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LOCKING 7.62
ENG. SCI.

ROYAL AIR FORCE—AIRCRAFT APPRENTICES

No. 1 RADIO SCHOOL, LOCKING

FINAL EXAMINATION IN EDUCATIONAL SUBJECTS
JANUARY, 1961 (97TH) ENTRY

JULY, 1962

MECHANICS AND ENGINEERING SCIENCE

Time allowed—Two hours

Candidates are to attempt FIVE *questions*

Advanced Stream candidates may not *attempt Question* 8.
Normal Stream candidates may not *attempt Question* 9.

All questions carry equal marks

Take $g = 32$ ft/sec^2 or 9·81 metres/sec^2

[P.T.O.

1. (*a*) A diver working under water is trying to gauge the time by watching the sun. He is surprised when the sun begins to set because it still appears quite high in the sky. Explain this phenomenon and calculate the apparent angle of elevation of the setting sun as seen by the diver. (Refractive Index of water = 1·33).

   (*b*) Two vertical glass tubes, 33 in long and 1 sq. in. in cross-section, are connected at the bottom by a horizontal tube.

   The resulting U-tube contains mercury which rises to a height of 6·8 in. in each limb. Find the greatest volume of water that can be poured into one of the limbs, assuming the specific gravity of mercury to be 13·6.

2. (*a*) (i) Explain briefly the three methods by which heat may be transmitted.

   (ii) Explain, with the aid of a diagram, how the transfer of heat by the methods in part (i) is minimised in the vacuum flask.

   (*b*) A man observes a flash of lightning and t secs later hears the associated roll of thunder. Assuming the speed of sound in air is 1,100 ft per sec, find an expression for the distance, in miles, between the lightning and the man.

3. (*a*) A rugby player is attempting a penalty kick 22 yd from the goal-posts. The vertical component of the initial velocity is 48 ft/sec.

   Calculate :

   (i) the greatest height reached by the ball, and

   (ii) the time taken to reach this height.

   (*b*) The ball passes 1 ft above the cross-bar, which is 10 ft above the ground, after having reached its maximum height. Calculate:

   (i) the time taken by the ball to drop to this height from the maximum height,

   (ii) the total time taken to reach this position, and

   (iii) the horizontal component of the velocity of the ball assuming it to be constant.

4. A ship is being towed by four tugs, A, B, C and D. Tug A exerts a pull of 130 tons wt in a direction 30° to port, B a pull of 75 tons wt 50° to port, C a pull of 120 tons wt 20° to starboard and D a pull of 100 tons 40° to starboard, the angles all being measured from the fore and aft axis of the ship. Calculate :

   (i) the resultant forward force on the ship,

   (ii) the direction in which the ship would tend to move, and

   (iii) the magnitude and direction of the additional force that would be required to make the ship travel dead-ahead.

5. (*a*) Define the moment of a force about a point.

   (*b*) The coupling at the front of a railway wagon is 6 in higher than that at the rear ; the axles are 8 ft apart and the centre of gravity of the wagon is midway between the axles. If the pull in each of the couplings is 2,500 lbs wt find the difference between the loads on the front and rear axles.

6. Masses of 0·2 Kg and 0·16 Kg are connected by a light, inextensible string passing over a light, smooth pulley. Find the acceleration with which the greater mass descends. After falling 1 metre from rest the greater mass is brought to rest on reaching the ground. What interval then elapses before the string again becomes taut ?

7. (*a*) Define

(i) *Kinetic Energy*, and
(ii) *Potential Energy*.

(*b*) The area of cross-section of the nozzle of a hose-pipe is $1\frac{1}{2}$ sq in, and an engine pumps water through it with a velocity of 80 ft/sec.

Calculate :

(i) the weight of water delivered per second,
(ii) the kinetic energy of this water, and
(iii) the least H.P. of the engine if the nozzle is 18 ft above the level of the water supply.

(Weight of water = 62·5 lbs per cu ft)

8. (*Normal Stream only*)

ABCD is a uniform thin square board of side 8 in. From the board is cut a circular disc of radius 2 in, the centre of the disc being 3 in from AB and BC.
Find the distance of the centre of gravity of the remainder from DC and AD.

9. (*Advanced Stream only*)

A particle moves in a straight line with simple harmonic motion, the centre of oscillation being A. When the particle is 18 in from A its velocity is 4 ft per sec and its acceleration is 6 ft per sec^2.

Calculate :

(i) the amplitude of the motion,
(ii) the period of the motion, and
(iii) the maximum velocity attained.