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Forces and Dynamics

Exam — Forces & Dynamics

Pre-med/IB-style questions on forces and Newtonian dynamics: free-body diagrams, net force, action–reaction, friction, tension/connected bodies, apparent weight (elevators/orbit), drag/terminal velocity, and circular motion (including banked curves). Difficulty increases gradually and focuses on conceptual traps.

75 items — Printable Exam

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1 **A block rests on a smooth (frictionless) horizontal table while a horizontal force pulls it to the right. Which set of forces should appear on the block's free-body diagram?**

A Only the weight (mg) downward

B Weight (mg) downward and the applied force to the right

C Weight (mg) downward, normal force upward, and the applied force to the right

D Weight (mg) downward, normal force upward, applied force to the right, and friction to the left

E Normal force upward and friction to the left only

2 **A glider moves in a straight line at constant velocity on a frictionless air track. Which statement about the net force on the glider is correct?**

A The net force must point in the direction of motion.

B The net force must point opposite the direction of motion.

C The net force is zero.

D The net force equals the glider's weight.

E The net force depends on how fast it is moving.

3 **An object has acceleration 0. Which of the following must be true?**

A No forces act on the object.

B Only one force acts on the object.

C The net (resultant) force on the object is zero.

D The object must be at rest.

E The object must be moving in a circle.

4 **A person pushes on a wall with a horizontal force. Which is the Newton's 3rd law reaction force to the push on the wall?**

A The wall's weight acting downward

B The friction force on the person's shoes

C The wall pushes on the person with equal magnitude in the opposite direction

D The normal force on the wall from the ground

E The person's weight acting downward

5 **A block is at rest on a rough incline and would slide down if friction were absent. The static friction force on the block points:**

A Down the slope

B Up the slope

C Perpendicular to the slope, away from the surface

D Perpendicular to the slope, into the surface

E Always vertically upward

6 **On a frictionless surface, a constant net force F produces acceleration a on a mass m. If the net force becomes 2F (same m), the acceleration becomes:**

A a/2

B a

C 2a

D 4a

E It depends on the object's speed

7 **Two forces of equal magnitude F act on an object, one east and one north. The magnitude of the net force is:**

A 0

B F

C $\sqrt{2}$ F

D 2F

E F/$\sqrt{2}$

8 **A 10 N force acts east and a 10 N force acts west on an object. The object is initially moving east. What can you conclude about its acceleration at that instant?**

A It accelerates east because it is moving east.

B It accelerates west because friction must exist.

C Its acceleration is zero because the net force is zero.

D Its acceleration equals g.

E It must stop immediately.

9 **Which statement best defines an object's weight?**

A The amount of matter in the object

B The gravitational force acting on the object

C The object's resistance to acceleration

D The object's momentum divided by time

E The object's volume

10 **An elevator is moving upward but slowing down. Compared with mg, the normal force on a passenger (scale reading) is:**

A Greater than mg

B Equal to mg

C Less than mg

D Zero

E Negative

11 **An elevator is moving downward but slowing down. Compared with mg, the normal force on a passenger (scale reading) is:**

A Greater than mg

B Equal to mg

C Less than mg

D Zero

E It must equal the passenger's mass

12 **A block rests on a rough incline. The maximum possible static friction is $f_{s,max} = \mu\_s N$. As the incline angle increases (same block and surface), $f_{s,max}$ generally:**

A Increases because gravity increases

B Decreases because the normal force decreases

C Stays constant because μ_s is constant

D Becomes equal to mg

E Becomes equal to μ_s mg for all angles

13 **A block sits on a horizontal rough surface. If you place an extra mass on top, increasing the normal force, the maximum static friction between block and surface:**

A Increases

B Decreases

C Stays the same

D Becomes zero because contact area increases

E Depends only on speed

14 **A block is sliding to the right across a rough horizontal surface. The kinetic friction force on the block points:**

A To the right

B To the left

C Upward

D Downward

E Kinetic friction is zero when moving

15 **A heavy crate rests on a rough horizontal floor. No horizontal forces act on it. Which is true about the static friction force on the crate?**

A It equals μ_s N automatically.

B It equals μ_k N automatically.

C It is zero.

D It points to the left.

E It points to the right.

16 **Two identical blocks (each mass m) are connected by a light rope on a frictionless surface. A horizontal force F pulls the right block to the right. What is the tension in the rope?**

A F

B F/2

C 2F

D F/4

E It must be zero because the surface is frictionless

17 **Two blocks of masses m and 2m are connected by a light rope on a frictionless surface. A horizontal force F pulls the SMALLER block (m) to the right. What is the rope tension?**

A F/3

B F/2

C 2F/3

D F

E 3F/2

18 **Two blocks of masses m and 2m are connected by a light rope on a frictionless surface. A horizontal force F pulls the LARGER block (2m) to the right. What is the rope tension?**

A F/3

B F/2

C 2F/3

D F

E 3F/2

19 **For the two-block system with masses m and 2m on a frictionless surface, the same external force F is applied. In which case is the rope tension larger?**

A Larger when pulling the 2m block

B Larger when pulling the m block

C The same in both cases

D Zero in both cases

E It depends on the blocks' speeds, not masses

20 **Two blocks m1 and m2 are connected by a light rope on a frictionless surface. A horizontal force F is applied to either block to pull the system. The system's acceleration magnitude is:**

A Different depending on which block is pulled

B Always F/m1

C Always F/m2

D F/(m1 + m2)

E Zero because internal forces cancel

21 **A sled on a rough horizontal surface is pulled by a rope at an upward angle. Compared with pulling with the same tension horizontally, the normal force on the sled is:**

A Larger

B Smaller

C Unchanged

D Zero

E Always equal to mg

22 **A block rests on a table. You pull straight upward on the block with a force equal to its weight mg, and the block is not glued to the table. The normal force from the table on the block is:**

A mg

B 2mg

C 0

D mg/2

E Cannot be determined without the table mass

23 An astronaut in orbit is described as "weightless" because the normal force on them is nearly zero. Which statement is correct about gravity acting on them?

A Gravity is zero in orbit, so no forces act.

B Gravity still acts, but the astronaut and spacecraft are in free fall together, so there is little/no support force.

C The astronaut's mass becomes zero, so gravity cannot act.

D Gravity reverses direction, balancing the normal force.

E Weightless means acceleration is zero.

24 A skydiver reaches terminal velocity while falling. Which statement is correct?

A Drag is greater than weight, so the diver speeds up.

B Drag equals weight, so acceleration is zero and speed is constant.

C Weight becomes zero at terminal velocity.

D Acceleration equals g at terminal velocity.

E Speed must be zero at terminal velocity.

25 A ball is thrown straight upward. During the upward motion, air resistance acts opposite the motion. Compared with g, the magnitude of the ball's acceleration is:

A Less than g

B Equal to g

C Greater than g

D Zero until it reaches the top

E Greater than g only if the ball is heavy

26 **A ball is dropped and falls downward through air. Before reaching terminal velocity, compared with g, the magnitude of its acceleration is typically:**

A Greater than g

B Equal to g

C Less than g

D Always zero

E Independent of drag

27 **A parachutist is moving downward but has just opened a parachute, greatly increasing drag. Which combination could be true immediately after opening?**

A Velocity downward, acceleration downward

B Velocity downward, acceleration upward

C Velocity upward, acceleration downward

D Velocity upward, acceleration upward

E Velocity zero, acceleration zero

28 **A car moving in a circle on a flat road suddenly encounters an icy patch (friction 0). Immediately after reaching the ice, the car's path (relative to the ground) is best described as:**

A Continuing in the same circular path

B Spiraling inward

C Moving approximately in a straight line tangent to the circular path

D Stopping immediately

E Moving radially outward from the center

29 **Which statement about "centripetal force" is correct?**

A It is a new kind of force that appears only in circles.

B It is the net inward (toward-center) force required for circular motion, supplied by real forces like tension, friction, or gravity.

C It always equals the object's weight mg.

D It points tangentially along the motion.

E It must be provided by a centrifugal force.

30 **A ball attached to a string moves in a vertical circle. At the very top of the circle, which forces act on the ball (ignoring air resistance)?**

A Only tension downward

B Only weight downward

C Both tension and weight downward

D Tension upward and weight downward

E Only a horizontal centripetal force

31 **In the same vertical-circle motion, what is the tension in the string at the very top when the ball is moving at the minimum speed needed to keep the string just taut?**

A 0

B mg

C 2mg

D It cannot be zero at the top

E It is always larger than mg at the top

32 **At the bottom of a vertical circle for a ball on a string moving fast enough to stay taut, which statement about tension T and weight mg is correct?**

A $T = mg$

B $T < mg$

C $T > mg$

D $T = 0$

E T must be negative

33 **A car goes over the top of a rounded hill (convex) of radius r at speed v. Ignoring air resistance, as v increases the normal force N from the road:**

A Increases

B Decreases

C Stays equal to mg

D Becomes larger than mg

E Must be zero for any speed

34 **A car goes through the bottom of a dip (concave upward) of radius r at speed v. Ignoring air resistance, as v increases the normal force N from the road:**

A Decreases

B Increases

C Stays equal to mg

D Becomes zero

E Must equal mv^2/r only

35 **Which is the best rule for drawing a free-body diagram for an object?**

A Include forces the object exerts on other things, because they affect its motion.

B Include only forces acting ON the object, and label their directions.

C Include acceleration arrows as forces.

D Include only the largest force, since smaller ones are negligible.

E Include only weight and normal; ignore friction and tension.

36 **A person standing on roller skates pushes a wall to the right. The person rolls to the left. The best explanation is:**

A The person's force on the wall is larger than the wall's force on the person.

B The wall exerts an equal and opposite force on the person, accelerating them left.

C Gravity pulls them left because they are moving left.

D The normal force from the ground points left.

E The person moves left because friction always acts left.

37 **Two skaters at rest push off each other on frictionless ice. Skater A has smaller mass than skater B. Immediately after pushing, which is true?**

A Skater A experiences a larger force.

B Skater B experiences a larger force.

C They experience equal and opposite forces, but skater A has a larger acceleration.

D They have equal accelerations because the forces are equal.

E Skater A cannot move because it is lighter.

38 **A car travels at constant speed on a level road. The engine provides a forward driving force. What can you infer about resistive forces (air drag + rolling resistance)?**

A Resistive forces are zero.

B Resistive forces are smaller than the driving force.

C Resistive forces are larger than the driving force.

D Resistive forces equal the driving force in magnitude (net force zero).

E Resistive forces must be upward.

39 **On a frictionless surface, a force F produces acceleration a on mass m. If both the force and the mass are doubled, the acceleration is:**

- A 2a
- B a
- C a/2
- D 4a
- E 0

40 **A block of mass m slides on a horizontal surface with coefficient of kinetic friction μ_k. It is pulled by a constant horizontal force F and accelerates at a. If both F and m are doubled while μ_k stays the same, the new acceleration is:**

- A 2a
- B a
- C a/2
- D 0 (it must move at constant speed)
- E It depends on the initial speed

41 **A crate is pulled across a rough horizontal floor at constant speed. Which statement is correct about horizontal forces on the crate?**

- A The pulling force is larger than kinetic friction, so it speeds up.
- B The pulling force equals kinetic friction, so the net horizontal force is zero.
- C Kinetic friction must be zero because it is moving at constant speed.
- D The net force must point forward because it is moving forward.
- E The net force must point backward because friction exists.

42 **A block of mass m rests at rest on a rough incline of angle . It does not slip. If static friction is not at its maximum, the magnitude of the static friction force is:**

A μ_s mg cos

B μ_k mg cos

C mg sin

D mg cos

E 0

43 **A block rests on a rough incline. The angle is increased slowly until the block is just about to start sliding. At that instant, which relation is correct?**

A mg sin = μ_k mg cos

B mg sin = μ_s mg cos

C mg cos = μ_s mg sin

D mg = μ_s mg

E Static friction must be zero at the slipping point

44 **A block is pressed against a vertical wall with a horizontal force F. Coefficient of static friction between block and wall is μ_s. Which condition must be satisfied for the block to be able to remain at rest without sliding down?**

A μ_s F mg

B μ_s mg F

C F μ_s mg cos

D F = mg always

E The block can never be held by friction on a wall

45 **In the wall-friction setup (block pressed with force F, coefficient μ_s), if the pushing force is doubled to 2F, the maximum possible static friction becomes:**

A Half as large

B The same

C Twice as large

D Four times as large

E Zero

46 **A car turns left on a flat road at constant speed. Which horizontal force acts on the passenger to make them follow the curved path?**

A A real outward (rightward) centrifugal force

B A leftward force from the seat/door on the passenger

C A rightward force from gravity

D No force because speed is constant

E A forward driving force from the engine acting directly on the passenger

47 **A road is banked with the outer edge higher. A car drives around the curve slower than the "no-friction design speed." If friction is present, the friction force on the tires points:**

A Down the slope (toward the inner lower edge)

B Up the slope (toward the outer higher edge)

C Purely vertical upward

D Purely horizontal outward

E Friction must be zero on a banked road

48 **A road is banked with the outer edge higher. A car drives around the curve faster than the "no-friction design speed." If friction is present, the friction force on the tires points:**

A Up the slope (toward the outer higher edge)

B Down the slope (toward the inner lower edge)

C Purely vertical downward

D Purely horizontal inward

E Friction must reverse gravity

49 **In uniform circular motion, velocity is tangent to the path. The acceleration is:**

A Tangent to the path

B Radially outward

C Radially inward (toward the center)

D Always zero because speed is constant

E Always upward

50 **At some instant, the net force on an object is perpendicular to its velocity. At that instant, the object's speed is:**

A Increasing

B Decreasing

C Momentarily not changing (only direction changes at that instant)

D Becoming zero

E Impossible to determine

51 **In uniform circular motion, why does the centripetal force not change the object's kinetic energy?**

A Because centripetal force is zero

B Because centripetal force is always parallel to velocity

C Because centripetal force is perpendicular to the velocity, so it does no work

D Because gravity cancels centripetal force

E Because work is undefined for circular motion

52 **A block on a frictionless horizontal surface is pulled by a force of fixed magnitude F at an angle above the horizontal. As increases (keeping F constant), the horizontal acceleration:**

A Increases because the force points more upward

B Decreases because the horizontal component F cos decreases

C Stays constant because the force magnitude is constant

D Becomes negative

E Becomes zero for all angles

53 **A block is on a frictionless horizontal surface. A force is applied straight upward (vertical). The block's horizontal acceleration is:**

A Zero

B Equal to g

C Equal to F/m

D Larger than F/m because there is no friction

E Negative

54 **A force of 3 N acts east and 4 N acts north on an object. What is the magnitude of the net force?**

A 1 N

B 5 N

C 7 N

D 12 N

E 0 N

55 **A person of mass m stands on a scale in an elevator accelerating downward with acceleration magnitude g/2. Neglecting air resistance, the scale reads:**

A mg/2

B mg

C 2mg

D 0

E mg/4

56 **In an ideal Atwood machine, masses 2m and m hang on a massless rope over a frictionless pulley. The heavier mass (2m) moves down. The rope tension T is:**

A $T = mg$

B $T = 2mg$

C $mg < T < 2mg$

D $T > 2mg$

E $T < mg$

57 **A car is moving east but experiences a net force due north (e.g., a sudden sideways push). Immediately after the force begins, the car's acceleration points:**

A East

B West

C North

D South

E Along the velocity direction (east)

58 **A ball is thrown horizontally (ignore air resistance). While it is in flight, which forces act on it?**

A Weight downward and a forward force

B Weight downward and an upward normal force

C Only weight downward

D Weight downward and kinetic friction forward

E No forces act because it is moving

59 **A rocket in deep space produces a constant thrust force. As fuel burns, the rocket's mass decreases. Neglecting external forces, the rocket's acceleration magnitude will generally:**

A Decrease

B Stay the same

C Increase

D Become zero

E Reverse direction automatically

60 **Two horizontal forces act on a crate: 30 N to the right and 20 N to the left. Which is correct about the net force and acceleration?**

A Net force is 50 N right; acceleration right

B Net force is 10 N right; acceleration right

C Net force is 10 N left; acceleration left

D Net force is 0; acceleration is 0

E Acceleration depends only on speed, so cannot tell

61 **An object is in equilibrium under three concurrent forces (all acting at a point). Which graphical statement is correct?**

A The three forces must have equal magnitudes.

B The three forces must be parallel.

C If drawn head-to-tail, the three force vectors can form a closed triangle.

D One of the forces must be the weight mg.

E Equilibrium requires all forces to point upward.

62 **In the basic kinetic friction model used in many exams, the kinetic friction force magnitude is best approximated by:**

A μ_k N

B μ_s N

C mg

D m v

E It must increase strongly with speed in all cases

63 **In which situation is the normal force on an object on a surface guaranteed to equal its weight mg (assuming no other vertical forces)?**

A A block at rest on an incline

B A person in an elevator accelerating upward

C A block on a horizontal surface with no vertical acceleration

D A car at the top of a rounded hill

E A sled being pulled upward at an angle

64 **A person stands on a scale in an elevator with upward acceleration a (take upward as positive). Which expression best matches the scale reading N?**

A $N = mg - ma$

B $N = m(g + a)$

C $N = ma - mg$

D $N = mg$

E $N = m(g - a)$ for upward acceleration

65 **A block rests on a horizontal surface. You push downward on it with an additional force F_{down} while it remains at rest. Compared to its weight mg, the normal force from the surface is:**

A Less than mg

B Equal to mg

C Greater than mg

D Zero

E Negative

66 **A small block sits on top of a larger block. The larger block is pulled so the system accelerates on a horizontal surface. What sets the maximum acceleration so that the top block does not slip relative to the bottom?**

A The mass of the top block only

B The mass of the bottom block only

C The maximum static friction between the blocks (so $a_{max} = \mu\_s\ g$)

D The speed of the blocks

E It is always equal to g

67 **A box rests on the flat bed of a truck that accelerates forward. If the truck's acceleration is too large for static friction, the box will start to slip relative to the truck. Relative to the truck, the box slips:**

A Forward (toward the front)

B Backward (toward the rear)

C Upward

D Downward

E It cannot slip on a horizontal surface

68 **While the box does NOT slip on the accelerating truck bed, the static friction force on the box points:**

A Backward

B Forward

C Upward

D Downward

E Zero, because friction only acts when slipping

69 **When a bus accelerates forward suddenly, standing passengers tend to lurch backward relative to the bus mainly because:**

A A backward force from the bus pushes their bodies backward

B Their bodies tend to keep their original state of motion (inertia) while the bus moves forward under them

C Gravity tilts backward during acceleration

D Air resistance pushes them backward strongly

E A centrifugal force appears in straight-line motion

70 **When a car brakes suddenly, passengers tend to lurch forward relative to the car mainly because:**

A A forward force from the brakes pulls them forward

B Their bodies tend to keep moving forward due to inertia

C Gravity becomes stronger

D Friction always points forward inside the car

E Their mass decreases during braking

71 **A front-wheel-drive car accelerates forward on a dry road without wheel slip. What is the direction of the static friction force exerted by the road on the driven tires?**

A Forward

B Backward

C Upward

D Downward

E Zero because the tires roll without slipping

72 **A free (unpowered) cart wheel is pulled forward by a force applied at its axle and rolls without slipping. The direction of the static friction force exerted by the ground on the wheel is:**

A Forward

B Backward

C Upward

D Downward

E Zero for any rolling motion

73 **A block is pushed up a rough incline at constant speed. Which statement about forces along the incline is correct?**

A Applied force equals mg sin only

B Applied force equals friction only

C Applied force equals mg sin + friction (both oppose the motion up the slope)

D Net force must point up the slope because it's moving up

E Friction assists the motion up the slope, so it reduces the needed applied force

74 **A block slides down an incline with kinetic friction. If the coefficient of kinetic friction increases (same angle), the magnitude of the acceleration down the slope:**

A Increases

B Decreases

C Stays the same

D Becomes exactly g

E Becomes zero for any incline angle

75 **A car takes a flat curve where the maximum available static friction sets the maximum centripetal force. If the car's speed is doubled, by what factor must the curve radius increase to keep from skidding (same μ and mass)?**

A 2

B 4

C 1/2

D 1/4

E It does not need to change

#	Ans	Answer Text
1	C	Weight (mg) downward, normal force upward, and the applied force to the ...
2	C	The net force is zero.
3	C	The net (resultant) force on the object is zero.
4	C	The wall pushes on the person with equal magnitude in the opposite direc...
5	B	Up the slope
6	C	2a
7	C	$\sqrt{2}$ F
8	C	Its acceleration is zero because the net force is zero.
9	B	The gravitational force acting on the object
10	C	Less than mg
11	A	Greater than mg
12	B	Decreases because the normal force decreases
13	A	Increases
14	B	To the left
15	C	It is zero.
16	B	F/2
17	C	2F/3
18	A	F/3
19	B	Larger when pulling the m block
20	D	F/(m1 + m2)
21	B	Smaller
22	C	0
23	B	Gravity still acts, but the astronaut and spacecraft are in free fall to...
24	B	Drag equals weight, so acceleration is zero and speed is constant.
25	C	Greater than g
26	C	Less than g
27	B	Velocity downward, acceleration upward
28	C	Moving approximately in a straight line tangent to the circular path
29	B	It is the net inward (toward-center) force required for circular motion,...
30	C	Both tension and weight downward
31	A	0
32	C	T > mg
33	B	Decreases
34	B	Increases
35	B	Include only forces acting ON the object, and label their directions.
36	B	The wall exerts an equal and opposite force on the person, accelerating ...
37	C	They experience equal and opposite forces, but skater A has a larger acc...
38		Resistive forces equal the driving force in magnitude (net force zero).