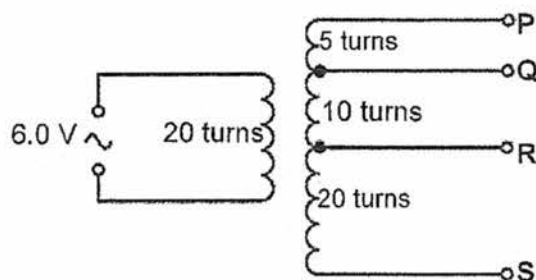


Fig. 37.1

Which pair of terminals should be connected such that the output will be 4.5 V?

- A PQ B QR C PR D QS

- 38 Fig. 38.1(a) shows a simple alternating current (a.c.) generator and Fig. 38.1(b) shows the initial voltage produced against time.

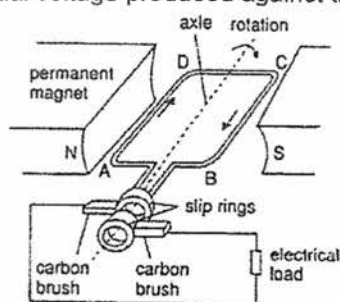


Fig. 38.1(a)

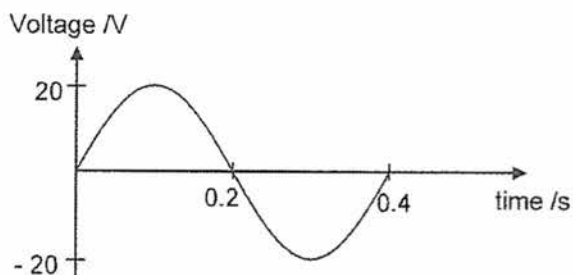


Fig. 38.1(b)

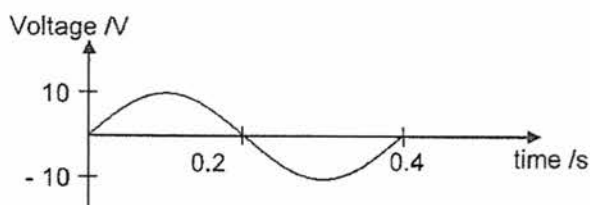


Fig. 38.2

After a certain change was made to the a.c. generator, the voltage against time waveform is as shown in Fig. 38.2. What is likely to be the change?

- A Reduce the rotating speed.
 - B Use a magnet that has a weaker strength.
 - C Increase the number of turns of the coil in the generator.
 - D Place a soft iron core in the centre of the coil.
- 39 Fig. 39.1 shows a trace on the cathode ray oscilloscope (CRO) when a source is connected to it. The amplitude of the input source is 10.0 V and the time-base of the CRO is 5.0 ms/div. Find the voltage gain of the CRO display and the frequency of the input source.

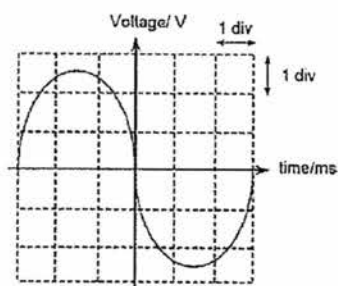


Fig. 39.1

Determine the voltage gain and the frequency of the trace.

	voltage gain / V div^{-1}	Frequency / Hz
A	2.5	30
B	2.5	33
C	4.0	30
D	4.0	33

- 40 Fig. 40.1 shows a magnet moving up and down (between P and R) above a coil of copper wire.

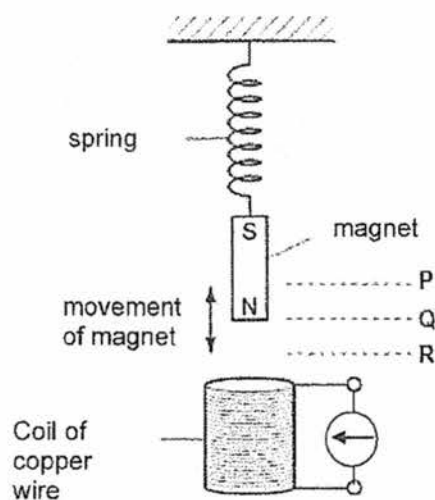


Fig. 40.1

Which of the following statements are true?

- (i) An induced alternating current is formed in the coil as the magnet moves up and down.
- (ii) When the N-pole of the magnet is at P or R, the galvanometer does not show any deflection.
- (iii) The galvanometer will show bigger deflections when more turns are made to the coil of copper wire.

- A (i) and (ii) only
B (ii) and (iii) only

- C (i) and (iii) only
D (i), (ii) and (iii)

End of Paper

Answer **all** the questions in the spaces provided.

1 Fig. 1.1 shows the vertical velocity of a skydiver from the moment he jumps off an aircraft during his skydiving trip.

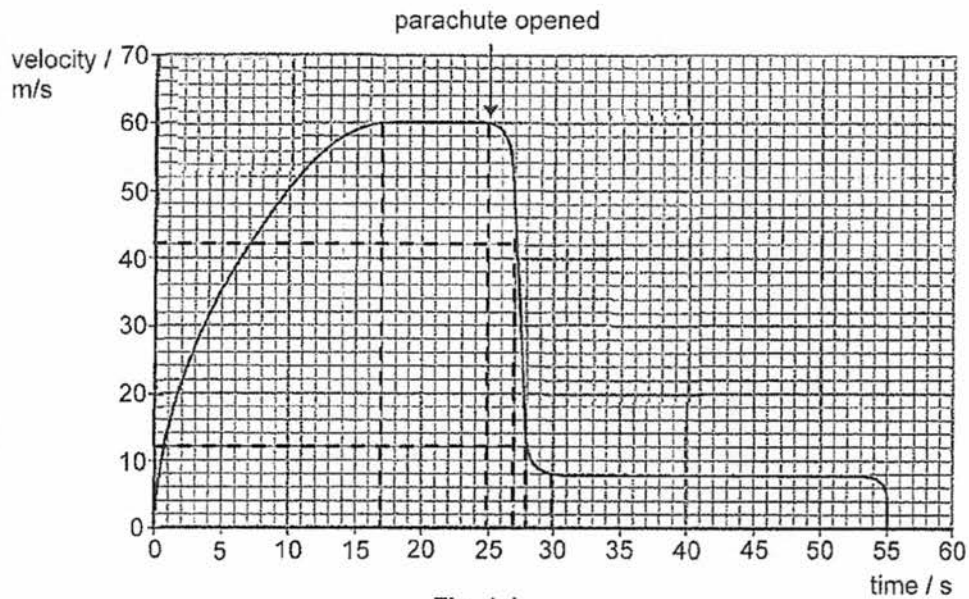


Fig. 1.1

Describe the motion of the skydiver during the first 30 s of his journey down.

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

[5]

- 2 Fig. 2.1 shows a hand-operated hydraulic jack used to lift up a load.

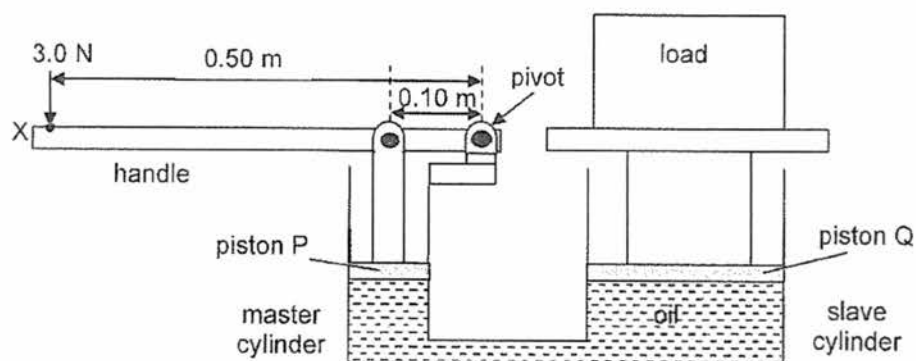


Fig. 2.1

Piston P and the handle are linked through the same pivot. When 3.0 N is applied downwards at point X, piston P in the master cylinder is pushed down with a force F_P , causing oil to flow into the slave cylinder.

- (a) State the *principle of moments*.

[2]

- (b) Calculate the force F_P applied directly on piston P.

$$F_P = \underline{\hspace{2cm}} \quad [2]$$

- (c) The area of piston P is 10 cm^2 and the area of piston Q is 200 cm^2 . Calculate the load being pushed upwards by piston Q.

$$\text{load} = \underline{\hspace{2cm}} \quad [2]$$

- (d) If piston P moved a distance of 25 cm downwards, determine the distance moved upwards by piston Q.

$$\text{distance} = \underline{\hspace{2cm}} \quad [2]$$

- 3 Fig. 3.1 shows the positions of particles of a medium at a particular instant when a sound wave, travelling from left to right, passes through the medium. Before the wave arrived, the particles were equally spaced at their original undisturbed positions as shown by the vertical lines.

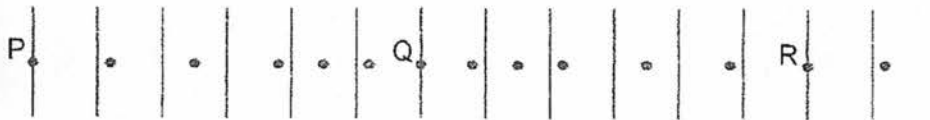


Fig. 3.1

- (a) State the type of wave formed in Fig. 3.1. Explain your answer.

_____ [2]

- (b) Given that Fig. 3.1 is drawn to full scale, determine the amplitude and the wavelength. (Give your answers to 1 d.p.)

amplitude = _____ [1]

wavelength = _____ [1]

- (c) If the sound has a frequency of 100 Hz, calculate the speed of the wave.

speed = _____ [2]

- (d) Calculate the time taken for the compression at Q to move to the position at R.

time = _____ [1]

- (e) Describe how the movement of the particle at point P will change (if any) when

- (i) A softer sound passes through it.

_____ [1]

- (ii) A lower pitch sound passes through it.

_____ [1]

- 4 An object is placed in front of a thin converging lens and a real image is formed on the opposite side of the lens. The object distance is varied and the image distance is measured. A graph of the image distance against object distance is shown in Fig. 4.1.

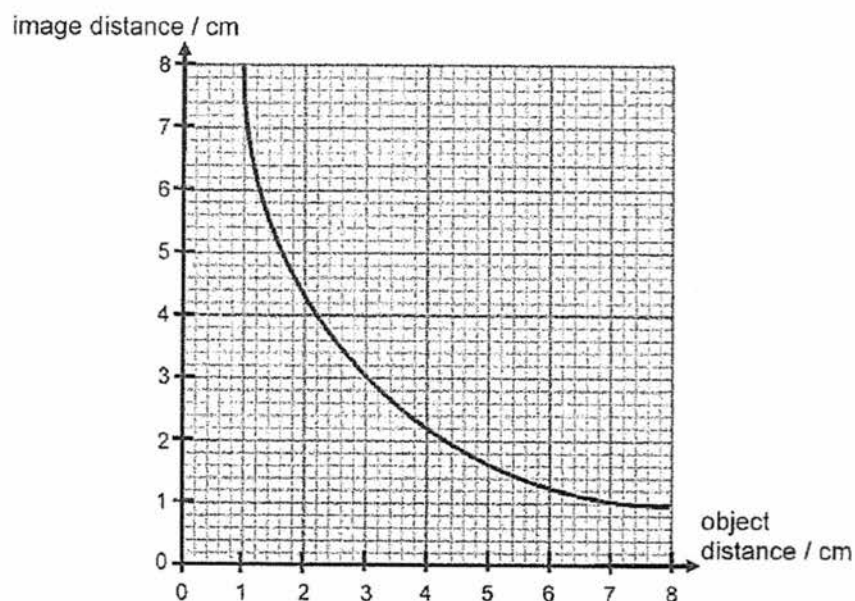


Fig. 4.1

- (a) Determine the focal length from Fig. 4.1.

focal length = _____ [1]

- (b) Fig. 4.2 shows an incomplete full-scale ray diagram. Using data from Fig. 4.1, complete Fig. 4.2 for the object when it is placed at a certain distance in front of the thin converging lens. Show the position the image (I) formed. [4]

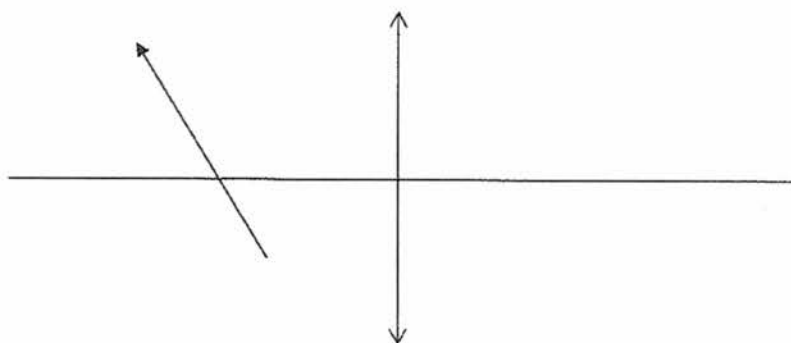


Fig. 4.2

- 5 Fig. 5.1 shows the heating curve of a substance X. The mass of X is 200 g and the heater used is rated at 100 W.

temperature / °C

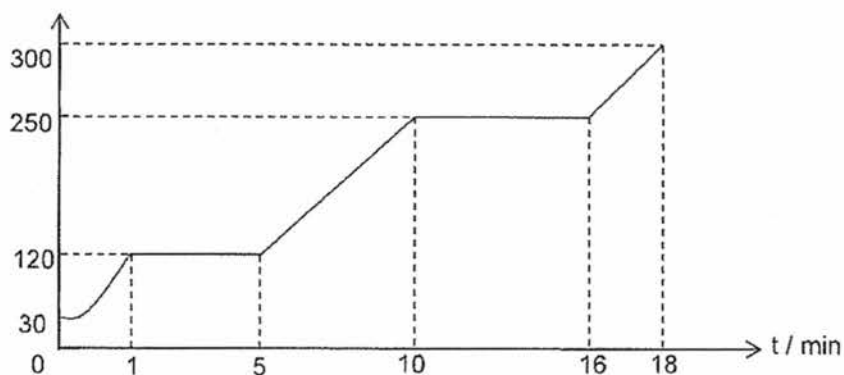


Fig. 5.1

- (a) Define *specific heat capacity*.

 _____ [1]

- (b) Calculate the specific heat capacity of liquid X.

specific heat capacity of liquid X = _____ [2]

- (c) Using the kinetic theory of matter, explain why the temperature remains constant from $t = 10$ min to $t = 16$ min.

 _____ [2]

- (d) Calculate the specific latent heat of vaporisation.

specific latent heat of vaporisation = _____ [2]

- 6 Fig. 6.1 shows a circuit connected to a 3.0 V battery and three identical fixed resistors ($2.0\ \Omega$ each). Under bright light, component X's resistance becomes $8.0\ \Omega$.

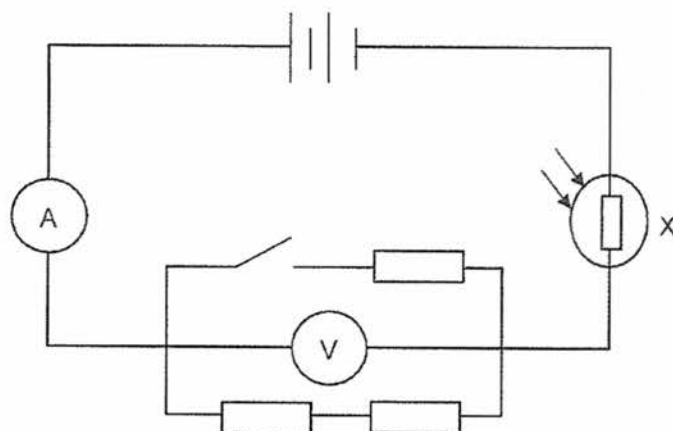


Fig. 6.1

- (a) Name component X.

[1]

- (b) Calculate the ammeter and voltmeter readings if the switch is opened in bright light condition.

ammeter reading = _____ [1]

voltmeter reading = _____ [2]

- (c) Calculate the effective resistance of the whole circuit in bright light condition when the switch is closed.

effective resistance = _____ [2]

- (d) The light falling on the LDR is dimmed, while the switch remains open. State with reasons how the ammeter and voltmeter readings will vary compared to your answer in (b).

[4]

- 7 Fig. 7.1 shows the structure of a circuit-breaker that uses an electromagnet. The circuit-breaker operates when the current is greater than 10 A.

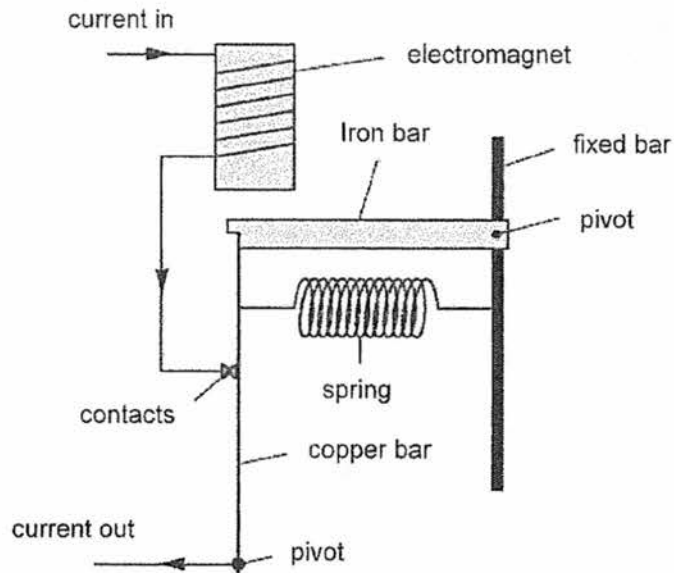


Fig. 7.1

- (a) On Fig. 7.1, label the poles (N & S) induced on both ends of the electromagnet.

[1]

- (b) Describe and explain how the circuit breaker works.

[3]

- (c) Suggest how the electromagnet can be altered so that the circuit-breaker stops the current at less than 10 A. Explain your answer.

[2]

Section B: [30 marks]

Answer **all** the questions in this section on the writing paper.
Answer only one of the two alternative questions in **Question 10**.

8 Read the passage carefully and then answer the questions that follow.

Gemstones used in jewellery are known for several of their physical properties – primarily lustre and optical brilliance. Lustre is a measure of the amount of light that strikes a gemstone's surface and is reflected. Flat and smooth surfaces increase a gemstone's lustre. Light that is not reflected by a gem's lustrous surface passes into the stone. The brilliance of a gemstone is a measure of the amount of light entering the gem that is reflected back to the viewer. Precise techniques are used to cut gemstones into shapes that produce maximum brilliance. The combination of a specialised shape and the gemstone's inherent high refractive index gives gems their brilliance.

Refractive index is a measure of how much light is slowed/bent as it passes through a material. A higher value, or more 'bending power' means greater ability for the gem, with proper cutting, to re-route light back out to the observer rather than passing through the gem to the backside, and thus creating more total brilliance. A lower value means more light will 'pass through' or create a 'window' or see-through zone, as you tilt the stone or view it less than straight on. Thus, less brilliance because more light is simply escaping out the back of the gem rather than being captured and returned back out the front for you to see as light play and sparkle.

Thus, a gem's refractive index is very much a measure of its expected brilliance (assuming optimal cutting which must use matching angles and symmetry to maximise it).

Note that when a value is listed as with two values with a hyphen, it means the material is doubly refractive. In other words, the value from light entering the side is different than light entering the top.

material	refractive index
Diamond	2.42
Moissanite	2.65 ~ 2.69
Ruby	1.76 ~ 1.77
Sapphire	1.76 ~ 1.77
Emerald	1.57 ~ 1.60

Reference: <https://betterthandiamond.com/pages/Listing-of-Gem-Refractive-Index-or-brilliance-potential.html>

- (a) State the two phenomena that occur to give a gem its brilliance. [2]
- (b) Suggest a gem that can produce the maximum brilliance. Explain your choice. [3]
- (c) Calculate the critical angle of diamond. [2]
- (d) The speed of light through an unknown gemstone is 1.9×10^8 m/s. Identify the gemstone. Show all necessary working. [3]

9 Fig. 9.1 shows the electrical wiring in a table lamp.

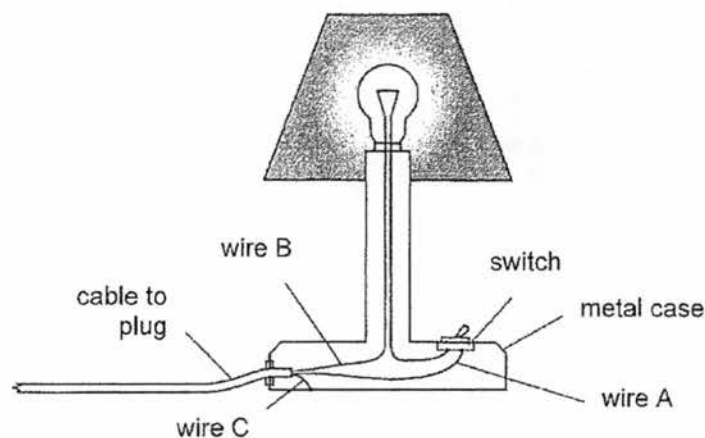


Fig. 9.1

- (a) Explain why wire A rather than wire B is connected to the live terminal in the plug. [2]
- (b) The cable is connected to a plug which contains a fuse. Explain the purpose and action of the fuse. [2]
- (c) Wire A becomes loose and touches the metal case. Explain why a person who touches the metal case feels no shock and is not harmed. [3]
- (d) The lamp is marked "230 V, 100 W". Calculate the resistance of the lamp when it is working normally. [2]
- (e) There is another lamp with no wire connected to the case. Suggest a possible reason why this lamp is safe to use. [1]

10 EITHER

A 5.0 kg box is stationary on a rough horizontal surface. A constant horizontal force F is then applied to it. Fig. 10.1 shows a graph of the variation of F applied with time. The box moves with an acceleration of 0.20 m/s^2 in the first 10 s.

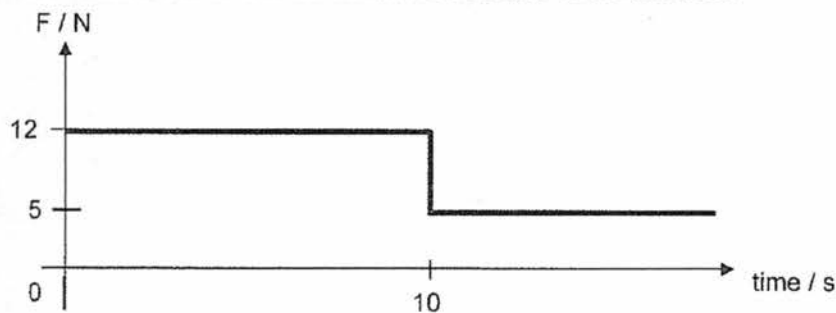


Fig. 10.1

- (a) Calculate the speed of the object when the time is at 10 s. [2]
- (b) Hence, calculate the distance travelled by the box in the first 10 s. [2]
- (c) Calculate the frictional force between the surfaces. Assume that air resistance is negligible. [2]
- (d) From 10 s onwards, the box is being pulled on a smooth surface. State the change to its acceleration, if any, and explain your answer. [2]
- (e) In the presence of air resistance, how would the acceleration change in the first 10 s. Explain this change in terms of the forces acting on the box. [2]

OR

A town is supplied with electrical energy from a power station some distance away by power cables as shown in Fig. 10.2.

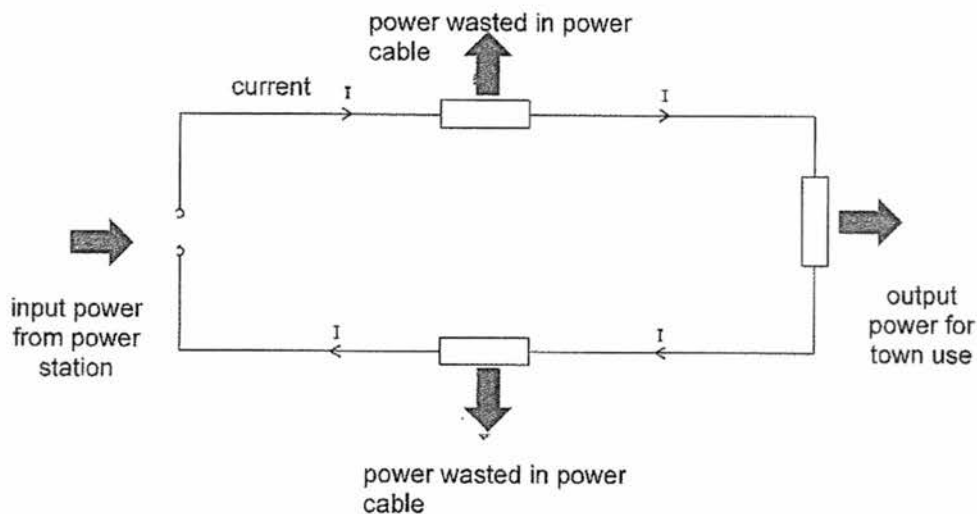


Fig. 10.2

- (a) The input power from the power station is 100 kW, at 20 kV. The total resistance of the cables is 5.0Ω . Calculate
 - (i) the current I in the cables, [1]
 - (ii) the power loss in the cables, [1]
 - (iii) the voltage supplied to the town. [2]

- (b) Fig. 10.3 shows another way of supplying electrical energy to the town using transformers.

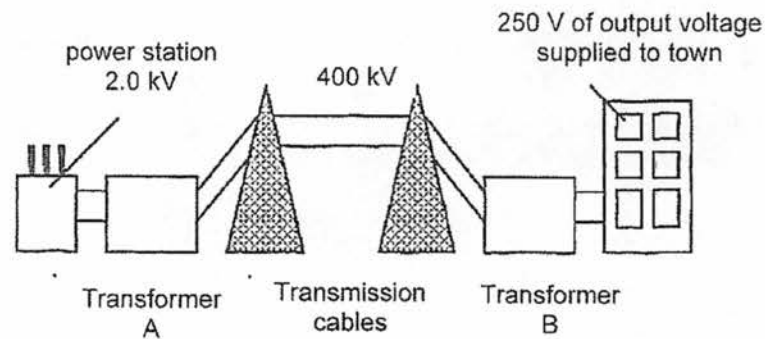


Fig. 10.3

- (i) Name the types of transformers used for transformer A and transformer B. [1]
- (ii) Explain why transformer A is necessary for the transmission. [2]
- (iii) Explain why the transmission cables used have to be quite thick. [1]
- (iv) Calculate the turn ratio for transformer B. [2]

End of Paper

Marking Scheme

1	2	3	4	5	6	7	8	9	10
B	C	A	C	C	A	A	A	D	A

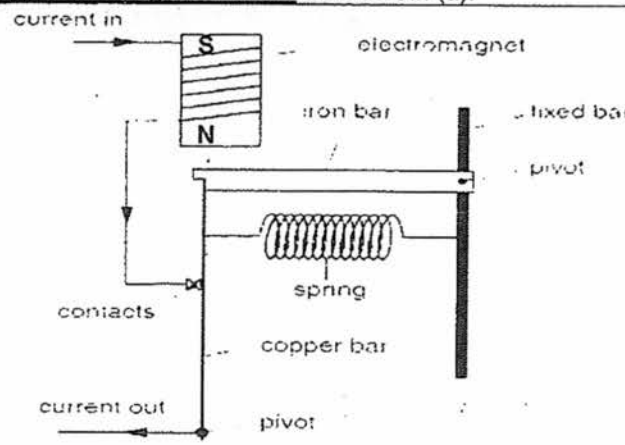
11	12	13	14	15	16	17	18	19	20
A	C	C	A	D	D	B	C	D	D

21	22	23	24	25	26	27	28	29	30
B	C	B	C	D	D	A	A	C	A

31	32	33	34	35	36	37	38	39	40
B	A	B	C	A	C	C	B	D	D

Section A: [50]

1	From 0 s to 17 s, the skydiver has a <u>decreasing acceleration</u> . He moves at a <u>constant velocity</u> of 60 m/s from 17 s to 25 s. From 25 s to 27 s, he experiences an <u>increasing deceleration</u> . In the next 1 s, he has a <u>uniform deceleration</u> of 30 m/s ² . From 28 s to 30 s, he experiences a <u>decreasing deceleration</u> .	[1] [1] [1] [1] [1]
2(a)	Principle of Moments states that the <u>sum of clockwise moments is equal to the sum of anticlockwise moments</u> about the <u>same pivot</u> such that the system is <u>in equilibrium</u> .	[1] [1]
(b)	$3.0 \times 0.50 = F_P \times 0.10$ $F_P = 15 \text{ N}$	[1] [1]
(c)	$F_P/A_P = F_Q/A_Q$ $15/10 = F_Q/200$ load = 300 N [allow ecf]	[1] [1]
(d)	work done is same at P and Q, $F_P \times D_P = F_Q \times D_Q$ $15 \times 0.25 = 300 \times D_Q$ $D_Q = 0.0125 \text{ m}$ [allow ecf]	[1] [1]
3(a)	Longitudinal waves. The particles vibrate parallel to the direction of the wave motion.	[1] [1]
(b)	Amplitude = 0.8 cm Wavelength = 11.7 cm	[1] [1]
(c)	$v = 100 \times 0.117$ = 11.7 m/s or 1170 cm/s [allow ecf]	[1] [1]
(d)	$T = 1/f$ = 1 / 100 = 0.010 s. Time taken for compression to move = 0.010 / 2 = 0.0050 s [allow ecf]	[1] [1]
(e)		
(i)	Particle P will <u>vibrate</u> from its rest position with a <u>shorter maximum displacement</u> . [or shorter amplitude]	[1]
(ii)	Particle P will <u>oscillate less times in one second</u> . [or frequency decreases]	[1]
4	$2f = 3.0 \text{ cm}$ focal length = 1.5 cm	[1]
(a)		
(b)	1 ray passing through optical centre without bending 1 ray passing through focal point and parallel to principle axis Correct drawing and position of image Correct arrows drawn (from O to I)	2 sets [2] [1] [1]

5(a)	Specific heat capacity is the amount of thermal energy needed by a unit mass to raise its temperature by 1K or 1°C.	[1]
(b)	$Q = mc\Delta\theta$ $100 \times (5.0 \times 60) = 0.20 \times c \times (250 - 120)$ $c = 1150 \text{ J kg}^{-1}\text{°C}^{-1}$ (to 3 sig. fig)	[1] [1]
(c)	During boiling, energy is absorbed to overcome the forces of attraction between the molecules, thus internal potential energy increases and kinetic energy remains constant. Since K.E. is constant, temperature is also constant.	[1] [1]
(d)	$100 \times (6 \times 60) = 0.20 \times I_f$ $I_f = 180\,000 \text{ J/kg}$	[1] [1]
6(a)	Light Dependent Resistor	[1]
(b)	$I = V/R$ $= 3.0 / 12$ $= 0.25 \text{ A}$ [2 sig fig]	[1]
	$V = RI$ $= 4.0 \times 0.25$ $= 1.0 \text{ V}$ [2 sig fig]	[1]
	[1] for working	[1]
(c)	Effective resistance $= 8.0 + (1/2 + 1/4)^{-1}$ $= 9.3 \, \Omega$ [2 sig fig]	[1] [1]
(d)	The <u>resistance of the LDR increases</u> drastically, thus causing the <u>overall resistance</u> to be largely <u>increased</u> . Hence the <u>current</u> flowing will be <u>greatly reduced</u> and the <u>ammeter reading</u> will be <u>less</u> than that in (a). The <u>potential difference across the LDR</u> will also greatly <u>increase</u> , thus the <u>potential difference across the fixed resistors</u> will be <u>reduced</u> , thus the <u>voltmeter reading</u> will be <u>less</u> than that in (a).	[1] [1] [1] [1]
7(a)		[1]

(b)	When the current is <u>greater than 10 A</u> , the electromagnet becomes <u>strongly magnetised</u> and <u>attracts</u> the iron bar upwards. The <u>spring pulls</u> the copper bar, <u>breaking the contacts</u> . The <u>circuit is now open</u> and the <u>current stops flowing</u> .	[1] [1] [1]
(c)	<u>Increase the number of turns</u> in the coil. This will <u>increase the attractive force</u> acting on the iron bar when the current is less 10 A. (accept other answers involving force on the iron bar)	[1] [1]

Section B: [30]

8		
(a)	Refraction and total internal reflection	[2]
(b)	Moissanite A gem with <u>high refractive index</u> would have <u>small critical angle</u> . This means that there is <u>higher probability for incident angles of light travelling from denser to less dense medium to be greater than critical angle</u> . Hence, <u>more total internal reflection of light could occur</u> and <u>these light rays will be refracted out</u> to give the gems their brilliance.	[1] [1] [1]
(c)	$\sin c = \frac{1}{n} = \frac{1}{2.42}$ $c = 24.4^\circ$	[1] [1]
(d)	$n = \text{speed of light in vacuum} / \text{speed of light in gemstone}$ $= 3.0 \times 10^8 / 1.9 \times 10^8$ $= 1.58$ Emerald	[1] [1] [1]
9(a)	Wire A is connected to a <u>switch</u> . When the switch is opened, the lamp will be disconnected from <u>high voltage</u> .	[1] [1]
(b)	A fuse <u>prevents excessive current flow</u> and overheating of the cable. It <u>melts and breaks the circuit</u> when excessive current flows through the cable.	[1] [1]
(c)	The metal case is <u>earthed</u> by wire C. When the metal casing becomes live, a <u>large current flows through the earth wire</u> instead of the user because it has a lower resistance than the human body. This causes the <u>fuse to melt</u> . Thus, the metal case is <u>disconnected from high voltage</u> and the user does not get an electric shock.	[1] [1] [1]
(d)	$P = V^2 / R$ $100 = 230^2 / R$ $R = \underline{529 \Omega}$	[1] [1]
(e)	The outer casing is made of plastic. Current cannot flow through easily. Or The lamp has double insulation.	[1]

10E		
(a)	$a = (v-u) / t$ $0.20 = (v - 0) / 10$ $v = 2.0 \text{ m/s}$	[1] [1]
(b)	Distance = area under graph $= \frac{1}{2} \times 2.0 \times 10$ $= 10 \text{ m}$	[1] [1]
(c)	$F_r = F - \text{friction}$ $m \times a = 12 - \text{friction}$ $5.0 \times 0.20 = 12 - \text{friction}$ friction = 11 N	[1] [1]
(d)	The box's acceleration increases. Since $F - f = ma$, $5.0 - 0 = 5.0a$, $a = 1.0 \text{ m/s}^2$.	[1] [1]
(e)	As the object <u>moves faster</u> , the amount of <u>air resistance</u> acting on it <u>increases</u> . This will cause the <u>resultant force F_R</u> on the object to <u>decrease</u> . Since $F_R = m \times a$, the <u>acceleration will decrease</u> as well.	[1] [1]
100		
(ai)	$P = VI \Rightarrow 100\,000 = 20000 \times I \Rightarrow I = 5.0 \text{ A}$	[1]
(ii)	Power loss = $I^2 R = 5.0^2 \times 5.0 = 125 \text{ W}$	[1]
(iii)	Voltage drop = $IR = 5.0 \times 5.0 = 25 \text{ V}$ Voltage supplied to town = $20000 - 25 = 19975 \text{ V} = 20000 \text{ V}$ (3 sig fig)	[1] [1]
	Alternatively, Useful power = $100\,000 - 125 = 99875 \text{ W}$ Voltage supplied to town, $V = P / I = 99875 / 5.0 = 19975 \text{ V} = 20000 \text{ V}$ (3 sig fig)	
(bi)	Step-up transformer (A) and Step-down transformer (B)	[1]
(ii)	Transformer A steps up the voltage. Since <u>Power = Voltage x Current</u> , when a <u>high voltage</u> is used, <u>electrical current transmitted will be lower</u> . This results in <u>less electrical power loss</u> from the cables since <u>power loss = (current)² x resistance of the cables</u> .	[1] [1]
(iii)	Thick cables have <u>lower resistance</u> than thinner cables, and <u>can carry large amount of current with less heat loss</u> .	[1]
(iv)	$N_s/N_p = V_s/V_p$ $= 250 / 400000$ $N_s:N_p = 1:1600$	[1] [1]
	Also accept $N_p:N_s = 1600:1$	