		Surname		Type
Group Number		Name		A
List Number		e-mail		
Student ID		Signature		

ATTENTION:Each question has only one correct answer and is worth one point. Be sure to fill in completely the circle that corresponds to your answer on the answer sheet. Use a pencil (not a pen). Only the answers on your answer sheet will be taken into account.

Questions 1-5

A scale is adjusted so that when a large, shallow pan is placed on it, it reads zero Newton. There is a water faucet 1.6 m above the pan. When the faucet is turned on, water leaves the faucet with a speed of 2 m/s and falls into the pan at a rate R = 0.14 kg/s. Take g = 10 m/s^2.

1. What is the magnitude of the velocity of water as it strikes the pan in m/s?

(a) 3 (b) $4\sqrt{2}$ (c) 5 (d) 4 (e) 6

2. Just after water strikes the pan what is the momentum change per unit time in kgm/s^2?

(a) 0.14 (b) 0.56 (c) 0.84 (d) 0.42 (e) 0.28

3. What is the scale reading at t = 0 s (Water just strikes to the pan initially)

(a) 0.84 N (b) 1 N (c) 10 N (d) 1.4 N (e) 0.64 N

4. What is the mass of water in the pan at t = 4 s in kg?

(a) 0.56 kg (b) 1.5 kg (c) 2 kg (d) 1 kg (e) 3 kg

5. What is the scale reading at t = 4 s? (Assume that the increase in water level is negligible)

(a) 10.2 N (b) 15.6 N (c) 6.44 N (d) 21 N (e) 16 N

Questions 6-8

Two objects, A (m_A = 1.0 kg) and B (m_B = 2.0 kg), collide. The velocities before the collision are $\vec{v_A} = 2\hat{\imath}$ m/s and $\vec{v_B} = 4\hat{\jmath}$ m/s. The velocity of object A after the collision is given by $\vec{v_A}' = -0.4\hat{\imath} + 2\hat{\jmath}$ m/s.

6. What is the speed of object B just after the collision (v_B')?

(a) $\sqrt{8.76}$ m/s (b) $\sqrt{10.44}$ m/s (c) $\sqrt{8.44}$ m/s (d) $\sqrt{9.36}$ m/s (e) $\sqrt{9.64}$ m/s

7. What is $\tan\theta$, where θ is the angle between the velocity of B (v_B') and the x-axis?

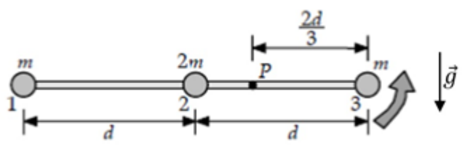
(a) 1.5 (b) 5 (c) 2 (d) 2.5 (e) 3

8. What is the energy lost due to the collision?

(a) 7.16 J (b) 7.48 J (c) 5.48 J (d) 6.56 J (e) 6.38 J

Questions 9-15

A rigid, massless rod has three masses attached to it. The rod is free to rotate in a vertical plane about a frictionless axle perpendicular to the rod through the point P, and it is released from rest in the horizontal position at t=0s.



9. Find the moment of inertia of the system about the point P.

(a) $7md^2$ (b) $4md^2$ (c) $\frac{7md^2}{3}$ (d) $\frac{22md^2}{9}$ (e) $\frac{4md^2}{9}$

10. Find the magnitude of the torque about point P at t=0s.

(a) 0 (b) mgd (c) $\frac{3}{4}mgd$ (d) $\frac{7mgd}{9}$ (e) $\frac{4}{3}mgd$

11. Find the angular acceleration of the system at t=0s.

(a) $\frac{6g}{11d}$ counter clockwise (b) $\frac{3g}{7d}$ counter clockwise (c) $\frac{3g}{7d}$ clockwise (d) $\frac{6d}{11g}$ counter clockwise (e) $\frac{6g}{11d}$ clockwise

12. Find the linear acceleration of the mass labelled as "3" at t=0s.

(a) $\frac{4g}{11}$ down (b) 0 (c) $\frac{2g}{7}$ up (d) $\frac{2g}{7}$ down (e) $\frac{4g}{11}$ up

13. Find the maximum kinetic energy of the system.

(a) $\frac{4}{5}mgd$ (b) $\frac{4}{3}mgd$ (c) $\frac{5}{4}mgd$ (d) $\frac{3}{4}mgd$ (e) mgd

14. Find the maximum angular speed attained by the rod.

(a) $\sqrt{\frac{7g}{6d}}$ (b) $\sqrt{\frac{4g}{3d}}$ (c) $\sqrt{\frac{12g}{11d}}$ (d) $\sqrt{\frac{6g}{7d}}$ (e) $\sqrt{\frac{11g}{12d}}$

15. Find the maximum value of the magnitude of the angular momentum of the system about point P.

(a) $md^{\frac{3}{2}}\sqrt{(\frac{14g}{3})}$ (b) $\frac{44}{9}md^{\frac{3}{2}}\sqrt{\frac{3g}{11}}$ (c) $md^{\frac{3}{2}}\sqrt{(\frac{5g}{14})}$ (d) $22md^{\frac{3}{2}}\sqrt{(\frac{14g}{3})}$ (e) $\frac{44}{9}md^{\frac{3}{2}}\sqrt{\frac{5g}{21}}$

Questions 16-20

The turbine and associated rotating parts of a jet engine have a total moment of inertia of 10 kgm^2. The turbine is accelerated uniformly from rest to an angular speed of 100 rad/s in a time of 25 s. Find

16. the angular acceleration,

(a) 1/4 rad/s^2 (b) 4 rad/s^2 (c) 1/2 rad/s^2 (d) 2 rad/s^2 (e) 5 rad/s^2

17. the net torque required,

(a) 20 Nm (b) 5 Nm (c) 50 Nm (d) 40 Nm (e) 2 Nm

18. the angle turned through in 25 s,

(a) 1750 rad (b) 1000 rad (c) 500 rad (d) 750 rad (e) 1250 rad

19. the work done by the net torque,

(a) 100000 J (b) 12500 J (c) 50000 J (d) 0 (e) 25000 J

20. the kinetic energy of the turbine at the end of the 25 s.

(a) 25000 J (b) 0 (c) 100000 J (d) 50000 J (e) 12500 J

Questions 21-25

The potential energy between two identical point like objects of the same mass, m, is given by the relation, $U(r) = m.A[(\frac{r_0}{r})^{12} - 2(\frac{r_0}{r})^6]$. Here r is the distance between the objects, r_0 is the equilibrium distance where the net force on the objects is zero, and A is a constant.

21. What is the unit of A?

(a) N.kg/m^9 (b) N.kg/m^6 (c) N.m/kg (d) N.kg/m^{12} (e) N/m.kg

22. What is the minimum value of the potential energy?

(a) $-6mA$ (b) $-mA$ (c) $3mA$ (d) $-2mA$ (e) $-3mA$

23. What is the magnitude of the force applied by one of the objects on the other at the distance that the *potential energy becomes minimum*?

(a) $F = 3mA$ (b) $F = mA[r_0^{11} - 2r_0^5]$ (c) $F = mA[r_0^{12} - 2r_0^6]$ (d) $F = 0$ (e) $F = 2mA$

24. What is the magnitude of the force applied on each object as a function of the distance r?

(a) $F = 12m.A[+\frac{r_0^{12}}{r^{13}} - \frac{r_0^6}{r^7}]$ (b) $F = m.A[-\frac{r_0^{13}}{r^{11}} - \frac{r_0^7}{r^5}]$ (c) $F = m.A[-\frac{r_0^{13}}{r^{11}} + \frac{r_0^7}{r^5}]$ (d) $F = 12m.A[-\frac{r_0^{12}}{r^{13}} - \frac{r_0^6}{r^7}]$ (e) $F = m.A[+\frac{r_0^{12}}{r^{13}} - \frac{r_0^6}{r^9}]$

25. Consider that one of the objects is fixed. What is the minimum work that must be done to bring the other object from a distance r_0 to $2r_0$.

(a) $W = mA(1 - 2^{-12} - 2^{-7})$ (b) $W = 12mA(1 + 2^{-11} - 2^{-6})$ (c) $W = 12mA(-1 - 2^{-11} + 2^{-6})$ (d) $W = mA(1 + 2^{-12} - 2^{-5})$ (e) $W = mA(-1 - 2^{-12} + 2^{-7})$