CANDIDATE NAME

CLASS

INDEX NUMBER

Section B			
Q9	**Q10**	**Q11E**	**Q11O**

Section B (30 marks)

Answer all questions in this section.

Answer only one of two alternative questions in **Question 11**.

9 A lorry crane as shown in Fig. 9.1 is used in a construction site to lift concrete beams. The boom is pivoted onto the lorry such that the distance from the pivot point of the boom to the lorry's back wheel is 2.0 m.

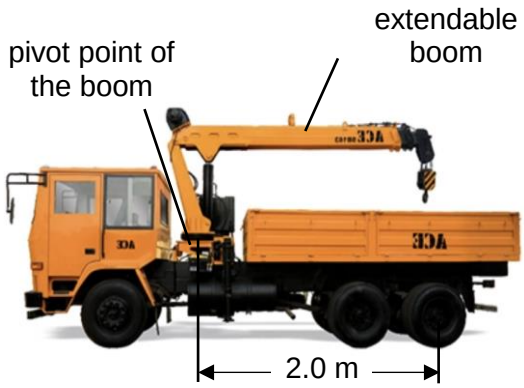

Fig. 9.1

http://www.acecrane.in/sb-163-lorry-loader-crane-4561877.html

Table 9.1 summarises the maximum load that the lorry crane can carry and the corresponding distances from the load to the lorry's back wheel when the boom is horizontal.

Table 9.1

length of boom / m	*distance from the load to the lorry's back wheel / m*	*maximum load / kg*
4.0	2.0	3000
6.0	4.0	1500
8.0	6.0	1000
10.0	8.0	750
12.0	10.0	600

(a) Using the data from Table 9.1, state and explain the relationship between the distance from the load to the lorry's back wheel and the maximum load that the lorry crane can carry.

……..

……..[2]

(b) The weight of the uniform boom is 10 000 N.

(i) Calculate the minimum weight of the lorry. Assuming that the distance from the centre of gravity of the lorry to the lorry's back wheel is 2.5 m.

weight = ... [2]

(ii) The actual weight of the boom is much heavier than 10 000 N. Explain why when the length of the boom is 4.0 m, the maximum load that can be lifted is the same as the maximum load shown in Table 9.1.

……..

……..[1]

(c) Lorry cranes have additional support extended sideways as shown in Fig. 9.2.

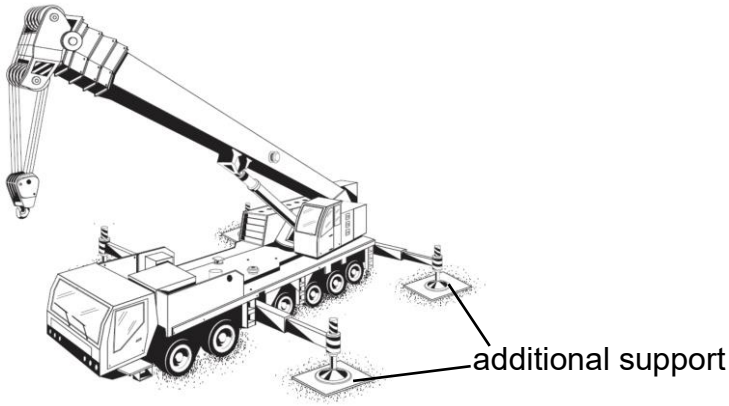

Fig. 9.2

https://www.cranes.org.nz/uploads/2/0/5/7/20572552/crane_stability_and_ground_pressure.pdf

Explain how the additional support increases the stability of the lorry crane.

……..

……..[1]

(d) The concrete beam is freely suspended as shown in Fig. 9.3.

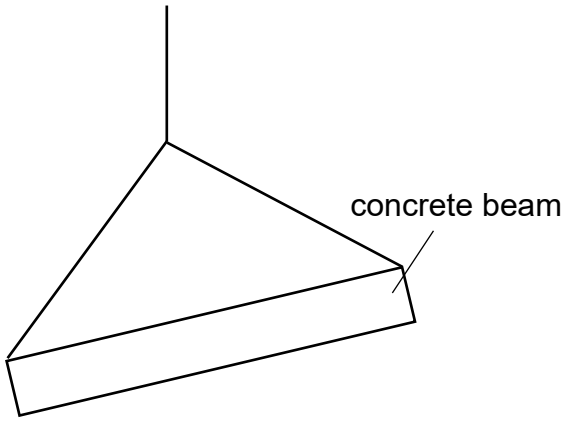

Fig. 9.3

(i) Mark the centre of gravity of the concrete beam with the letter ‘x’. Explain your answer.

……

……

……..[2]

(ii) The concrete beam is made of 10% steel and 90% concrete by volume. If the density of steel and concrete is 7800 kg/m^3 and 2400 kg/m^3 respectively, determine the average density of the beam.

average density = ... [2]

10 Fig. 10.1 shows a solenoid that is connected to a battery such that a north pole is induced at the right end of the solenoid.

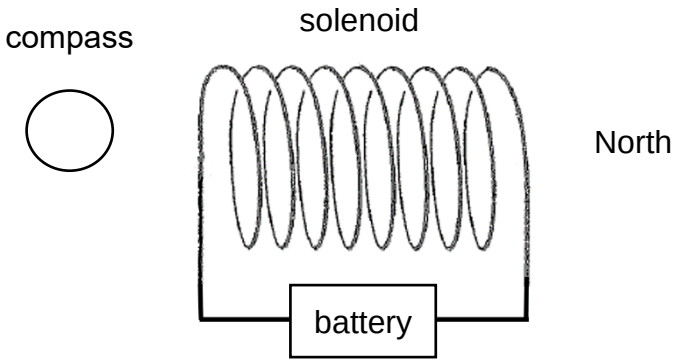

Fig. 10.1

(a) Draw an arrow at the left end of the solenoid to indicate the direction of the current flowing through the solenoid. [1]

(b) A compass is placed at the left side of the solenoid. Draw an arrow to show how will the compass needle point. [1]

(c) Fig. 10.2 shows a modified d.c. motor. The permanent magnet is replaced with the solenoid from Fig. 10.1.

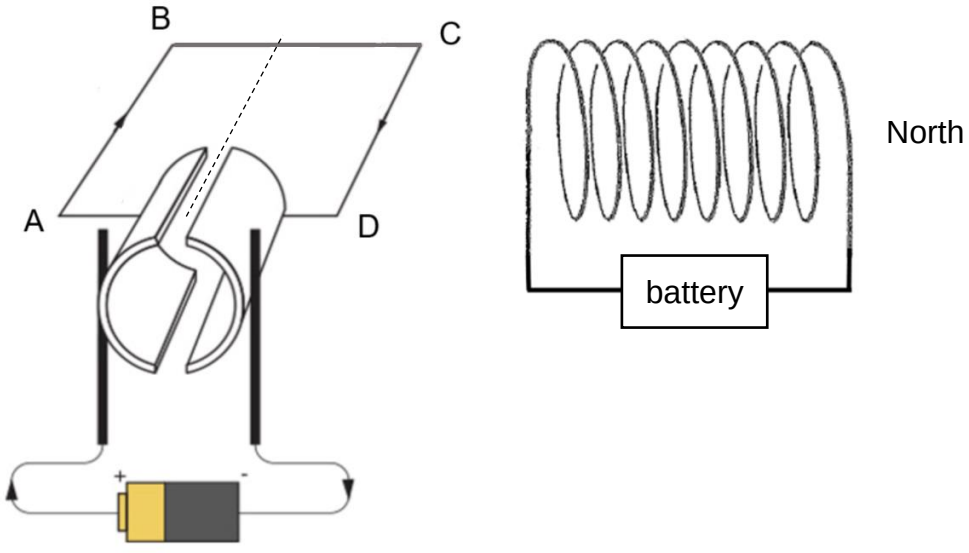

Fig. 10.2

(i) On Fig. 10.2, draw an arrow on wire AB to show the direction of the force induced on wire AB. [1]

(ii) Explain how a force is induced on wire AB.

……..……..

……..……..

……..……..

……..……..…..[2]

(iii) The plane of coil is initially horizontal as shown in Fig. 10.2 and the coil rotates more than 90° from this starting position. It then continues to rotate in the same direction. State and explain which feature of the d.c. motor allows the coil to continue to rotate in the same direction.

……..……..

……..……..

……..……..…..[2]

(d) In a typical d.c. motor, soft iron core is added to the centre of the wire coil as shown in Fig. 10.3.

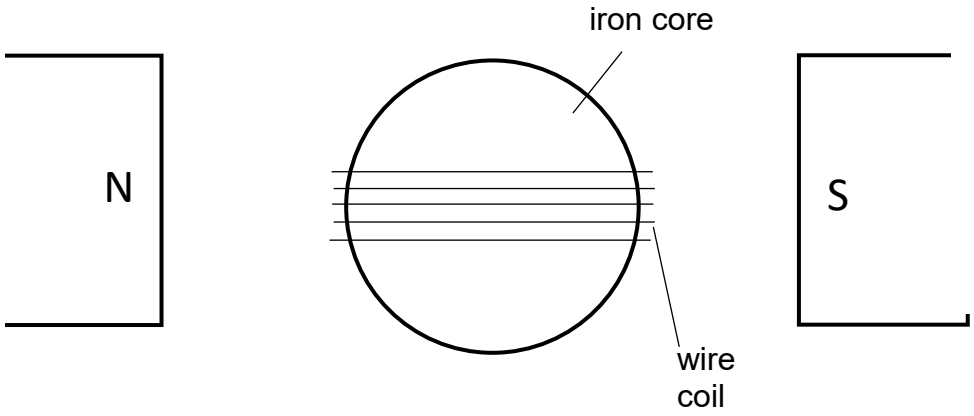

Fig. 10.3

(i) Explain how the soft iron core increases the turning effect of the d.c. motor.

……..……..

……..……..…..[1]

(ii) On Fig. 10.3, draw the magnetic field lines between the south pole of the magnet and the iron core when no current flows through the wire coil. [1]

(iii) Explain how the iron core is induced into a magnet.

……..……..

……..……..

……..……..…..[1]

11E Fig. 11.1 shows the track of a 500 kg roller coaster. An electric motor pulls the roller coaster along the track OABC. The efficiency of the electric motor is 80 % and it takes 2.0 min to pull the roller coaster from point A to point B at a constant speed.

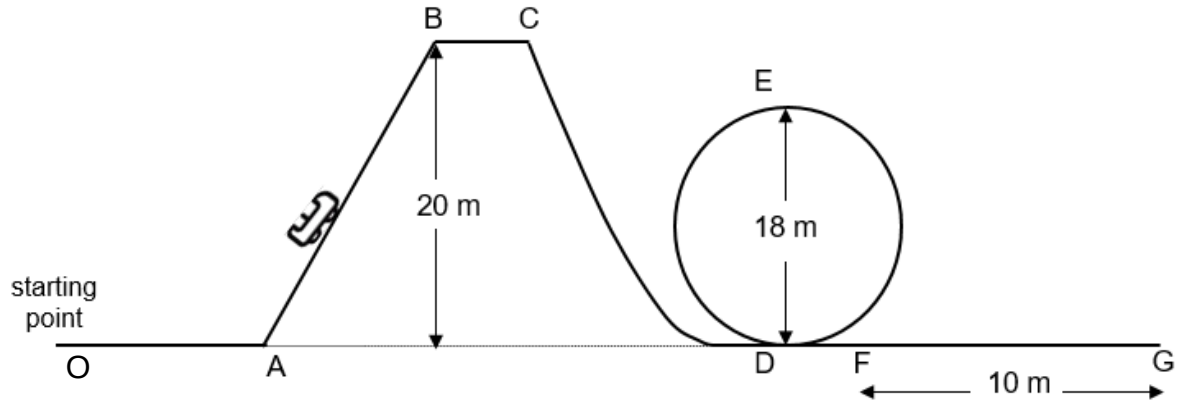

Fig. 11.1

(a) Describe how Principle of Conservation of Energy is applied as the roller coaster moves from point A to B.

……..

……..[2]

(b) Determine the power of the electric motor.

power = ... [2]

(c) The electric motor is replaced with one that gives a larger power to the roller coaster. Describe and explain the effect on the speed of the roller coaster if it still moves from A to B at a constant speed.

……..

……..[1]

(d) At point C, the speed of the roller coaster is 0.20 m/s and it continues to move down the track due to gravity. Assume that along the track C to F, the frictional force is negligible.

(i) Calculate the speed of the roller coaster at point E.

speed = ... [2]

(ii) In reality the speed of the roller coaster is smaller than the speed calculated in **(b)(i)**. Explain why the actual speed is lower.

……..……..

……...[1]

(e) At point F, the speed of the roller coaster is 15 m/s. The average resistive force experienced by the roller coaster along FG is 4000 N. It is observed that the 10 m track FG is not long enough for the roller coaster to come to a stop at end of track FG.

To overcome this issue, the end of track FG has to be elevated. Calculate the height of elevation of FG so that the roller coast can come to a stop at the end of the track.

height = ... [2]

11O A student uses a water tank to study the behaviour of a water wave as it travels from region A to region B of different water depths. A powerful light source placed above the water tank produces regions of bright and dark bands of light at the base of the water tank, as shown in Fig. 11.2.

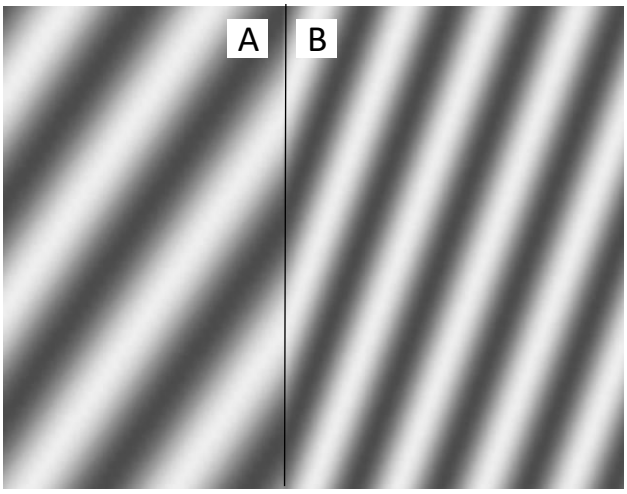

Fig. 11.2

https://web2.ph.utexas.edu/~vadim/Classes/2014f/refraction.html

(a) Explain why water waves are transverse waves.

……..

……..[1]

(b) After passing through the water, light rays converge to form bright bands of light at the base of the water tank.

(i) On Fig. 11.2, mark a distance equal to the wavelength of the water wave in region A. Label the wavelength with 'λ'. [1]

(ii) State and explain which region is deeper.

……..

……..

……..[2]

(c) At time = 0, a ping pong ball is found to be at the centre of a dark band. If the speed of the water wave is 20 cm/s and the wavelength is 10 cm, draw on Fig. 11.3, how the displacement of the ping pong ball changes with time for 2 complete oscillations. Indicate the time when the displacement = 0 mm. The amplitude of the water wave is A. [2]

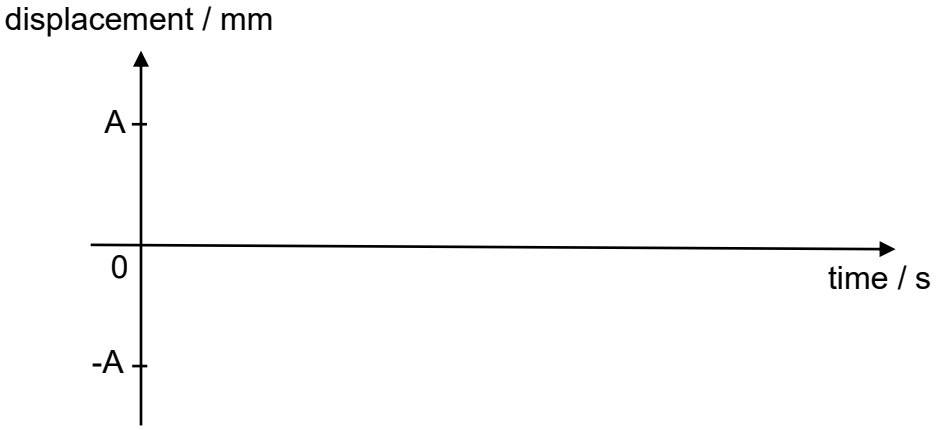

Fig. 11.3

(d) The water wave in Fig. 11.2 is produced by dropping a concrete beam into the water tank. When the beam hits the base of the tank, sound is produced. Fig. 11.4 shows the displacement-time graph of a water particle as sound is transmitted through the water.

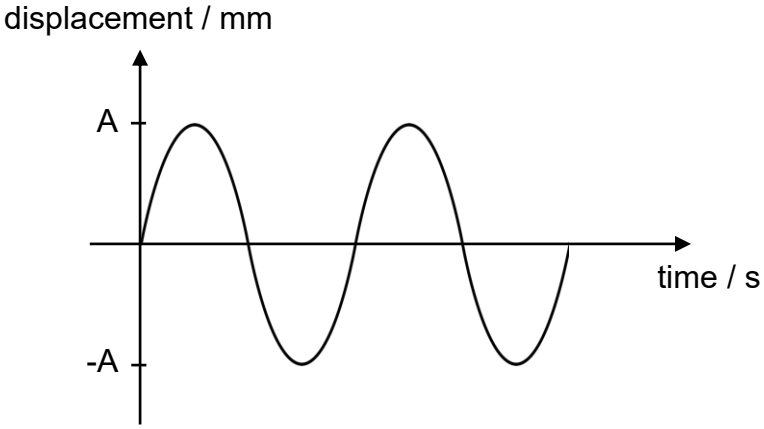

Fig. 11.4

(i) Explain how sound energy is transferred through the water without transferring matter.

……..

……..

……..[2]

(ii) A metal nail is also dropped into the water tank. The loudness of the sound produced by the metal nail is half that of the sound produced by the beam. The frequency of the sound produced by the metal nail is twice that of the sound produced by the beam.

Draw on Fig. 11.4, how the displacement of a water particle will change with time as the sound produced by the metal nail is transmitted through the water. [2]

END OF PAPER