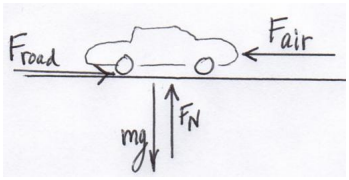
General Physics I Exam 2 - Chs. 4, 5 & 6 - Forces, Circular Motion, Energy Oct. 15, 2008

Name Rec. Instr. Rec. Time

For full credit, make your work clear to the grader. Show the formulas you use, the essential steps, and results with correct units and correct number of significant figures. Partial credit is available if your work is clear. Point values are given in parenthesis. Use g = 9.80 m/s^2. Exact conversions: 1 inch = 2.54 cm, 1 ft = 12 in., 1 mile = 5280 ft. Prefixes: p=10^{-12}, n=10^{-9}, $\mu = 10^{-6}$, m=10^{-3}, c=10^{-2}, k=10^{3}, M=10^{6}, G=10^{9}, T=10^{12}.

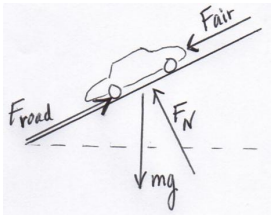
1. (4) The diagram shows the forces acting on a car accelerating to the right. The pavement is level. F_{road} is the friction force of the road on the tires, and F_{air} is air resistance. Select the correct relationship between the force magnitudes.



a) (2) a. $F_{\text{road}} < F_{\text{air}}$ b. $F_{\text{road}} = F_{\text{air}}$ c. $F_{\text{road}} > F_{\text{air}}$

b) (2) a. $F_N < mg$ b. $F_N = mg$ c. $F_N > mg$

2. (4) A car is moving at constant speed up a 30° incline; the forces are shown on the diagram. Choose the correct relationships between the force magnitudes.



a) (2) a. $F_{\text{road}} = F_{\text{air}}$ b. $F_{\text{road}} = F_{\text{air}} + mg\sin\theta$ c. $F_{\text{road}} = F_{\text{air}} - mg\sin\theta$

b) (2) a. $F_N = mg$ b. $F_N = mg\sin\theta$ c. $F_N = mg\cos\theta$

3. (2) When the acceleration of an object is zero,

a. there are no forces acting on it. b. there is no net force acting on it.
c. the normal force on the object must balance the gravitational force.

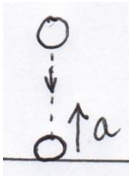
4. (2) A rock (weight 25 N) is suspended from a cable attached to the ceiling of a moving elevator. If the tension in the cable is 18 N, you can conclude that

a. the elevator has a downward acceleration. b. the elevator is moving at constant speed.
c. the elevator has an upward acceleration.

5. (6) The acceleration due to gravity on the moon's surface is about 1.6 m/s^2. If you could ride your bike there (supposedly on a smooth pavement and in an atmosphere as we have on Earth), which of these activities would be Easier, Harder, or the Same difficulty as on Earth? Indicate with **E, H or S** in the blanks.

____ a. lifting your bike 20 cm off the ground. ____ b. pedalling at constant speed on a level road.
____ c. accelerating on a level road at 3.6 m/s^2. ____ d. pedalling at constant speed up a 12° incline.
____ e. braking to a stop down a 6.0° slope. ____ f. making a sharp turn on icy level pavement.

6. (6) A 2.5 kg ball is dropped, and bounces back up off the floor. At an instant when it is contacting the floor, its acceleration is 32 m/s^2 upward. At that instant, how large is the force of the ball acting on the floor?



7. (2) **T F** Static friction can only act on stationary objects.

8. (2) **T F** Kinetic friction can cause an object to speed up.

9. (2) **T F** In a football game, the force of a tackler on a running back is greater than the force of the running back on the tackler.

10. (2) **T F** Using static friction between tires and road, a car can brake (i.e., decelerate) more strongly going up an incline than going down the same incline.

11. (12) While standing on a skateboard of negligible mass, with frictionless wheels, Alice (50.0 kg) uses a bow to shoot a 125-gram arrow. Just after letting go of the arrow, the bowstring is pushing it forward with a force of 89 N. At that instant,

a) (4) What is the magnitude of the arrow's instantaneous acceleration?

b) (4) The net force on Alice has magnitude a. less than 89 N. b. equal to 89 N. greater than 89 N.

c) (4) What is the magnitude of Alice's instantaneous acceleration?

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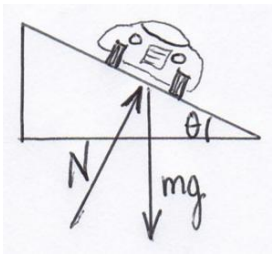
12. (12) A 1200-kg automobile is going around a curve of radius $r = 220$ m at constant speed. The curve is banked 32°. The driver wants to go at the optimum speed for the curve, so static friction from the tires is not needed.



a) (4) How large is the vertical component of the normal force (N_y), in newtons?

b) (4) What force or force component is the "centripetal force"? Determine its magnitude in newtons.

c) (4) By using the centripetal force in Newton's 2nd Law, determine the optimum speed for the curve.

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13. (14) The mass of Jupiter is $M = 1.90 \times 10^{27}$ kg, and its radius is $R = 71500$ km. A satellite is in a circular orbit around Jupiter at a radius of 3× Jupiter's radius.

a) (2) How does the satellite's centripetal acceleration, a, compare to the acceleration due to gravity at the orbit, g? a. $a < g$. b. $a = g$. c. $a > g$.

b) (6) What speed does the satellite have in its orbit?

c) (6) What is the period of the orbit?

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14. (2) A force $\vec{F}$ acting through a displacement $\vec{d}$ does no work when

a. $\vec{F}$ is parallel to $\vec{d}$. b. $\vec{F}$ is perpendicular to $\vec{d}$. c. $\vec{F}$ is anti-parallel to $\vec{d}$.

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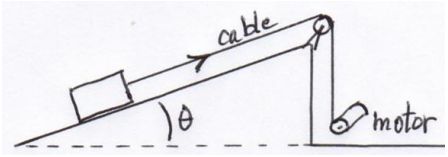
15. (10) A 1400-kg car accelerates from 45.0 mph (20.1 m/s) to 65.0 mph (29.1 m/s) over a distance of 440. m in 35.0 s. There is an air resistance force of 125 N acting against the motion.

a) (5) What is the net work done on the car by all forces acting on it?

b) (5) How much work was done by the force of the road acting on the tires to accelerate the car?

16. (16) A motor applies a constant tension of 2.50 kN to a cable passing over a pulley, pulling a 520-kg crate through 8.00 m in 60.0 s up a frictionless 25° incline.



a) (6) Find the work done by the cable tension acting on the crate.

b) (6) Find the work done by the gravitational force acting on the crate.

c) (4) What was the average power output of the motor?

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17. (12) A spring exerts a force of 88 N when compressed 16.0 cm.

a) (6) How much potential energy is stored in the spring, when compressed 16.0 cm?

b) (6) The spring, compressed 16.0 cm, is used to launch a 55-gram ball horizontally. What is the maximum speed with which the ball can be launched?